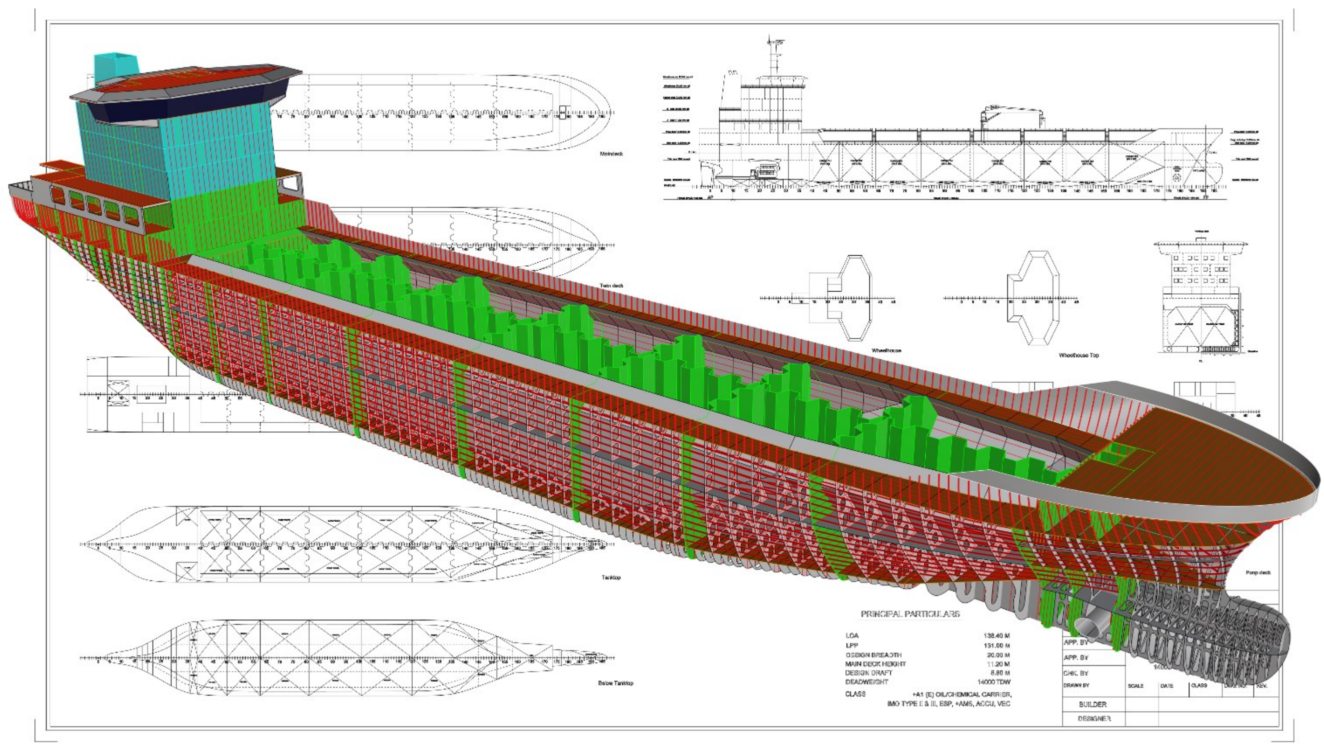
EXPRESS MARINE 2017 1.2

- algorithmic marine structure modelling plug-in for Rhino –



USER MANUAL

ExpressMarine User Manual

Bold and *Italic*

Bold is used when referring to names of menus, menu options, dialog boxes, buttons, tabs, field labels, keyboard and mouse buttons and other named items in the user interface.

Italic is used for text to be typed in by the user.

Contact Information

If you have any questions regarding ExpressMarine, please do not hesitate to contact us.

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1. Overview of ExpressMarine

ExpressMarine is a plug-in for Rhino that enables designers to rapidly build up a parametric preliminary 3D model of marine structures.

Its main advantage is the dramatic reduction of the modelling time through the integration of 2D drawings and the 3D model in a single, common environment.

Weight and Center of Gravity results become available much earlier in the tender phase and the model topology allows easy updates throughout all design stages.

It is the ideal rapid pre-processor of the structural model to be further used in other marine design software for detailed engineering, class drawings, structural weight distribution and management.

Modelling efficiency is highly increased by eliminating manual translation of the concept drawings into the 3 dimensional model.

Time consuming, repetitive tasks are being automated through mathematical algorithms tailored for marine design.

The model topology is achieved through parametric definition of each element; the link between 3D elements and the 2D drawings is permanent, thus offering effortless modifications and design follow up.

Up-to-date Weight and Center of Gravity values are permanently available for individual structural elements or for groups of multiple items.

The modelling method is similar to that of Rhino, so that the users will have a smooth start to using the tool.

Existing models created in Rhino or any other software that can export a Rhino compatible file type, can be imported and converted into an ExpressMarine parametric model for further editing.

The plug-in is not constrained to shiplike models, but it can also be applied to other marine structures such us offshore floaters, oil rigs and platforms, pontoons, fish farms, etc.

Results

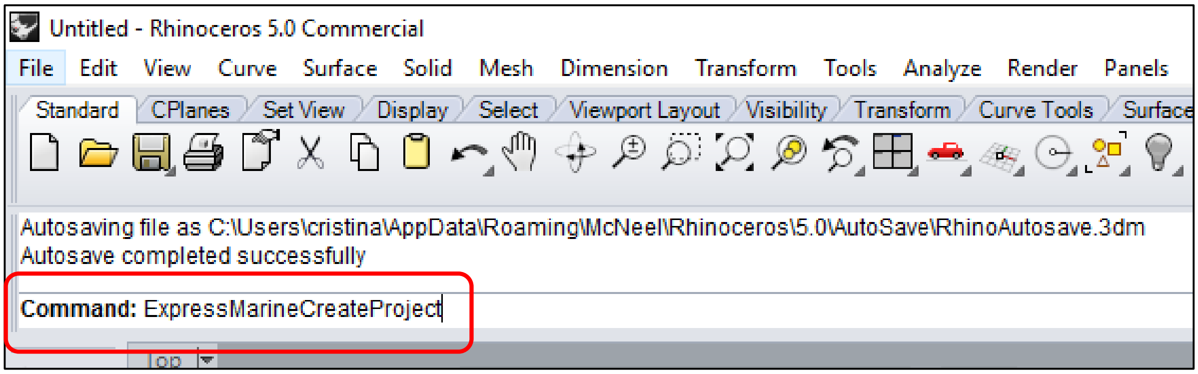
Live Weight and Center of Gravity results for entire model, or any groups, subgroups or individual elements.

The export of the complete preliminary 3D models to other existing software for further use is a seamless process thanks to Rhino’s power of outputting multiple file types.

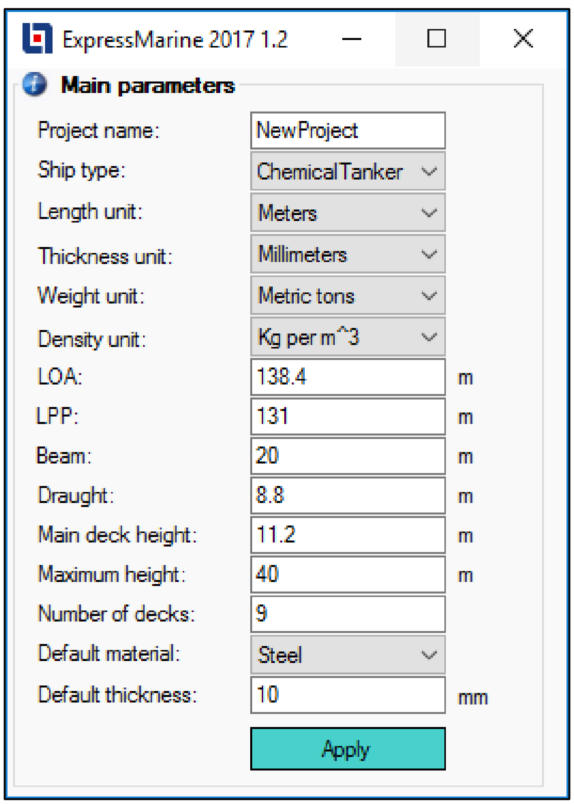
Tables with data such as weight, center of gravity, mass moments etc. can be exported.

2. Starting ExpressMarine

Open Rhino and navigate to ExpressMarine menu, then click on New Project button. Alternatively type in **Command:** *ExpressMarineCreateProject*



The ExpressMarine **Main Parameters** window will pop-up:



Fill in main dimensions, ship type and the unit system.

Project name: the name of the project

Ship type: select one of the available ship types from the dropdown list

Length unit: meters, millimeters or feet

Thickness unit: meters, centimeters, millimeters, feet or inches

Weight unit: metric tons, long tons, kilograms or pounds

LOA: length overall

LPP: length between perpendiculars

Beam: width of the vessel

Draught: draught of the vessel (optional)

Main deck height: main deck height of the vessel (optional)

Maximum height: will determine the size of the profile and midship section rectangles.

Number of decks: will control the number of tiers in the Tree view, which will be equal to number of decks + 1, due to the addition of the double bottom tier. Generally, the ceiling of the highest tier is not considered deck.

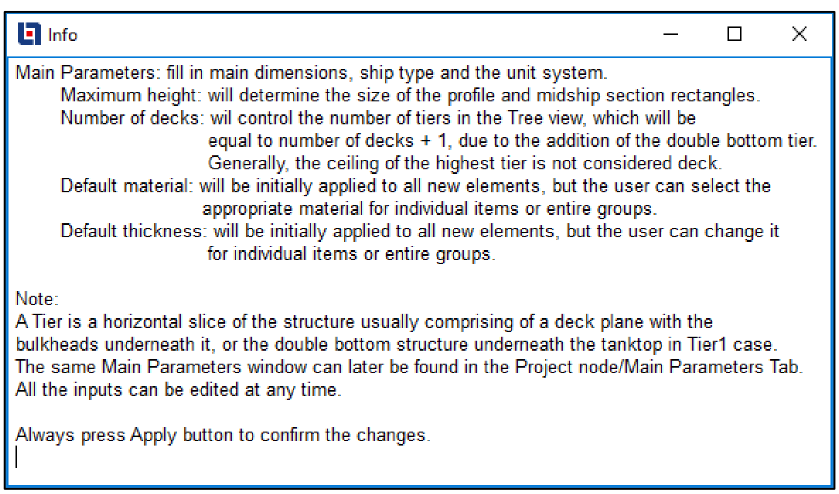
Default material: will be initially applied to all new elements, but the user can select the appropriate material for individual items or entire groups.

Default thickness: will be initially applied to all new elements, but the user can change it for individual items or entire groups.

Note: a Tier is a horizontal slice of the structure usually comprising of a deck plane with the bulkheads underneath it, or the double bottom structure underneath the tanktop in Tier1 case.

The same Main Parameters window can later be found in the Project node/Main Parameters Tab. All the inputs can be edited at any time.

Note: Help and information can be found by clicking the **info button**.



Press **Apply** button to confirm the changes. The ExpressMarine window will appear.

Saving and Opening ExpressMarine projects

Saving and Opening ExpressMarine projects is done as with any regular Rhinoceros project.

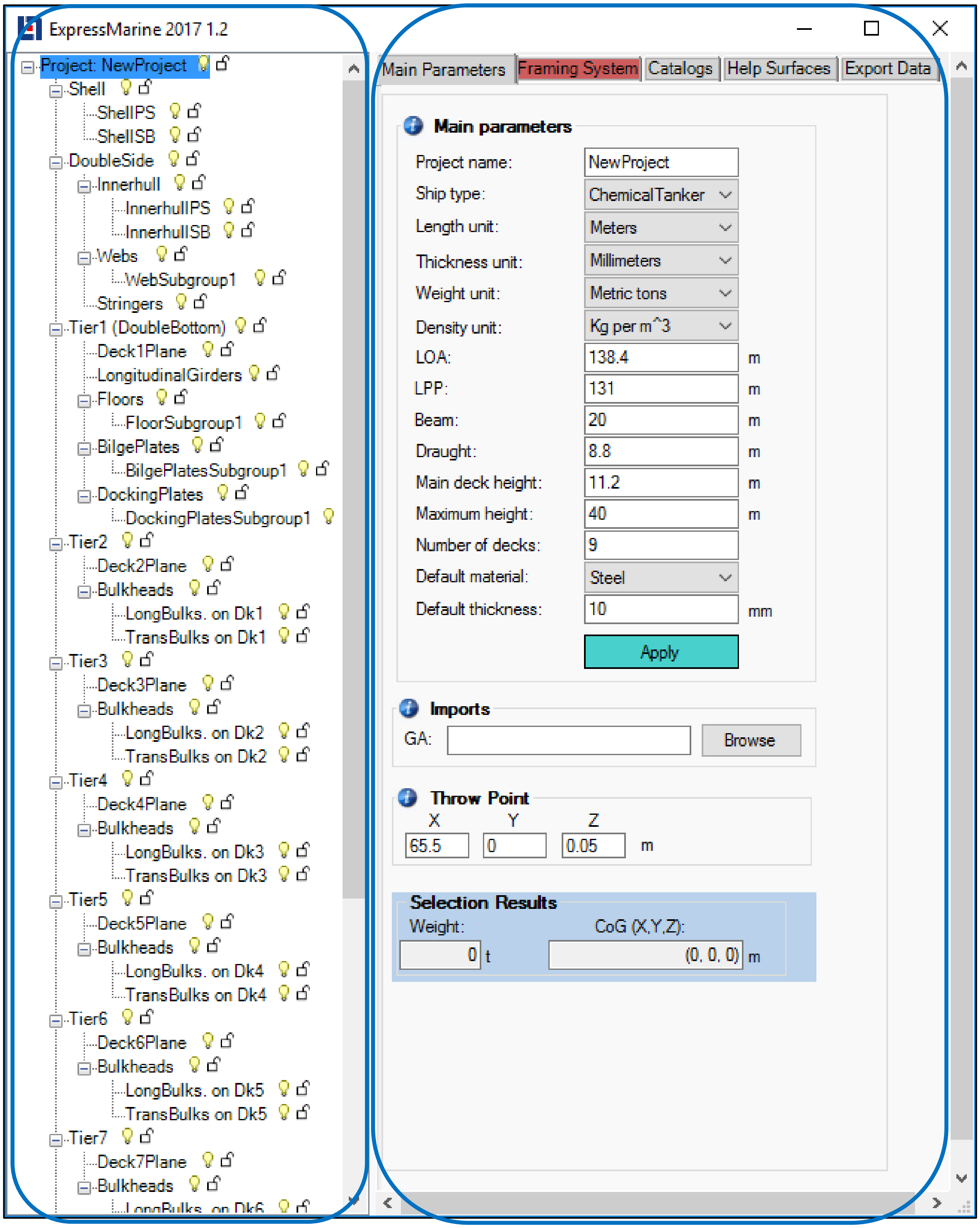
The file extension is the same as Rhino files (.3dm).

It is reccommended to use a suggestive project name to show that the file includes an ExpressMarine project, example Tanker_EM.3dm.

All ExpressMarine data is saved within the Rhino file.

When opening an ExpressMarine project, if a valid license is detected, ExpressMarine will open automatically with Rhino. Otherwise, the file will open as a simple Rhino model (no ExpressMarine window, no structural data, no topology, no hierarchy, etc.).

2.1 Tree View



TREE VIEW

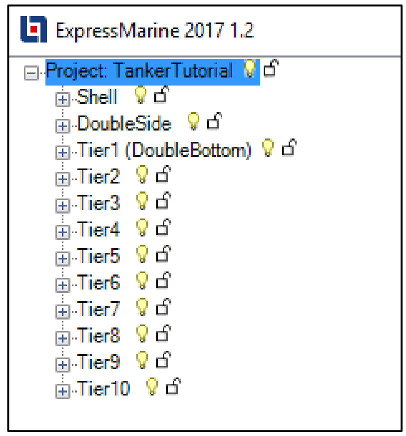
CONTROL PANEL

ExpressMarine is organized in a hierarchical tree structure.

The main node is the **Project node** which contains the Main Parameters tab, the Framing System tab and the Export Data tab.

2.1.1 Secondary nodes

The Project node is divided in secondary nodes: **Shell**, **Double Side** and **Tiers** (**Tier1, Tier2,** etc.):



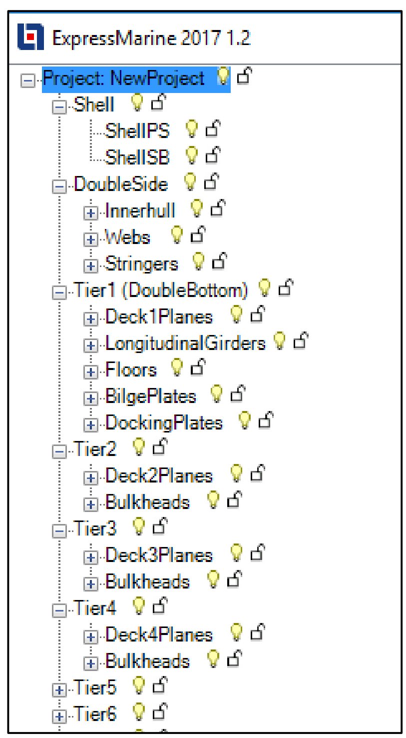
2.1.2 Groups

Secondary nodes are further split into **Groups**:

There are two types of Groups:

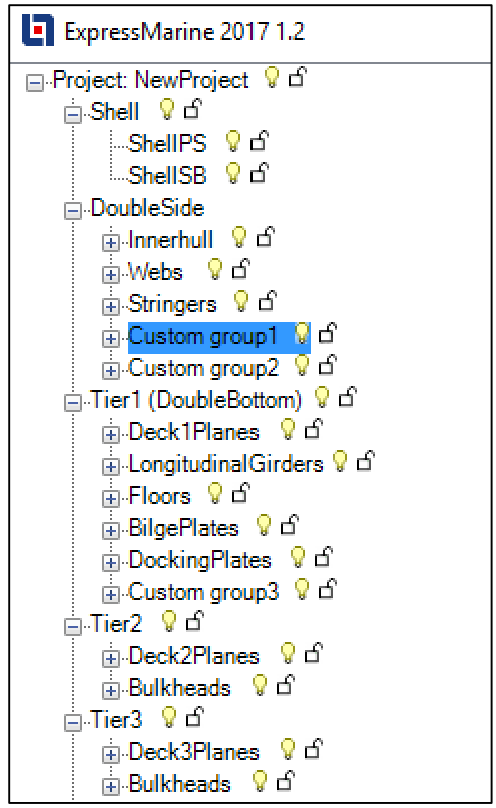
- <u>**Specialized groups**</u>

  Innerhull, **Webs**, **Stringers, Deck Planes, Longitudinal Girders, Floors, Bilge Plates, Docking Plates, Deck Planes, Bulkheads**



- **Custom groups**

  User defined (Custom group1, Custom group2, Custom Group3, etc.)

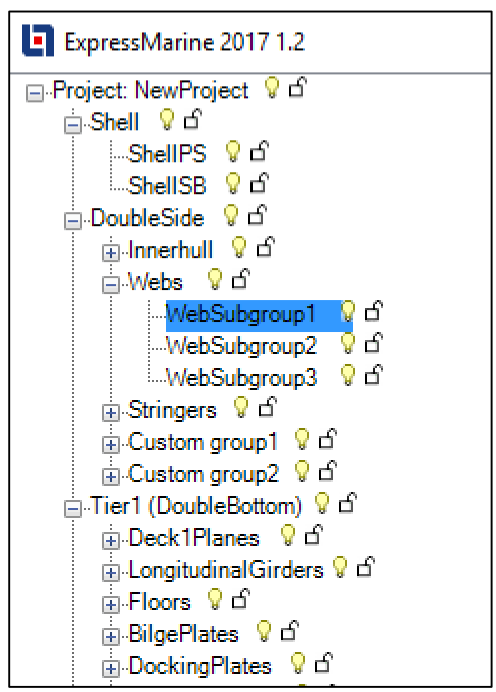


2.1.3 Subgroups

Groups can further split into **Subgroups**:

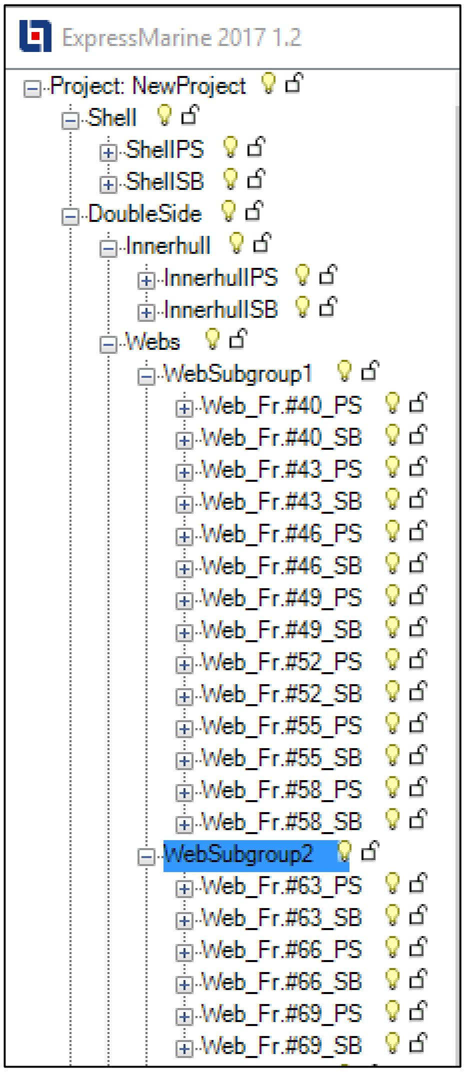
- **Specialized Subgroups**

  Specialized Groups can only split into Specialized Subgroups of the same type.



Specialized Elements

Specialized Subgroups can only contain individual **specialized elements:**



To hide an element or a group, simply click the lightbulb icon. The lightbulb will turn off .

To protect the definition of an element or a group being modified, click the lock icon and the symbol will change to .

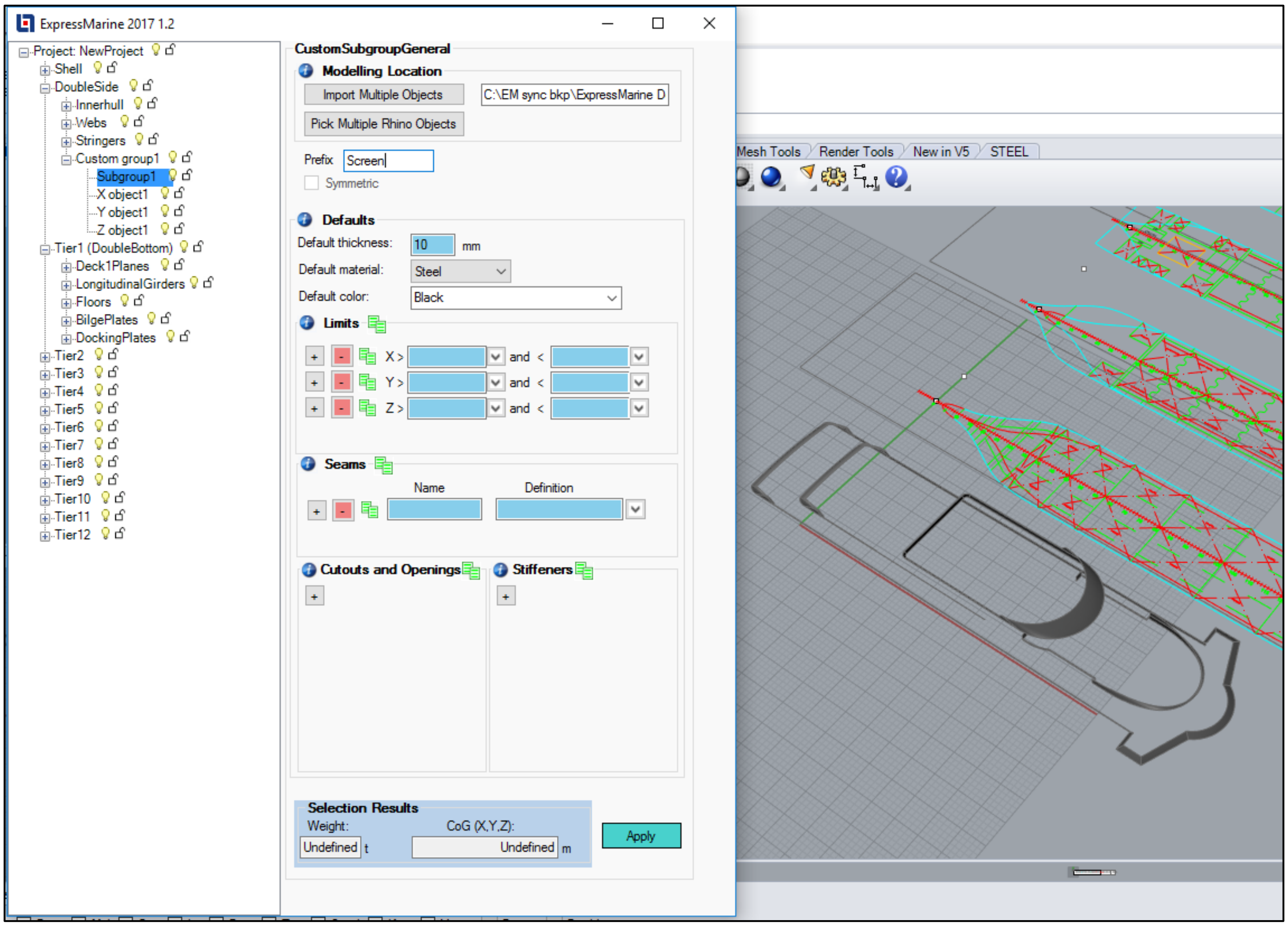
- **Custom Subgroups**

Custom Groups can contain the following **Custom Subgroups**:

- **Custom Subgroups: General Group**
- **Custom Subgroups: Series** (X-series, Y-series, Z-series)
- **Custom Elements**: X-object, Y-object, Z-object

All these can be renamed or deleted, by right click/**Rename** or **Delete**.

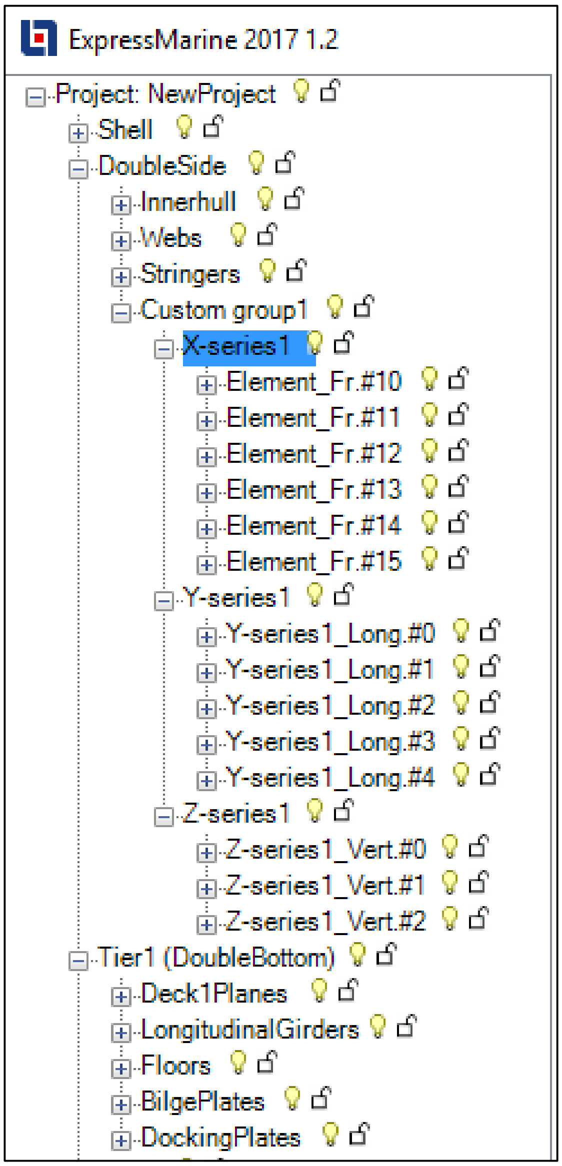
General Group



The user can import a file with multiple objects inside and each surface will become an individual Express Marine element after **Apply**.
Use a suggestive Prefix which will become the base for the element name.
The newly created element can be renamed, deleted, and modifications can be made to its structural default settings.

Series (X, Y, Z)

Series are groups of repetitive elements with common default features.
For more information, please check the Subgroup Generation chapter.



Elements (X, Y, Z)

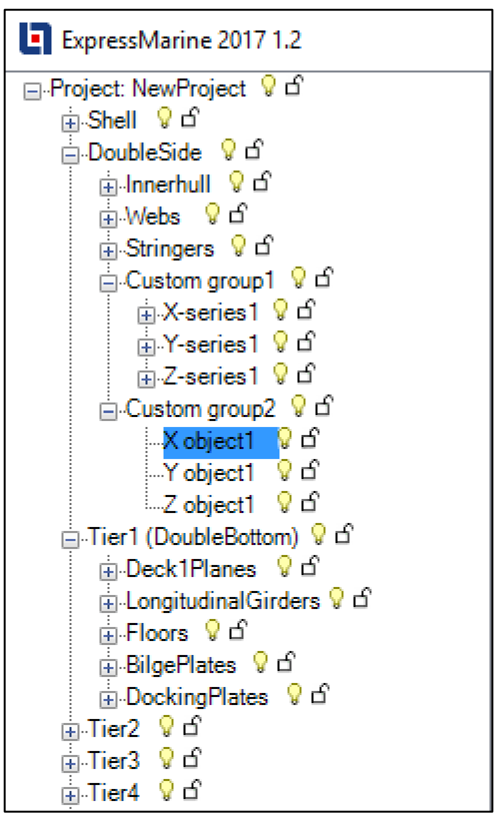
They are individual structural objects.
Each element is generated on a parent surface which ideally should extend beyond the defined limits.

Depending on their main orientation of the parent surface, the element can be an X-object, Y-object or a Z-object.

The parent surface of an X-object is either an X Plane (equivalent to YZ isoplane) or a 3D surface with means orientation along the X-axis. Floors, Bilge Plates, Docking Plates, Webs, Transverse Bulkheads are X-objects.

The parent surface of an Y-object is either an Y Plane (equivalent to XZ isoplane) or a 3D surface with means orientation along the Y-axis. Longitudinal Girders, Innerhull, Longitudinal Bulkheads are Y-objects.

The parent surface of an Z-object is either an Z Plane (equivalent to XY isoplane) or a 3D surface with means orientation along the Z-axis. Decks and Stringers are Z-objects.



2.2 Main parameters tab

Imports / General arrangement drawing

It is recommended to simplify the general arrangement drawing before (in your drafting software) or after the import (in Rhino), by removing or hiding unnecessary items in the drawing (equipment, text, hatches, and any other item not relevant from the structural point of view).

A good layer arrangement will also increase efficiency.
Check that traces (curves representing structural elements) do not overlap, or are not duplicated.
The use of closed curves should be avoided (example: rectangles representing the casing, see Figure 2.2.A).

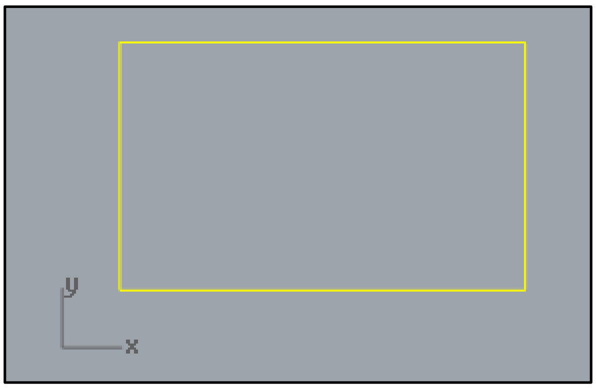
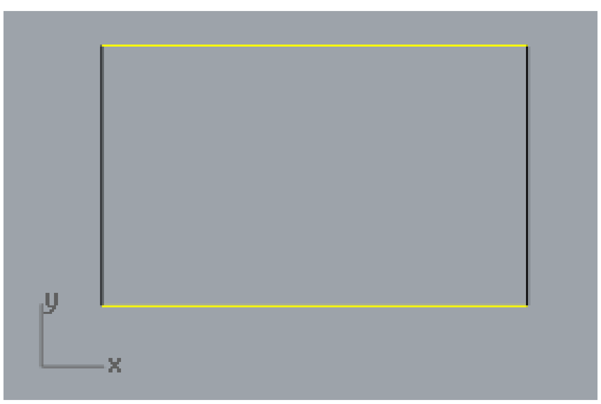


Figure 2.2.A

In this case it is recommended to use Rhino command *Explode* to separate complex traces into curves with clear main direction (see figure 2.2.B representing longitudinal traces and 2.2.C representing transverse traces).



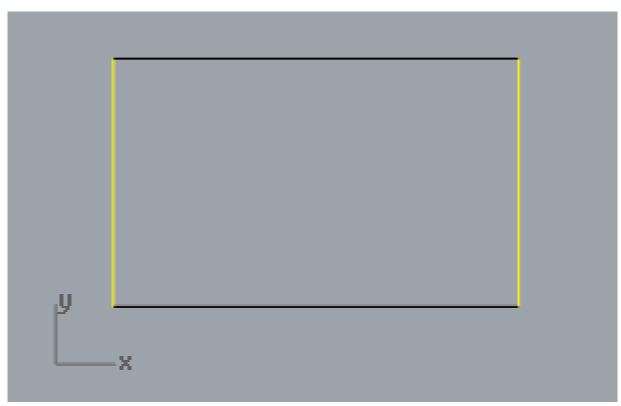
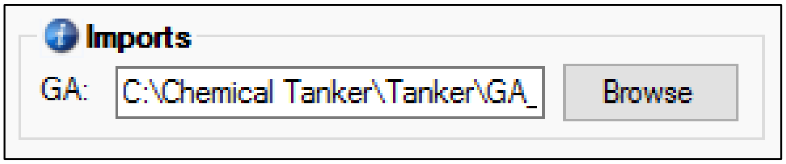


Figure 2.2.B

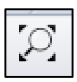
Figure 2.2.C

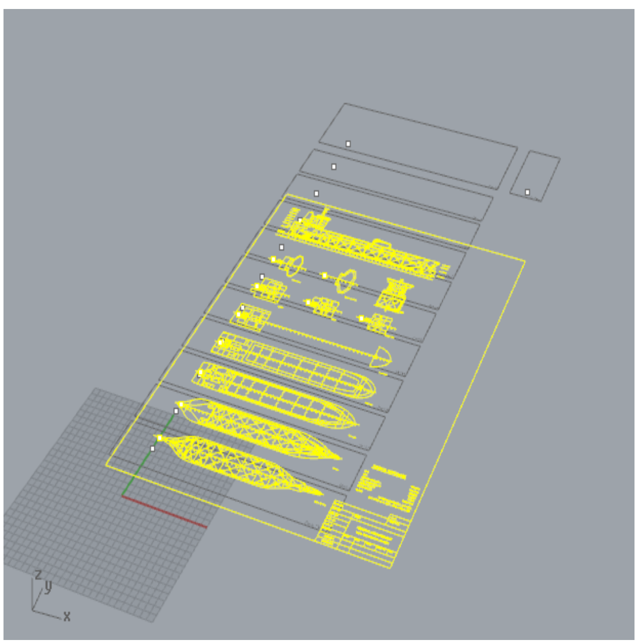
In the **Imports**, press **Browse** button and select the general arrangement drawing file, then press **Open.**



The GA will be imported into the model. If the units of the drawing is mm and the 3D model's is meter, the size of the drawing is 1000 times larger.

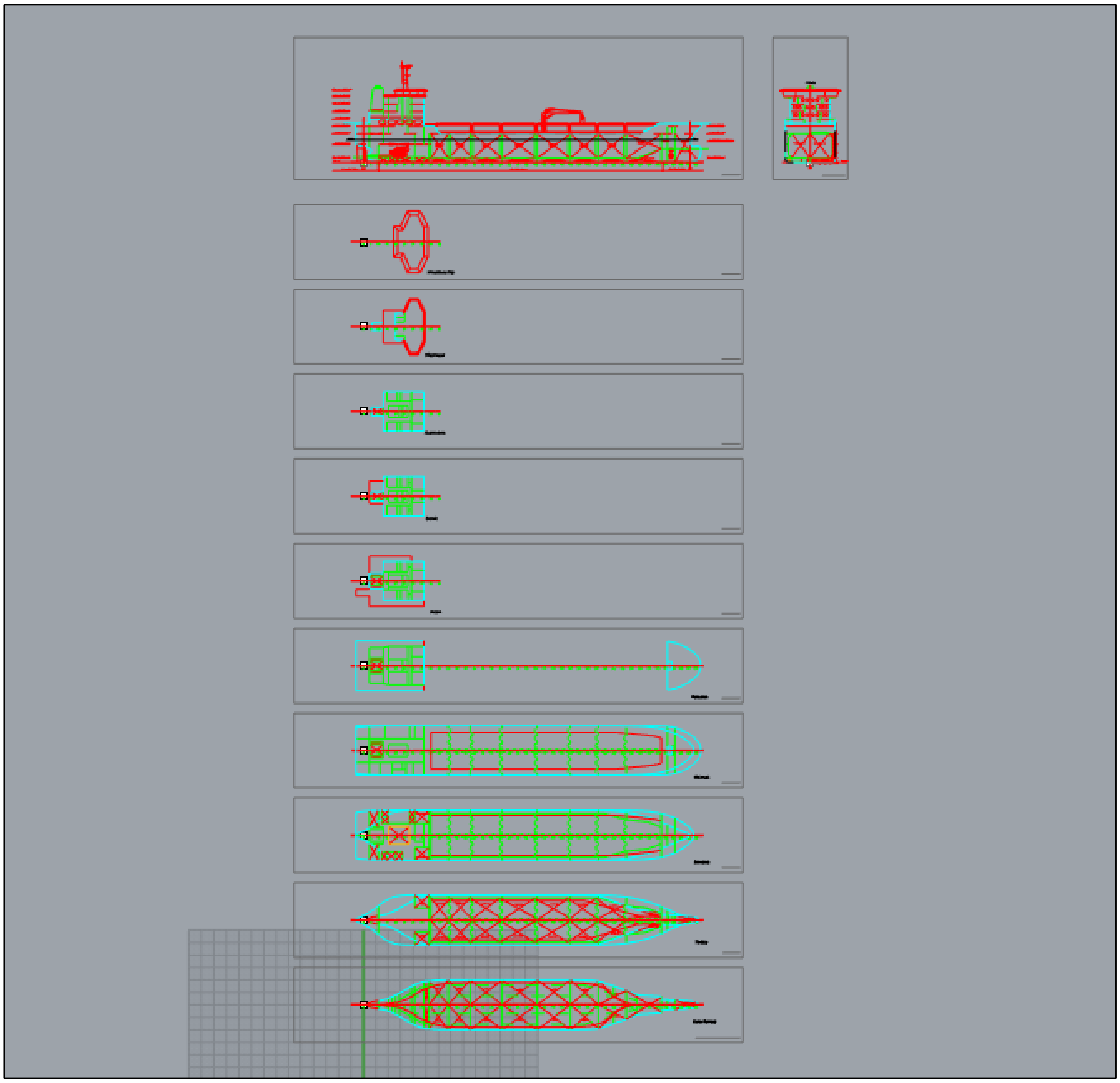
In this case, scale down the drawing : selecting all the new objects by typing *SelLast* command, the entire drawing will glow yellow, then type *Scale* command and press Enter, type *0,0,0* for the Origin point and press Enter, and type *0.001* and Enter to scale down by 1000 times.

Press ZoomExtents  and the drawing should look as in the following example:

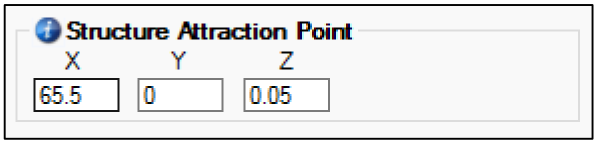


Once the general arrangement scale is correct, start moving each section into the appropriate selection box, by using the *Move* command.

Repeat the same procedure for all sections and the result will be:



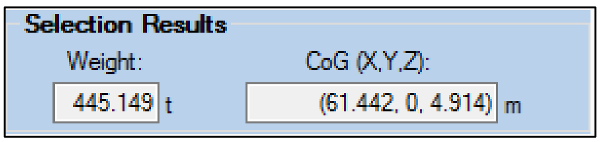
Throw Point



This will determine the side onto which the stiffeners will be generated, and also the profile flange or bulb will be oriented towards this point.

By default, it is located at X = Lpp/2, Y = 0 and Z slightly above the baseline.

Selection Results



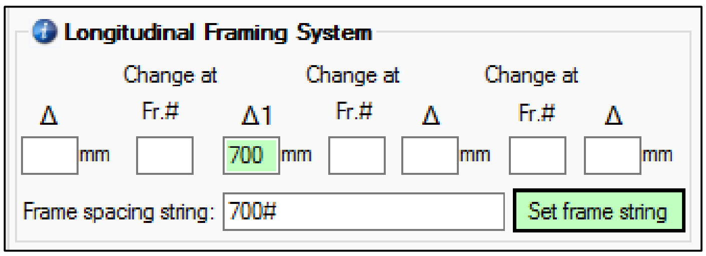
Up-to-date Weight and Center of Gravity values are available here. Being in the main node, the selection is the entire structure, therefore these are the results for the entire ship.

2.3 Framing System tab

2.3.1 Longitudinal Framing System

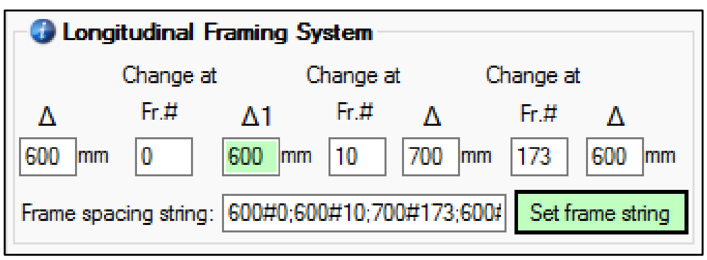
Fill in the appropriate frame spacing interval (Δ) and location where the spacing changes.
Aft Perpendicular is set at Frame number 0.
*If longitudinal spacing is constant, input only Δ**1** value.*
Press **Set frame string** button to convert the inputs into the frame spacing string, then press **Apply** to generate the frame scale.

Example 1:



Resulting Frame spacing string: **700#**
This will create a constant frame spacing system with the origin in zero.

Example 2:



Resulting Frame spacing string: **600#0;600#10;700#173;600#**

In this case the frame spacing will be 600 mm up to Fr.#10, then 700 mm up to Fr.#173, and 600 mm from Fr.#173 forward.

If more interval changes are required, simply add to the Frame spacing string extra pairs of frame number and the new interval, as following:
- if at Example 2 a new frame spacing (500 mm) is required from Fr.#185, add to the previous Frame spacing string the pair ***185;500#***
Note the semicolon between the frame number and the frame spacing. The complete Frame spacing string should now be: **600#0;600#10;700#173;600#185;500**

Press **Apply** button to regenerate the new framing system.

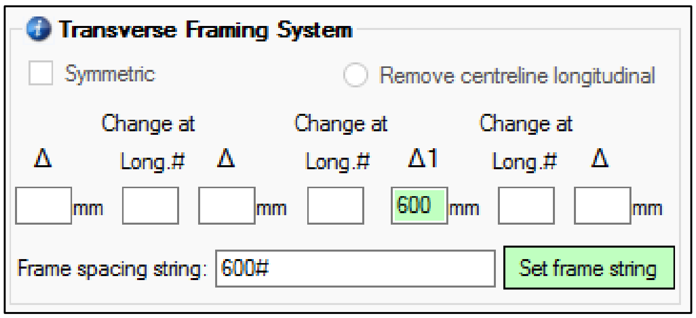
2.3.2 Transverse framing system

Fill in the appropriate frame spacing interval (Δ) and location where the spacing changes. CentreLine is set at Long.#0.

*If the transverse spacing is constant, input only Δ**1** value.*

Press **Set frame string** button to convert the inputs into the frame spacing string, then press **Apply** to generate the frame scale.

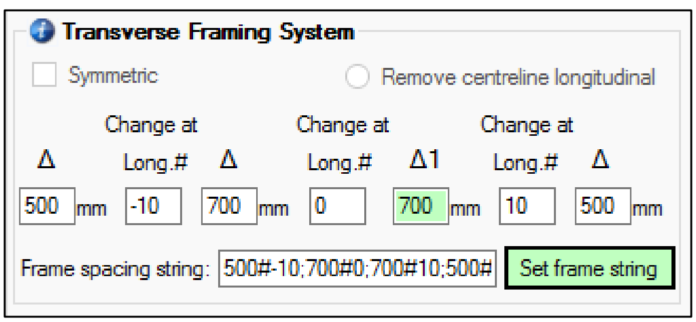
Example 1:



Resulting "Frame spacing string": **600#**

This will create a constant frame spacing system with the origin in Y=0.

Example 2:



Resulting "Frame spacing string": **500#-10;700#0;700#10;500#**

This will create a symmetric transverse framing system with interval 700 mm between Long.#-10 and Long.#10, and 500 mm outside. If more interval changes are required, simply add to the Frame spacing string extra pairs of frame number and the new interval, as following:

- if at Example 2 a new frame spacing (500 mm) is required from Long.#15, add to the previous Frame spacing string the pair ***15;500#***

Note the semicolon between the frame number and the frame spacing. The complete Frame spacing string should now be: **500#-10;700#0;700#10;500#15;500#**

Press **Apply** button to regenerate the new framing system.

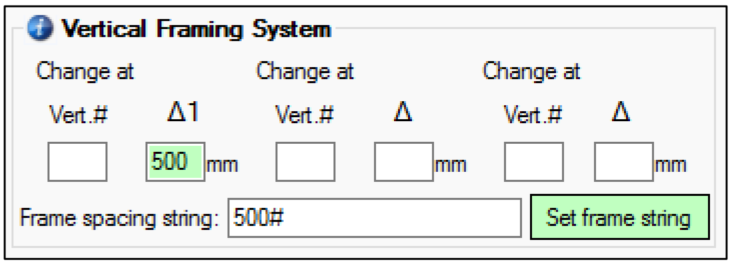
2.3.3 Vertical Framing System

Fill in the appropriate frame spacing interval (Δ) and location where the spacing changes. BaseLine is set at Vert. number 0.

*If the vertical spacing is constant, input only Δ**1** value.*

Press **Set frame string** button to convert the inputs into the frame spacing string, then press **Apply** to generate the frame scale.

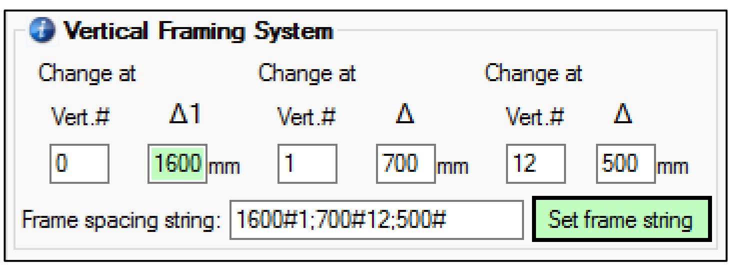
Example 1:



Resulting "Frame spacing string": **500#**

This will create a constant frame spacing system with the baseline in Z=0.

Example 2:



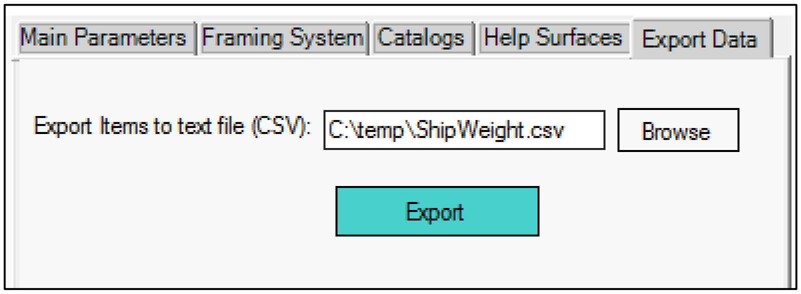
Resulting "Frame spacing string": **1600#1;700#12;500#**

In this case, the first vertical coincides with the tanktop average height.

From tanktop to main deck (Vert.#) frame spacing is 700 mm. Above main deck frame spacing is 500 mm.

2.4 Export Data Tab

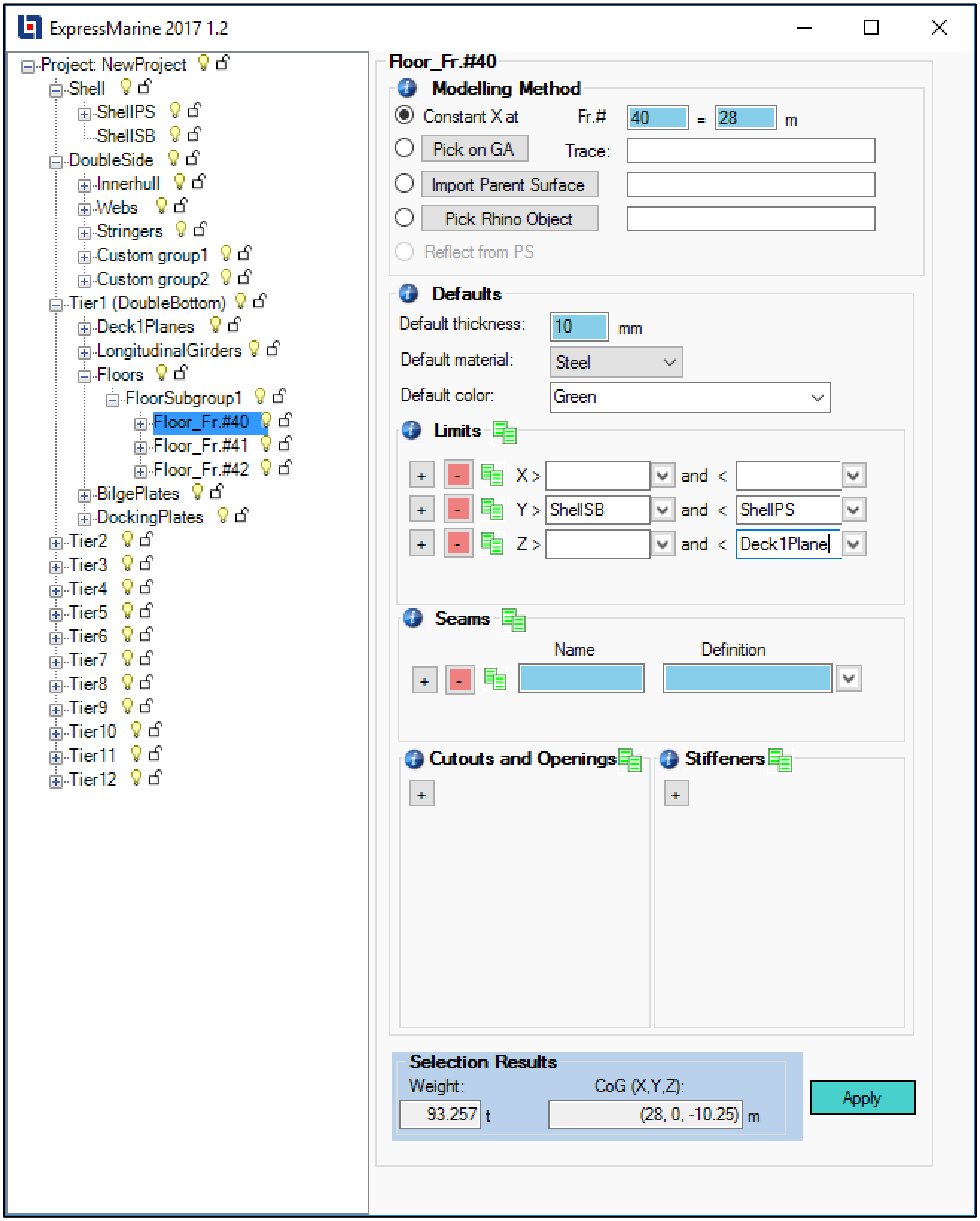
Export weight data in table format.



3. Modelling the geometry

3.1 Element generation

All individual structural objects (floors, webs, stringers, etc.) share the same control panel layout. Example of Element's Control Panel layout:

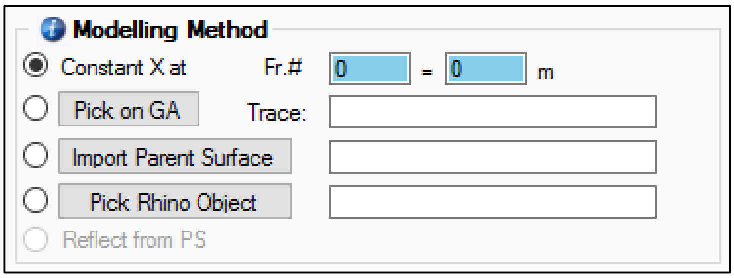


3.1.1 Modelling Method

Modelling methods to create this object:

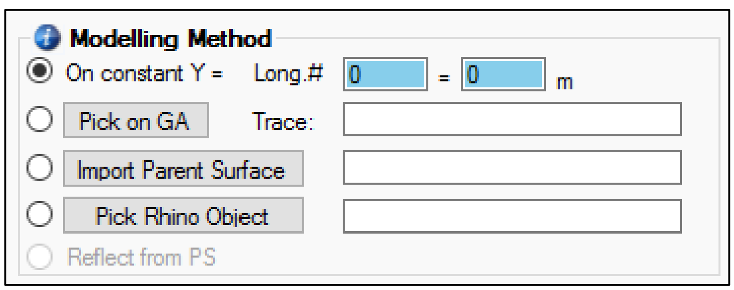
- **Constant X at**

The object will be created on an YZ plane at the given coordinate.
This method is used for the following elements: Floor, Web, Bilge Plate, Docking Plate, Transverse Bulkhead, X-object.



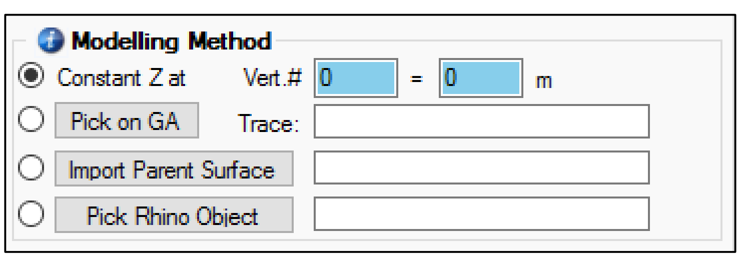
- **On constant Y**

The object will be created on a XZ plane at the given coordinate.
This method is used for the following elements: InnerhullPS, InnerhullSB, Longitudinal Girder, Longitudinal Bulkhead, Y-object.



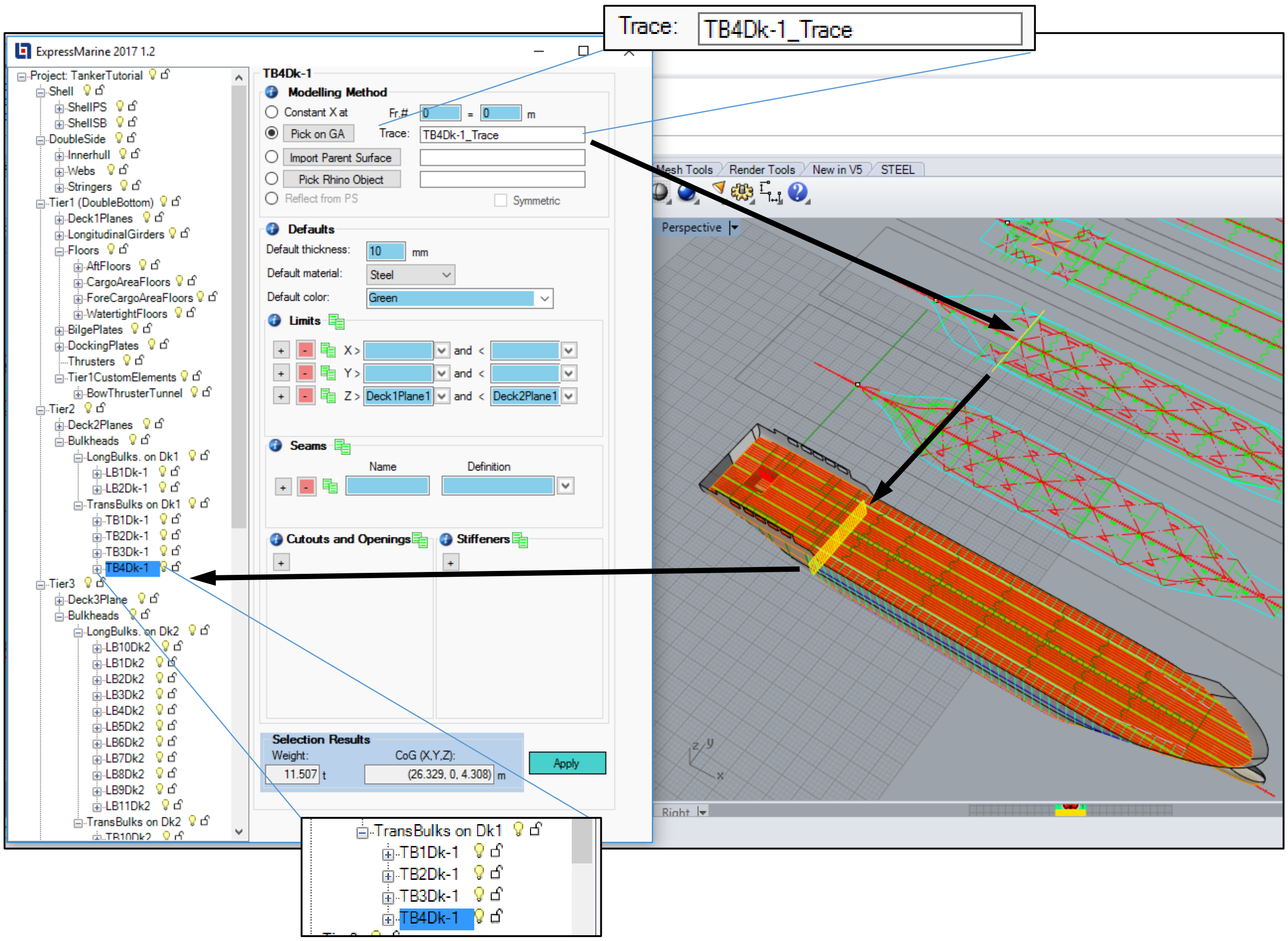
- **Constant Z at**

The object will be created on a XY plane at the given coordinate.
This method is used for the following elements: Deck, Stringer, Z-object.



- ## [Pick on GA]

A 3D object can have a corresponding trace (curve) in the general arrangement. Using this method, the object will be created by extruding that trace along the appropriate axis. I.e. bulkheads, longitudinal girders, etc. are extruded upwards if they are picked from the deck sections.
Decks are extruded horizontally if they are picked in the profile, etc.



- ## [Import Parent Surface]

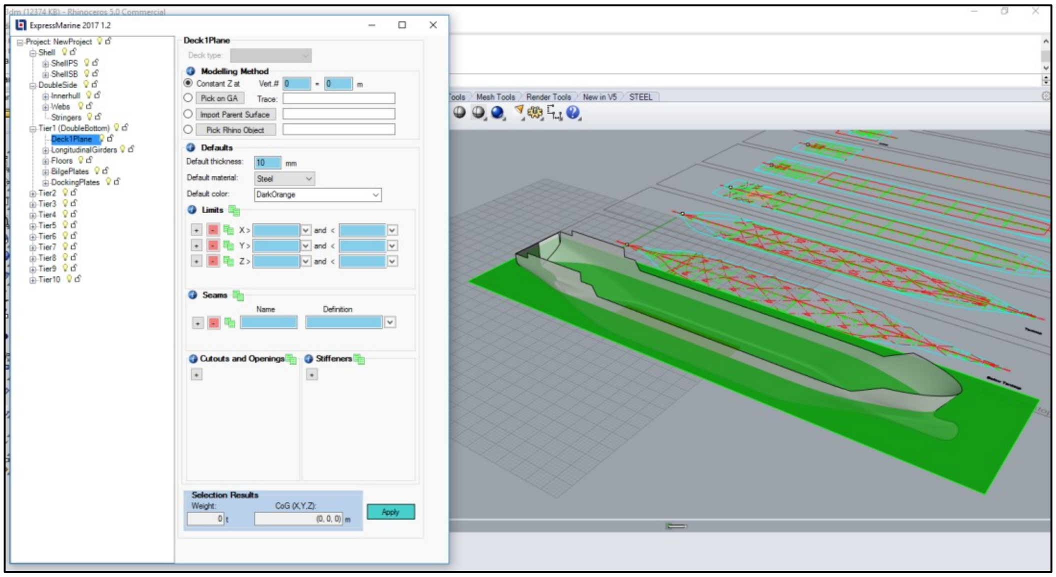
Import a surface in a format that is supported by the Rhino import. This will become the parent surface of the element.
Initially it will be displayed locked, for confirmation that it is the right import.
If not, press Import Parent Surface button again and pick a different file.
Set the rest of the structural properties (material, thickness, color, limits, cutouts and openings, stiffeners) and press **Apply** button to generate the element.

- ## Pick Rhino Object

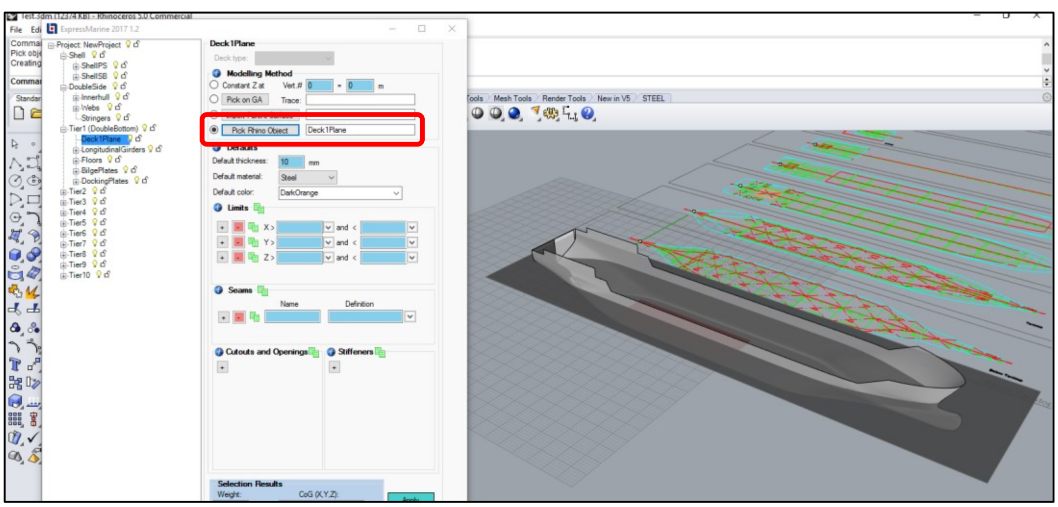
  Pick an existing Rhino surface to be transformed into an ExpressMarine element. The original Rhino object will become the parent surface.

Example:

- In **Deck1Plane** node, **Modelling Method**: select Pick Rhino Object radio button.
- Pick the Rhino object with a simple click on the green surface:

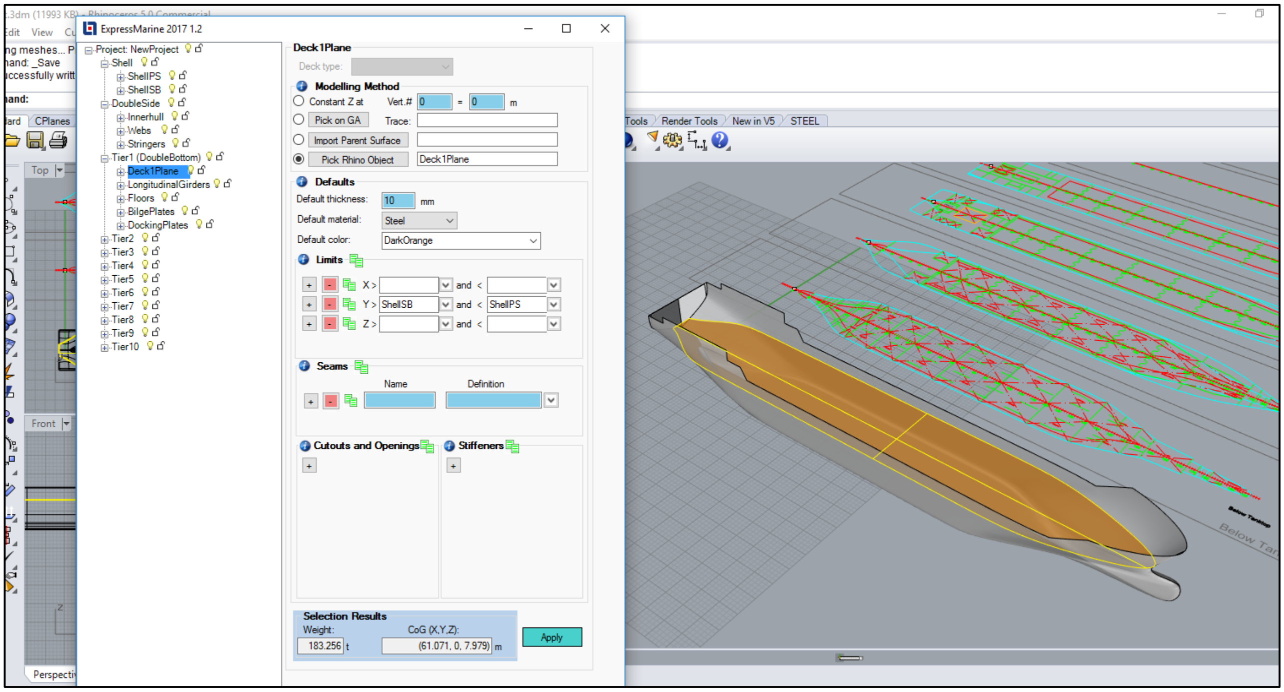


- After the object has been picked, the rhino object name *Deck1Plane* appeared automatically in the coresponding box, and the surface color turned grey meaning that it is locked:

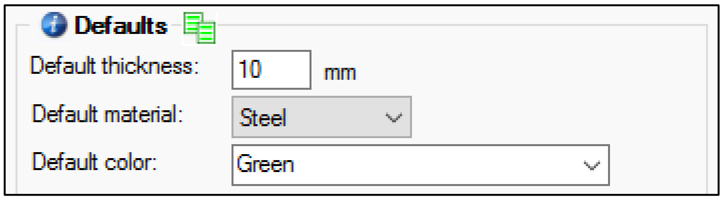


- Fill in the desired **Defaults**, **Limits**, **Seams**, **Cutouts and Openings** and **Stiffeners** settings.
- Press 

to generate **Deck1Plane**. Now the grey surface (the Rhino surface) became an ExpressMarine element:



3.1.2 Defaults



Depending on the type of objects, some default values are predefined. The user can choose to change, add or keep these values.

If the current tree node has children (sub nodes), then these settings will be transferred to all children. If the child settings are changed, the parent default settings will not overwrite them.

Default values inherit from the parents, will be displayed in light blue background, or white background after editing.

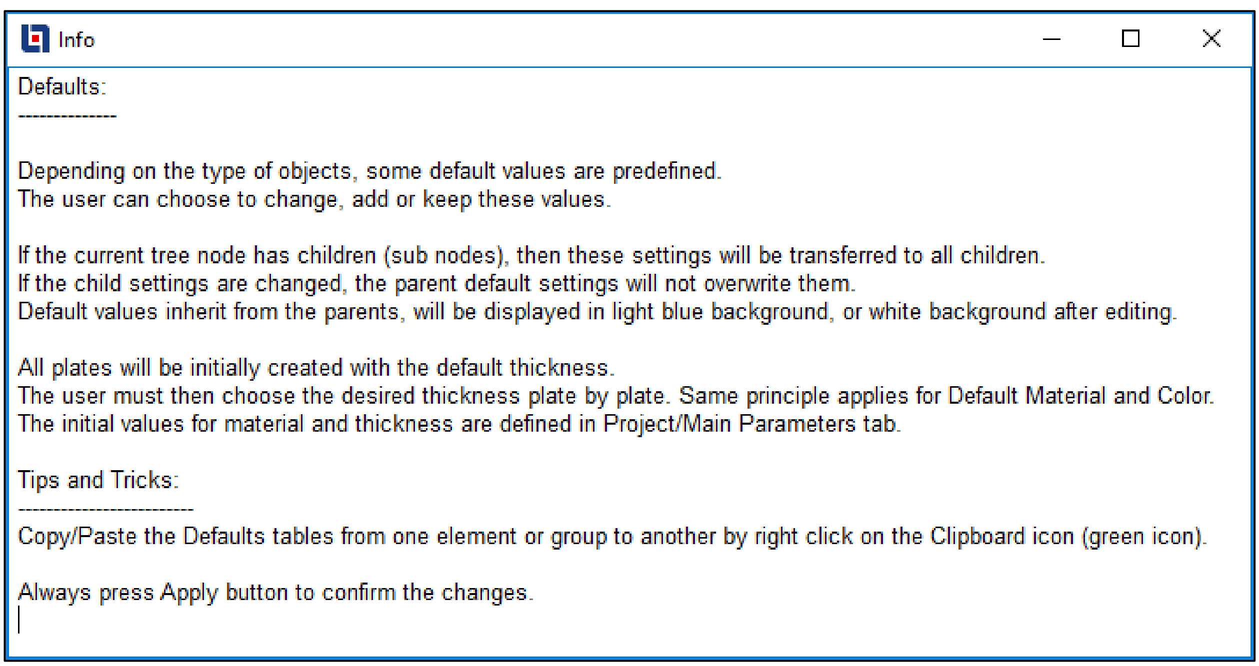
All plates will be initially created with the **default thickness**. The user must then choose the desired thickness plate by plate. Same principle applies for **default material** and **default color**.

When choosing a color, start typing to get suggestions.

The initial values for material and thickness are defined in Project/Main Parameters tab.

Always press **Apply** button to confirm the changes.

The same information can be also found by clicking the **info button** .



Info

Defaults:

Depending on the type of objects, some default values are predefined.
The user can choose to change, add or keep these values.

If the current tree node has children (sub nodes), then these settings will be transferred to all children.
If the child settings are changed, the parent default settings will not overwrite them.
Default values inherit from the parents, will be displayed in light blue background, or white background after editing.

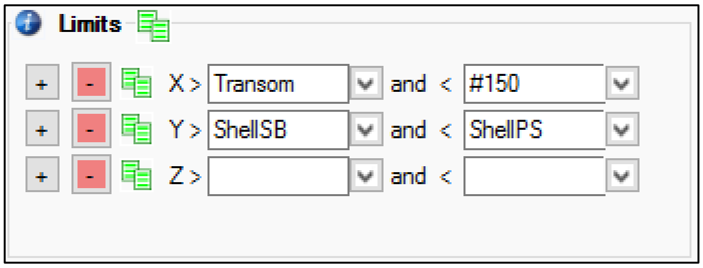
All plates will be initially created with the default thickness.
The user must then choose the desired thickness plate by plate. Same principle applies for Default Material and Color.
The initial values for material and thickness are defined in Project/Main Parameters tab.

Tips and Tricks:

Copy/Paste the Defaults tables from one element or group to another by right click on the Clipboard icon (green icon).

Always press Apply button to confirm the changes.

3.1.3 Limits



Use the limits table to trim the reference surfaces to the desired shape.

+ Add new limit.

- Remove this limit definition.

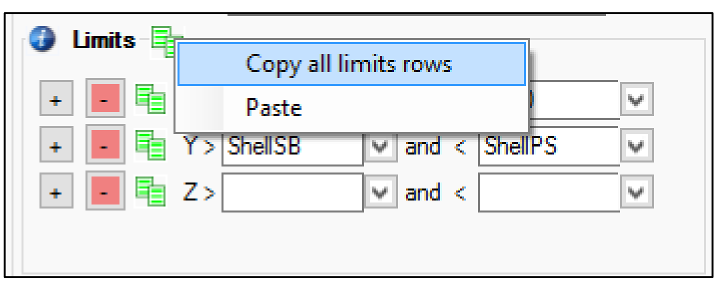
When defining one limit, choose the Direction (X, Y or Z), and the actual Limit used as a border (this can be a coordinate value in **Length unit** (e.g. *-5*), a framing system value (e.g. *#150*) or a surface (e.g. *ShellSB*)):

- “>” will keep the part of the surface from the limit onwards (positive direction of the axes)

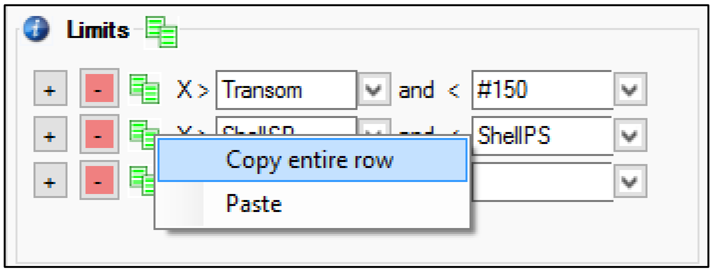
- “<”will keep the part of the surface up to the limit

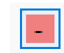
Tips and tricks

- Copy/Paste the Limits table from one element or group to another by right click on the Clipboard icon 

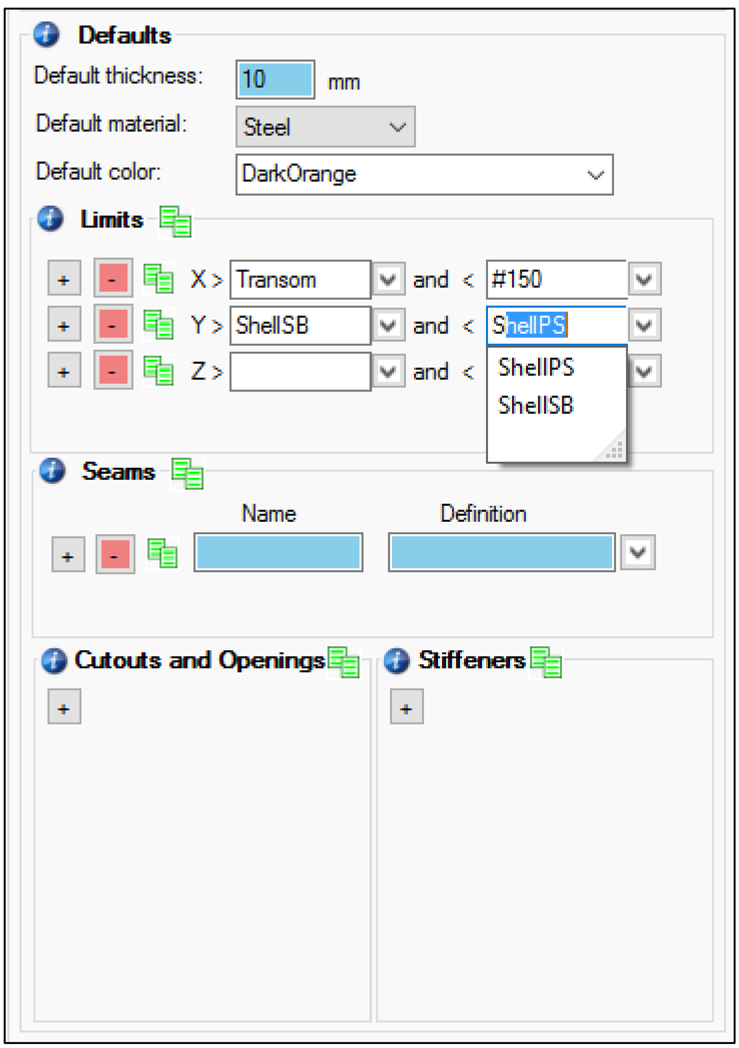


- Copy/Paste of an entire X, Y and Z limit definition can be achieved by right click on the  button, then Copy entire row/ Paste



- The first X, Y and Z limit row cannot be deleted, but the  button will clear the entire content and starting from the second and onwards, same button will remove the entire row

- If an existing object is used as a limit, start typing the name, and suggestions will be displayed



3.1.4 Seams

Apply seams to divide the element into different plates so that individual thickness, material, etc. can be set. A seam can be created at a constant X, Y or Z coordinate, a frame number, or at the intersection with the parent surface of an existing element in the dropdown list.

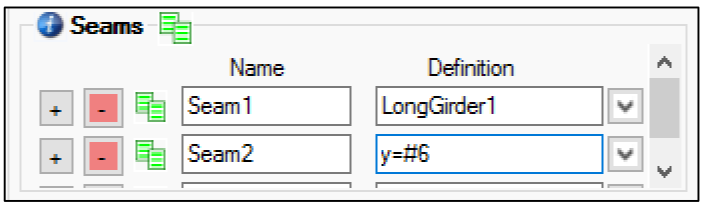
Use the seams table to create seams.

Name: give a name for the seam.

Definition: select or input a definition for the seam.

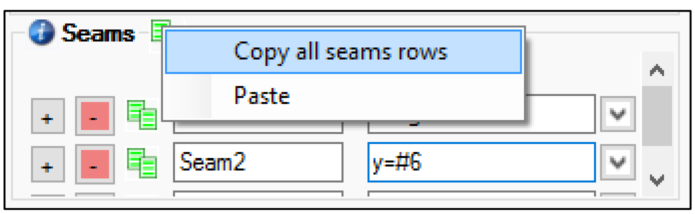
\+ Add new seam.

\- Remove this seam definition.

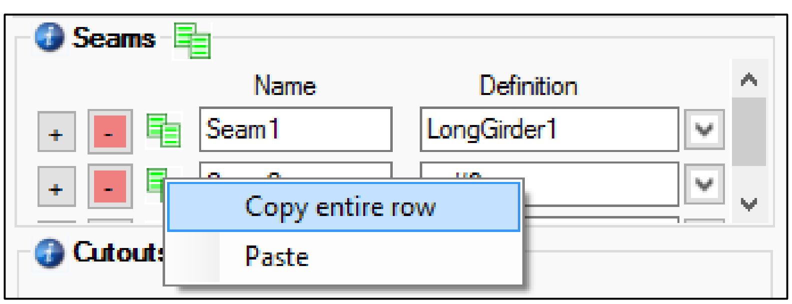


Tips and tricks

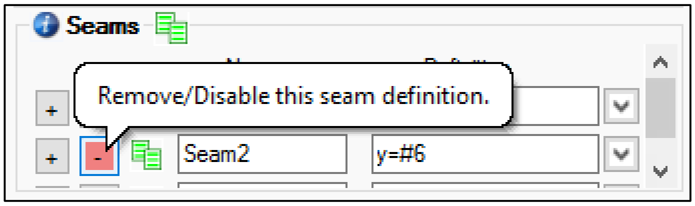
- Copy/Paste the Seams table from one element or group to another by right click on the Clipboard icon 



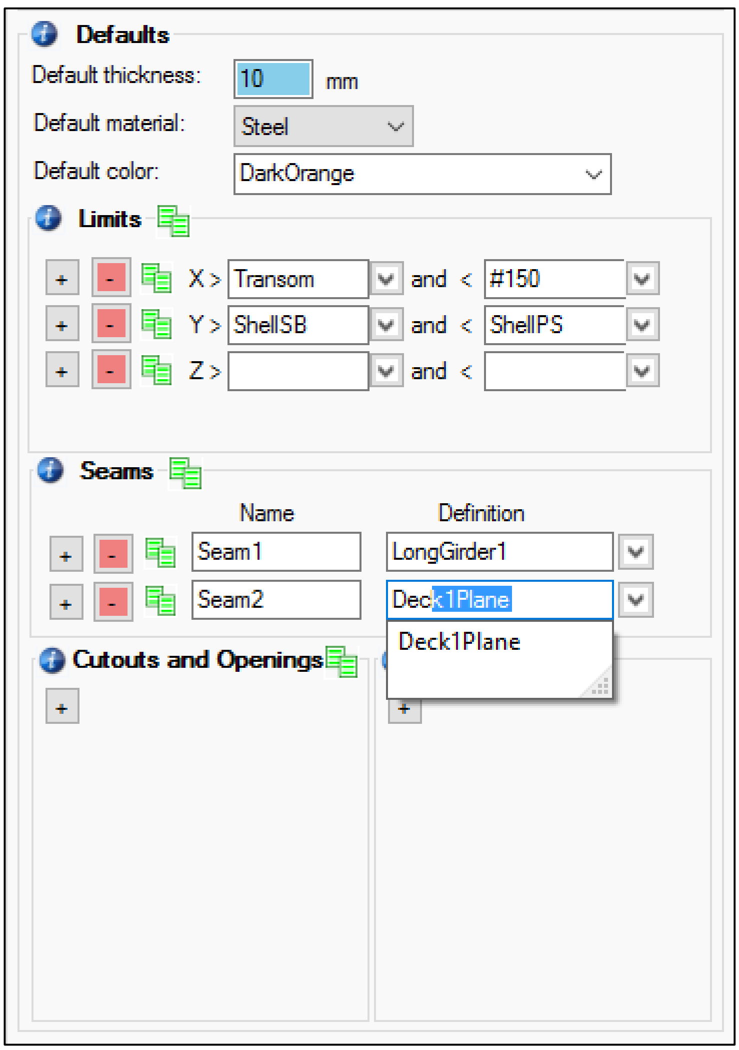
- Copy/Paste of an entire seam definition can be achieved by right click on the  button, then Copy entire row/ Paste



- The first seam row cannot be deleted, the button will clear the entire content and starting from the second and onwards, same button will remove the entire row



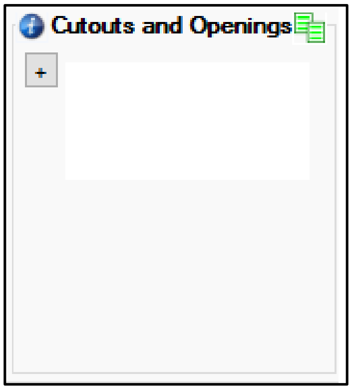
- If an existing object is used as a limit, start typing the name, and suggestions will be displayed



3.1.5 Cutouts and Openings

Use the **Cutouts and Openings** section to create individual or series of cutouts/openings.

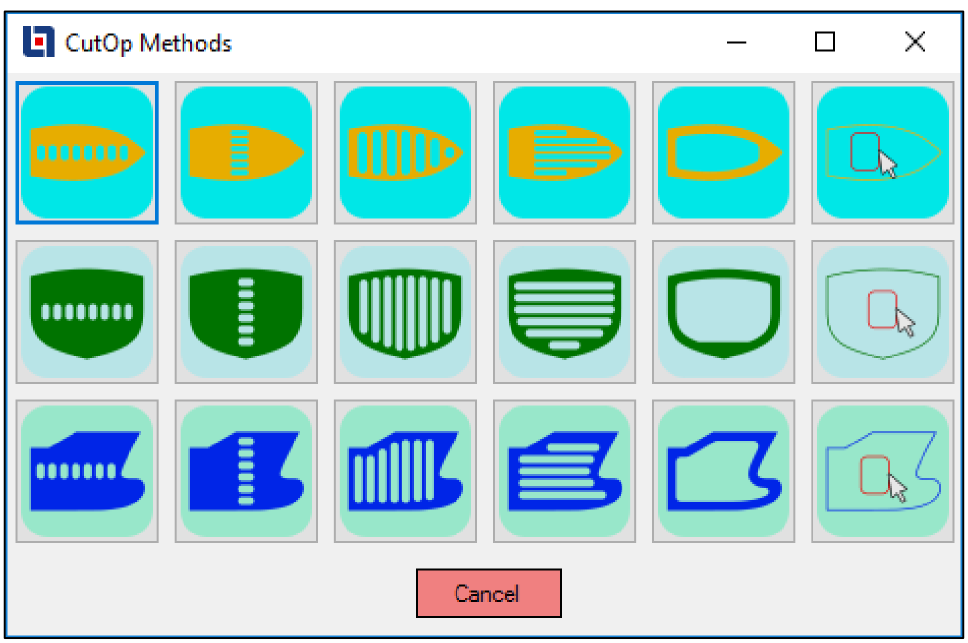
+ button is to Add new cutout/opening definition.



If no opening has been defined, only the + (add new cutout definition) and  (Copy/Paste opening definition) are available.

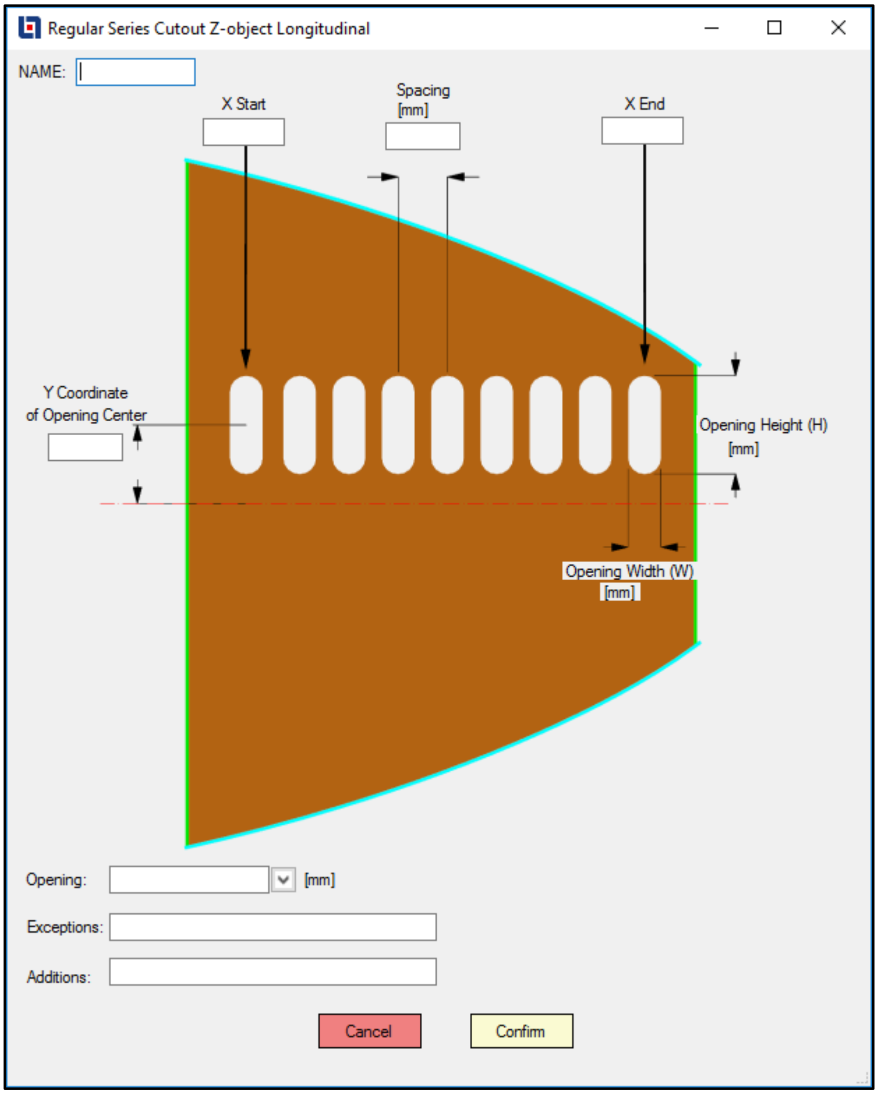
To add new opening press + button or use  butoon to Paste openings copied from another object.

If + button is being presed to create an opening, the **CutOp Methods** window will appear:



Select the appropriate icon to open the Opening Definition window.

If the first icon  was selected, the following Opening Definition window will open:



NAME: the name for the individual or series of cutouts/openings.

Opening: choose an existing opening or input a custom one in the following format:

- manholes: H (height) x W (width), i.e. **600x400**
- rounded corners rectangle: H(height) x W(width) x R(radius), i.e. **1000x600x150**
- circular: R (radius) or D (diameter), i.e. **R250**, **D450**
- variable height: W (width). I.e. **600** for openings of 600 mm width and height adapting to the local shape

Note: Thickness unit is used to define opening dimensions.

Use Radius 0 (zero) to create rectangular openings. I.e. 1000x600x0

Spacing: distance between two consecutive cutouts/openings (valid only for Series).

Start (X Start): location on the chosen axis of the first cutout/opening in the series (valid only for Series methods).

End (X End): location on the chosen axis of the last cutout/opening in the series (valid for all Series methods).

Location (Y Coordinate of Opening Center): the position of the cutouts/openings center along the second axes of the Plane defined above. I.e. if the Plane is XY (Z-obj) and the selected axes is X, then Interval, Start and End are X values and the Location is the Y value of the openings center (valid only for Series of identical openings).

Exceptions: Fill in locations where you want to remove certain cutouts/openings or mini series of cutouts/openings. Format example: #5; #10 [#4 #12 #20]
This will remove cutouts/openings at frame number 5, 10 and every 4th frame from 12 to 20.
You can use spaces, semicolon or both to separate each exception.

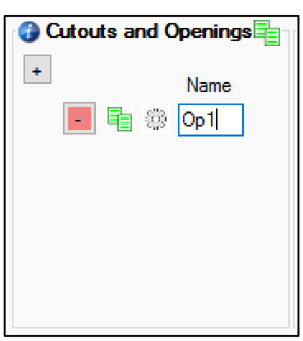
[#4 #12 #20] can also be written as (#4 #12 #20) or {#4 #12 #20}

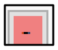
Additions: Fill in locations where you want to add extra cutouts/openings, one by one or a miniseries of cutouts/openings. Format example: #5; #10 [#4 #12 #20]
This will add extra cutouts/openings at frame number 5, 10 and every 4th frame from 12 to 20.
You can use spaces, semicolon or both to separate each addition.

[#4 #12 #20] can also be written as (#4 #12 #20) or {#4 #12 #20}

Confirm: wil register the inputs and will close the window

Fill in all the fields, then press Confirm. The opening name will now be visible as below:



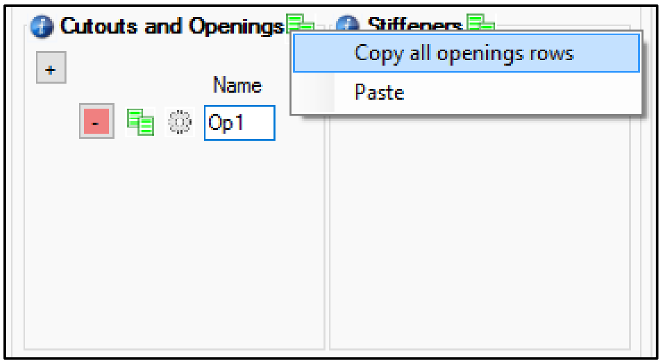
The  button will Disable/Remove this cutout/opening definition.

To edit the opening, press the edit button , and the opening definition window will open again.

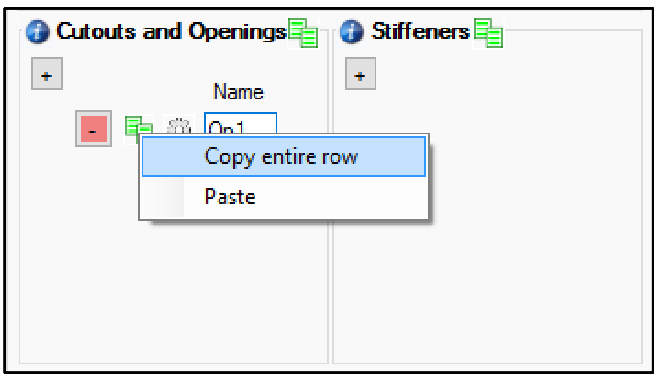
To add more openings, press again the + button and follow the same procedure as for the Op1.

Tips and tricks

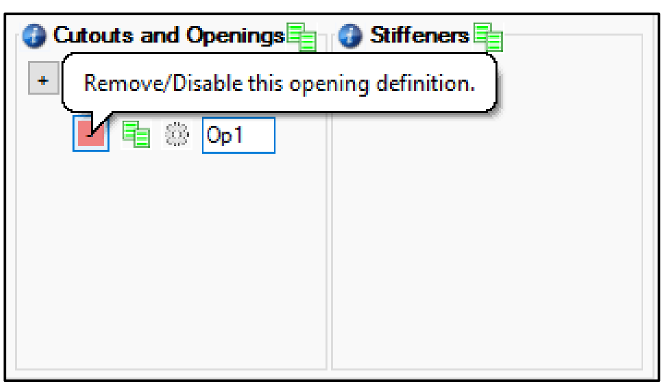
- Copy/Paste the Cutouts and Openings table from one element or group to another by right click on the Clipboard icon



- Copy/Paste of an entire opening definition can be achieved by right click on the button, then Copy entire row/ Paste



- The button will delete the current opening definition



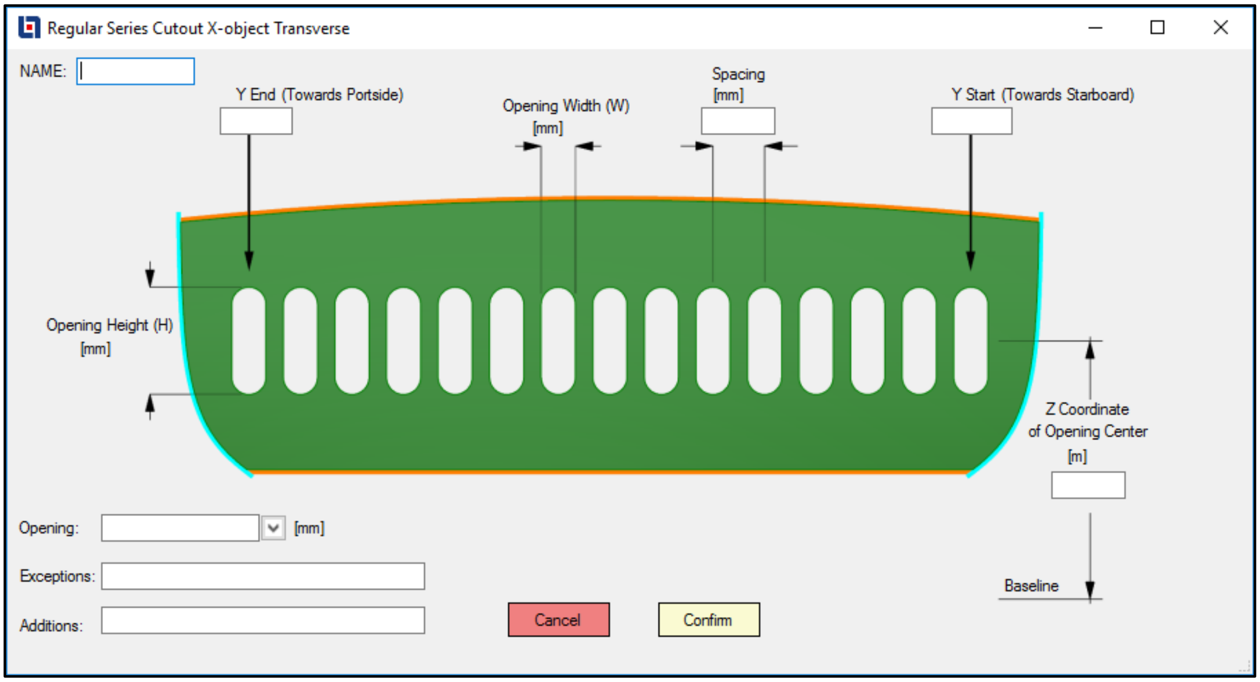
Series Method

Each object type (X-Object, Y-Object, Z-Object) can have two series types as following:

- **X-Object (YZ Plane)**:
  - Transverse Series (Y axis)
  - Vertical Series (Z axis)
- **Y-Object (XZ Plane)**:
  - Longitudinal Series (X axis)
  - Vertical Series (Z axis)
- **Z-Object (XY Plane)**:
  - Longitudinal Series (X axis)
  - Transverse Series (Y axis)

The following **CutOp icons** are appropriate for the **Series Method**:

X-Object / Transverse Series (YZ plane / Y axis)



NAME: the name for the individual or series of cutouts/openings.

Opening: choose an existing opening or input a custom one in the following format:

- manholes: H (height) x W (width), i.e. **600x400**
- rounded corners rectangle: H(height) x W(width) x R(radius), i.e. **1000x600x150**
- circular: R (radius) or D (diameter), i.e. **R250**, **D450**
- variable height: W (width). I.e. **600** for openings of 600 mm width and height adapting to the local shape

Note: Thickness unit is used to define opening dimensions.
Use Radius 0 (zero) to create rectangular openings. I.e. 1000x600x0

Opening **Width (W)** is oriented in the direction of the axis, and the Opening **Height (H)** is normal to the axis.

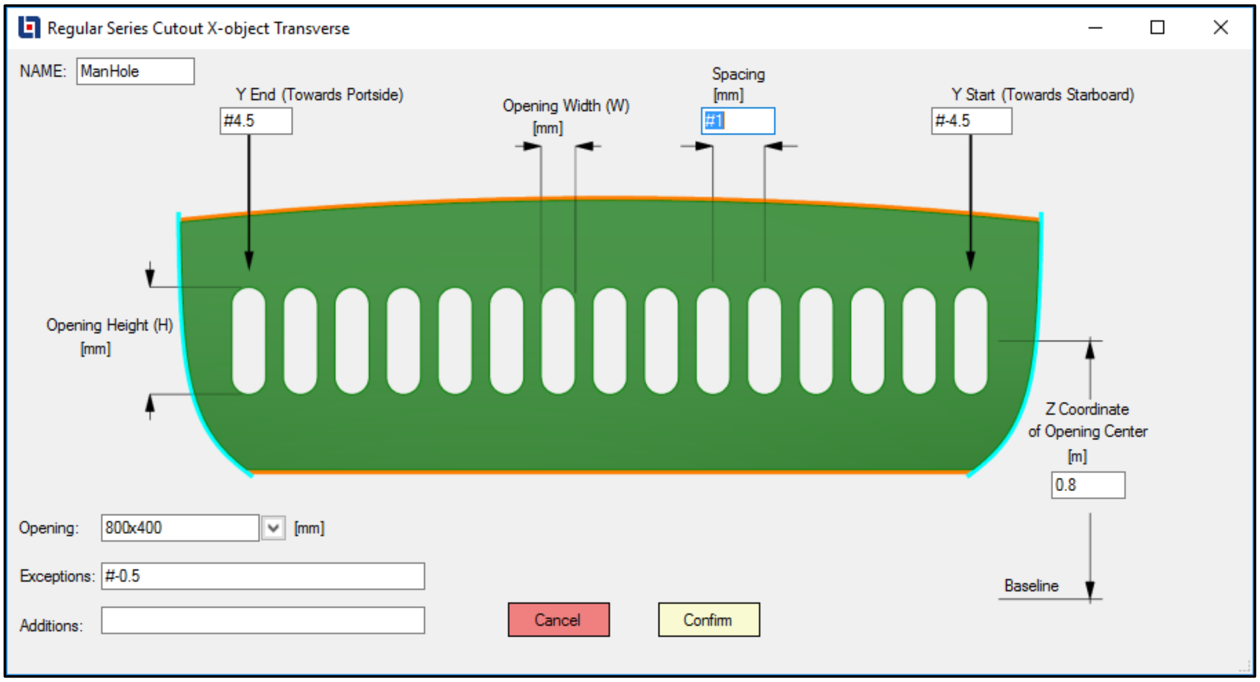
The **Z Coordinate of Opening Center** is the **Height** (Z coordinate) of the opening center.

Y Start is the Y coordinate of the first opening center.

Y End is the Y coordinate of the last opening center.

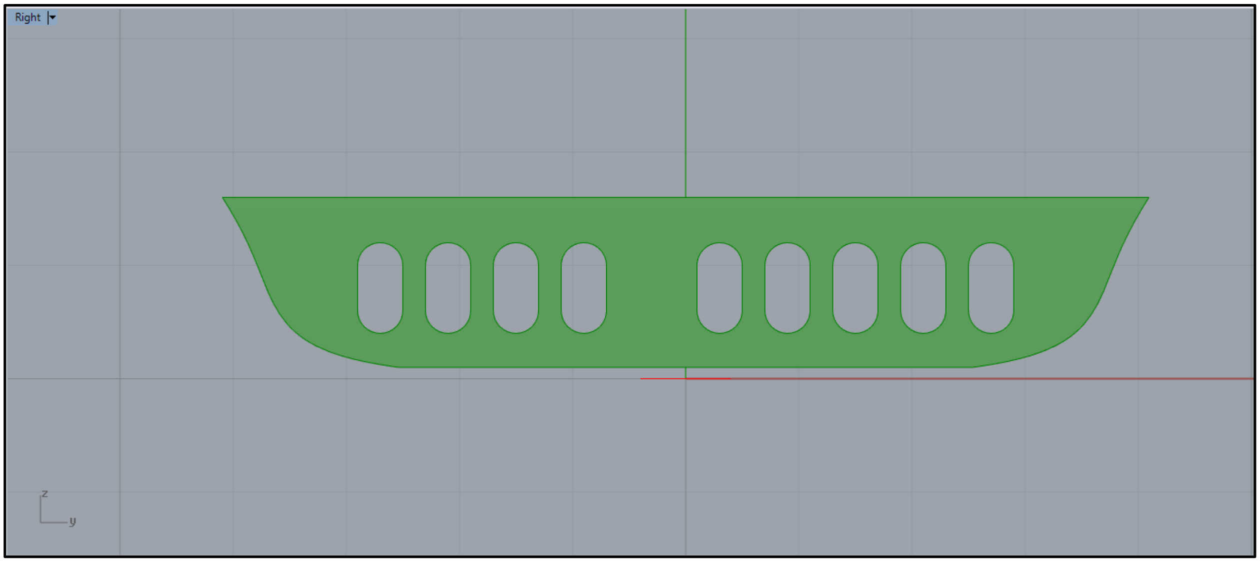
Spacing is the distance between the centers of two consecutive openings.

Example X-Object / Transverse Series (YZ plane / Y axis):

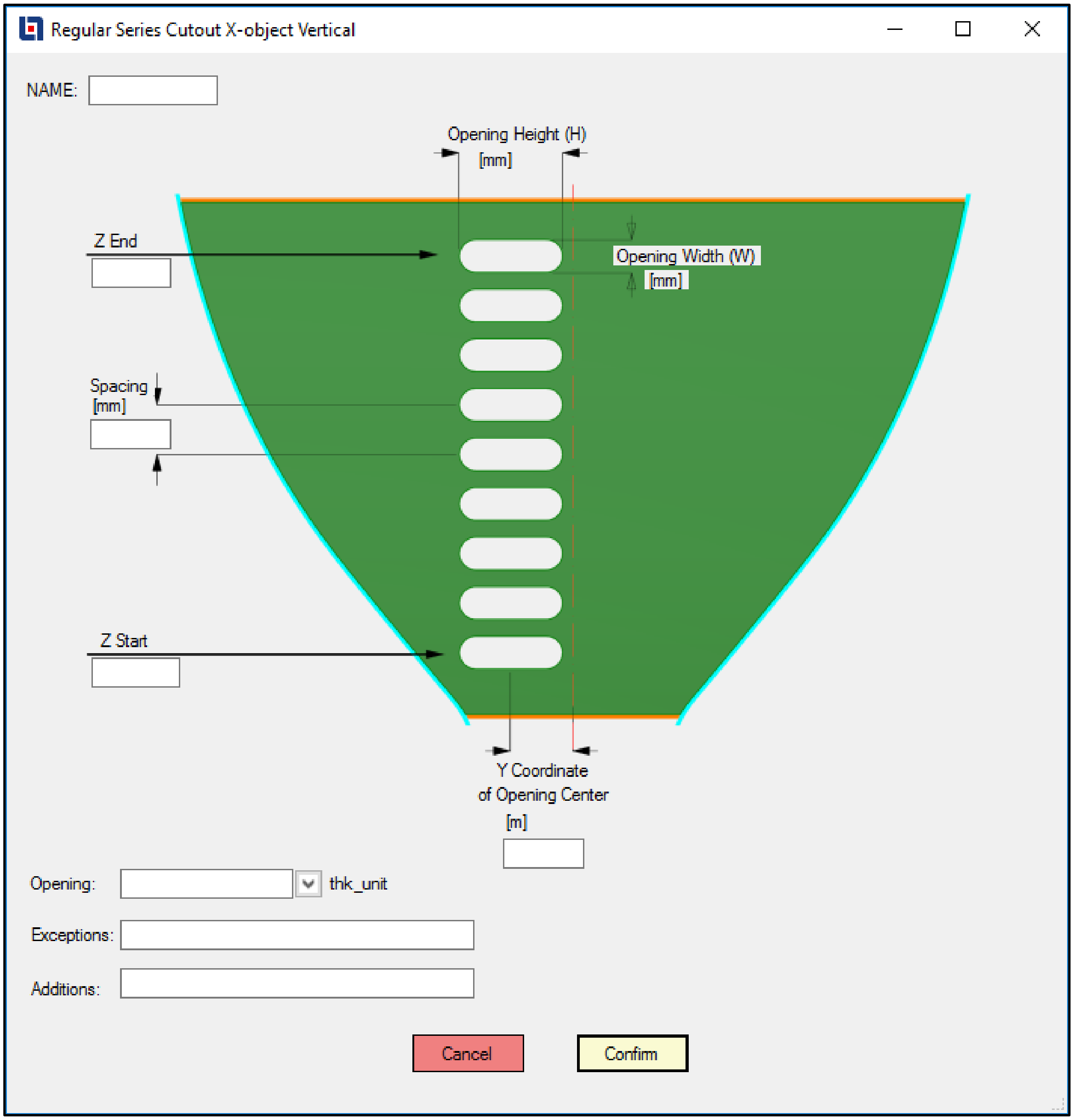


This is an example of the opening definition for a Floor. This will create a series of 800x400 mm openings, repeating along Y axis, starting from #-4.5 to #4.5, with 1 longitudinal frame space between them, at the height of 0.8 meters.

The result is the following:



X-Object / Vertical Series (YZ plane / Z axis)



NAME: the name for the individual or series of cutouts/openings.

Opening: choose an existing opening or input a custom one in the following format:

- manholes: H (height) x W (width), i.e. **600x400**
- rounded corners rectangle: H(height) x W(width) x R(radius), i.e. **1000x600x150**
- circular: R (radius) or D (diameter), i.e. **R250**, **D450**
- variable height: W (width). I.e. **600** for openings of 600 mm width and height adapting to the local shape

Note: Thickness unit is used to define opening dimensions.

Use Radius 0 (zero) to create rectangular openings. I.e. 1000x600x0

Opening **Width (W)** is oriented in the direction of the axis, and the Opening **Height (H)** is normal to the axis.

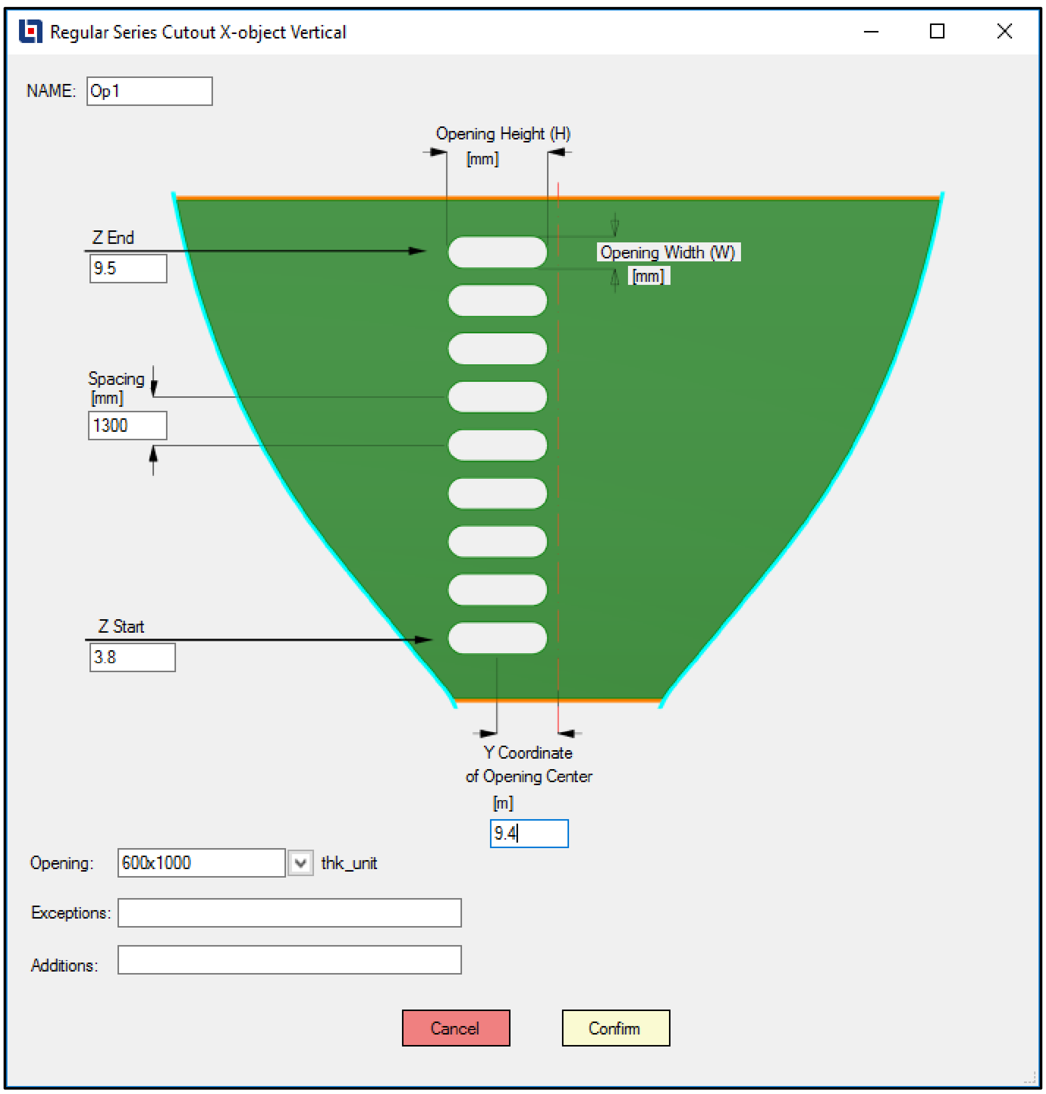
The **Y Coordinate of Opening Center** is the **Distance from CL** (Y coordinate of the opening center).

Z Start is the Z coordinate of the first opening center.

Z End is the Z coordinate of the last opening center.

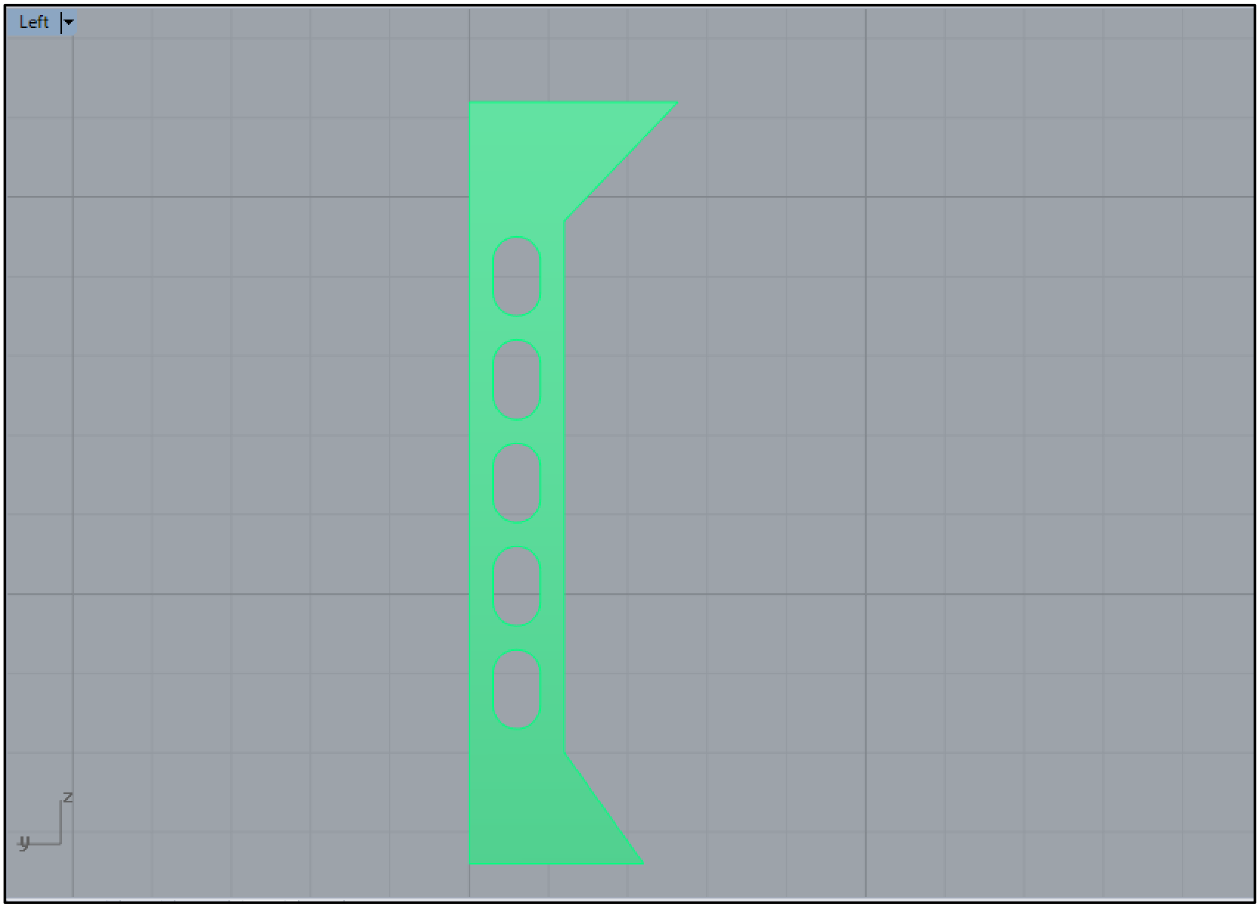
Spacing is the distance between the centers of two consecutive openings.

Example X-Object / Vertical Series (YZ plane / Z axis):

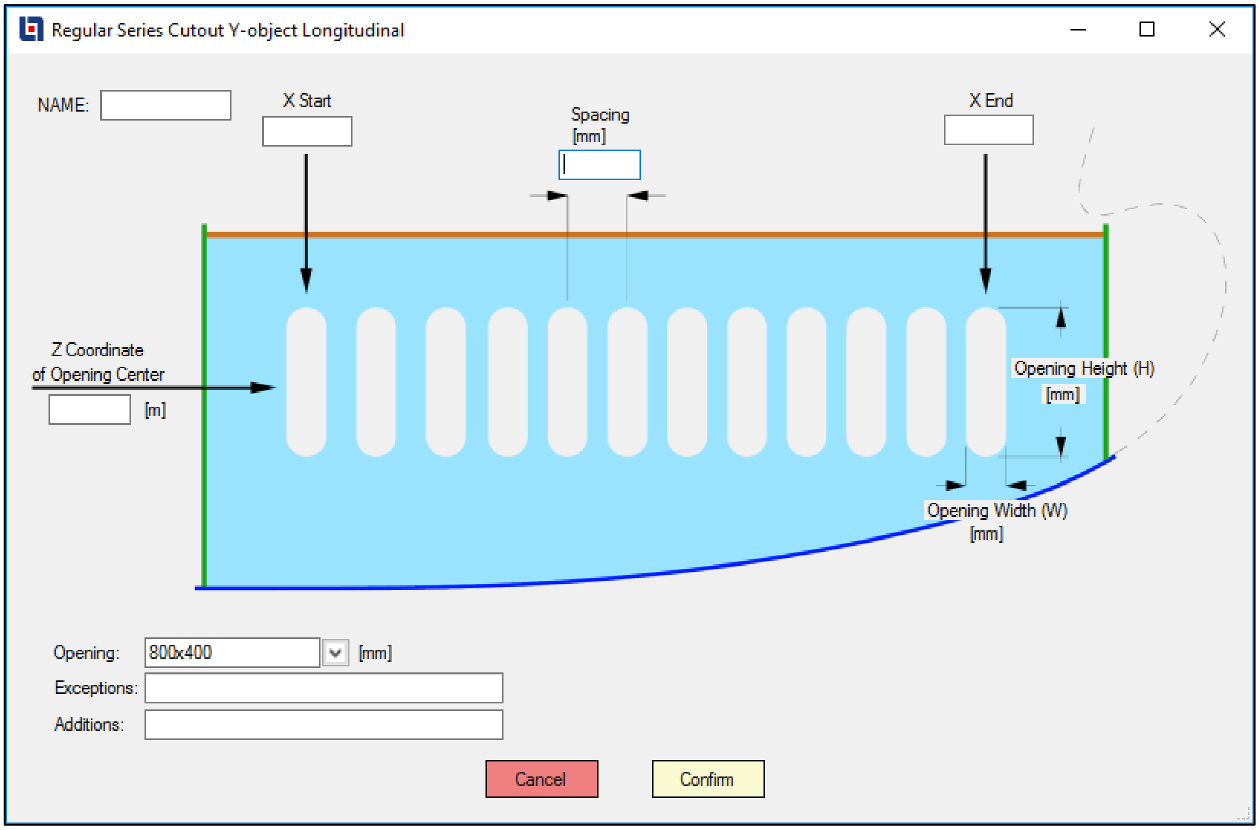


This is an example of the opening definition for a Web. This will create a series of 600x1000 mm openings, repeating along Z axis, starting at 3.8 meters up to 9.5 meters, with 1300 mm space between them, at the distance from centerline of 9.4 meters.

The result is the following:



Y-Object / Longitudinal Series (XZ plane / X axis)



NAME: the name for the individual or series of cutouts/openings.

Opening: choose an existing opening or input a custom one in the following format:

- manholes: H (height) x W (width), i.e. **600x400**
- rounded corners rectangle: H(height) x W(width) x R(radius), i.e. **1000x600x150**
- circular: R (radius) or D (diameter), i.e. **R250**, **D450**
- variable height: W (width). I.e. **600** for openings of 600 mm width and height adapting to the local shape

Note: Thickness unit is used to define opening dimensions.
Use Radius 0 (zero) to create rectangular openings. I.e. 1000x600x0

Opening **Width (W)** is oriented in the direction of the axis, and the Opening **Height (H)** is normal to the axis.

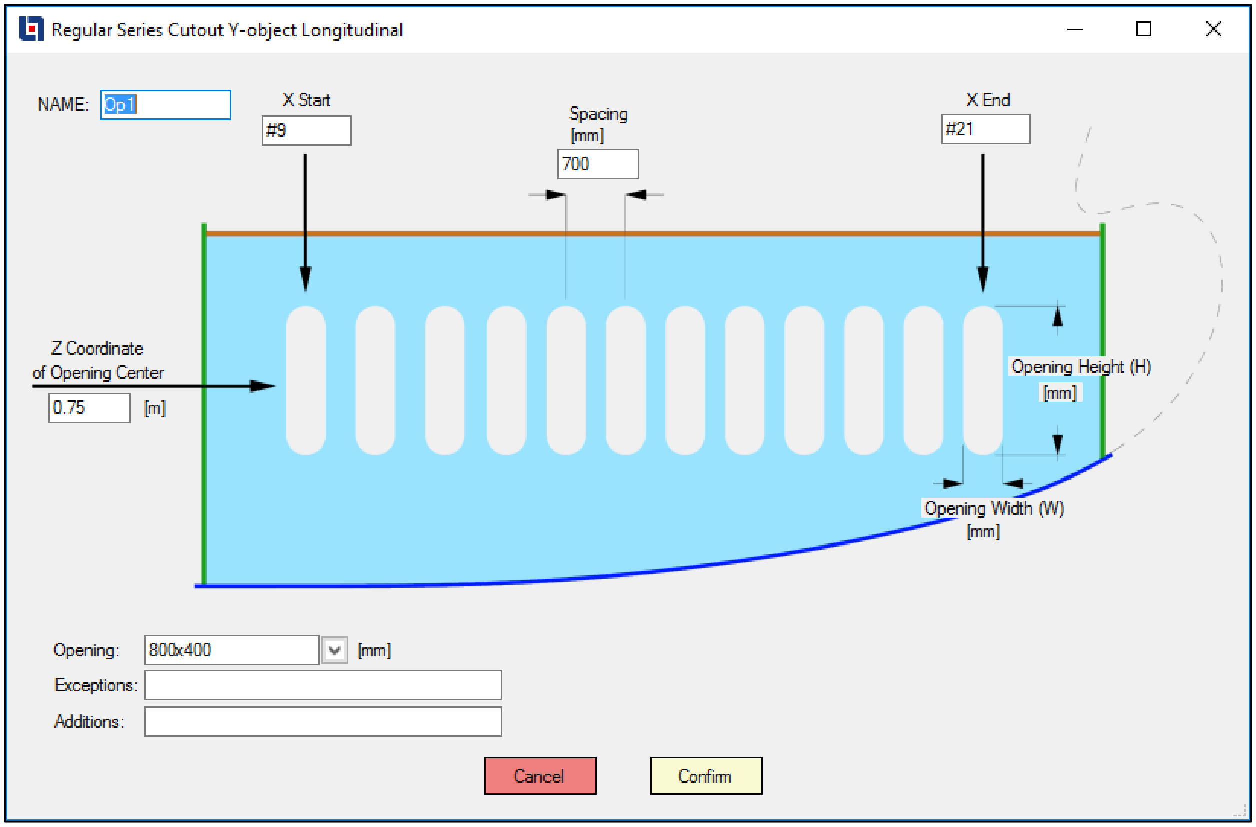
The **Z Coordinate of Opening Center** is the **Height** (Z coordinate) of the opening center.

X Start is the X coordinate of the first opening center.

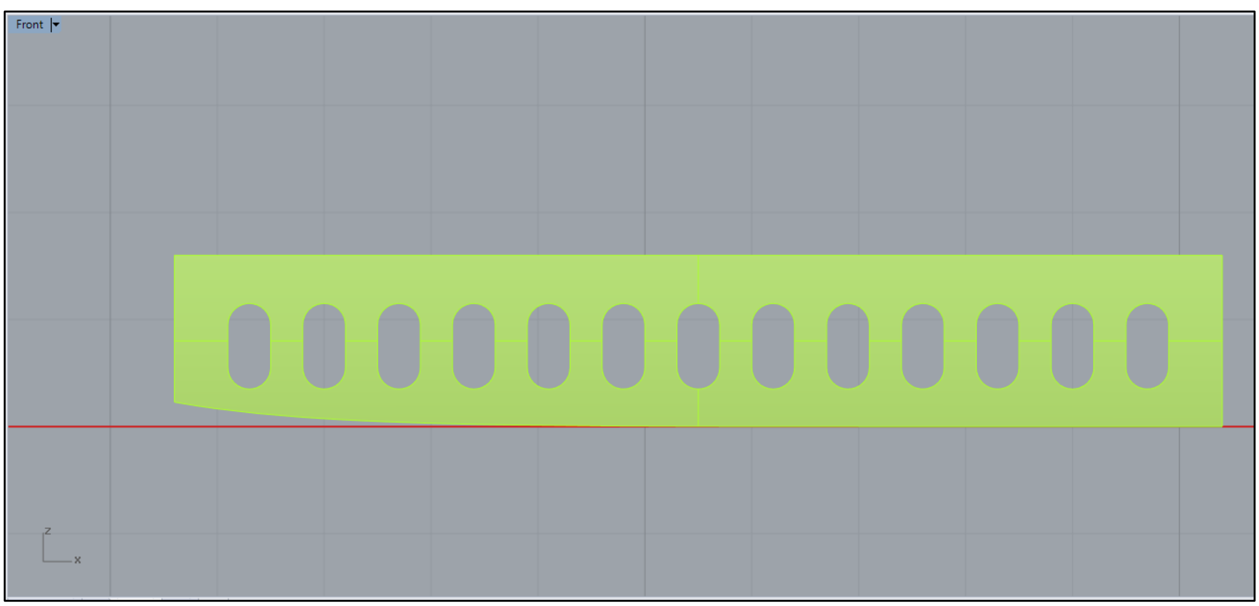
X End is the X coordinate of the last opening center.

Spacing is the distance between the centers of two consecutive openings.

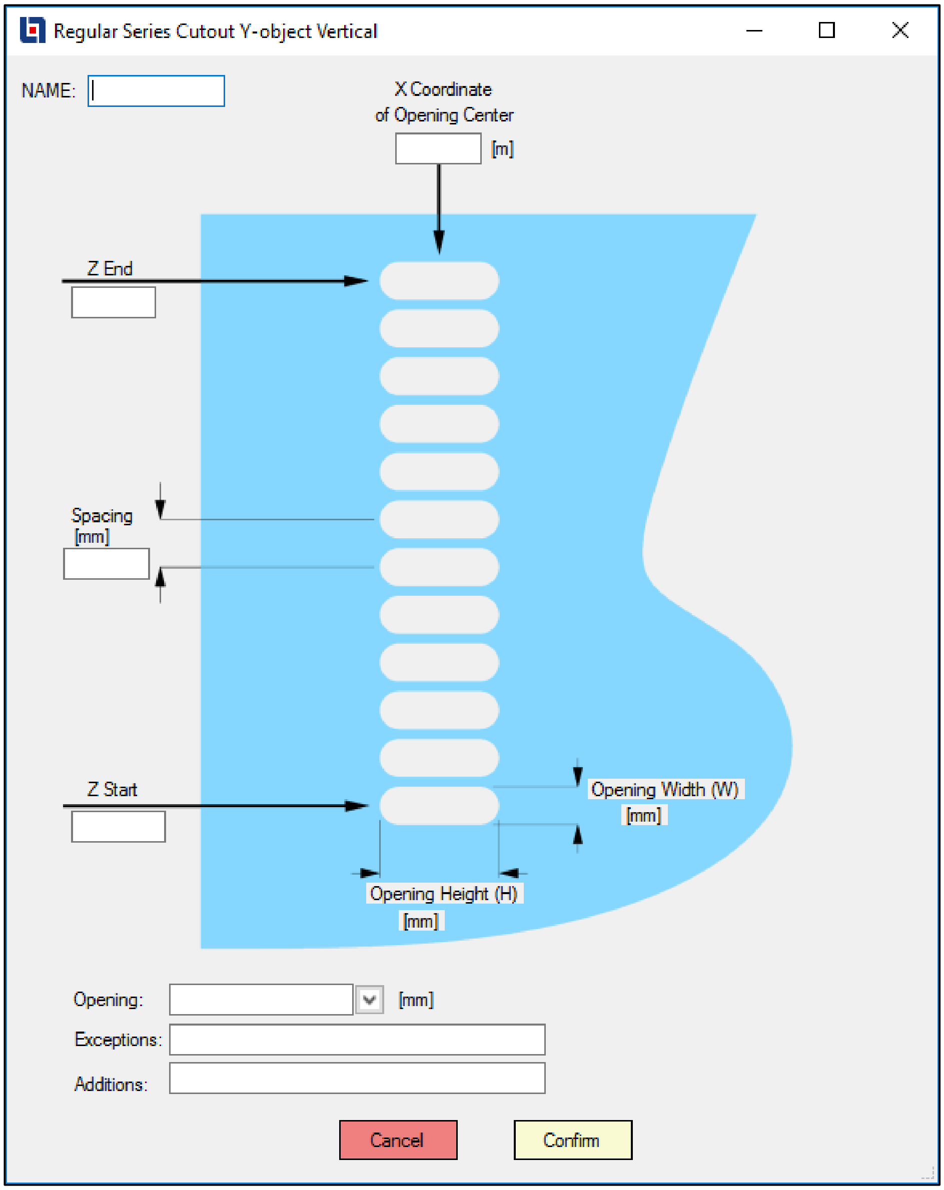
Example Y-Object / Longitudinal Series (XZ plane / X axis):



This is an example of the opening definition for a Girder. This will create a series of 800x400 mm openings, repeating along X axis, starting from X Start #9 up to X End #21, with 700 mm spacing, at the height Z Coordinate of 0.75 meters. The result is the following:



Y-Object / Vertical Series (XZ plane / Z axis)



NAME: the name for the individual or series of cutouts/openings.

Opening **Width (W)** is oriented in the direction of the axis, and the Opening **Height (H)** is normal to the axis.

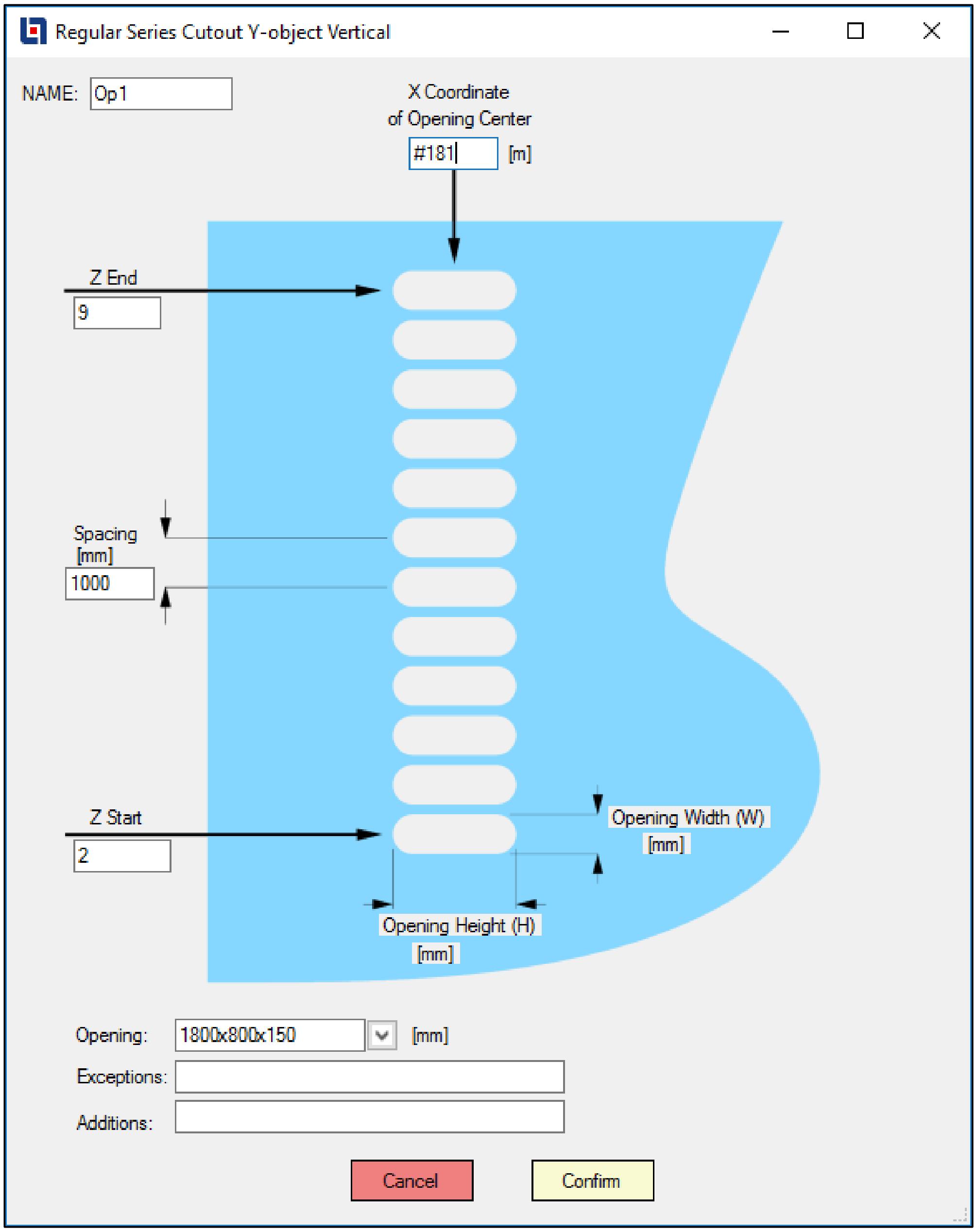
The **X Coordinate of Opening Center** is the **location** (X coordinate) of the opening center.

Z Start is the Z coordinate of the first opening center.

Z End is the Z coordinate of the last opening center.

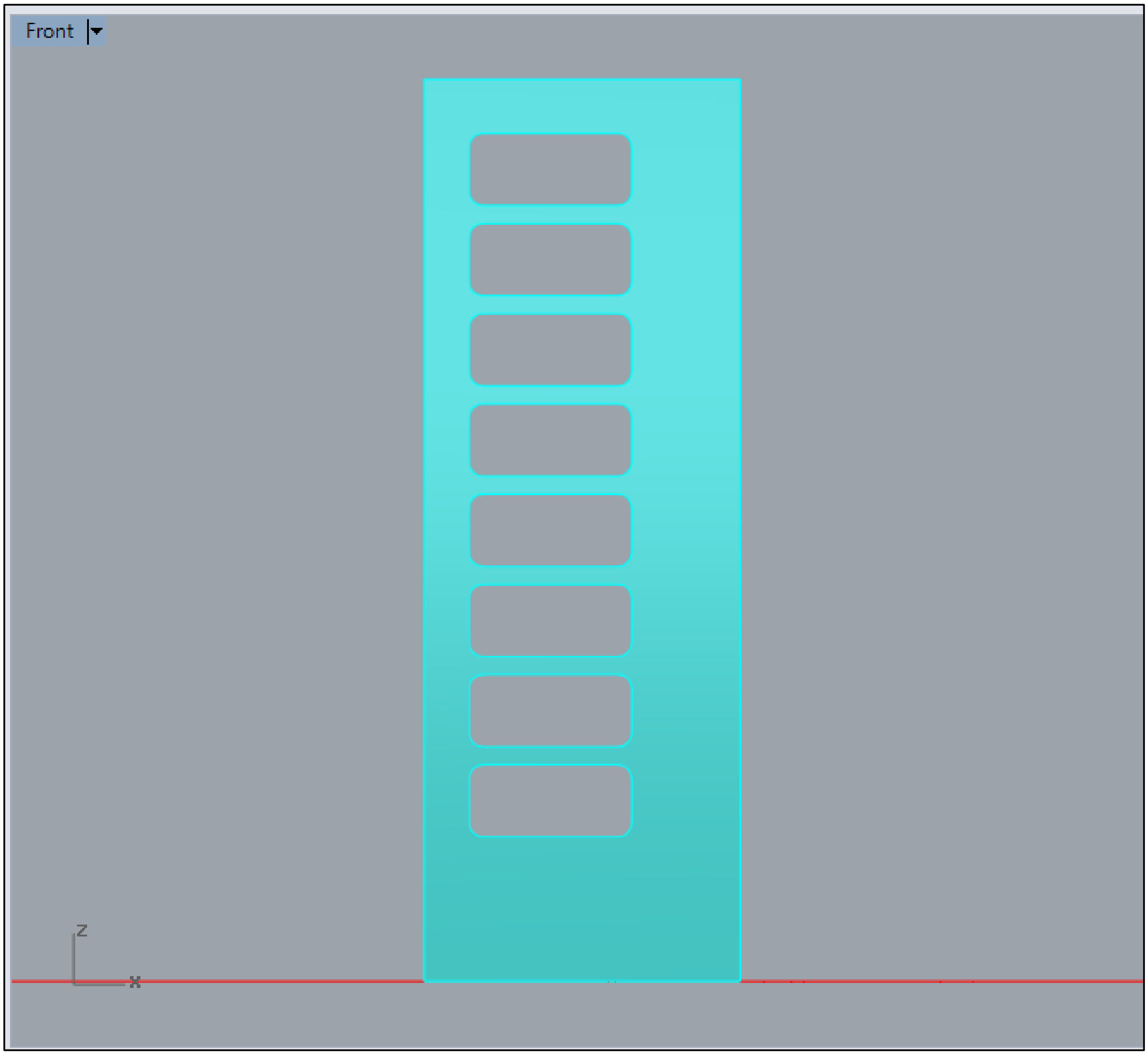
Spacing is the distance between the centers of two consecutive openings.

Example Y-Object / Vertical Series (XZ plane / Z axis):

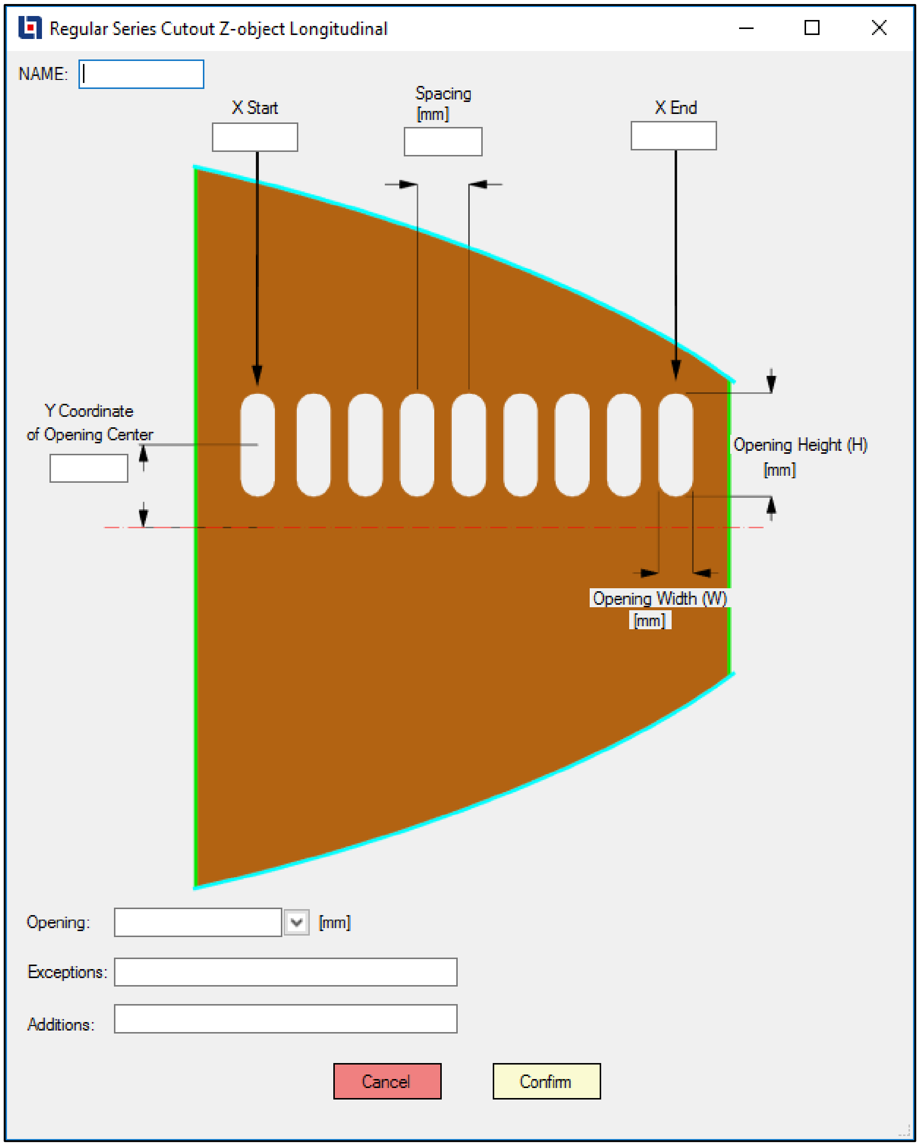


This is an example of the opening definition for a Y object. This will create a series of 1800x800x150 mm openings, repeating along Z axis, starting at 2 meters up to 9 meters, with 1000 mm spacing, at location X Coordinate of Opening Center #181.

The result is the following:


Front
z
x

Z-Object / Longitudinal Series (XY plane / X axis)



NAME: the name for the individual or series of cutouts/openings.

Opening **Width (W)** is oriented in the direction of the axis, and the Opening **Height (H)** is normal to the axis.

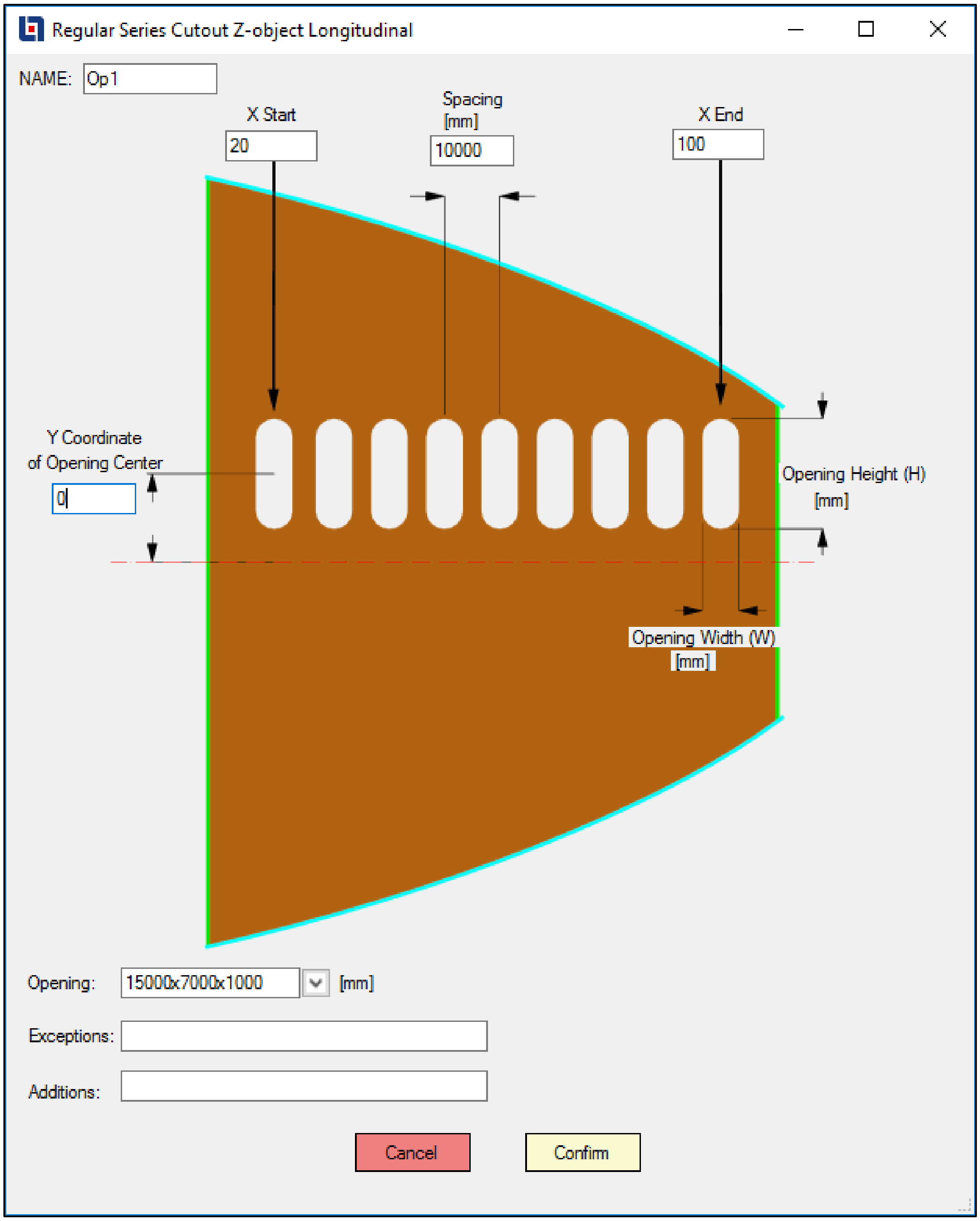
The **Y Coordinate of Opening Center** is the **location** (Y coordinate) of the opening center.

X Start is the X coordinate of the first opening center.

X End is the X coordinate of the last opening center.

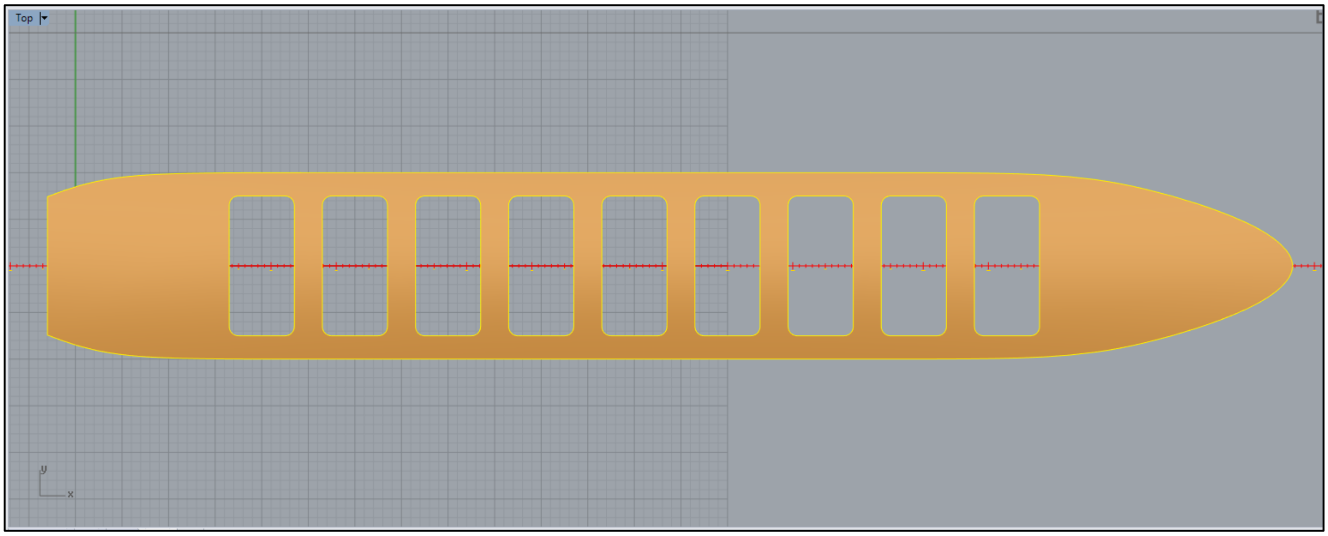
Spacing is the distance between the centers of two consecutive openings.

Example Z-Object / Longitudinal Series (XY plane / X axis):



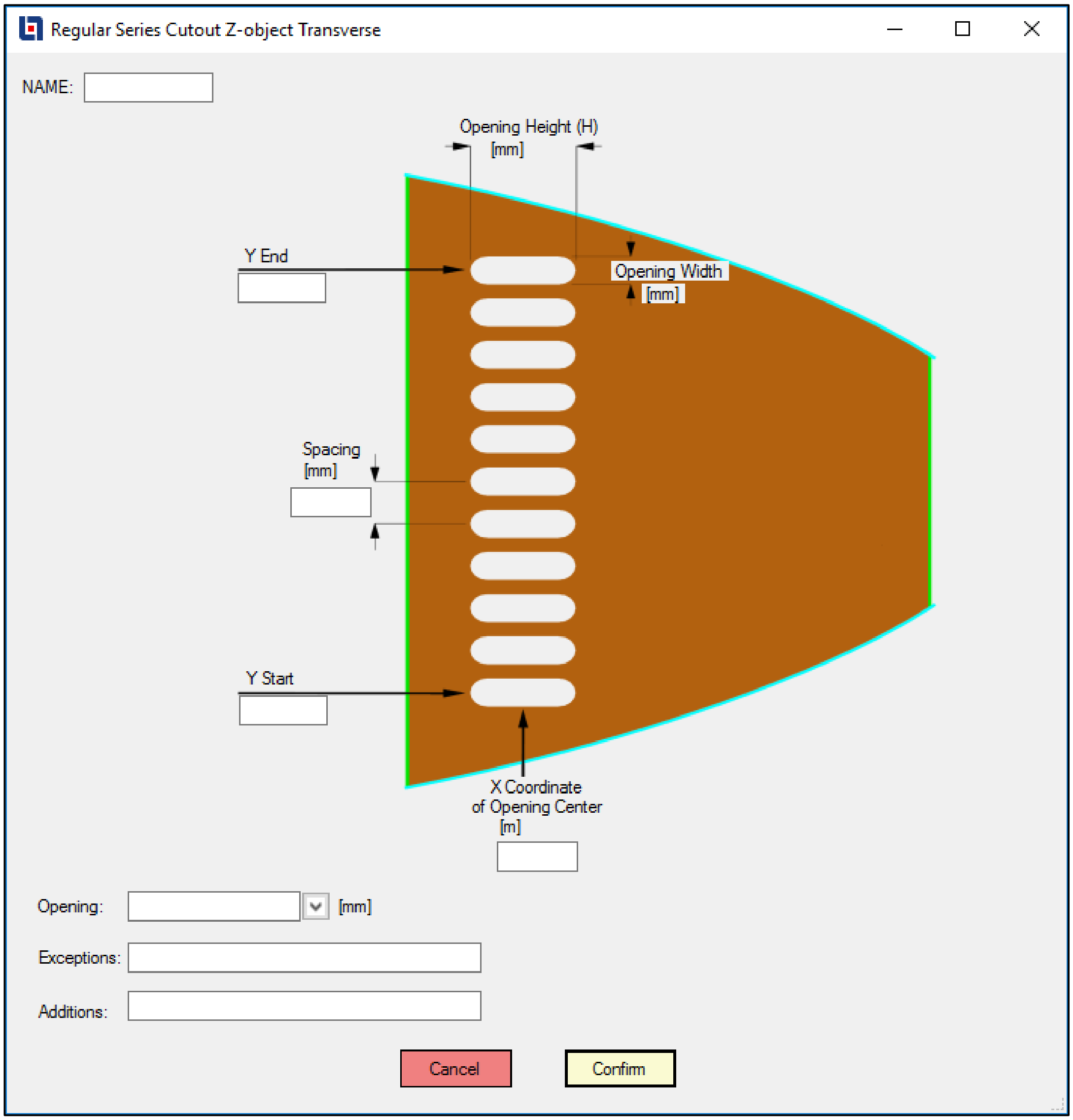
This is an example of the opening definition for a Z object. This will create a series of 15000x7000x1000 mm openings, repeating along X axis, starting at 20 meters up to 100 meters, with 10000 mm spacing, at location Y = 0.

The result is the following:



Top

Z-Object / Transverse Series (XY plane / Y axis)



NAME: the name for the individual or series of cutouts/openings.

Opening **Width (W)** is oriented in the direction of the axis, and the Opening **Height (H)** is normal to the axis.

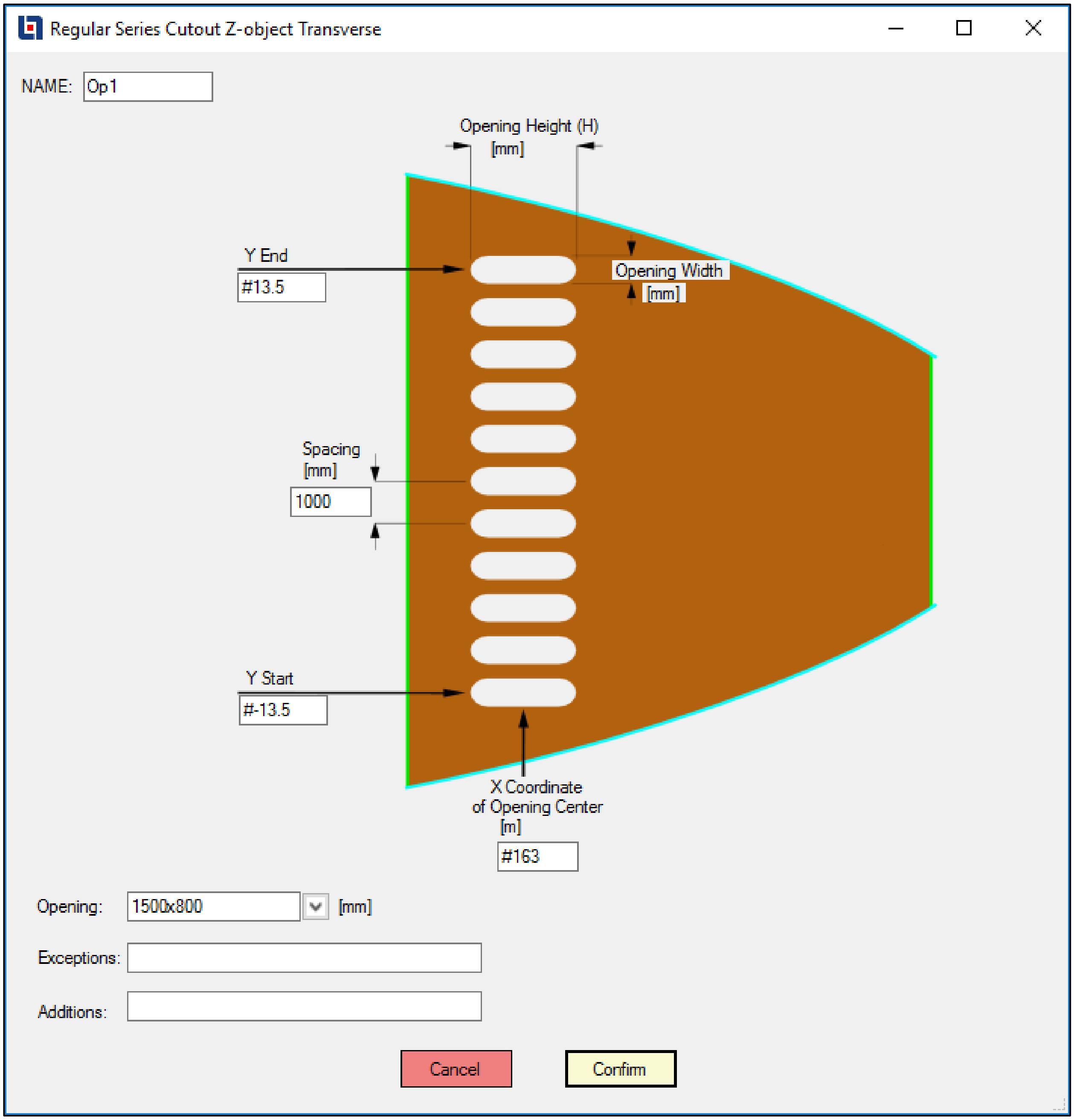
The **X Coordinate of Opening Center** is the **location** (X coordinate) of the opening center.

Y Start is the Y coordinate of the first opening center.

Y End is the Y coordinate of the last opening center.

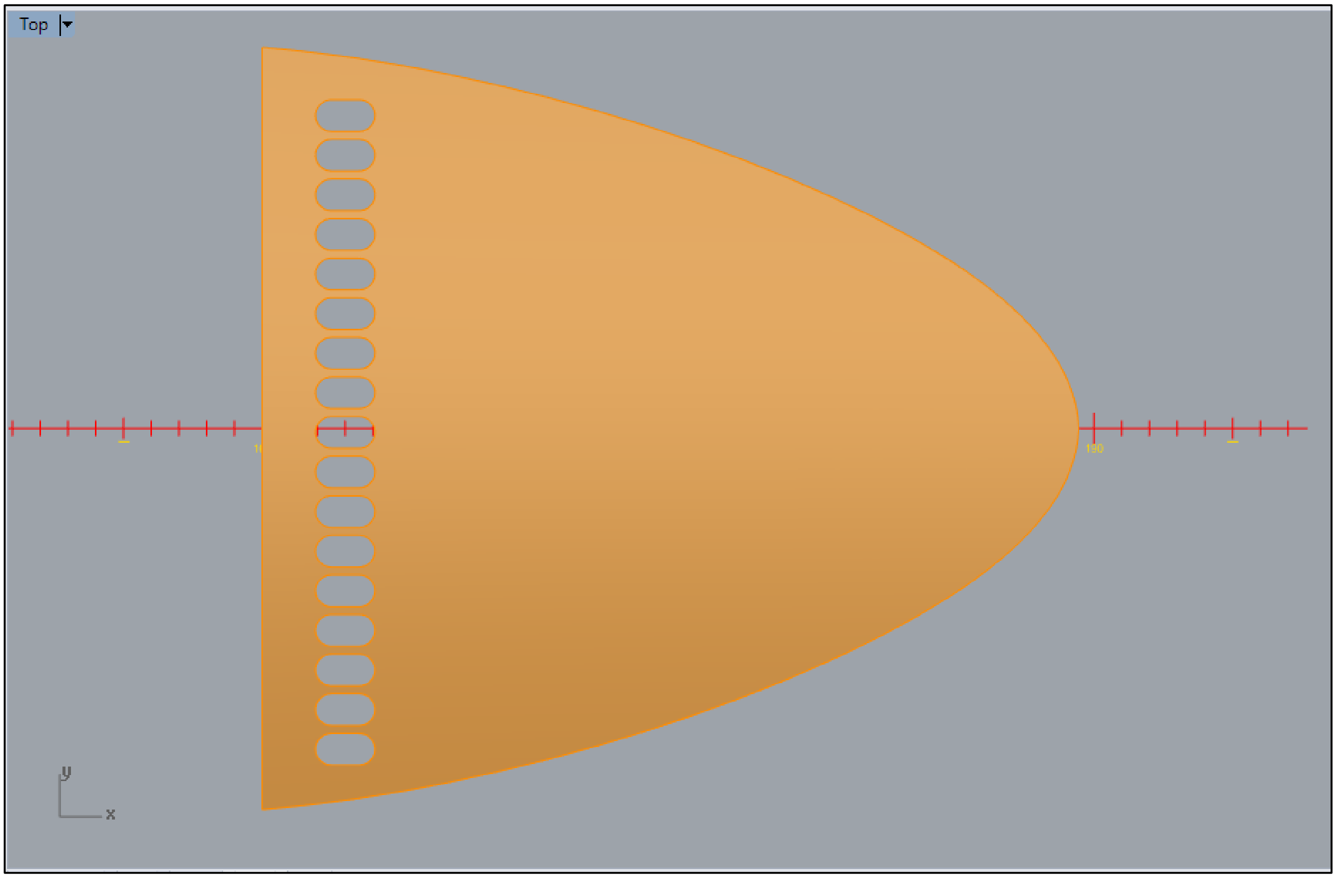
Spacing is the distance between the centers of two consecutive openings.

Example Z-Object / Transverse Series (XY plane / Y axis):



This is an example of the opening definition for a Z object. This will create a series of 15000x800 mm openings, repeating along Y axis, starting at #-13.5 up to #13.5, with 1000 mm spacing, at location X = #163.

The result is the following:


Top
y
x

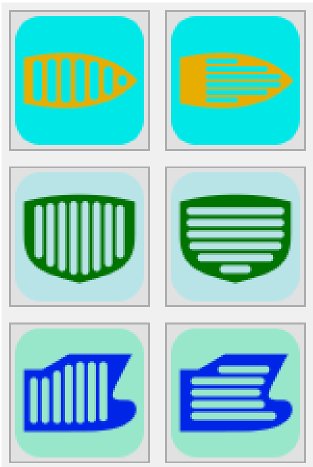
Variable Height Series Method

This method will generate series of openings of constant width (W) and with variable height adapting to a set of imposed borders.

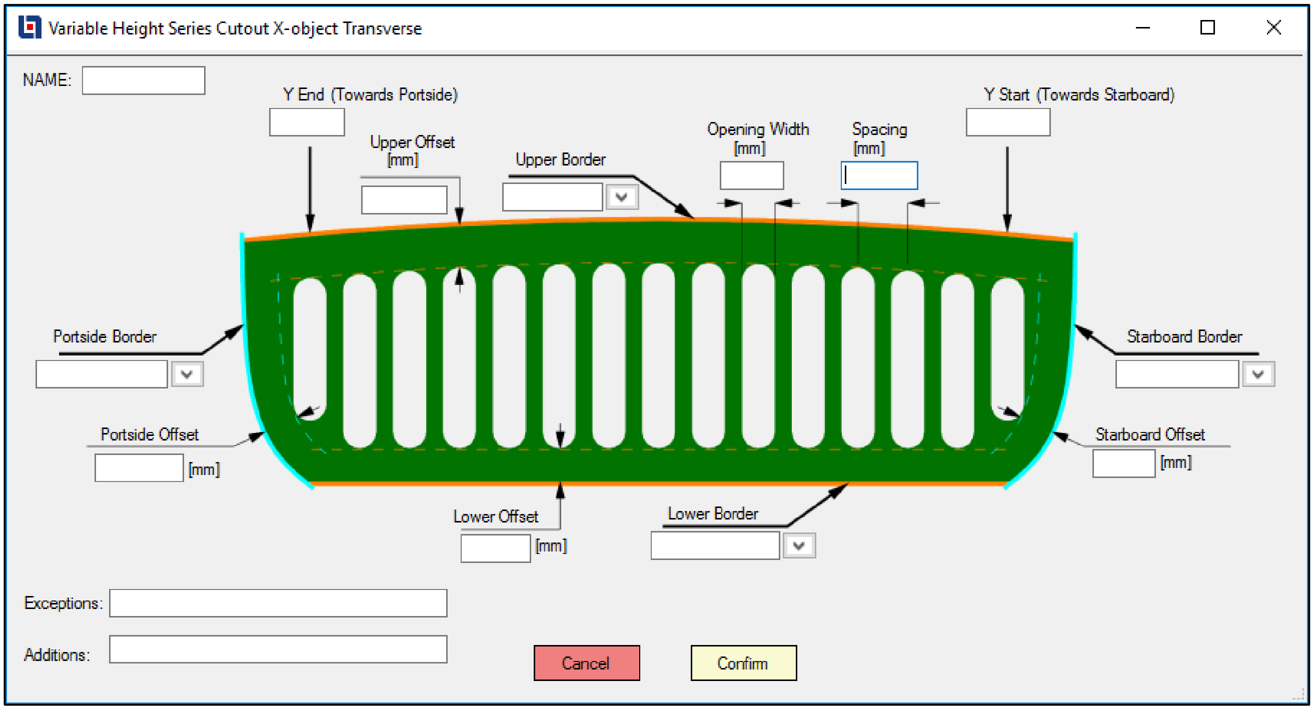
Each object type (X-Object, Y-Object, Z-Object) can have two variable height series types as following:

- **X-Object (YZ Plane)**:
  - Transverse Series (Y axis)
  - Vertical Series (Z axis)
- **Y-Object (XZ Plane)**:
  - Longitudinal Series (X axis)
  - Vertical Series (Z axis)
- **Z-Object (XY Plane)**:
  - Longitudinal Series (X axis)
  - Transverse Series (Y axis)

The following **CutOp icons** are appropriate for **Variable Height Series Method**:



X-Object / Variable Height - Transverse Series (YZ plane / Y axis)



NAME: the name for the individual or series of cutouts/openings.

Opening **Width (W)** is oriented in the direction of the axis and height is adapting to the local shape.

Y Start (Towards Starboard) is the Y coordinate of the first opening center.

Y End (Towards Portside) is the Y coordinate of the last opening center.

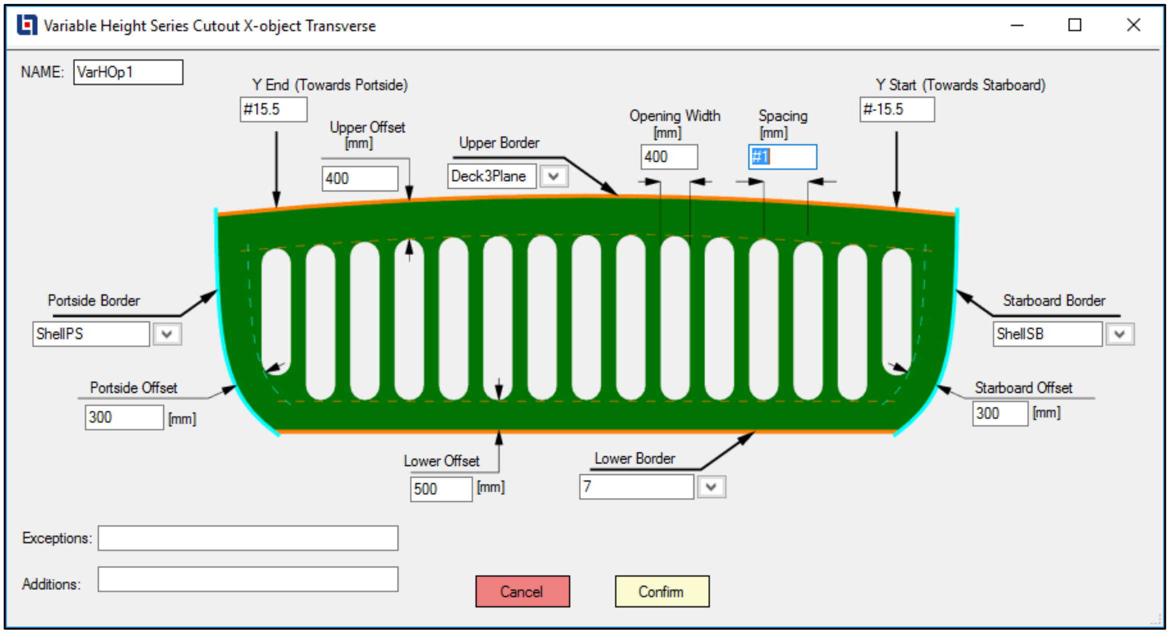
Spacing is the distance between the centers of two consecutive openings.

Upper Border/Lower Border/Portside Border/Starboard Border: represent the four borders between which the openings will be generated.

Upper Offset/Lower Offset/Portside Offset/Starboard Offset: represent the distance from the borders to the ends of the openings.

Note: Upper Border, Upper Offset, Lower Border, Lower Offset are optional. If used, they prevent any opening to be generated beyond them.

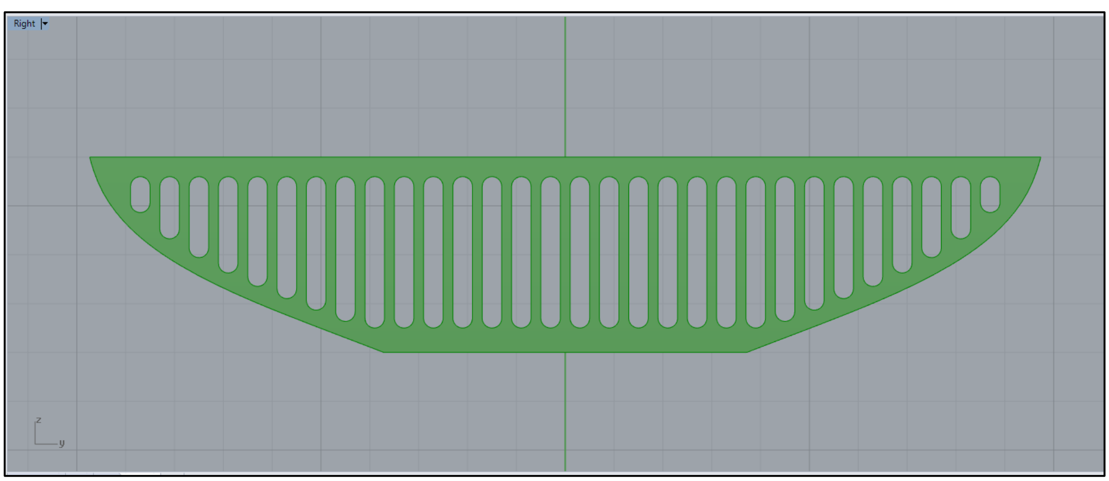
Example X-Object / Variable Height - Transverse Series (YZ plane / Y axis)



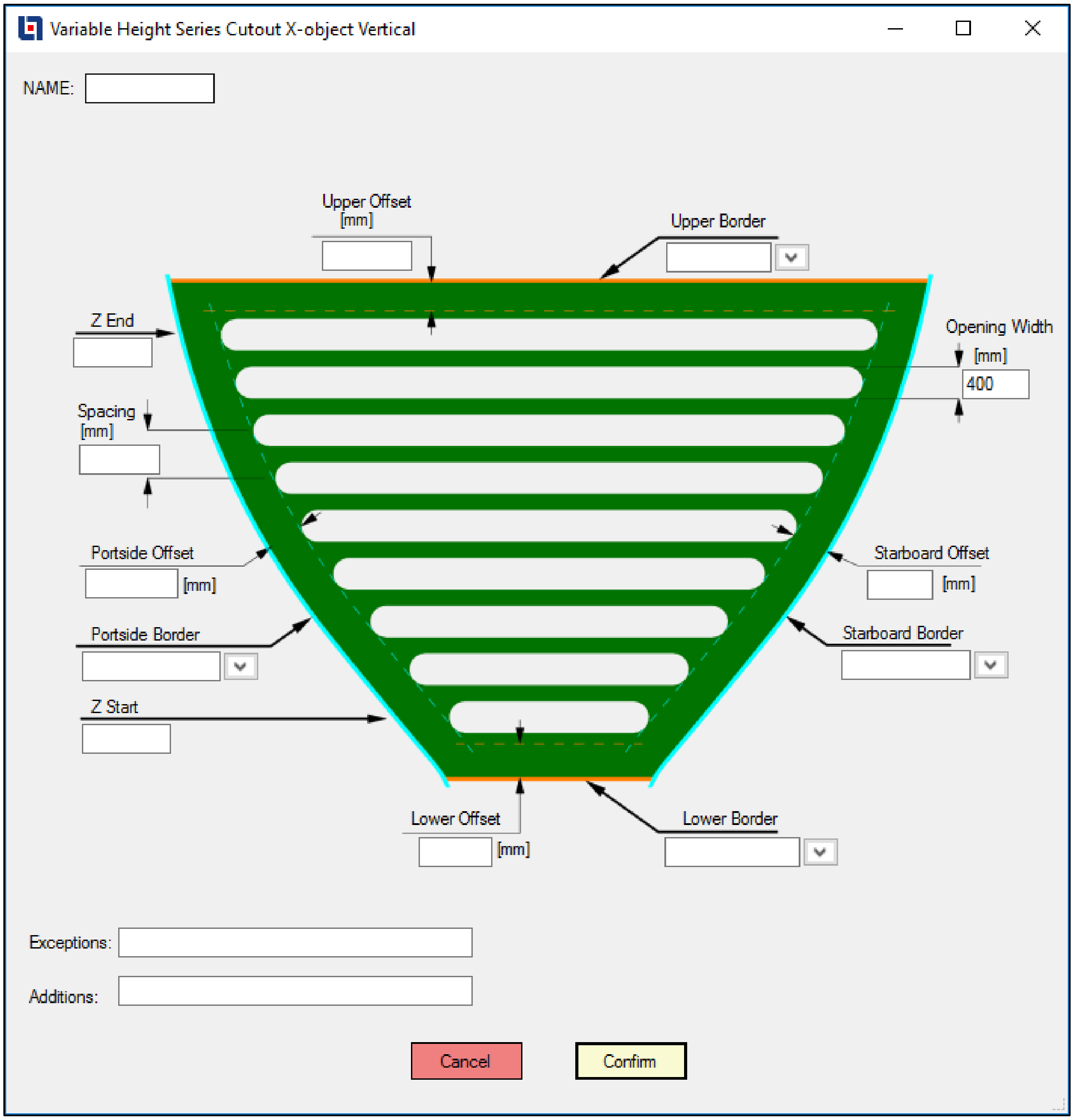
This is an example of the openings definition for a floor. This will create a series of variable height openings (adapting to the element shape), with **Opening Width 400 mm**, with **Y Start #-15.5** and **Y End #15.5**, with **1 longitudinal frame** space between them, no **exceptions** and no **additional** openings in this case.

The openings are bordered at the upper end (**Upper Border**) by **Deck3Plane** surface with a gap (**Upper Offset**) of **400 mm**, at the lower end (**Lower Border**) by **Z = 7 meters** with a gap (**Lower Offset**) of **500 mm**, at the portside end (**Portside Border**) by **ShellPS** surface with a gap (**Portside Offset**) of **300 mm** and at the starboard end (**Starboard Border**) by **ShellSB** surface with a gap (**SB Offset**) of **300 mm**.

The results is:



X-Object / Variable Height - Vertical Series (YZ plane / Z axis)



NAME: the name for the individual or series of cutouts/openings.

Opening **Width (W)** is oriented in the direction of the axis and height is adapting to the local shape.

Z Start is the Z coordinate of the first opening center.

Z End is the Z coordinate of the last opening center.

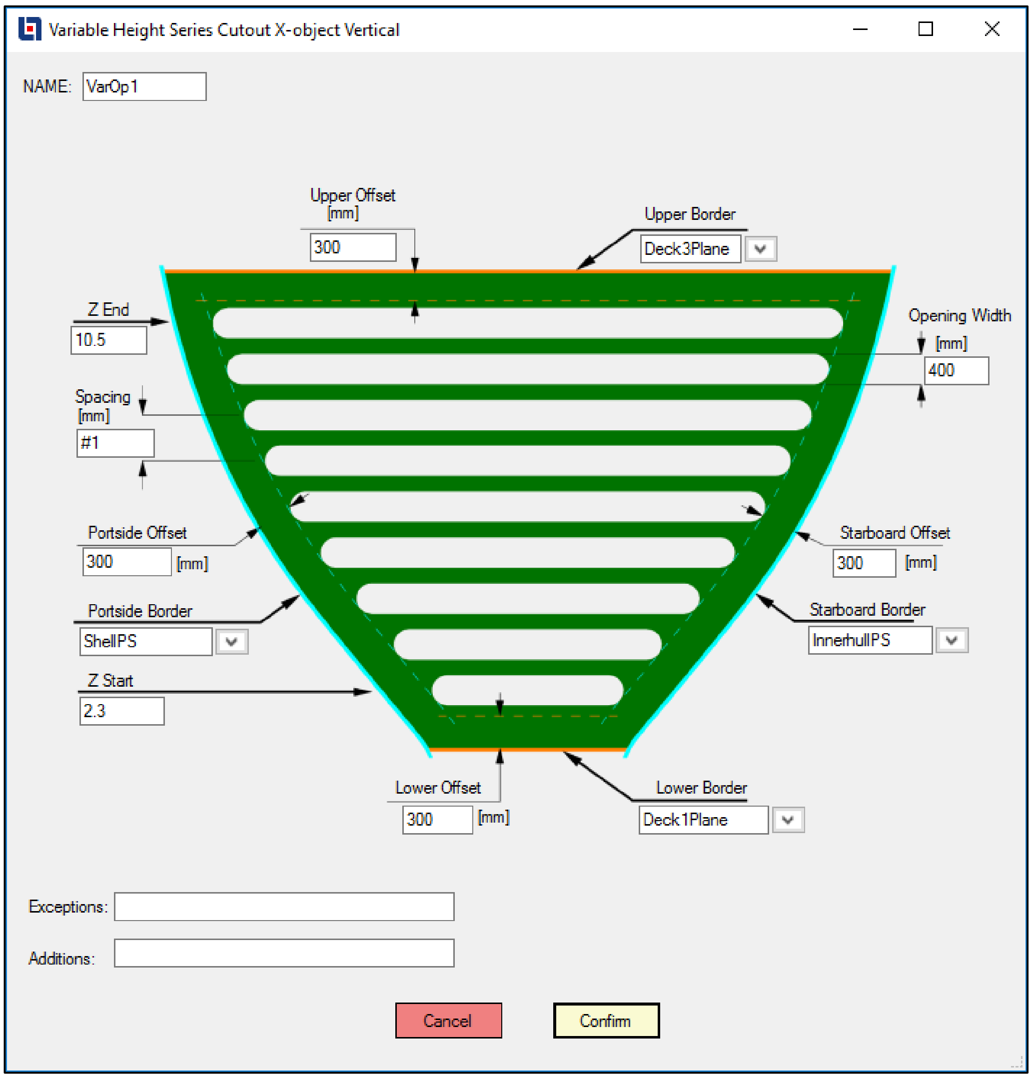
Spacing is the distance between the centers of two consecutive openings.

Upper Border/Lower Border/Portside Border/Starboard Border: represent the four borders between which the openings will be generated.

Upper Offset/Lower Offset/Portside Offset/Starboard Offset: represents the distance from the borders to the ends of the openings.

Note: Upper Border, Upper Offset, Lower Border, Lower Offset are optional. If used, they prevent any opening to be generated beyond them.

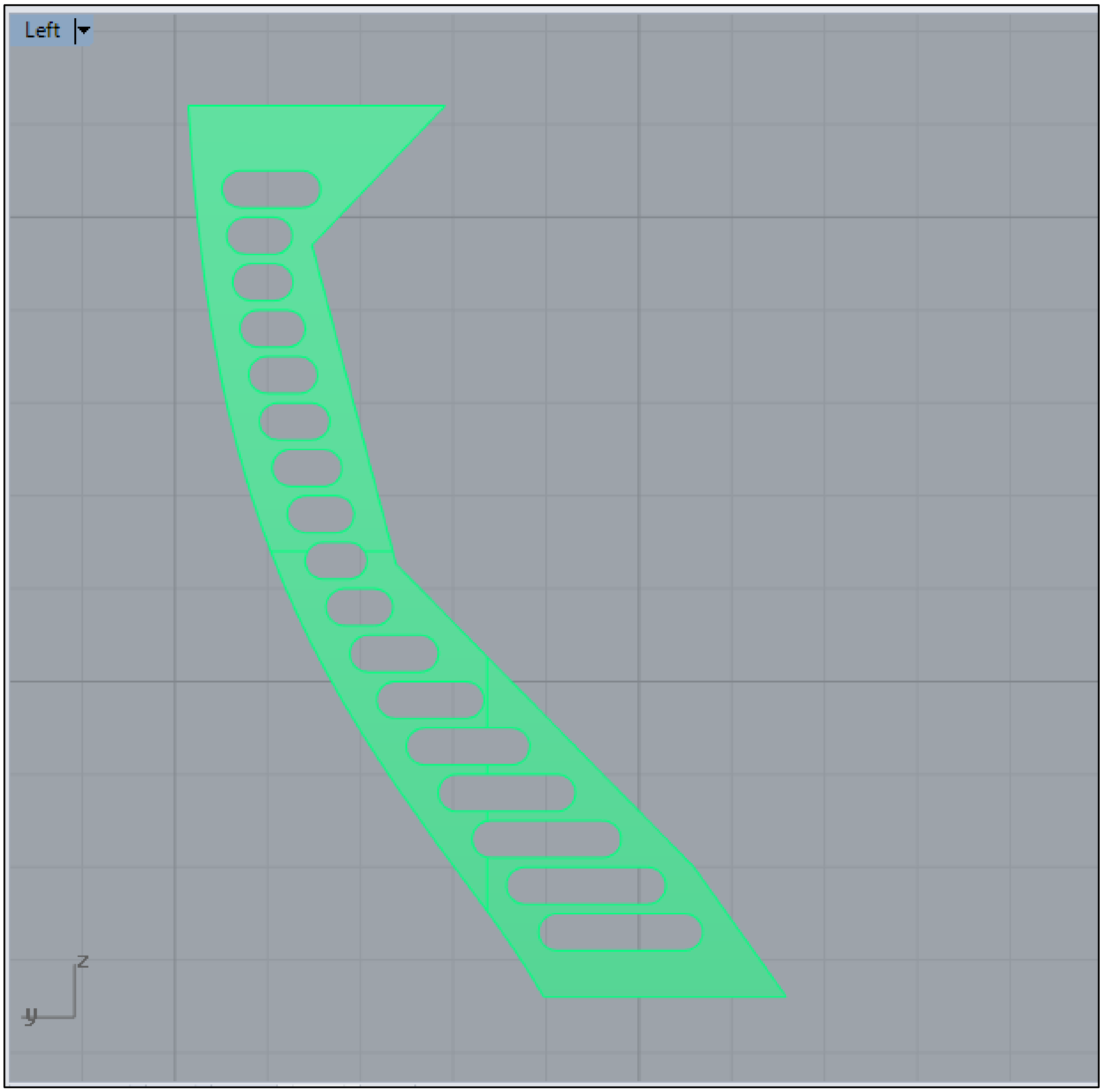
Example X-Object / Variable Height - Vertical Series (YZ plane / Z axis)



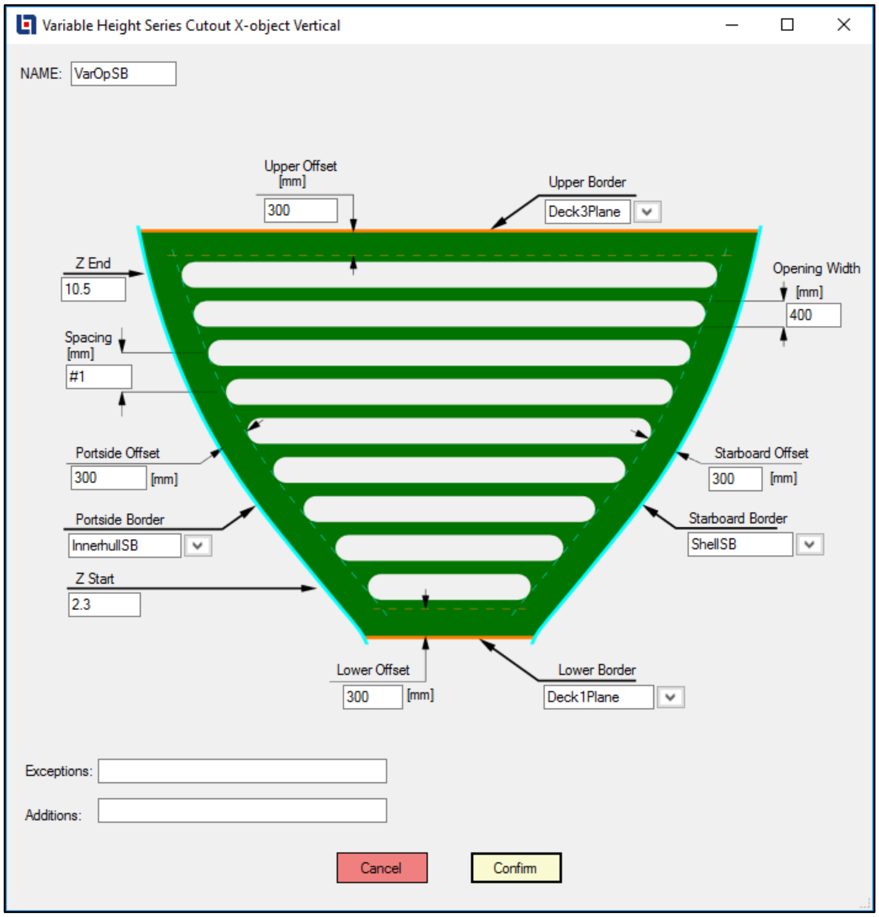
This is an example of the openings definition for a Web PS. This will create a series of variable height openings (adapting to the element shape), with 400 mm width, repeating along **Z axis**, **starting** at **Z**= **2.3** meters, **ending** at **Z**= **10.5** meters, with **1 vertical frame** space between them, no **exceptions** and no **additional** openings in this case.

The openings are bordered at the upper end (**Upper Border**) by **Deck3Plane** surface with a gap (**Upper Offset**) of **300 mm**, at the lower end (**Lower Border**) by **Deck1Plane** surface with a gap (**Lower Offset**) of **300 mm**, at the portside end (**PS Border**) by **ShellPS** surface with a gap (**PS Offset**) of **300 mm** and at the starboard end (**SB Border**) by **InnerhullPS** surface with a gap (**SB Offset**) of **300 mm**.

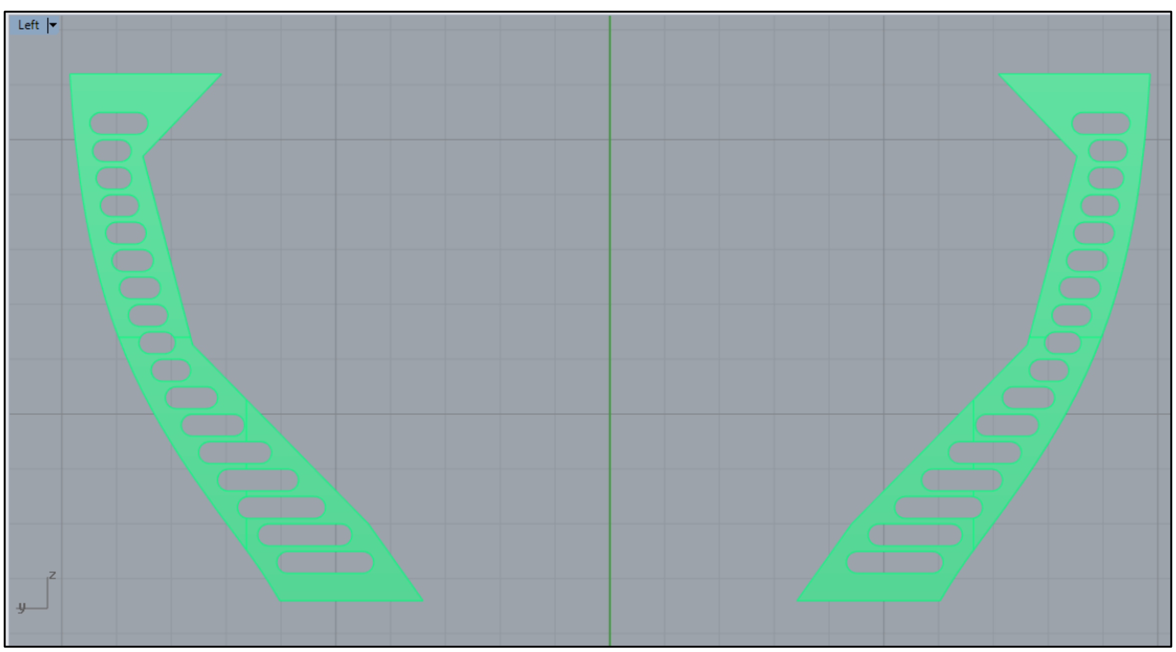
The result is the following:



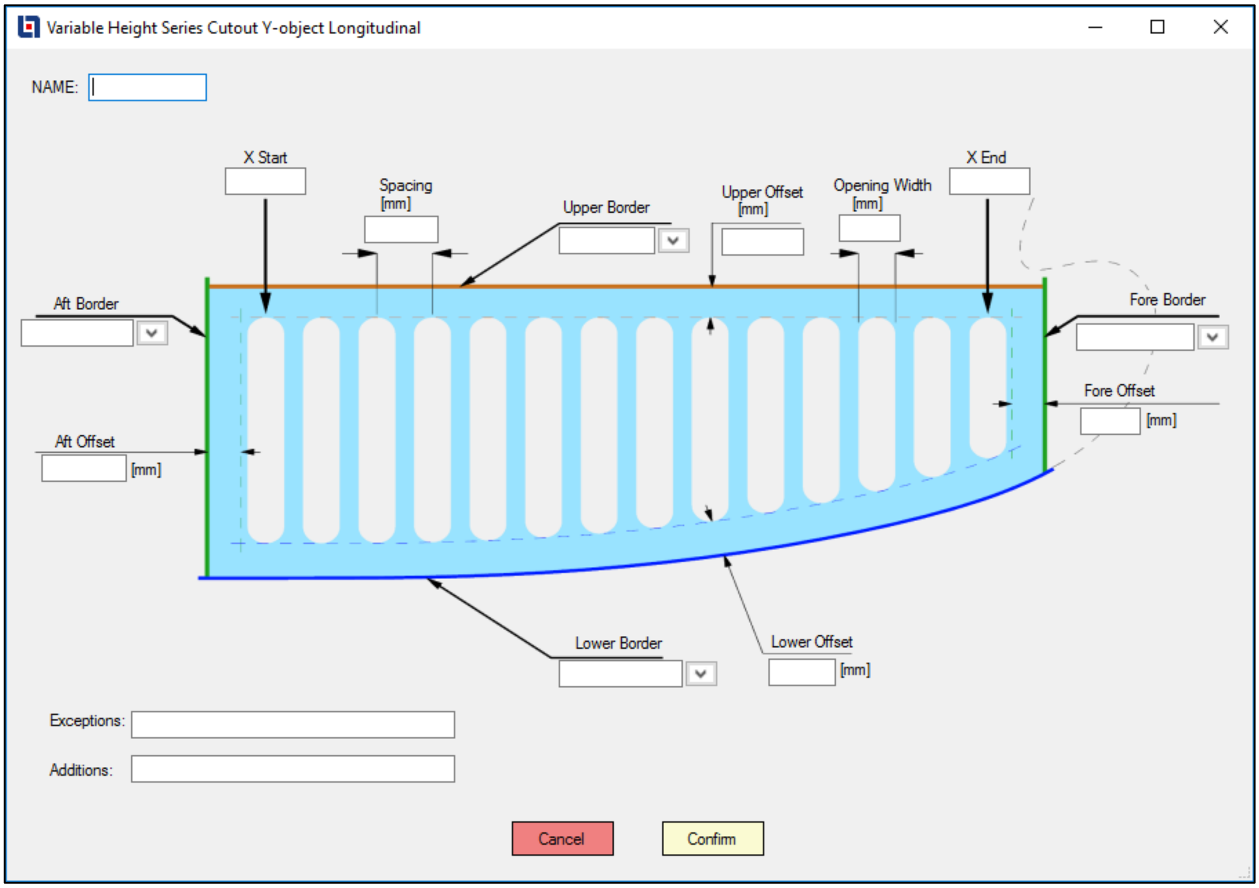
When creating symmetric elements with symmetric variable height series, it is necessary to define a new variable height opening with the corresponding Starboard side inputs:



For Web SB the openings are bordered at the portside end (**PS Border**) by **InnerhullSB** surface with a gap (**PS Offset**) of **300 mm** and at the starboard end (**SB Border**) by **ShellSB** surface with a gap (**SB Offset**) of **300 mm**. The final result will be:



Y-Object / Variable Height - Longitudinal Series (XZ plane / X axis)



NAME: the name for the individual or series of cutouts/openings.

Opening **Width (W)** is oriented in the direction of the axis and height is adapting to the local shape.

X Start is the X coordinate of the first opening center.

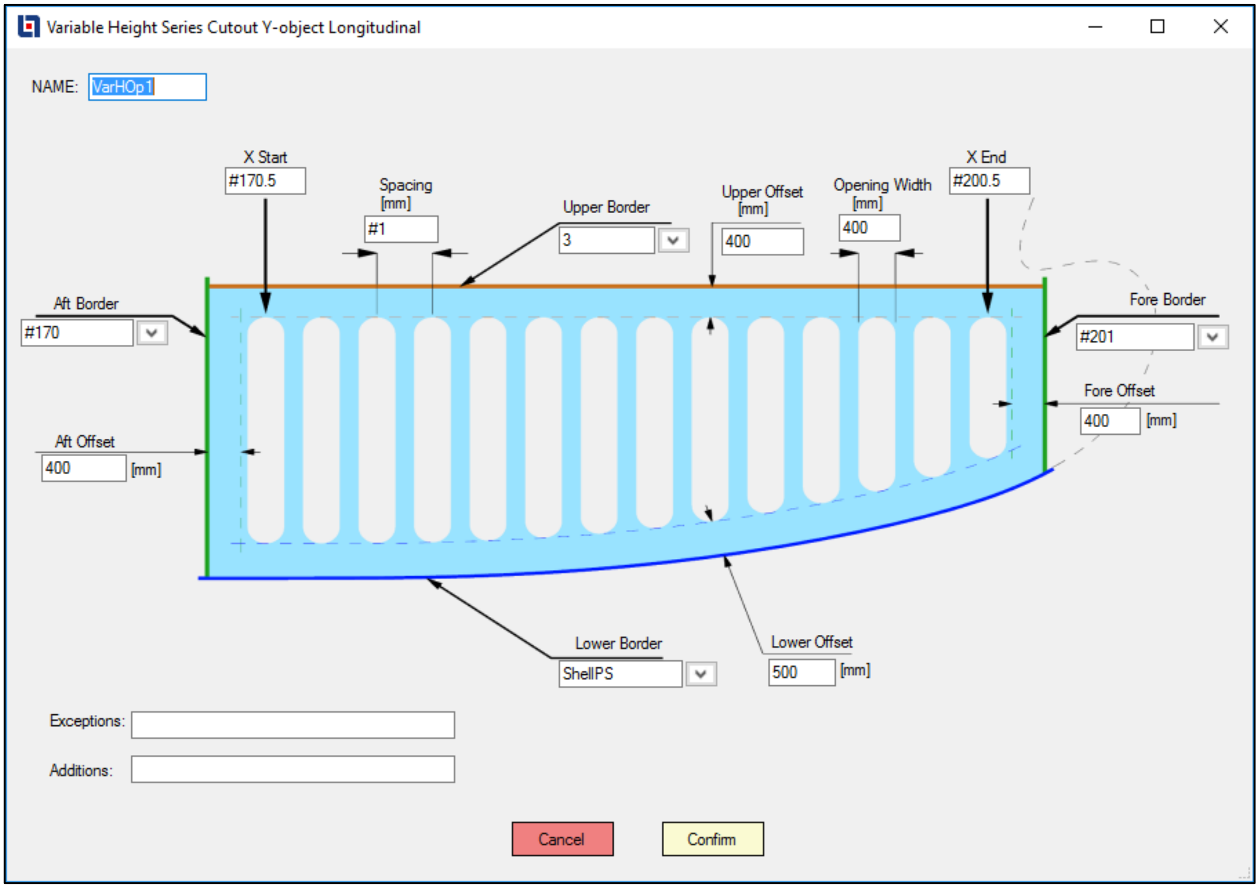
X End is the X coordinate of the last opening center.

Spacing is the distance between the centers of two consecutive openings.

Upper Border/Lower Border/Aft Border/Fore Border: represent the four borders between which the openings will be generated.

Upper Offset/Lower Offset/Aft Offset/Fore Offset: represent the distance from the borders to the ends of the openings.

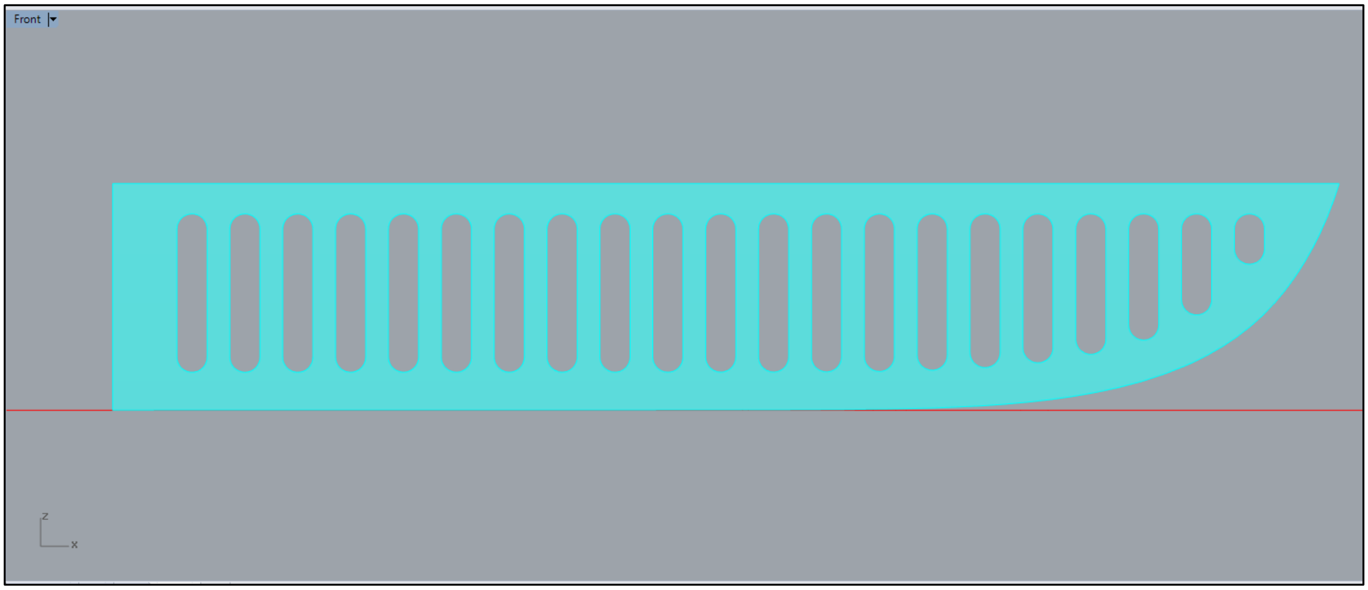
Example Y-Object / Variable Height - Longitudinal Series (XZ plane / X axis)



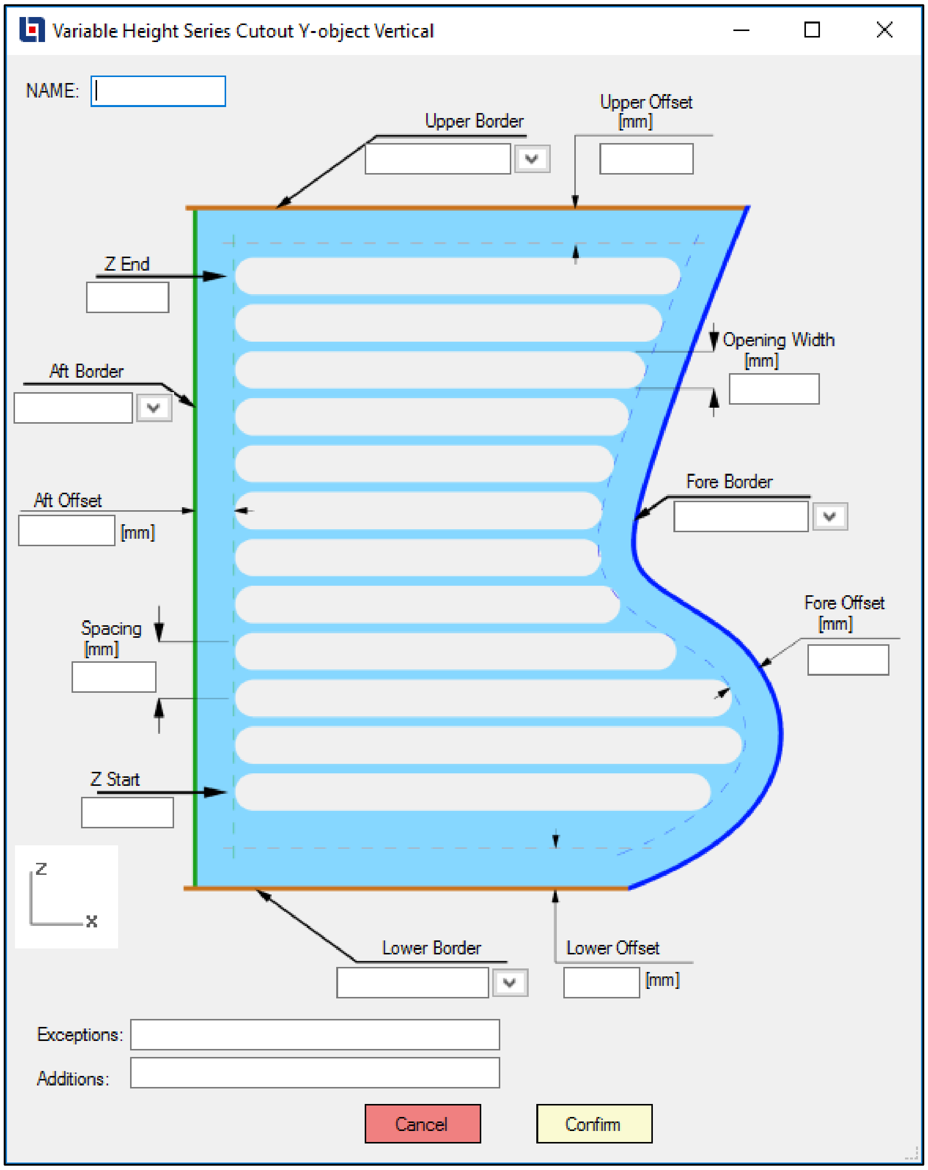
This is an example of the openings definition for a Longitudinal Girder. This will create a series of variable height openings (adapting to the element shape), with **Opening Width 400 mm**, **starting** at **X**= **#170.5**, **ending** at **X**= **#200.5**, with **1 frame** space between them, no **exceptions** and no **additional** openings in this case.

The openings are bordered at the upper end (**Upper Border**) by Z coordinate = **3** meters with a gap (**Upper Offset**) of **400 mm**, at the lower end (**Lower Border**) by **ShellPS** surface with a gap (**Lower Offset**) of **500 mm**, at the aft end (**Aft Border**) by X= **#170** with a gap (**Aft Offset**) of **400 mm,** and at the fore end (**Fore Border**) by X= **#201** with a gap (**Fore Offset**) of **400 mm**.

The result is the following:


Front
z
x

Y-Object / Variable Height - Vertical Series (XZ plane / Z axis)



NAME: the name for the individual or series of cutouts/openings.

Opening **Width (W)** is oriented in the direction of the axis and height is adapting to the local shape.

Z Start is the Z coordinate of the first opening center.

Z End is the Z coordinate of the last opening center.

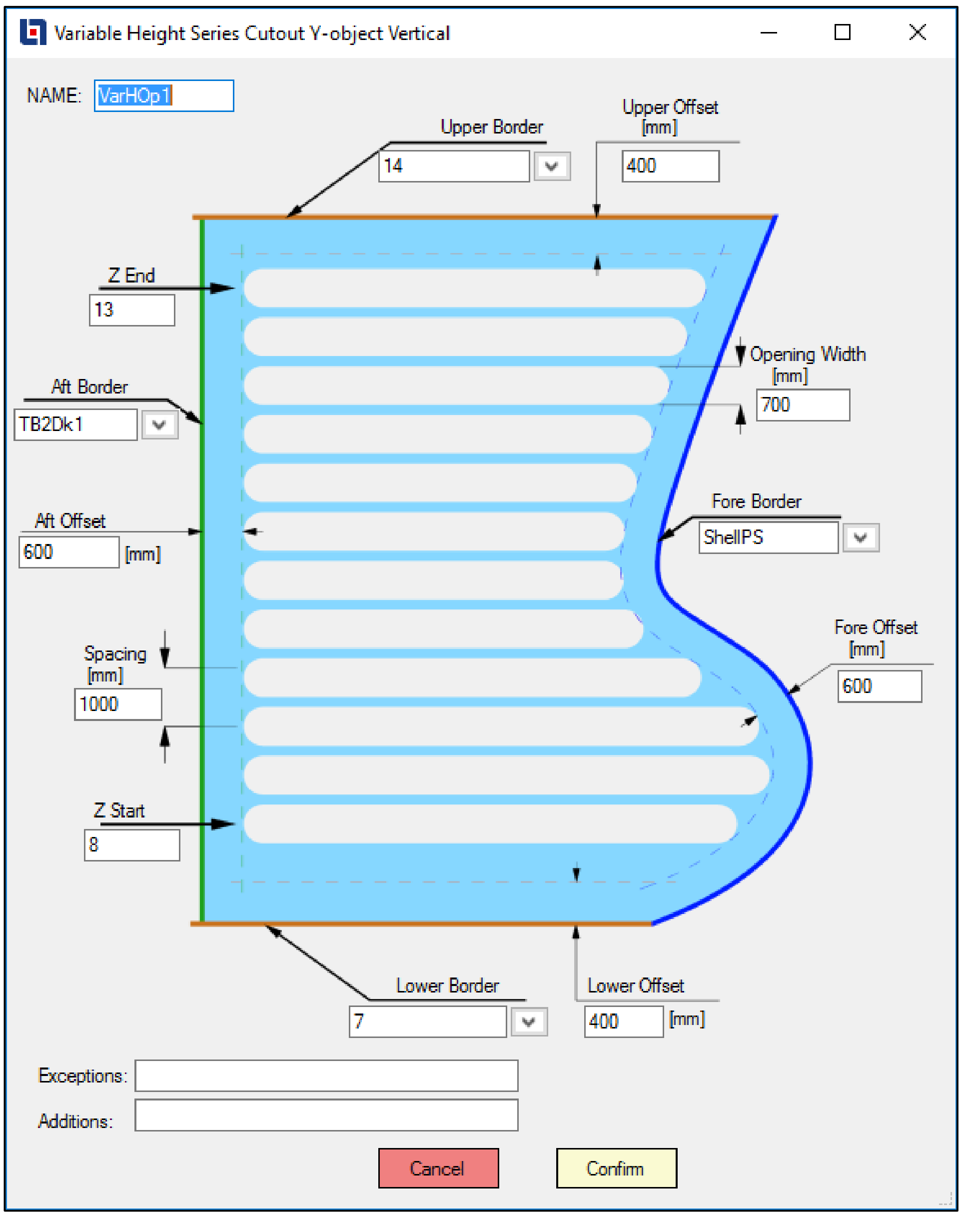
Spacing is the distance between the centers of two consecutive openings.

Upper Border/Lower Border/Aft Border/Fore Border: represent the four borders between which the openings will be generated.

Upper Offset/Lower Offset/Aft Offset/Fore Offset: represents the distance from the borders to the ends of the openings.

Note: Upper Border, Upper Offset, Lower Border, Lower Offset are optional. If used, they prevent any opening to be generated beyond them.

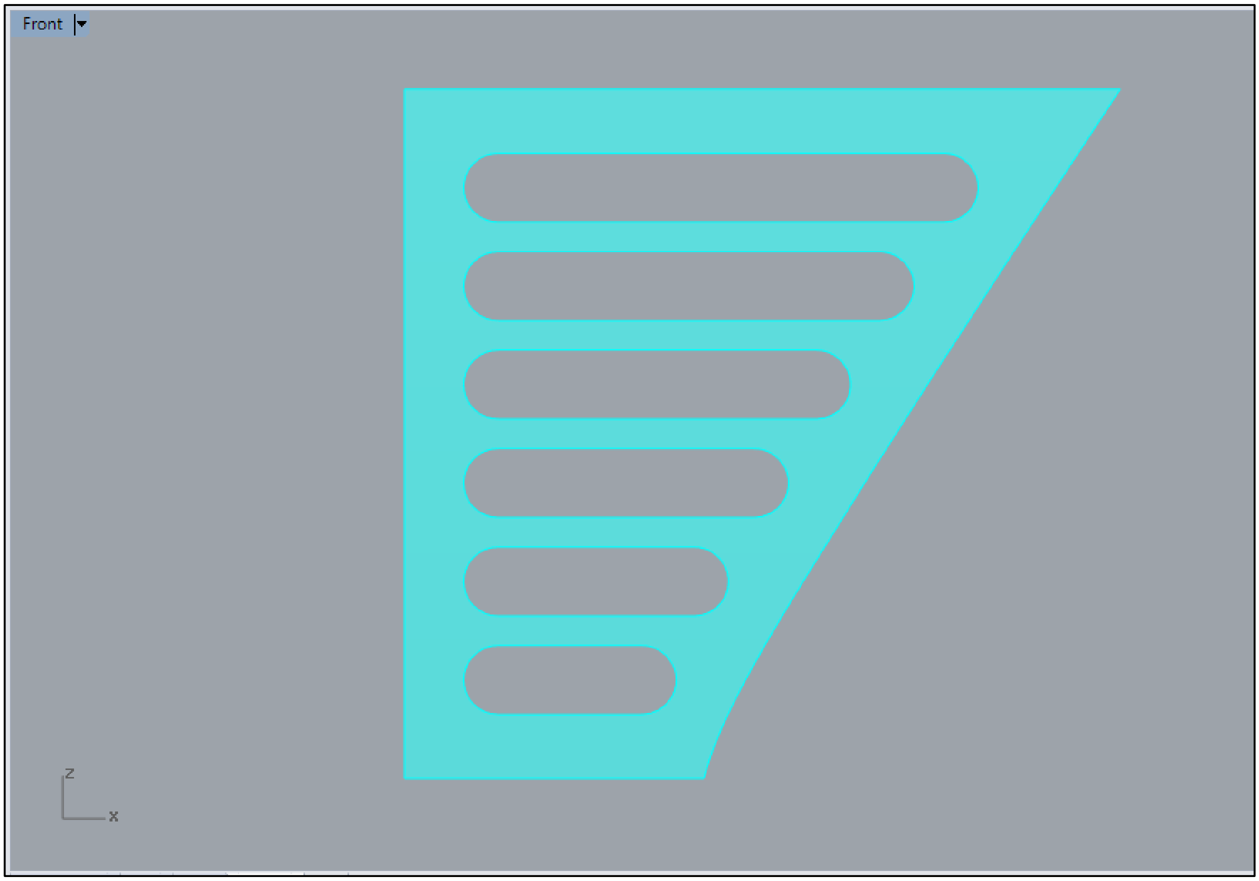
Example Y-Object / Variable Height - Vertical Series (XZ plane / Z axis)



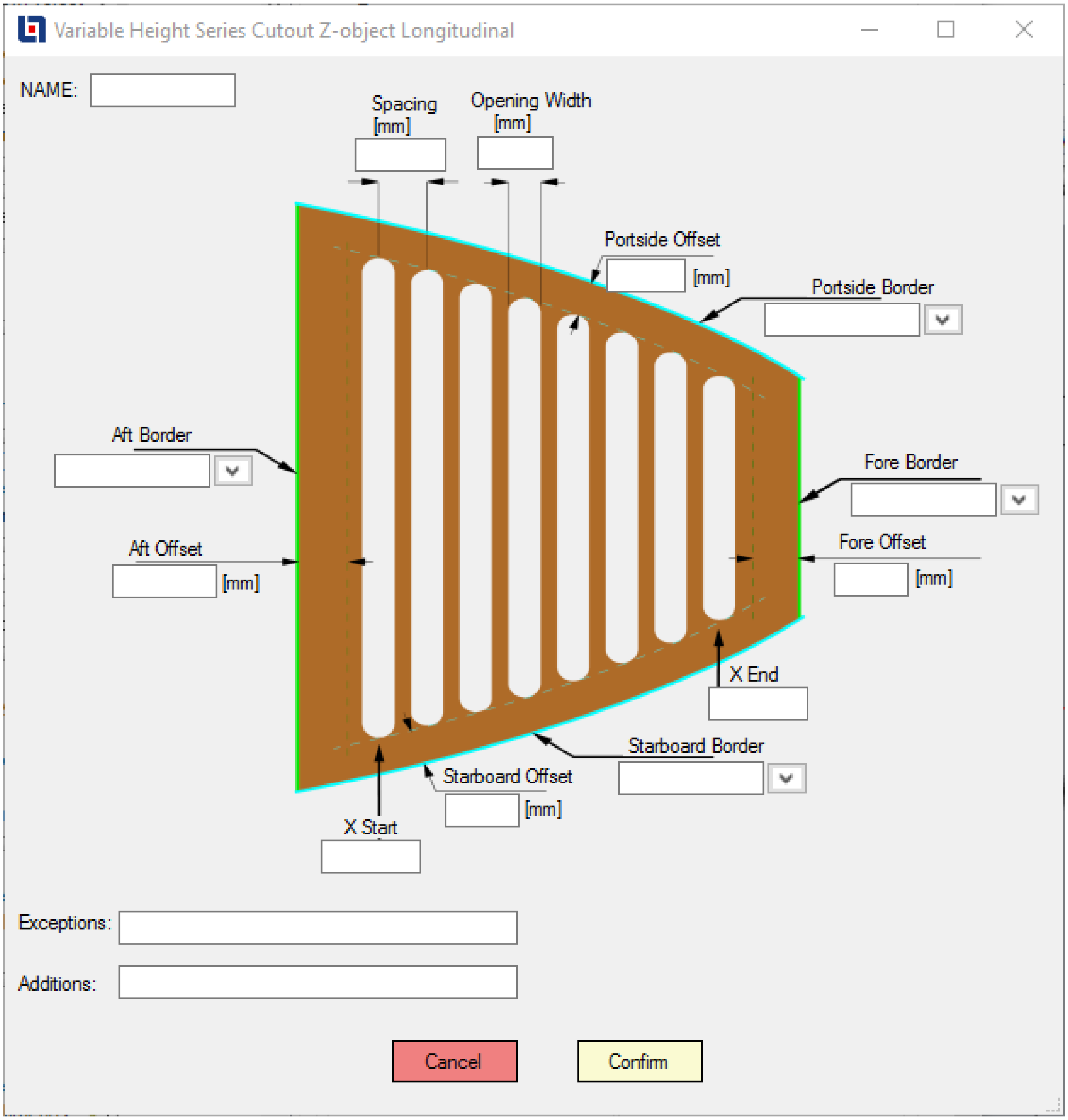
This is an example of the openings definition for a longitudinal element. This will create a series of variable height openings (adapting to the element shape), with 700 mm Opening Width, with **Z Start** = 8 meters, and **Z End** = 13 meters, with **1000 mm Spacing** between them, no **exceptions** and no **additional** openings in this case.

The openings are bordered at the upper end (**Upper Border**) by **Z Coordinate = 14 meters** with a gap (**Upper Offset**) of **400 mm**, at the lower end (**Lower Border**) by **Z Coordinate = 7 meters** with a gap (**Lower Offset**) of **400 mm**, at the aft end (**Aft Border**) by **TB2Dk1** surface with a gap (**Aft Offset**) of **600 mm** and at the fore end (**Fore Border**) by **ShellPS** surface with a gap (**Fore Offset**) of **600 mm**.

The result is the following:



Z-Object / Variable Height - Longitudinal Series (XY plane / X axis)



NAME: the name for the individual or series of cutouts/openings.

Opening **Width (W)** is oriented in the direction of the axis and height is adapting to the local shape.

X Start is the X coordinate of the first opening center.

X End is the X coordinate of the last opening center.

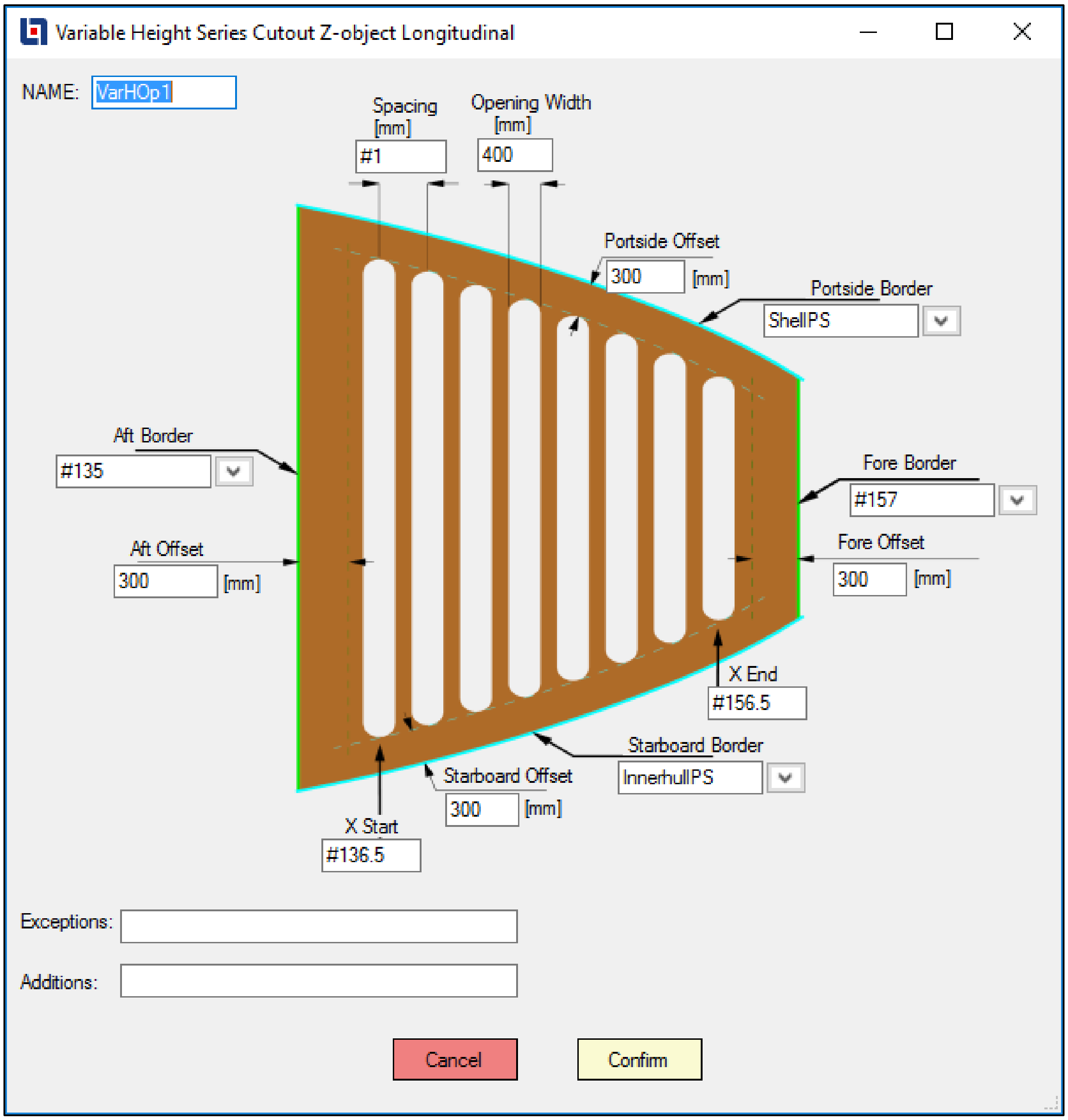
Spacing is the distance between the centers of two consecutive openings.

Portside Border/Starboard Border/Aft Border/Fore Border: represent the four borders between which the openings will be generated.

Portside Offset/ Starboard Offset/Aft Offset/Fore Offset: represents the distance from the borders to the ends of the openings.

Any blank offset means Zero.

Example Z-Object / Variable Height - Longitudinal Series (XY plane / X axis)

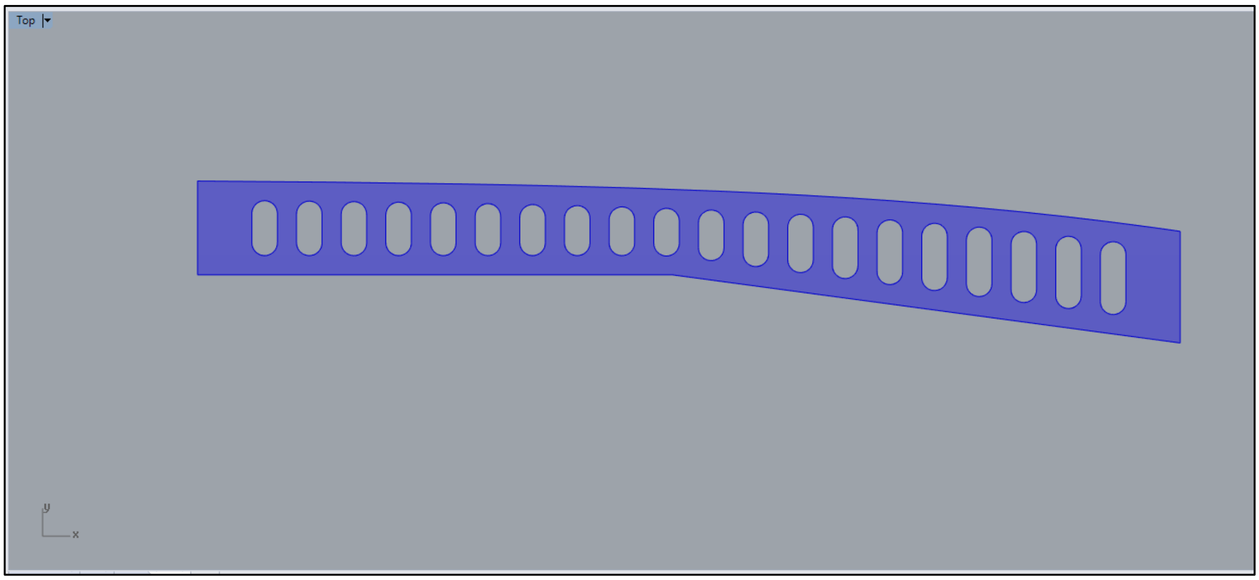


This is an example of the openings definition for a Stringer. This will create a series of variable height openings (adapting to the element shape), with **400 mm** Opening Width, repeating along **X**

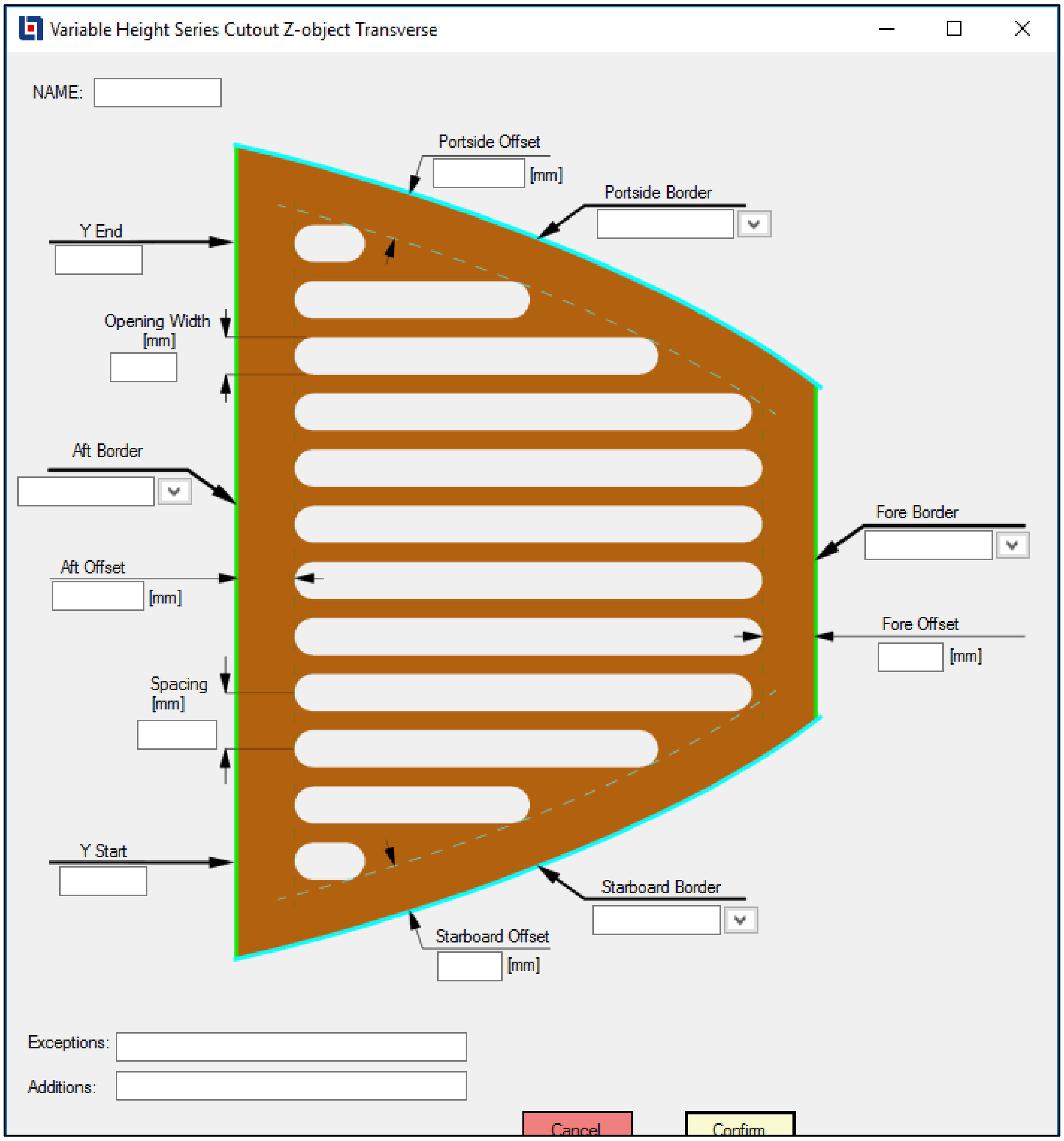
axis, **starting** at **X Start** = **#136.5**, **ending** at **X End** = **#156.5**, with **1 frame** space between them, no **exceptions** and no **additional** openings in this case.

The openings are bordered at the portside end (**PS Border**) by **ShellPS** surface with a gap (**PS Offset**) of **300 mm**, at the starboard end (**SB Border**) by **InnerhullPS** surface with a gap (**SB Offset**) of **300 mm**, at the aft end (**Aft Border**) by **#135** with a gap (**Aft Offset**) of **300 mm**, and at the fore end (**Fore Border**) by **#157** with a gap (**Fore Offset**) of **300 mm**.

The result is the following:



Z-Object / Variable Height - Transverse Series (XY plane / Y axis)



NAME: the name for the individual or series of cutouts/openings.

Opening **Width (W)** is oriented in the direction of the axis and height is adapting to the local shape.

Y Start is the Y coordinate of the first opening center.

Y End is the Y coordinate of the last opening center.

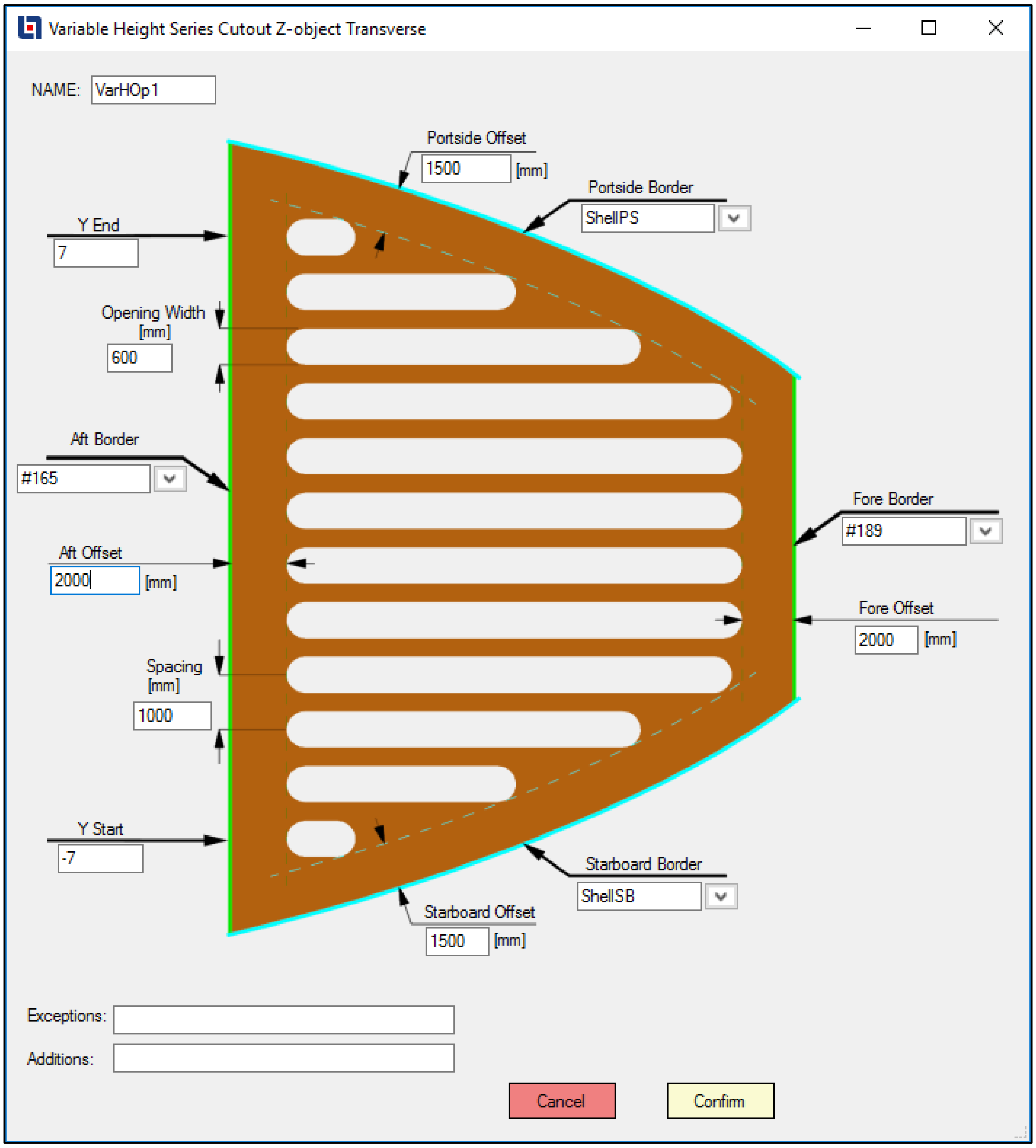
Spacing is the distance between the centers of two consecutive openings.

Portside Border/Starboard Border/Aft Border/Fore Border: represent the four borders between which the openings will be generated.

Portside Offset/ Starboard Offset/Aft Offset/Fore Offset: represents the distance from the borders to the ends of the openings.

Any blank offset means Zero.

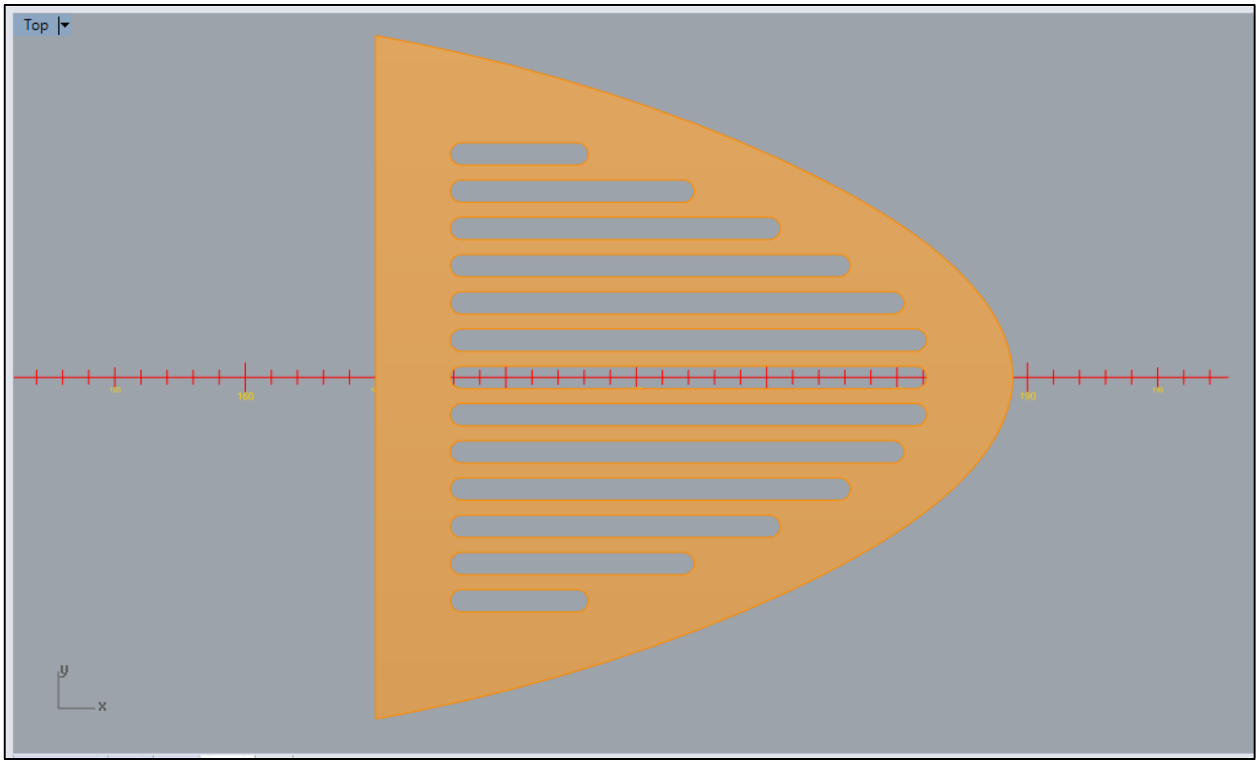
Example Z-Object / Variable Height - Transverse Series (XY plane / Y axis)



This is an example of the openings definition for a Deck. This will create a series of variable height openings (adapting to the element shape), with **600 mm** Opening Width, repeating along **Y axis**, **with Y Start** = **-7** meters, **and Y End** = **7** meters, with **1000 mm** space between them, no **exceptions** and no **additional** openings in this case.

The openings are bordered at the portside end (**PS Border**) by **ShellPS** surface with a gap (**PS Offset**) of **1500 mm**, at the starboard end (**SB Border**) by **ShellSB** surface with a gap (**SB Offset**) of **1500 mm**, at the aft end (**Aft Border**) by **#165** with a gap (**Aft Offset**) of **2000 mm** and at the fore end **(Fore Border**) by **#189** with a gap (**Fore Offset**) of **2000 mm**.

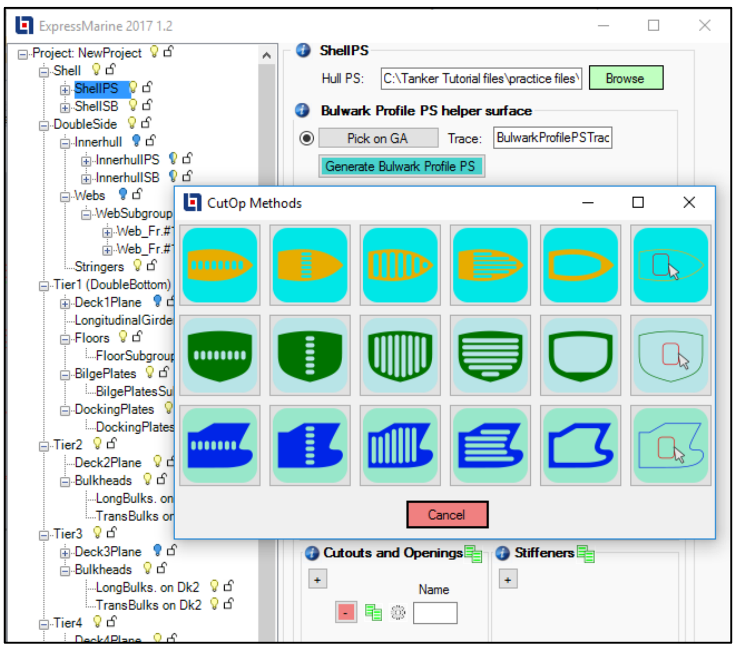
The result is the following:



By Trace Method

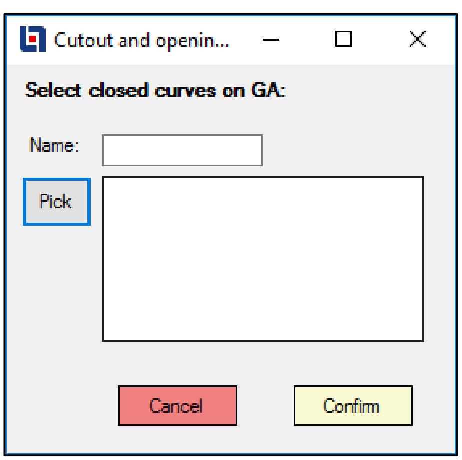
Each object type (X-Object, Y-Object, Z-Object) has a coresponding icon for By Trace Method:

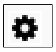
The user can choose the appropriate By Trace icon. For example, navigate to ShellPS node and click in Cutouts and Openings area the + button to open CutOp Methods window:



Select the Y- Object By Trace icon .

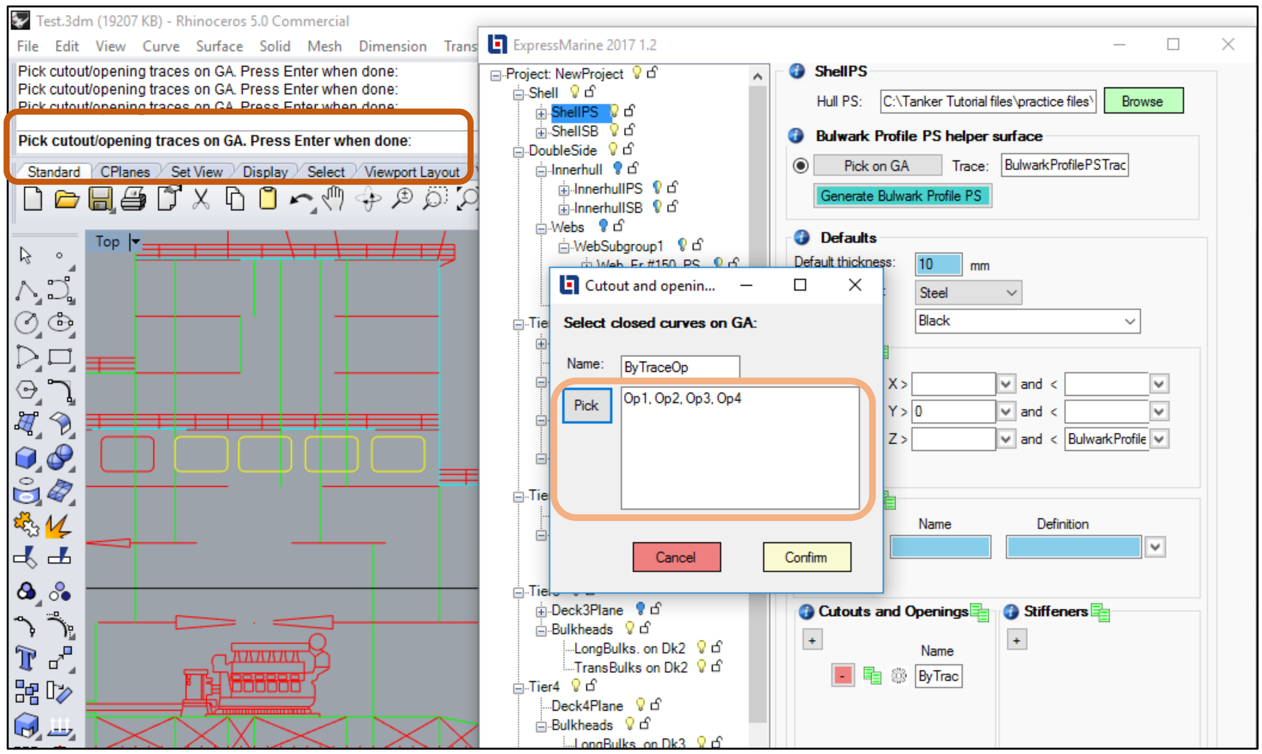
The Pick By Trace window will appear:



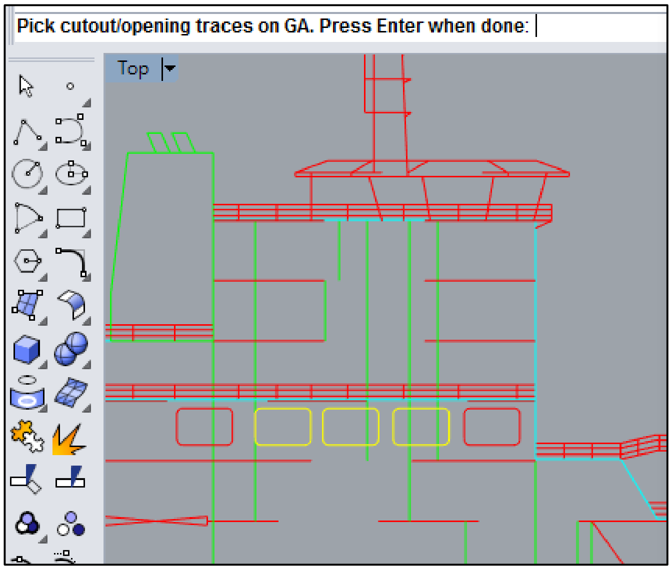
Give a name for the openings, then click the **Pick** button and select from the general arrangement one or more closed curves, then press Enter. Then Confirm and then press Apply to generate the openings. More curves can be added to the same cutout definition, by clicking the Edit opening  button and select again **Pick** button.

To remove one or more of the selected openings from the **Trace list**, follow the steps:

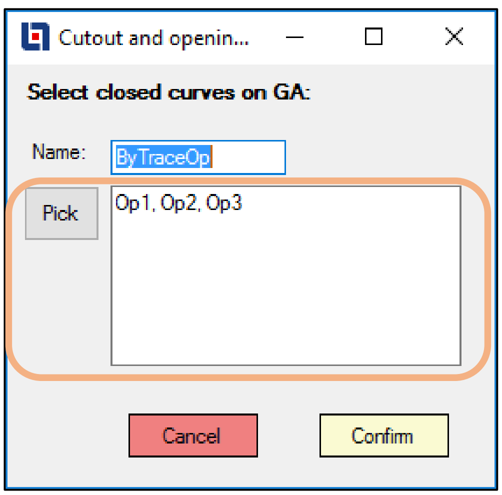
- Click again **Pick** button and all the selected traces (closed curves) from before will be highlighted in yellow:



- Hold the **Ctrl Key** and click on the traces to be unselected:



- then press **Enter Key** to confirm; The unselected trace (Op4) will disappear from the Trace list:



Press 

button to regenerate the openings.

Parametric Offsets Method

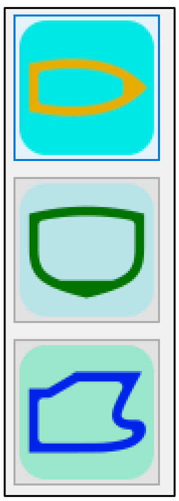
This method will generate a cutout defined by the offset of up to four borders.

Depending on the object type, the borders combination will be as following:

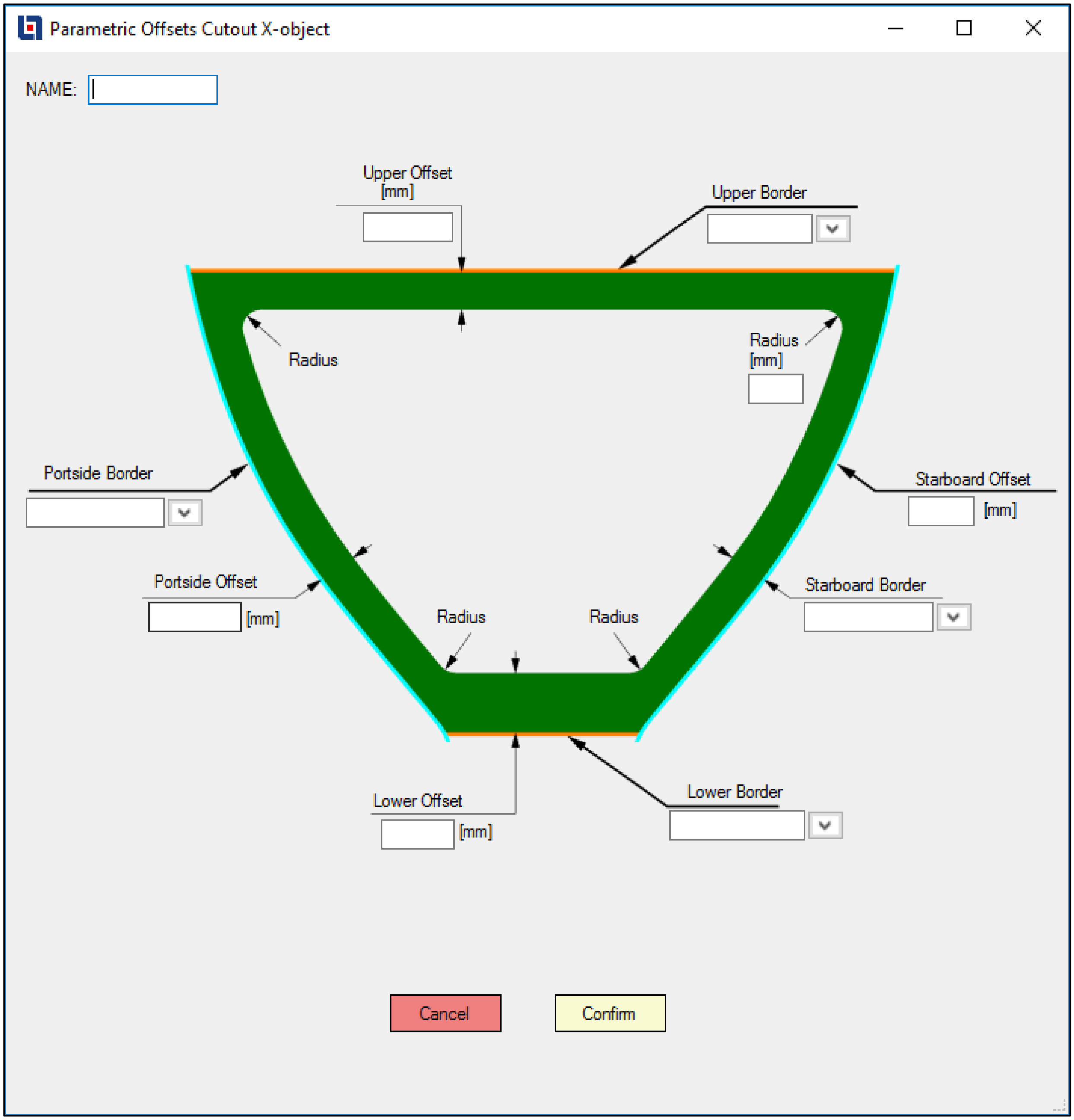
- X-object (YZ Plane): Upper, Lower, PS and SB Borders
- Y-object (XZ Plane): Upper, Lower, Aft and Fore Borders
- Z-object (XY Plane): PS, SB, Aft and Fore Borders

All borders require a corresponding offset, values must be in Thickness unit (set in Main Parameters tab). A global fillet Radius must be input in Thickness unit as well.

The following **CutOp icons** are appropriate for **Parametric Offsets Method**:



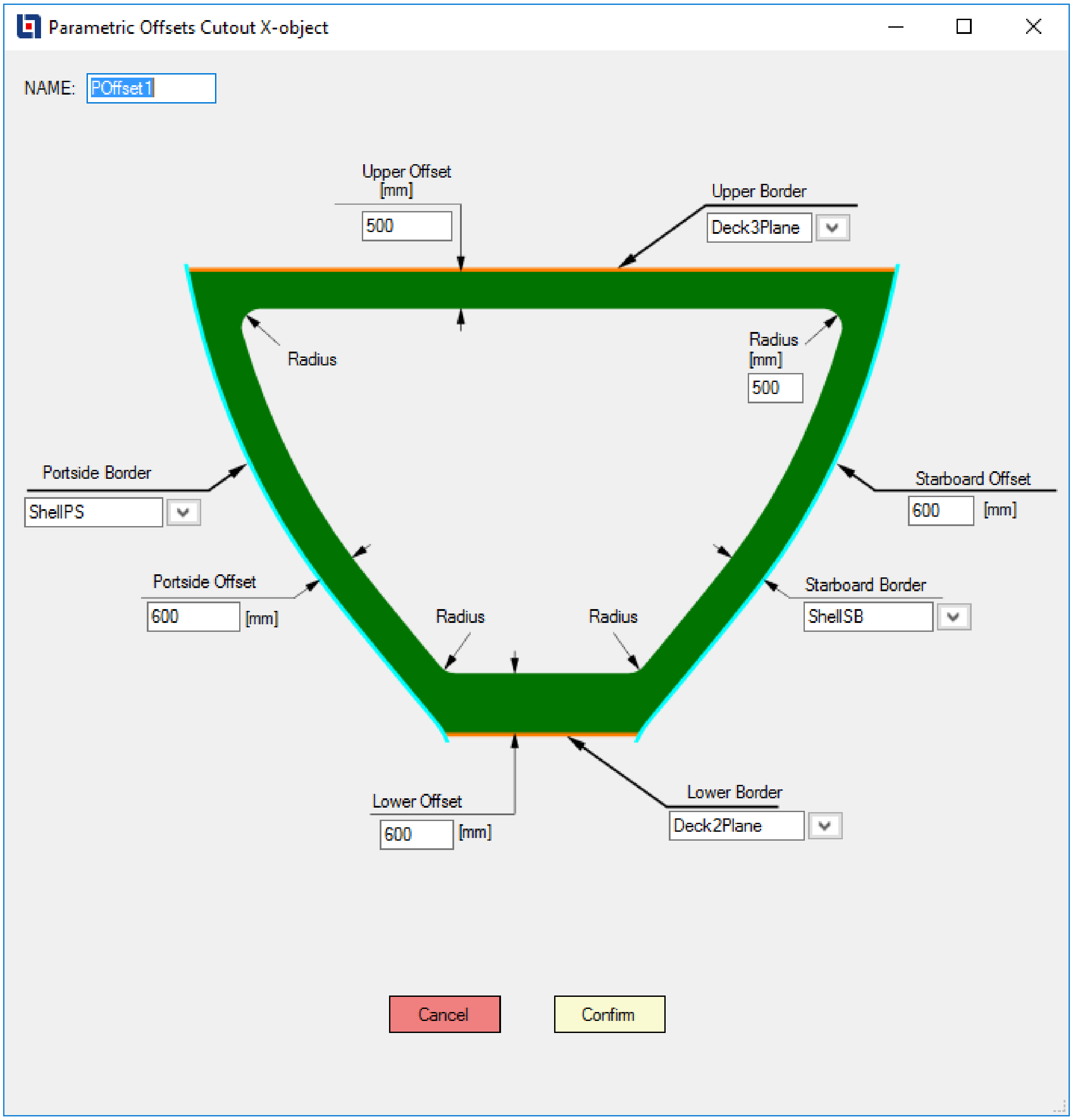
X-Object (YZ Plane)



Upper Border/Lower Border/Portside Border/Starboard Border: represent the four borders which will be offset to generate the cutout.

Upper Offset/Lower Offset/Portside Offset/Starboard Offset: represents the distance from the borders to the edge of the cutout.

Example X-Object (YZ Plane)

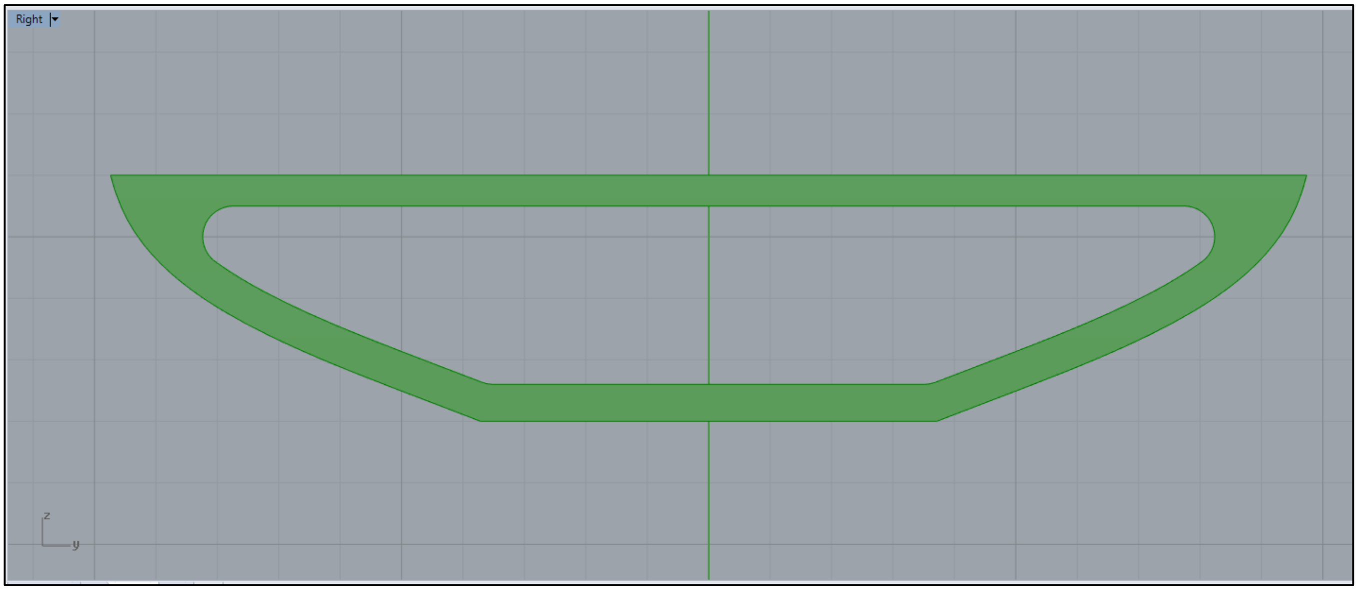


This is an example of the cutout definition for a floor.

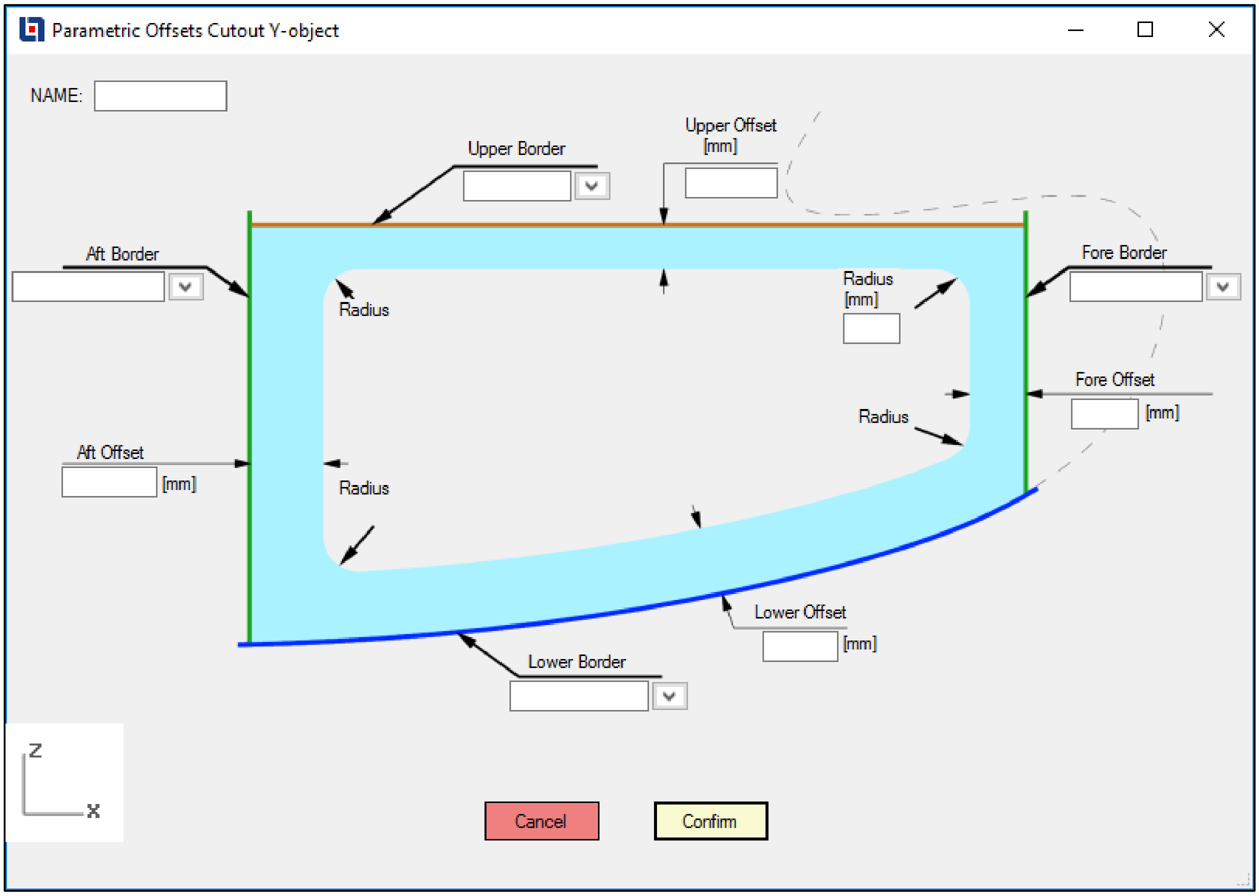
The cutout is bordered at the upper end (**Upper Border**) by **Deck3Plane** surface with a gap (**Upper Offset**) of **500 mm**, at the lower end (**Lower Border**) by **Deck2Plane** surface with a gap (**Lower Offset**) of **600 mm**, at the portside end (**Portside Border**) by **ShellPS** surface with a gap (**PS Offset**) of **600 mm** and at the starboard end (**Starboard Border**) by **ShellSB** surface with a gap (**SB Offset**) of **600 mm**.

The global fillet **Radius** is **500 mm**.

The result is the following:



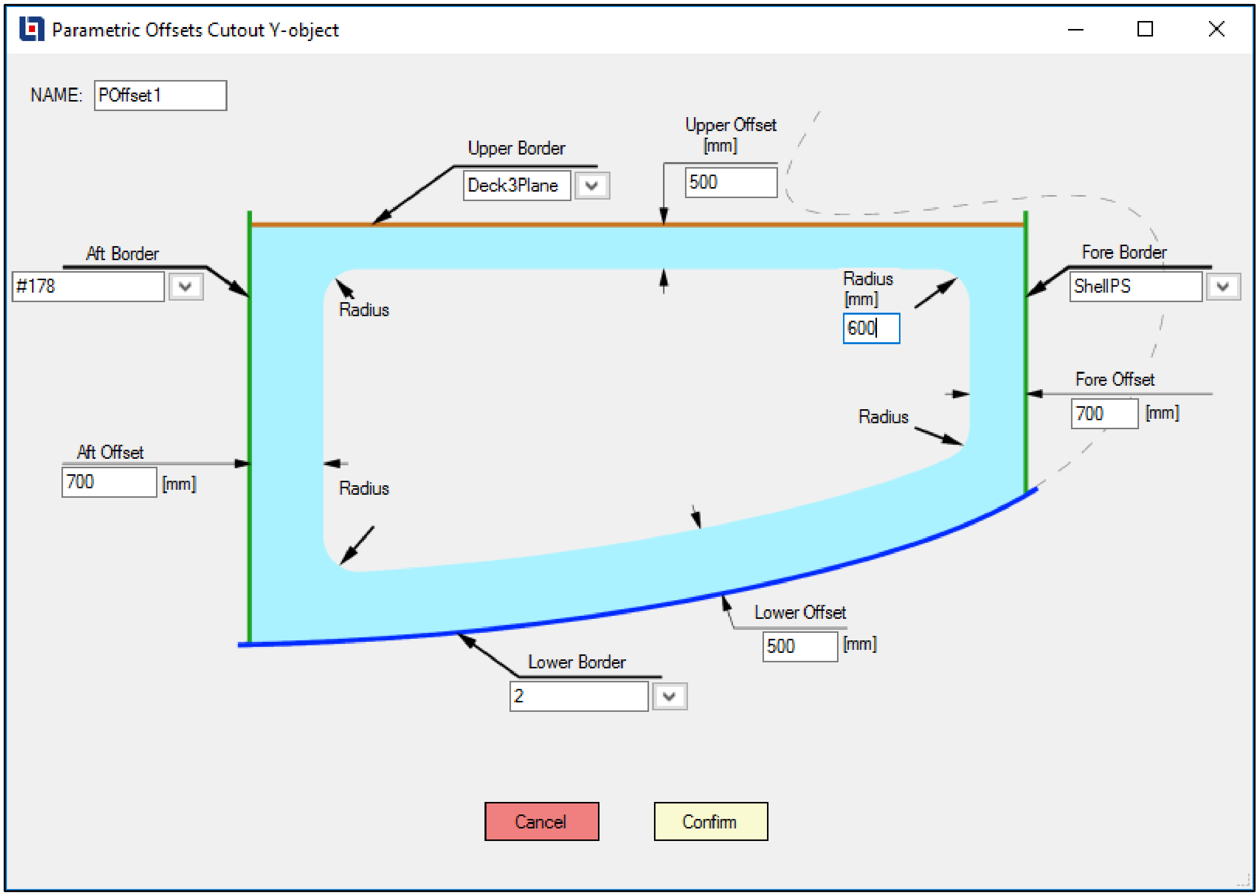
Y-Object (XZ Plane)



Upper Border/Lower Border/Aft Border/Fore Border: represent the four borders which will be offset to generate the cutout.

Upper Offset/Lower Offset/Aft Offset/Fore Offset: represents the distance from the borders to the edge of the cutout.

Example Y-Object (XZ Plane)

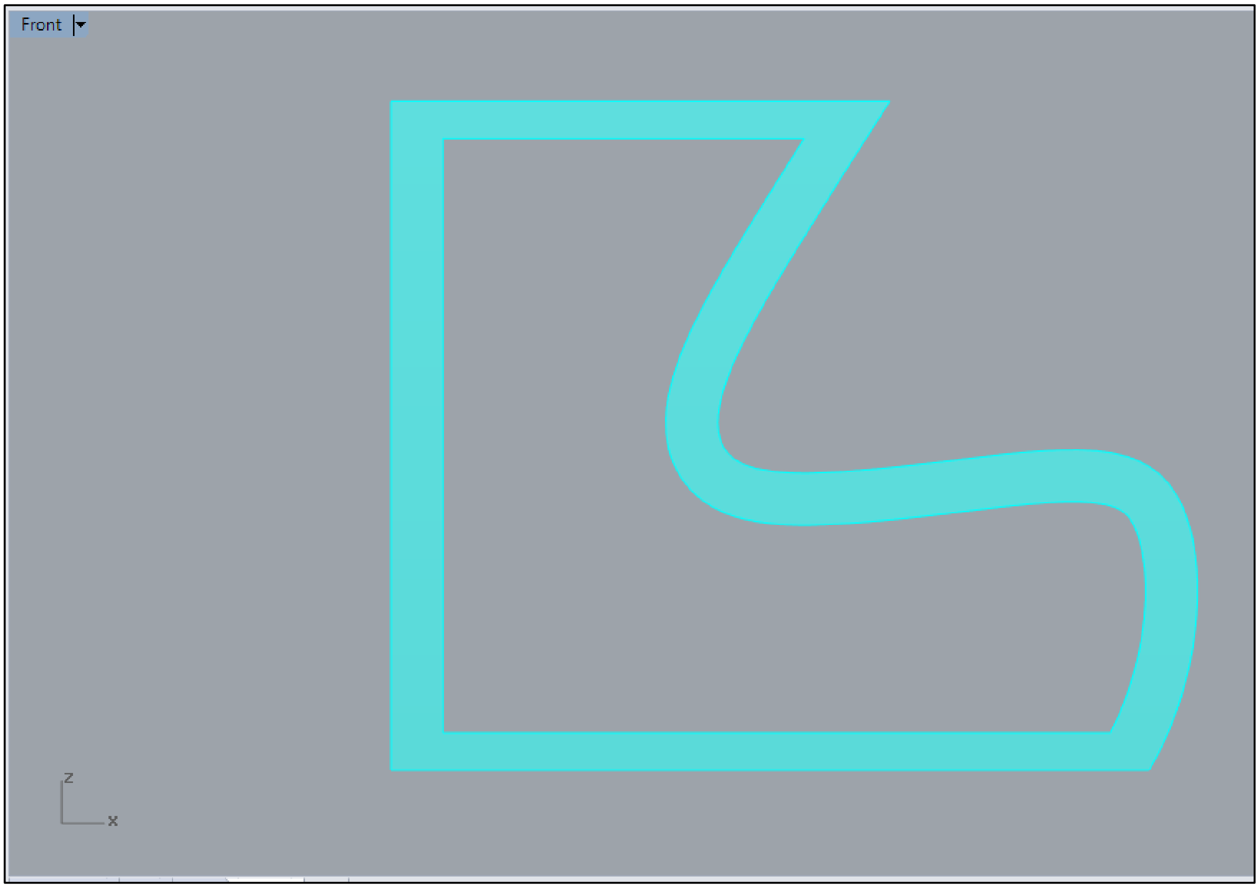


This is an example of the cutout definition for a girder.

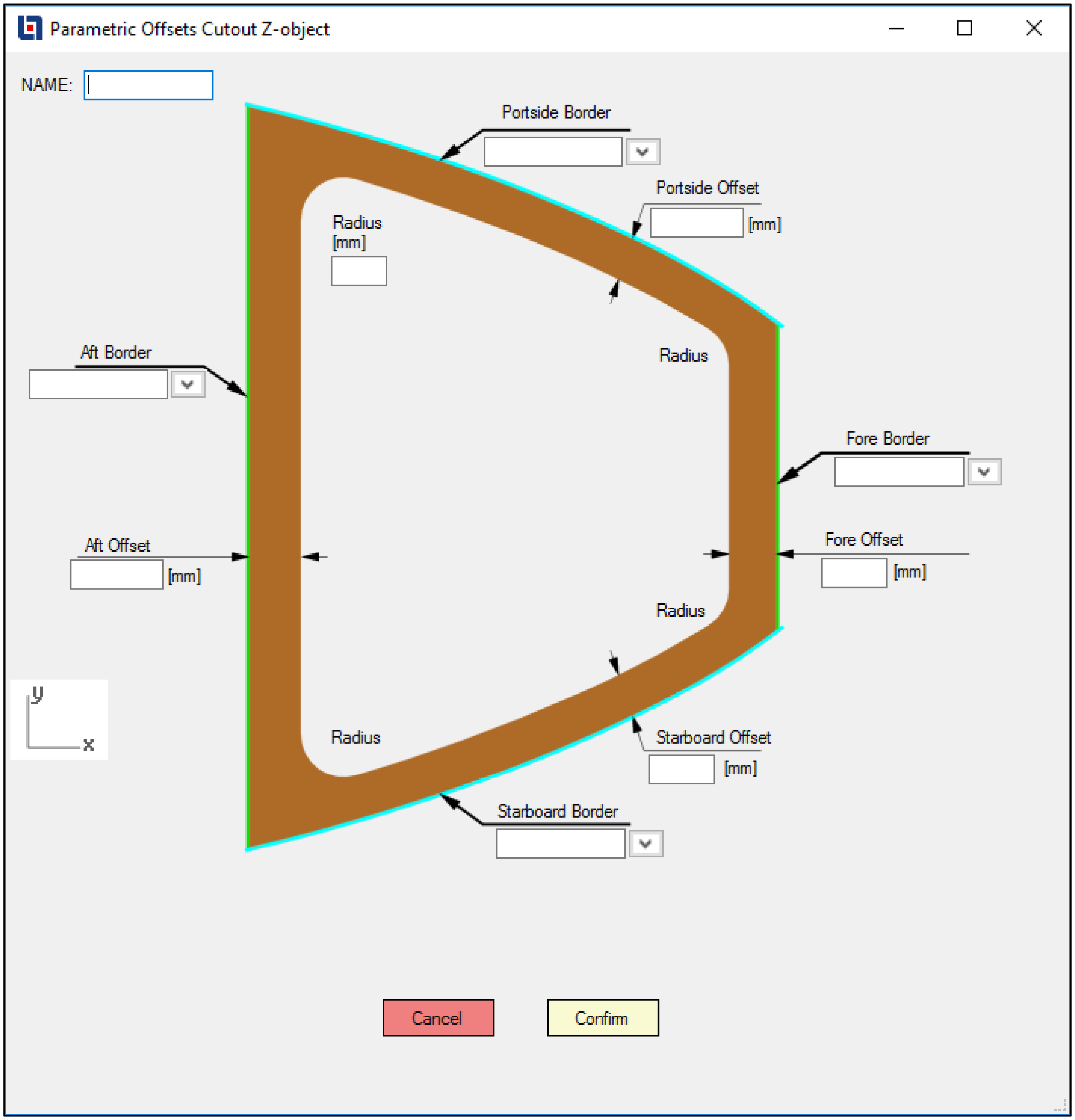
The cutout is bordered at the upper end (**Upper Border**) by **Deck3Plane** surface with a gap (**Upper Offset**) of **500 mm**, at the lower end (**Lower Border**) by Z = 2 meters, with a gap (**Lower Offset**) of **500 mm**, at the aft end (**Aft Border**) by **#178** with a gap (**Aft Offset**) of **700 mm** and at the fore end (**Fore Border**) by **ShellPS** surface with a gap (**Fore Offset**) of **700 mm**.

The global fillet **Radius** is **600 mm**.

The result is the following:


Front
z
x

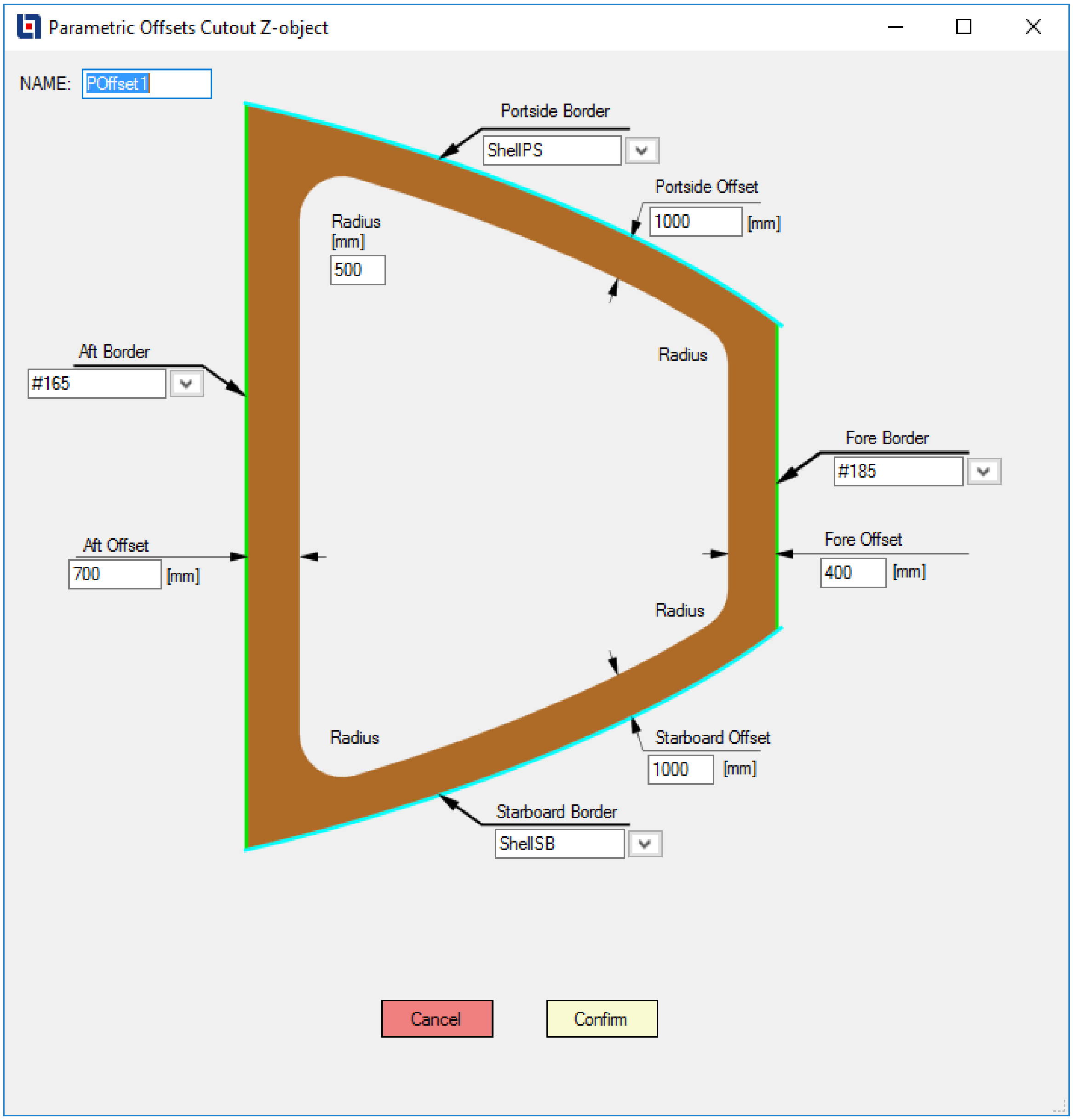
Z-Object (XY Plane)



Aft Border/Fore Border/Portside Border/Starboard Border: represent the four borders which will be offset to generate the cutout.

Aft Offset/Fore Offset/Portside Offset/Starboard Offset: represents the distance from the borders to the edge of the cutout.

Example Z-Object (XY Plane)

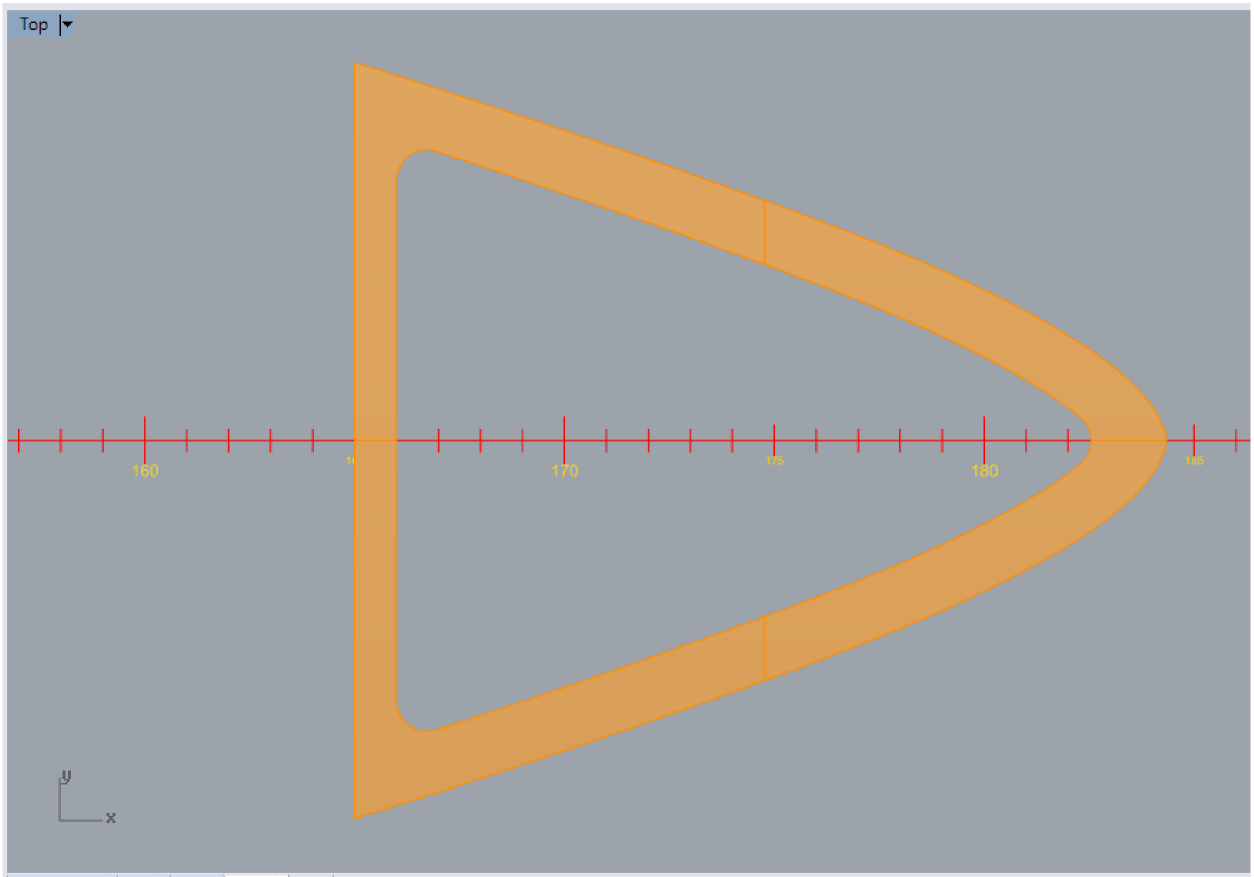


This is an example of the cutout definition for a deck.

The cutout is bordered at the Aft end (**Aft Border**) by **#165** with a gap (**Aft Offset**) of **700 mm**, at the fore end (**Fore Border**) by **#185** with a gap (**Fore Offset**) of **400 mm**, at the portside end (**PS Border**) by **ShellPS** surface with a gap (**PS Offset**) of **1000 mm** and at the starboard end (**SB Border**) by **ShellSB** surface with a gap (**SB Offset**) of **1000 mm**.

The global fillet **Radius** is **500 mm**.

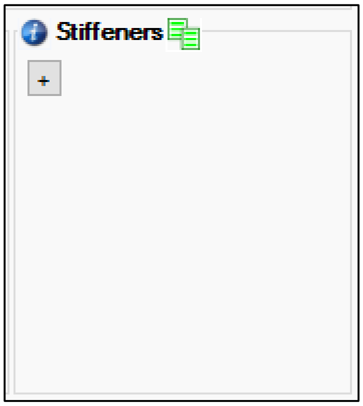
The result is the following:


Top
160
170
175
180
185
y
x

3.1.6 Stiffeners

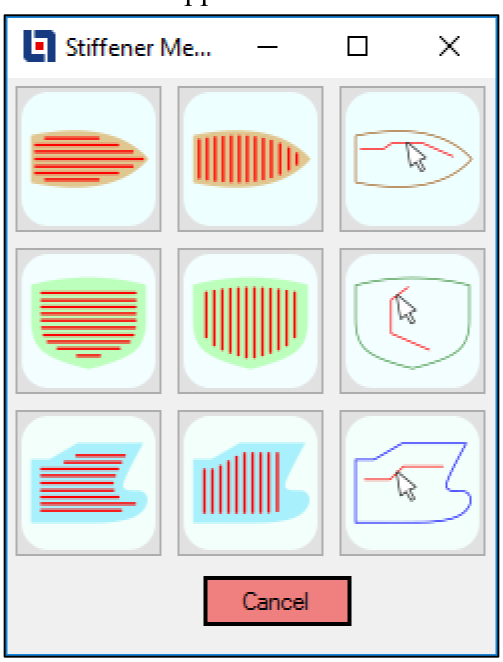
Use the **Stiffeners** section to create individual or series of stiffeners.

+ button is to Add new stiffener definition.

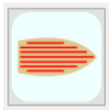


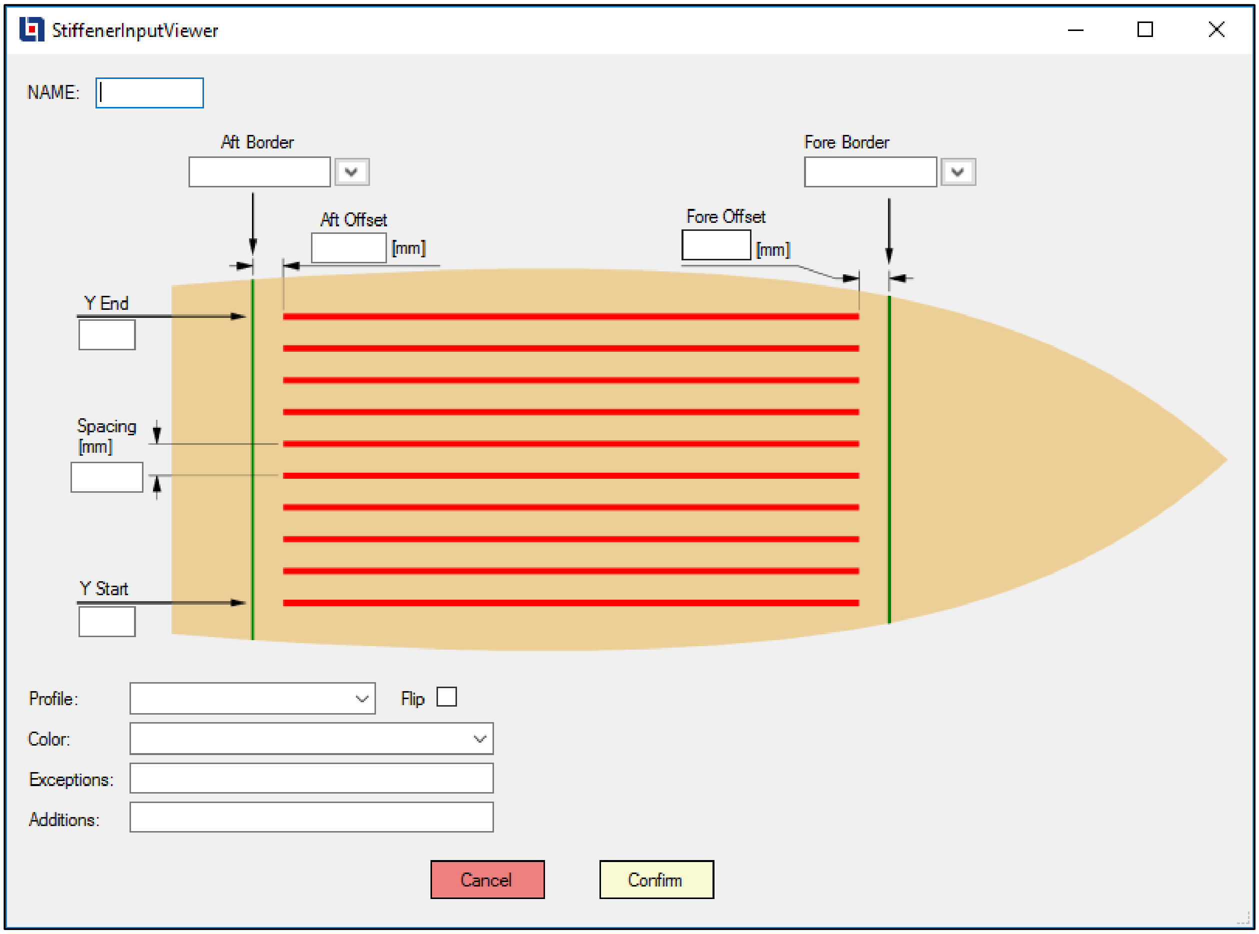
If no stiffener has been defined, only the + (add new stiffener definition) and  (Copy/Paste stiffener definition) are available.

To add new stiffener press + button or use  butoon to Paste stiffeners copied from another object.
If + button is being presed to create a stiffener or stiffener series, the **Stiffener Methods** window will appear:



Select the appropriate icon to open the Stiffener Definition window.

If the first icon  was selected, the following Stiffener Definition window will open:



NAME: give a name for the stiffener/series of stiffeners.

Profile: choose a profile predefined or input a custom one, i.e. FB100x10, L80x7x5, 300x8/100x10.

Note: Thickness unit is used to define stiffener dimensions.

Spacing: distance between two consecutive stiffeners.

Start: location on the chosen axis of the first stiffener in the series.

End: location on the chosen axis of the last stiffener in the series.

Exceptions: Fill in locations where you want to remove certain stiffeners or miniseries of stiffeners.

Format example: #5; #10 [#4 #12 #20]

This will remove stiffeners at frame number 5, 10 and every 4th frame from 12 to 20.
You can use spaces, semicolon or both to separate each exception.

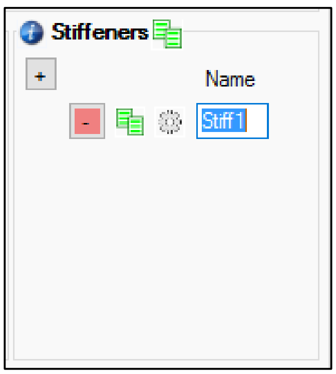
[#4 #12 #20] can also be written as (#4 #12 #20) or {#4 #12 #20}

Additions: Fill in locations where you want to add extra stiffeners, one by one or a mini series of stiffeners. Format example: #5; #10 [#4 #12 #20]
This will add extra stiffeners at frame number 5, 10 and every 4th frame from 12 to 20.
You can use spaces, semicolon or both to separate each addition.

[#4 #12 #20] can also be written as (#4 #12 #20) or {#4 #12 #20}

Confirm: wil register the inputs and will close the window

Fill in all the fields, then press Confirm. The stiffener name will now be visible as below:



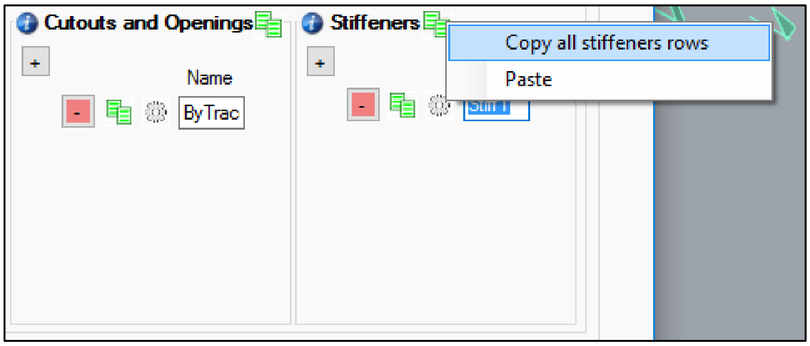
The - button will Disable/Remove this stiffener definition.

To edit the opening, press the edit button , and the stiffener definition window will open again.

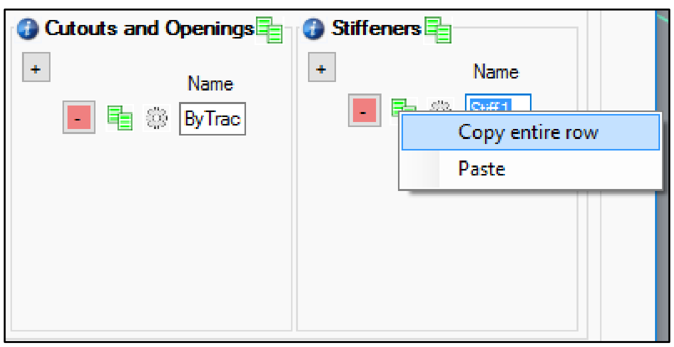
To add more stiffeners, press again the + button and follow the same procedure as for the Stiff1.

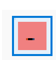
Tips and tricks

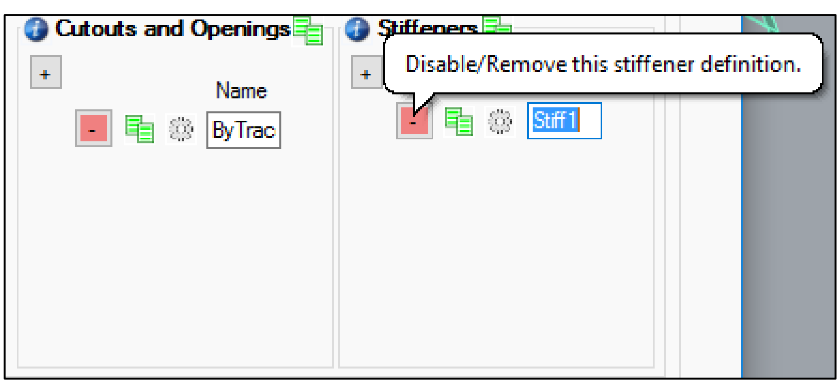
- Copy/Paste the Stiffeners table from one element or group to another by right click on the Clipboard icon 



- Copy/Paste of an entire stiffener definition can be achieved by right click on the  button, then Copy entire row/ Paste



- The  button will delete the current stiffener definition

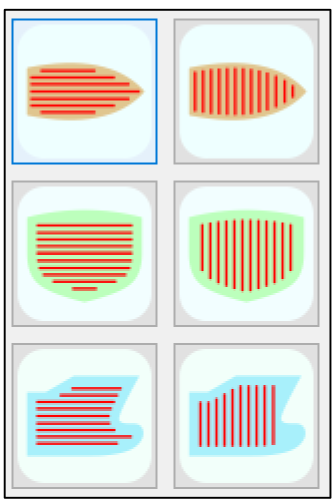


Series Method

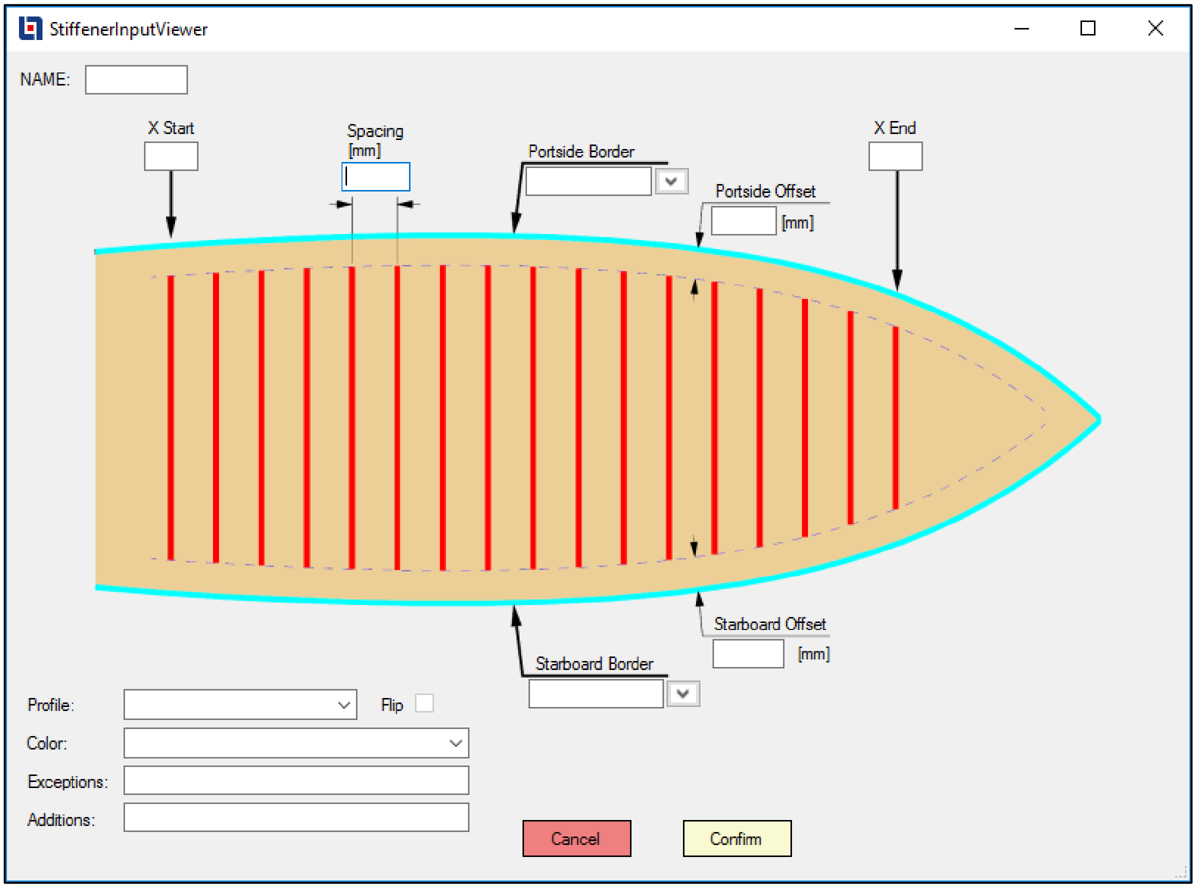
Each object type (X-Object, Y-Object, Z-Object) can have two series types as following:

- **X-Object (YZ Plane)**:
    - Vertical Stiffeners (Y axis Series)
    - Transverse (Horizontal) Stiffeners (Z axis Series)
- **Y-Object (XZ Plane)**:
    - Vertical (Transverse) Stiffeners (X axis Series)
    - Longitudinal (Horizontal) Stiffeners (Z axis Series)
- **Z-Object (XY Plane)**:
    - Transverse Stiffeners (X axis Series)
    - Longitudinal Stiffeners (Y axis Series)

The following **Stiffeners icons** are appropriate for the **Series Method**:



Z-Object / Transverse Stiffeners (XY plane / X axis)



NAME: the name for the individual or series of stiffeners.

Profile: choose a profile predefined or input a custom one, i.e. FB100x10, L80x7x5, 300x8/100x10.

Note: Thickness unit is used to define stiffener dimensions.

X Start is location on the X axis of the first stiffener in the series.

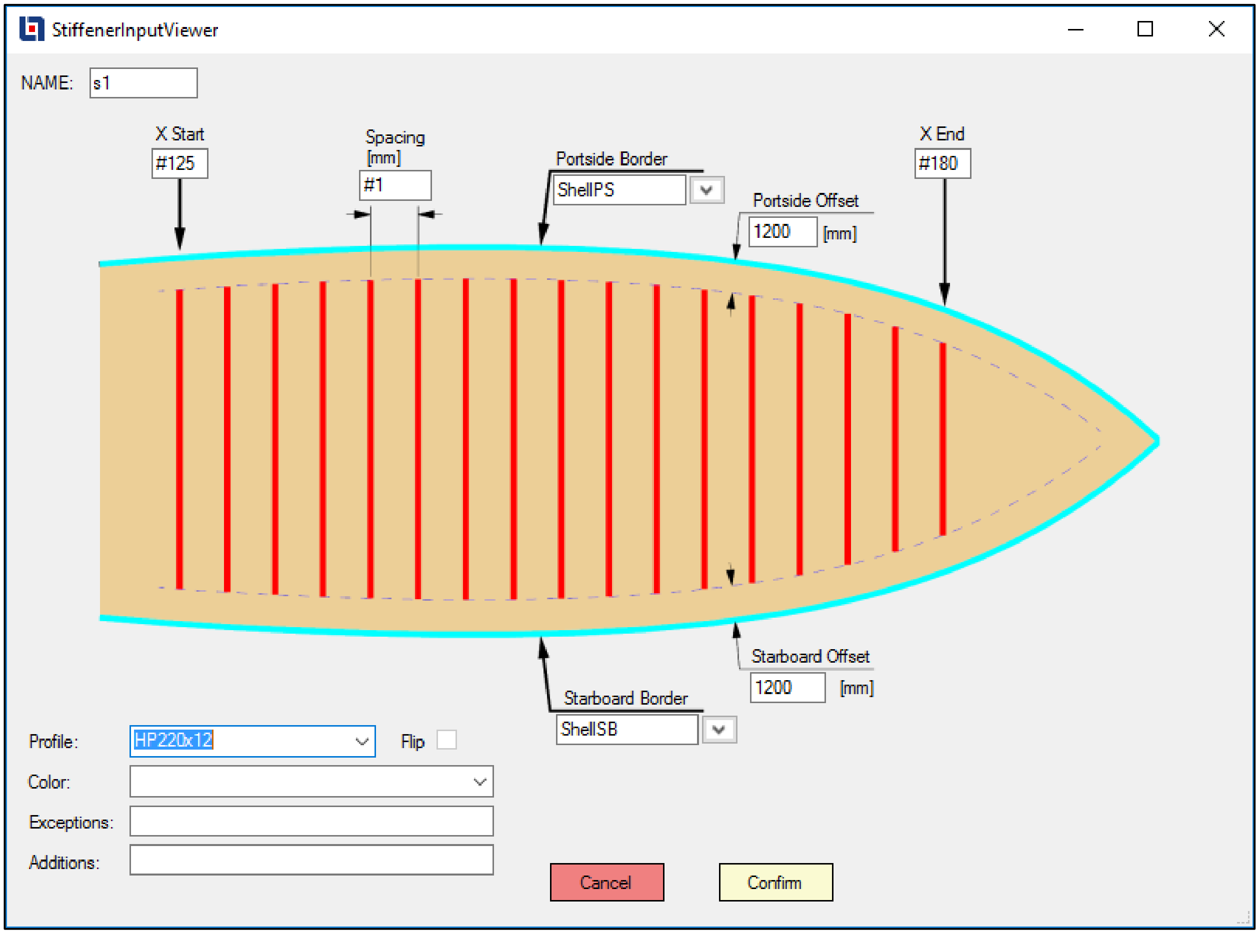
X End is location on the X axis of the last stiffener in the series.

Spacing is the distance between two consecutive stiffeners.

Portside Border/Starboard Border: represents the two borders between which the stiffeners will be generated.

Portside Offset/Starboard Offset: represents the distance from the borders to the ends of the stiffener.

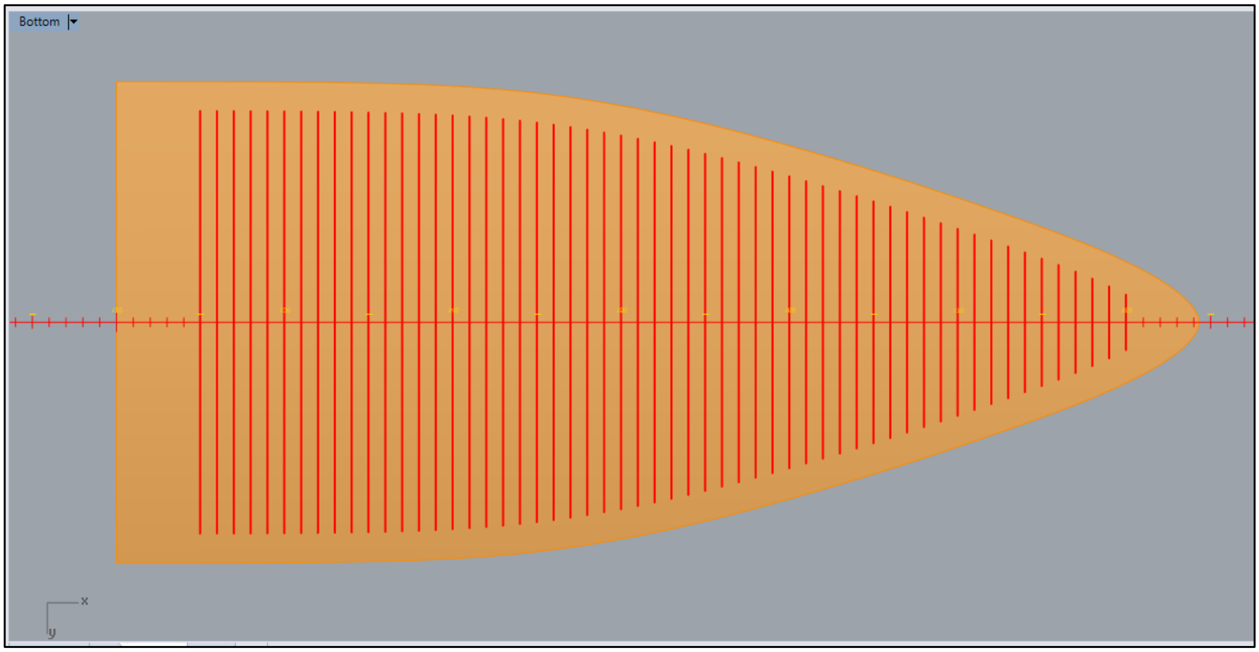
Example Z-Object / Transverse Stiffeners (XY plane / X axis)



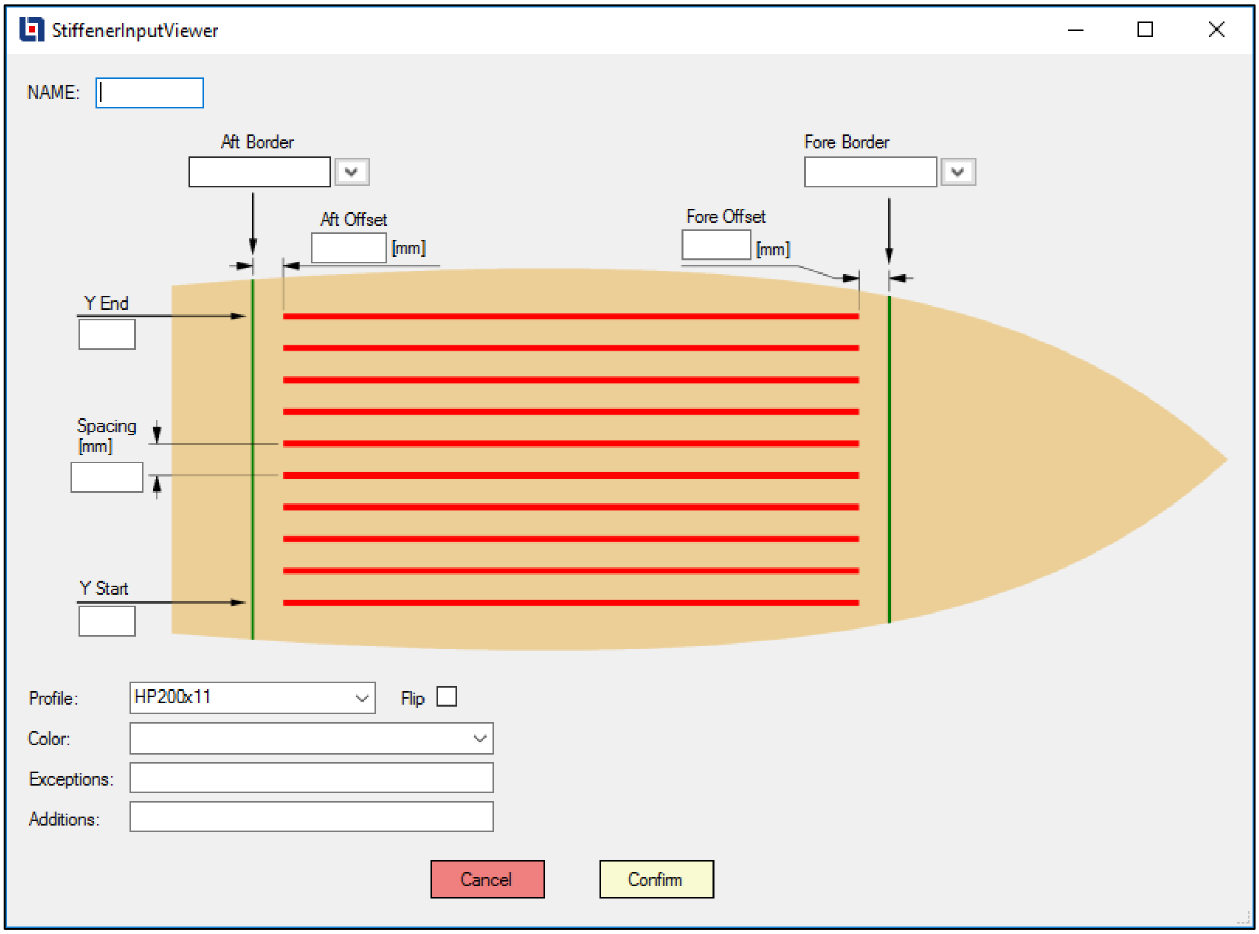
This is an example of the stiffeners definition for a Deck. This will create a series of **HP220x12** stiffeners, **starting** from **#125**, **ending at** #180, with **1 frame** space between them, with no exceptions and no additions.

The stiffeners are bordered at the starboard end (**Starboard Border**) by **ShellSB** surface with a gap (**Starboard Offset**) of **1200 mm**, and at the portside end (**Portside Border**) by **ShellPS** surface with a gap (**Portside Offset**) of **1200 mm**.

The result is the following:


Bottom
x
y

Z-Object / Longitudinal Stiffeners (XY plane / Y axis)



NAME: the name for the individual or series of stiffeners.

Profile: choose a profile predefined or input a custom one, i.e. FB100x10, L80x7x5, 300x8/100x10.

Note: Thickness unit is used to define stiffener dimensions.

Y Start is location on the Y axis of the first stiffener in the series.

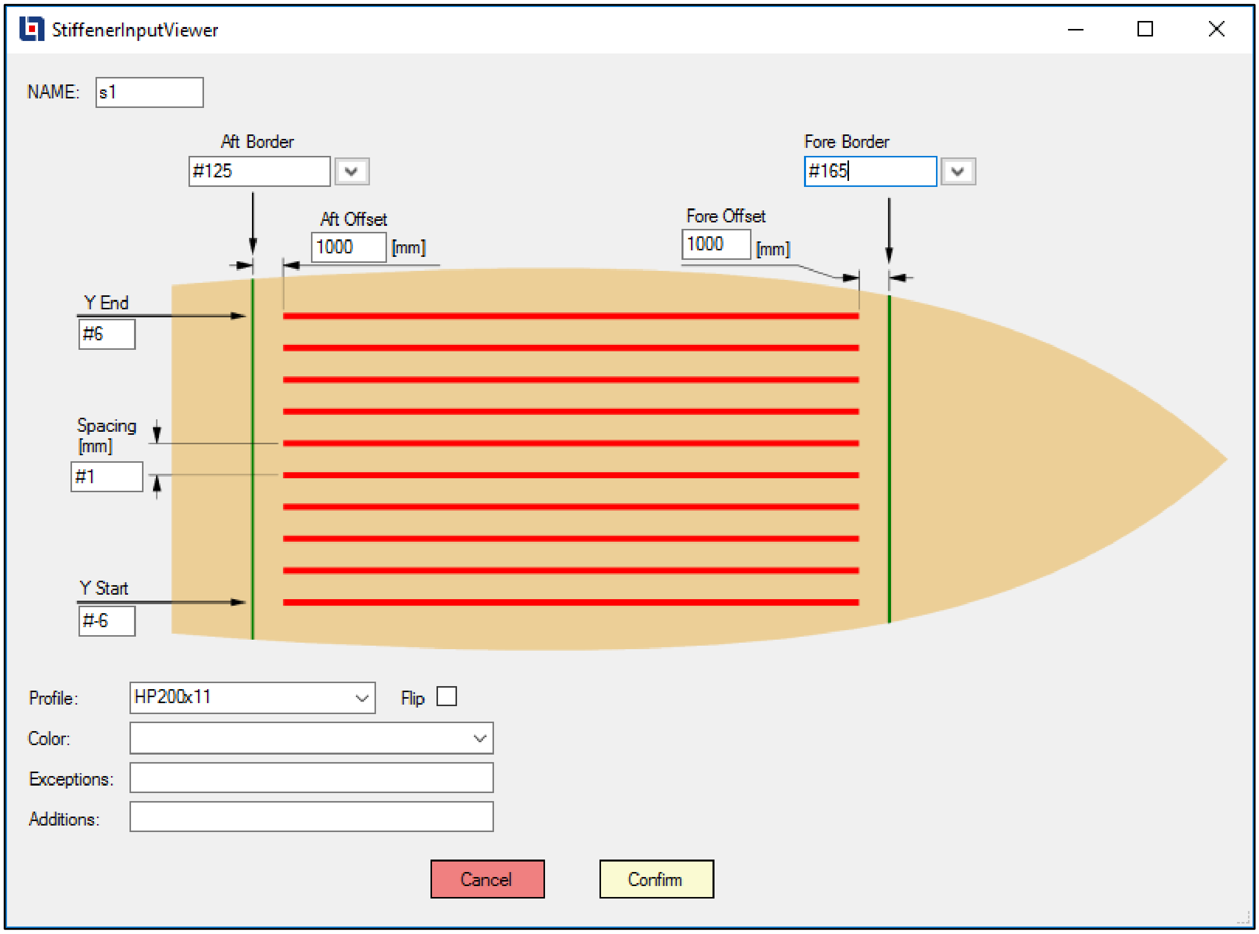
Y End is location on the Y axis of the last stiffener in the series.

Spacing is the distance between two consecutive stiffeners.

Aft Border/Fore Border: represents the two borders between which the stiffeners will be generated.

Aft Offset/Fore Offset: represents the distance from the borders to the ends of the stiffener.

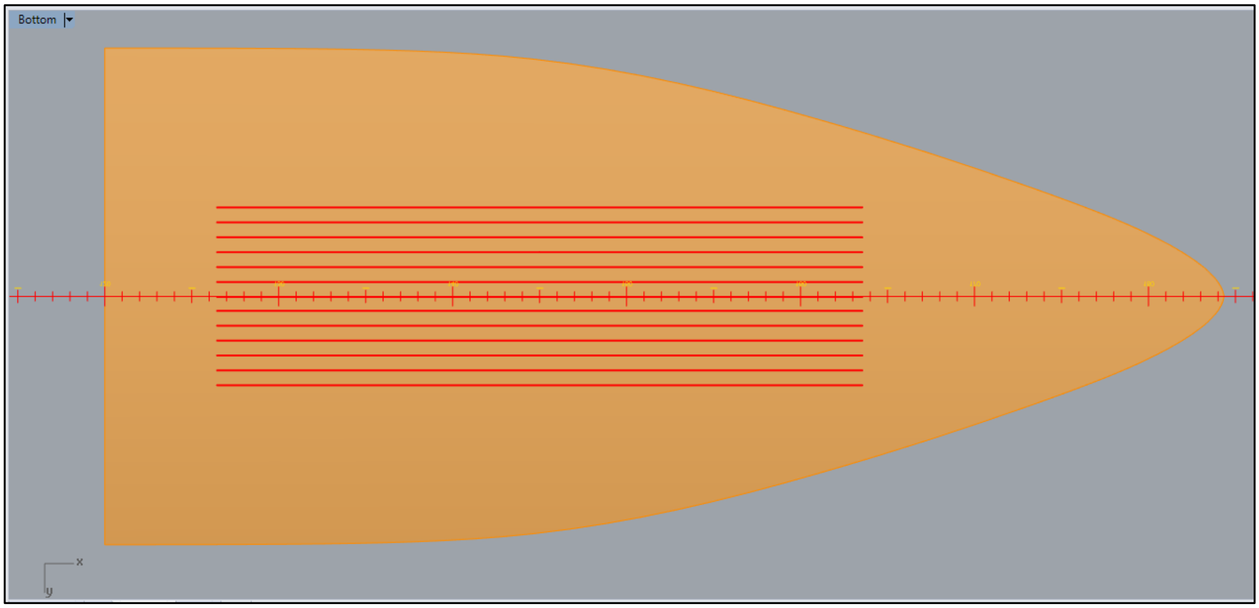
Example Z-Object / Longitudinal Stiffeners (XY plane / Y axis)



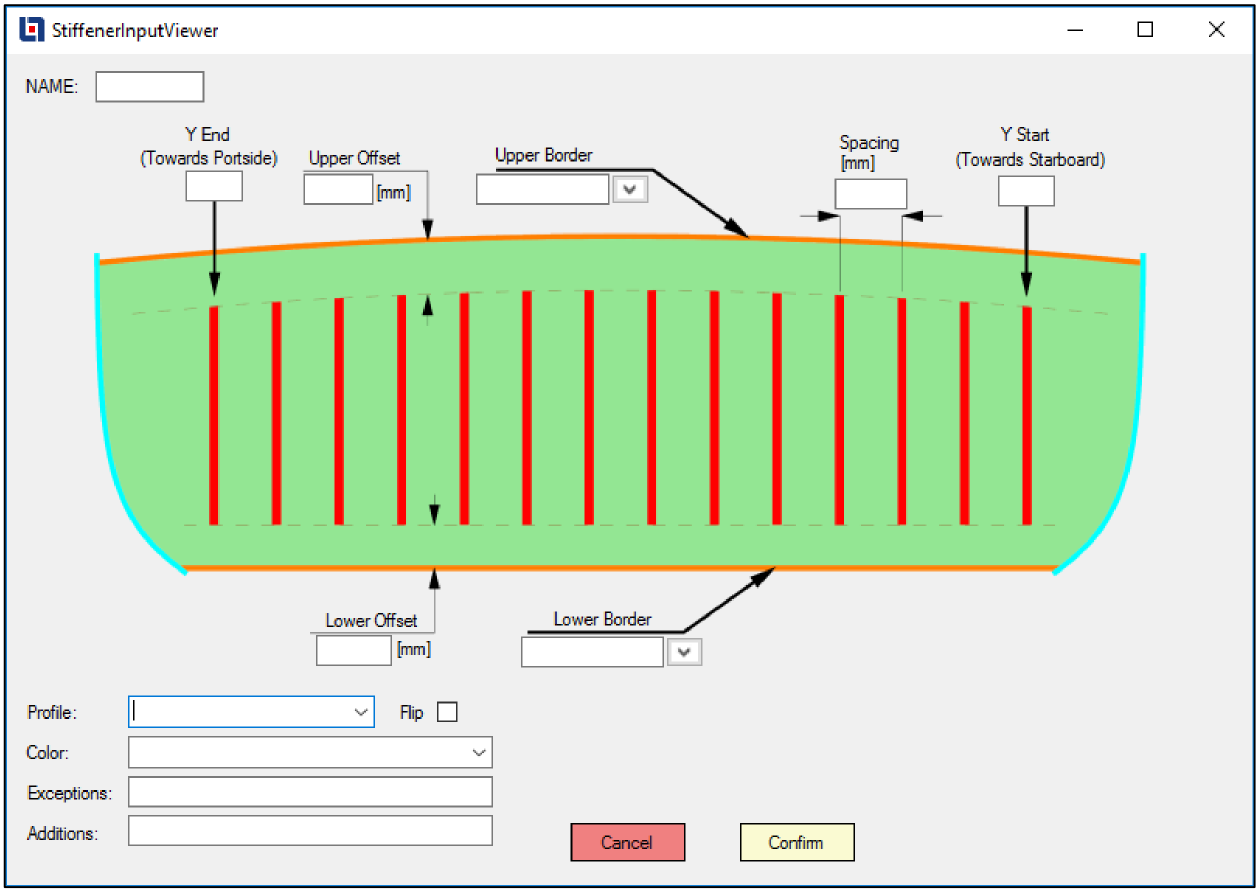
This is an example of the stiffeners definition for a Deck. This will create a series of **HP200x11** stiffeners, with **Y Start** = **#-6**, and **Y End** = #6, with **1 longitudinal frame** space between them, with no **exceptions**, no **additional** stiffeners.

The stiffeners are bordered at the aft end (**Aft Border**) by **#125** with a gap (**Aft Offset**) of **1000 mm**, and at the fore end (**Fore Border**) by **#165** with a gap (**Fore Offset**) of **1000 mm**.

The result is the following:


Bottom
x
y

X-Object / Vertical Stiffeners (YZ plane / Y axis)



NAME: the name for the individual or series of stiffeners.

Profile: choose a profile predefined or input a custom one, i.e. FB100x10, L80x7x5, 300x8/100x10.

Note: Thickness unit is used to define stiffener dimensions.

Y Start is location on the Y axis of the first stiffener in the series.

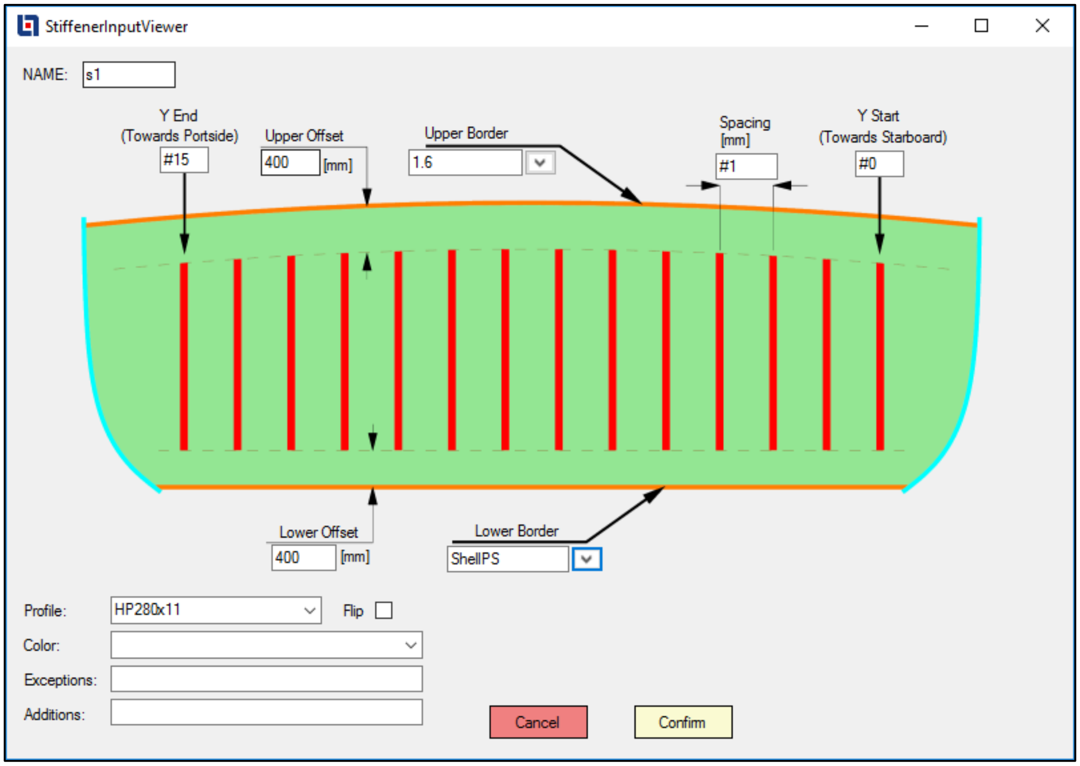
Y End is location on the Y axis of the last stiffener in the series.

Spacing is the distance between two consecutive stiffeners.

Upper Border/Lower Border: represents the two borders between which the stiffeners will be generated.

Upper Offset/Lower Offset: represents the distance from the borders to the ends of the stiffener.

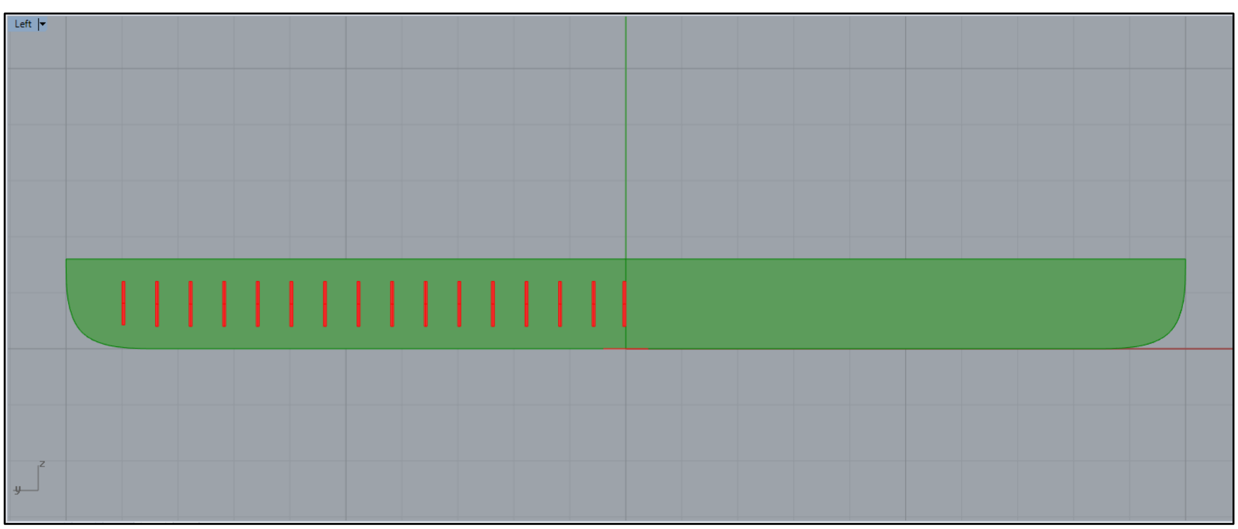
Example X-Object / Vertical Stiffeners (YZ plane / Y axis)



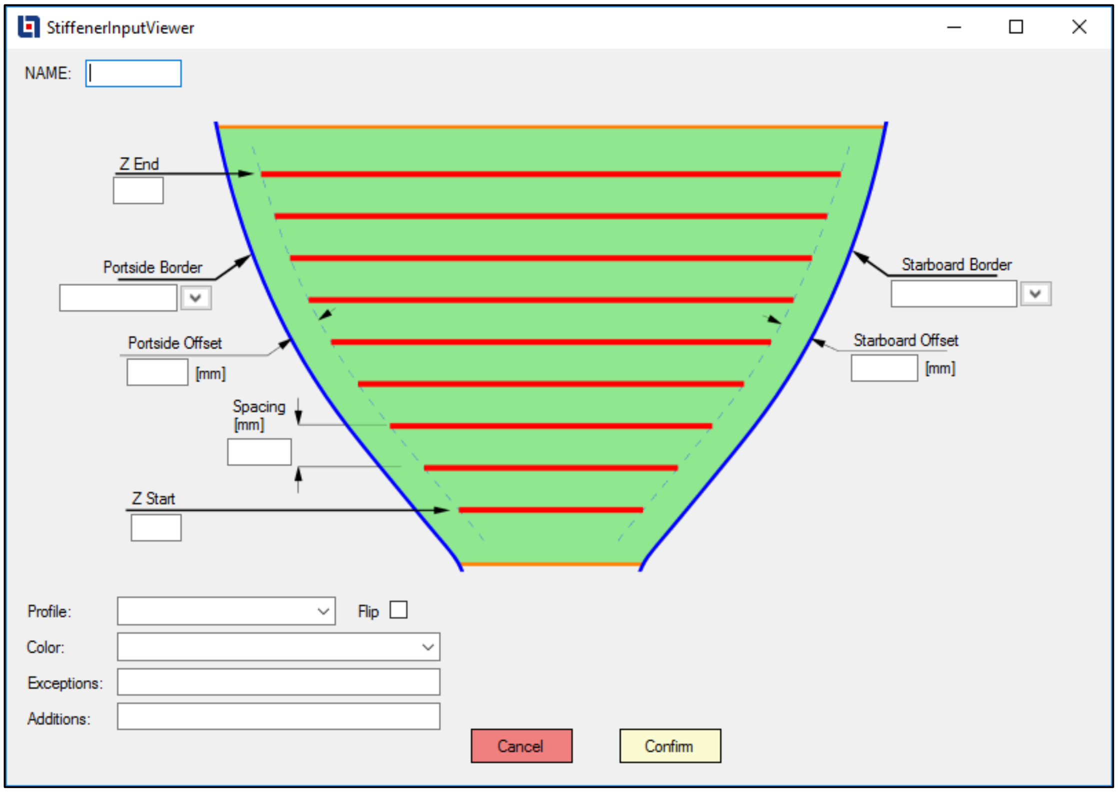
This is an example of the stiffeners definition for a Floor. This will create a series of **HP280x11** stiffeners, **with Y Start** = **#0**, **and Y End** = **#15**, with **1 longitudinal frame** space between them, no **exceptions** and no **additional** stiffeners in this case.

The stiffeners are bordered at the lower end (**Lower Border**) by **ShellPS** surface with a gap (**Lower Offset**) of **400 mm**, and at the upper end (**Upper Border**) by **Z** = **1.6 meters** with a gap (**Upper Offset**) of **400 mm**.

The result is the following:



X-Object / Transverse (Horizontal) Stiffeners (YZ plane / Z axis)



NAME: the name for the individual or series of stiffeners.

Profile: choose a profile predefined or input a custom one, i.e. FB100x10, L80x7x5, 300x8/100x10.

Note: Thickness unit is used to define stiffener dimensions.

Z Start is location on the Z axis of the first stiffener in the series.

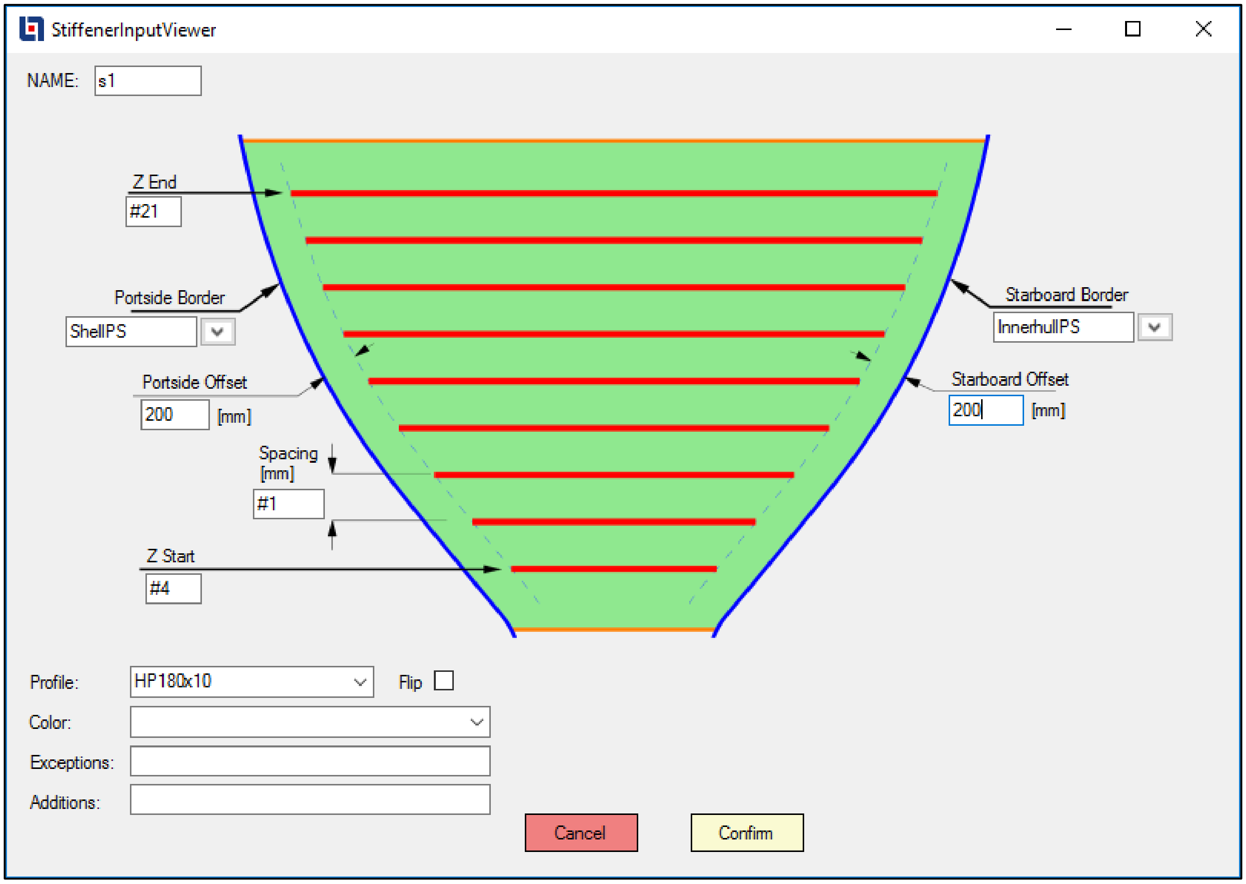
Z End is location on the Z axis of the last stiffener in the series.

Spacing is the distance between two consecutive stiffeners.

Starboard Border/Portside Border: represents the two borders between which the stiffeners will be generated.

Starboard Offset/ Portside Offset: represents the distance from the borders to the ends of the stiffener.

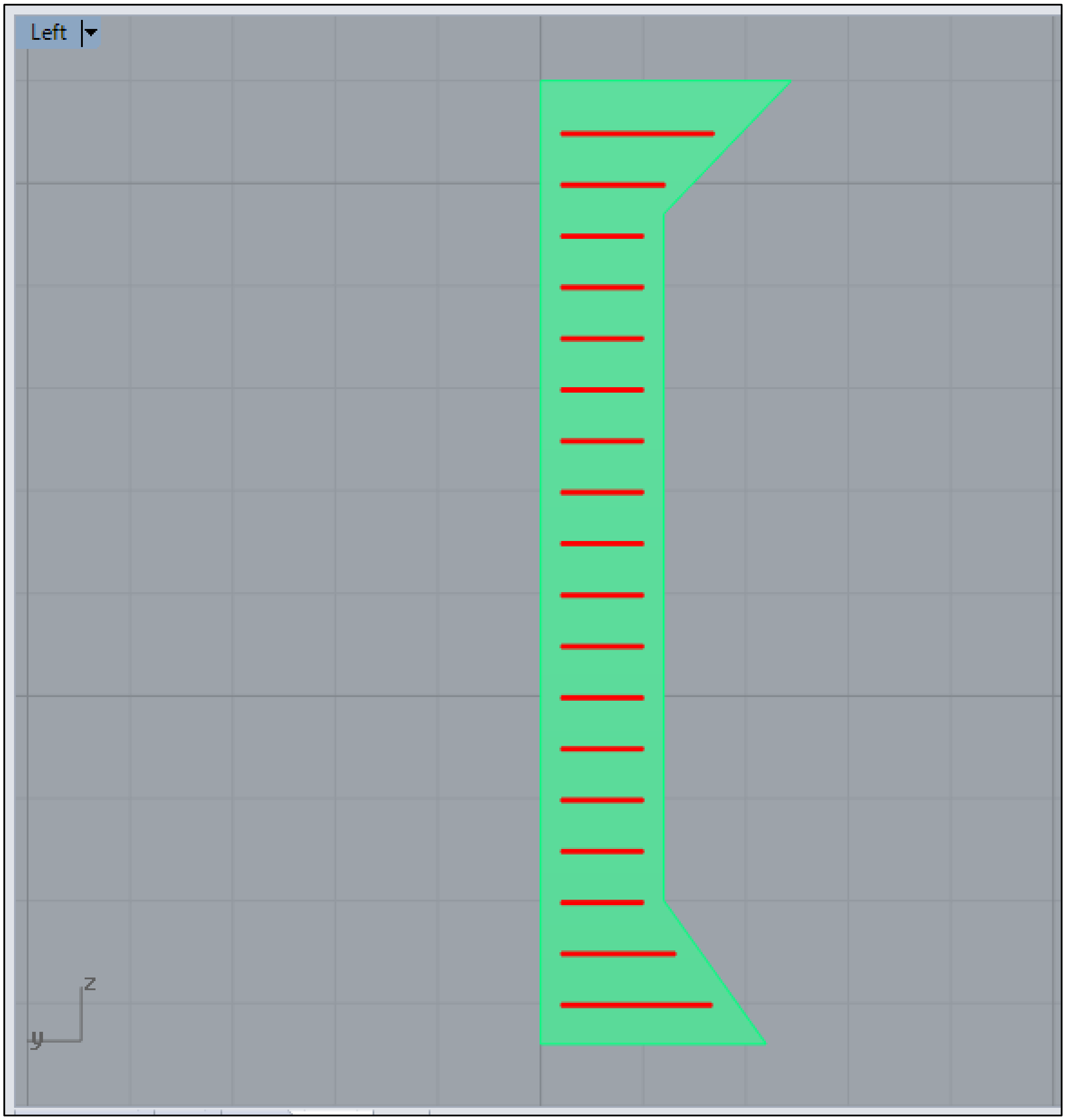
Example X-Object / Transverse (Horizontal) Stiffeners (YZ plane / Z axis)



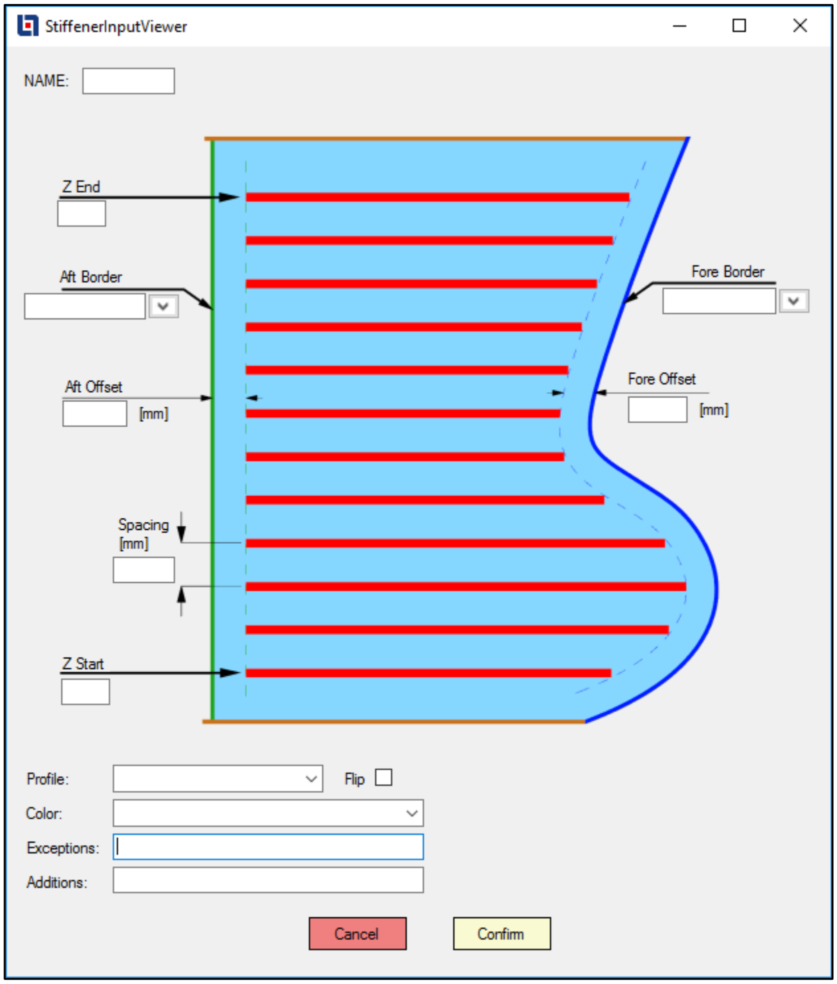
This is an example of the stiffeners definition for a Web. This will create a series of **HP180x10** stiffeners, **starting** at Vert. **#4**, **ending** at Vert. **#21**, with **1 vertical frame** space between them, no **exceptions** and no **additional** stiffeners in this case.

The stiffeners are bordered at the starboard end (**Starboard Border**) by **InnerhullPS** surface with a gap (**Starboard Offset**) of **200 mm**, and at the portside end (**Portside Border**) by **ShellPS** surface with a gap (**Portside Offset**) of **200 mm**.

The result is the following:


Left
z
y

Y-Object / Longitudinal (Horizontal) Stiffeners (XZ plane / Z axis)



NAME: the name for the individual or series of stiffeners.

Profile: choose a profile predefined or input a custom one, i.e. FB100x10, L80x7x5,

300x8/100x10.

Note: Thickness unit is used to define stiffener dimensions.

Z Start is location on the Z axis of the first stiffener in the series.

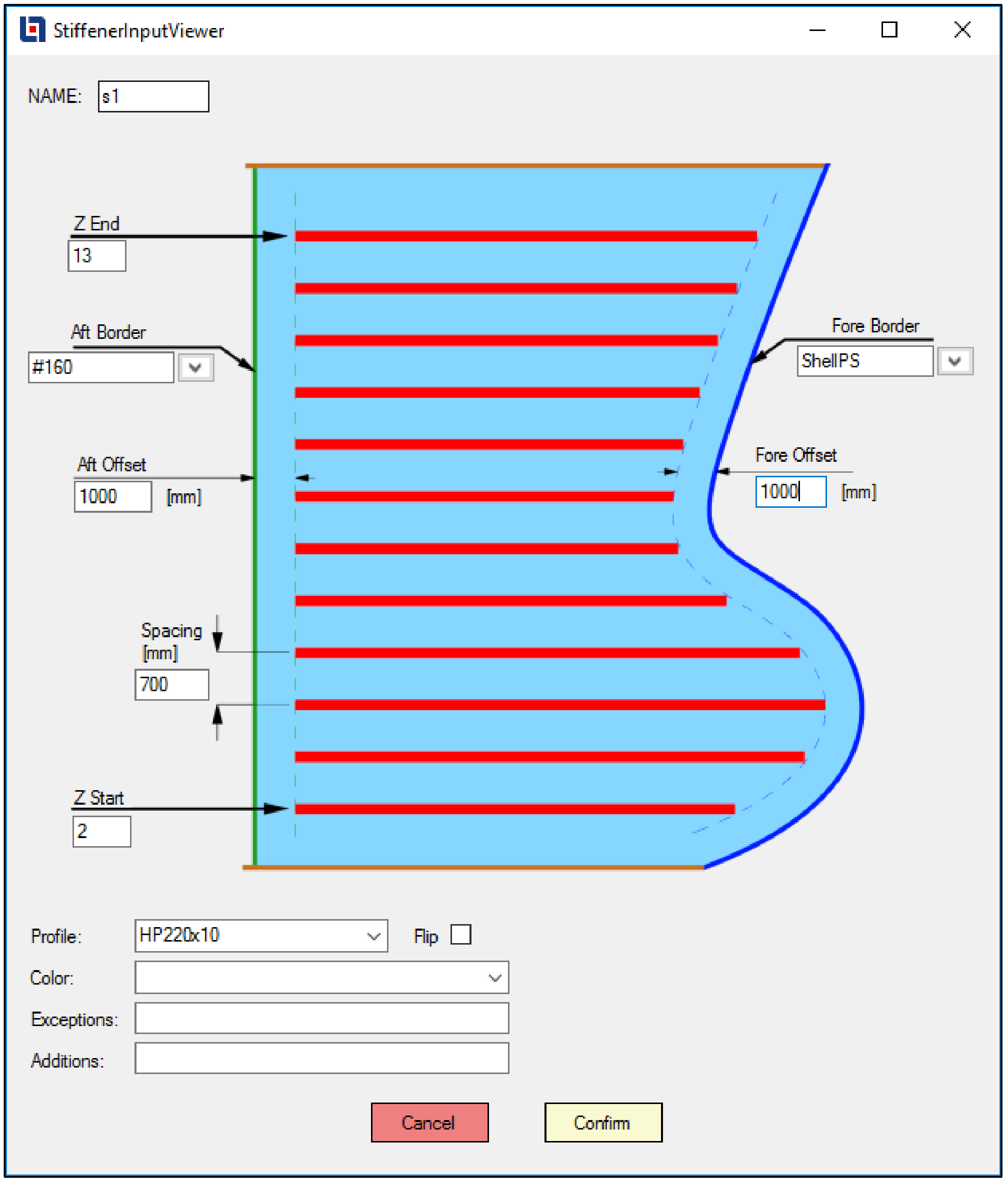
Z End is location on the Z axis of the last stiffener in the series.

Spacing is the distance between two consecutive stiffeners.

Aft Border/Fore Border: represents the two borders between which the stiffeners will be generated.

Aft Offset/ Fore Offset: represents the distance from the borders to the ends of the stiffener.

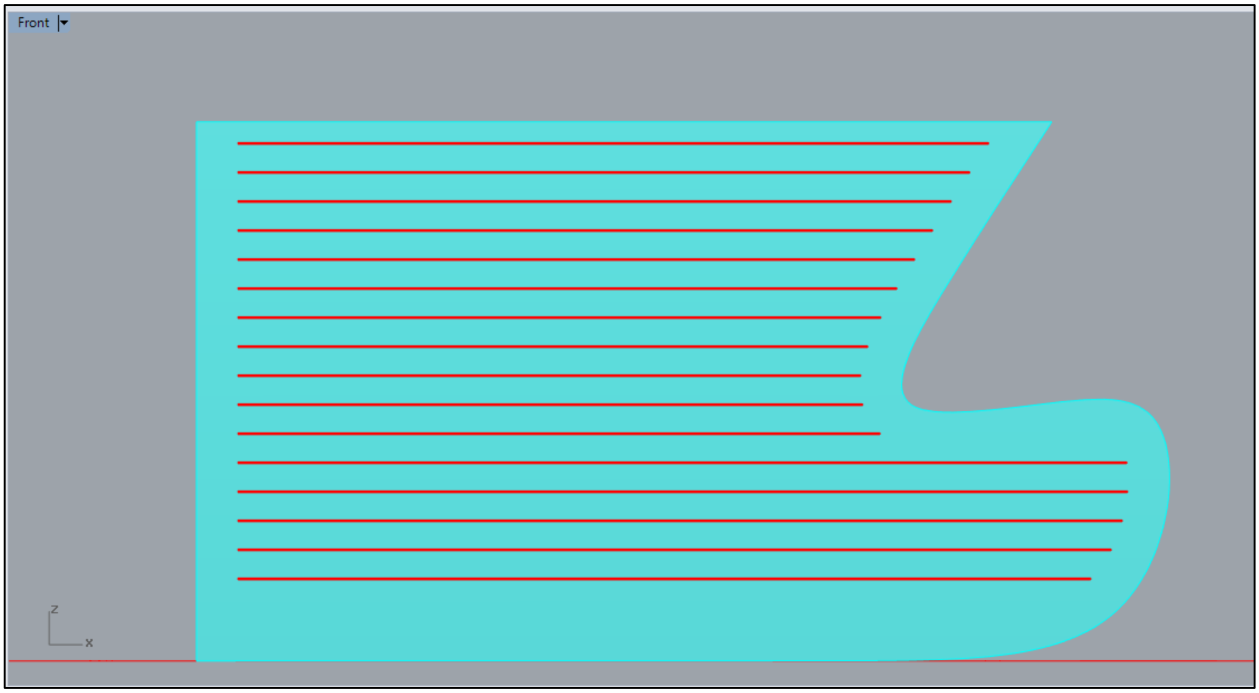
Example Y-Object / Longitudinal (Horizontal) Stiffeners (XZ plane / Z axis)



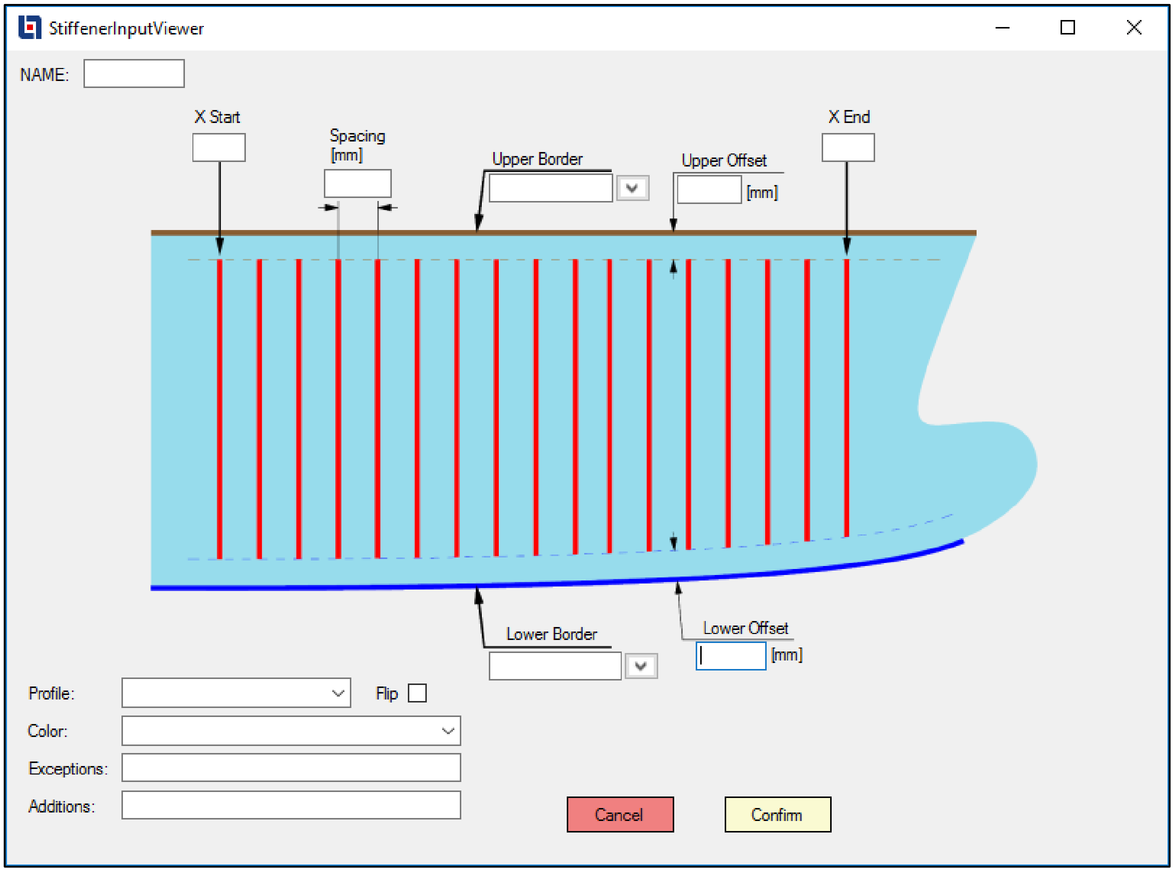
This is an example of the stiffeners definition for a longitudinal bulkhead. This will create a series of **HP220x10** stiffeners, with **Z Start = 2 meters**, and **Z End = 13 meters**, with **700 mm** space between them, no **exceptions** and no **additional** stiffeners in this case.

The stiffeners are bordered at the aft end (**Aft Border**) by **#160** with a gap (**Aft Offset**) of **1000 mm**, and at the fore end (**Fore Border**) by **ShellPS** surface with a gap (**Fore Offset**) of **1000 mm**.

The result is the following:



Y-Object / Vertical (Transverse) Stiffeners (XZ plane / X axis)



NAME: the name for the individual or series of stiffeners.

Profile: choose a profile predefined or input a custom one, i.e. FB100x10, L80x7x5, 300x8/100x10.

Note: Thickness unit is used to define stiffener dimensions.

X Start is location on the X axis of the first stiffener in the series.

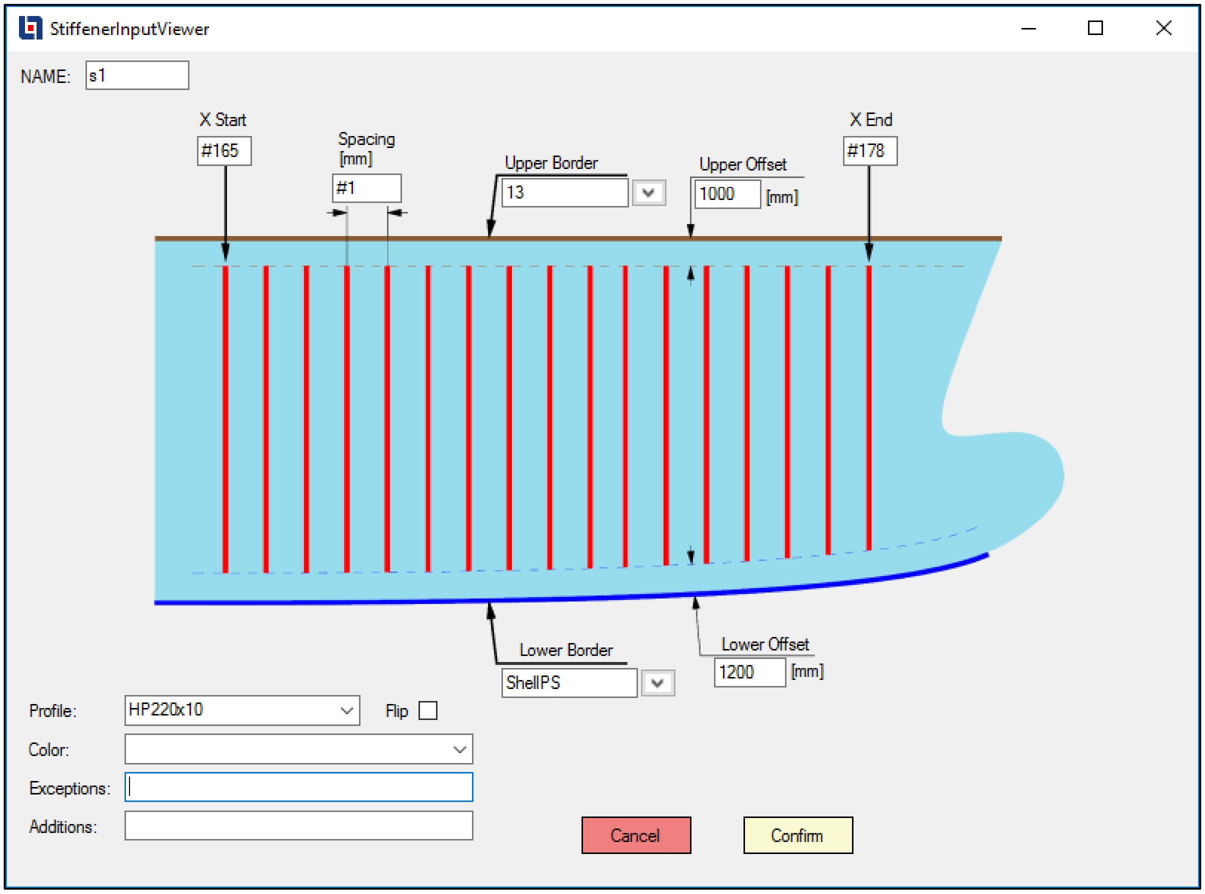
X End is location on the X axis of the last stiffener in the series.

Spacing is the distance between two consecutive stiffeners.

Upper Border/Lower Border: represents the two borders between which the stiffeners will be generated.

Upper Offset/ Lower Offset: represents the distance from the borders to the ends of the stiffener.

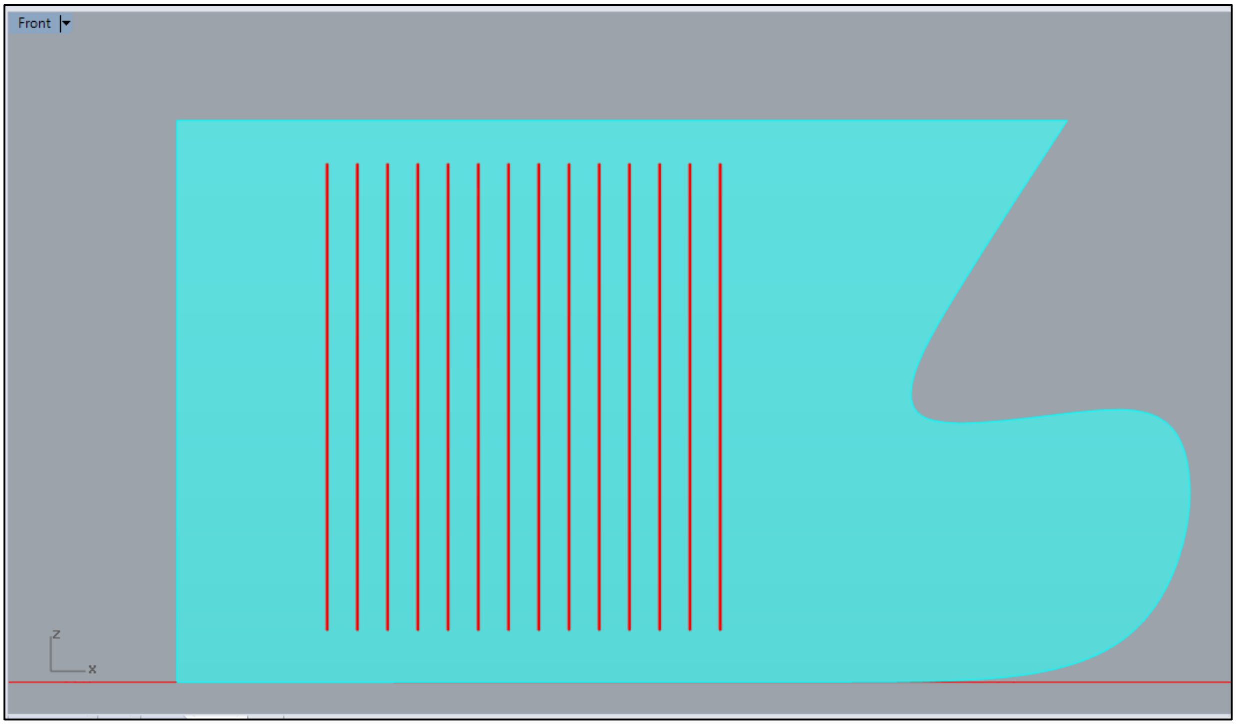
Example Y-Object / Vertical (Transverse) Stiffeners (XZ plane / X axis)



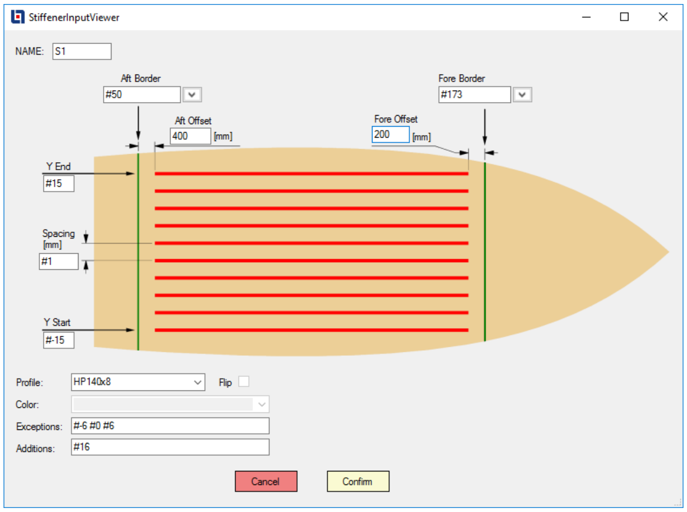
This is an example of the stiffeners definition for a longitudinal bulkhead. This will create a series of **HP220x10** stiffeners, **starting** at **X= #165**, **ending** at X = **#178**, with **1 frame** space between them, no **exceptions** and no **additional** stiffeners in this case.

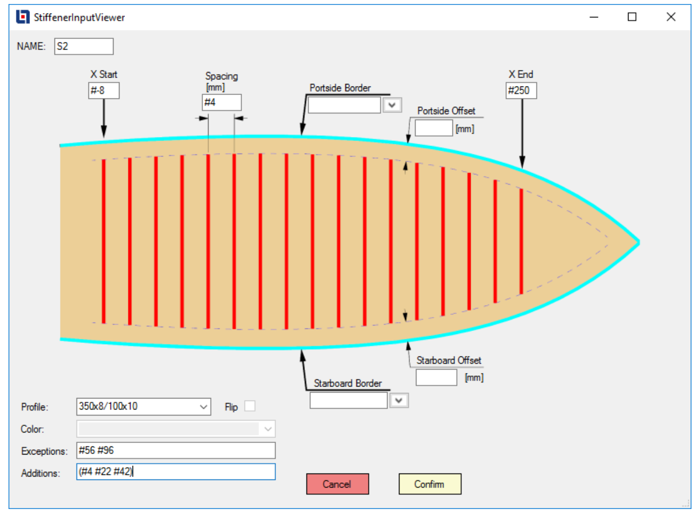
The stiffeners are bordered at the lower end (**Lower Border**) by **ShellPS** surface with a gap (**Lower Border**) of **1200 mm**, and at the upper end (**Upper Border**) by **Z = 13 meters** with a gap (**Upper Border**) of **1000 mm**.

The result is the following:


Front
z
x

Example: Stiffeners Series Method

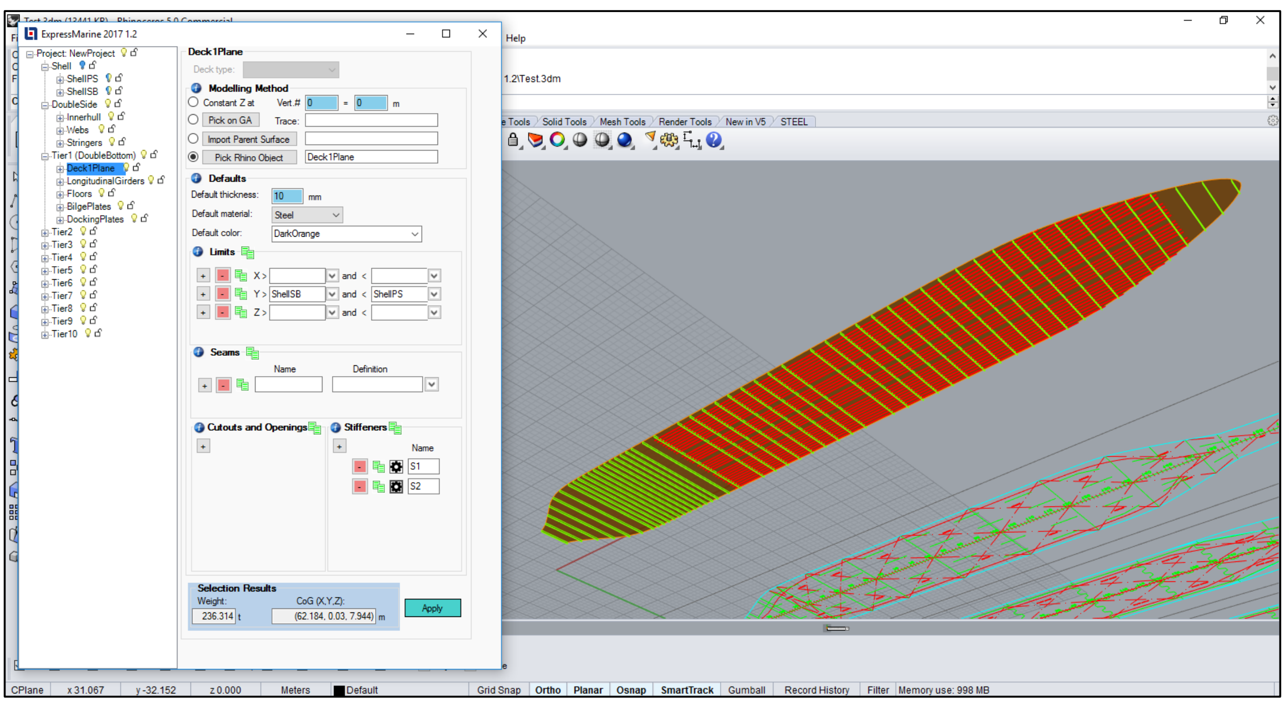




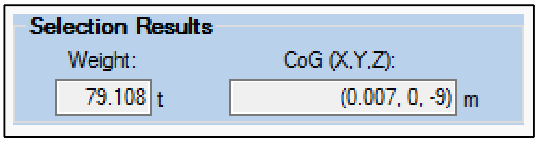
This is an example of the stiffener definition for a deck:

- S1 (in red) will create a series of HP140x8 longitudinal stiffeners, repeating along Y axis, starting from #-15 to #15, with 1 longitudinal frame space between them, skipping those at #6, #0 and #6, and adding one more at #16. The stiffeners are bordered at the aft end by Frame #50 with Aft Offset 400 mm and at the fore end by Frame #173with Fore Offset 200 mm.

- S2 (in green) will create a series of 350x8/100x10 transverse deck beams, repeating along X axis, starting from #-8 to #250, every 4th frame, skipping those at #56 and #96, and adding a miniseries.



Selection Results

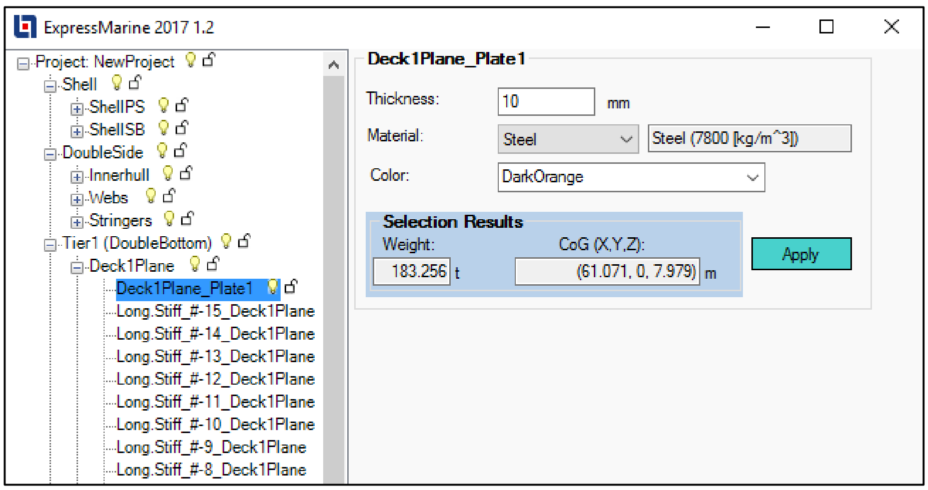


This will show the Weight and Center of Gravity of the selected element.

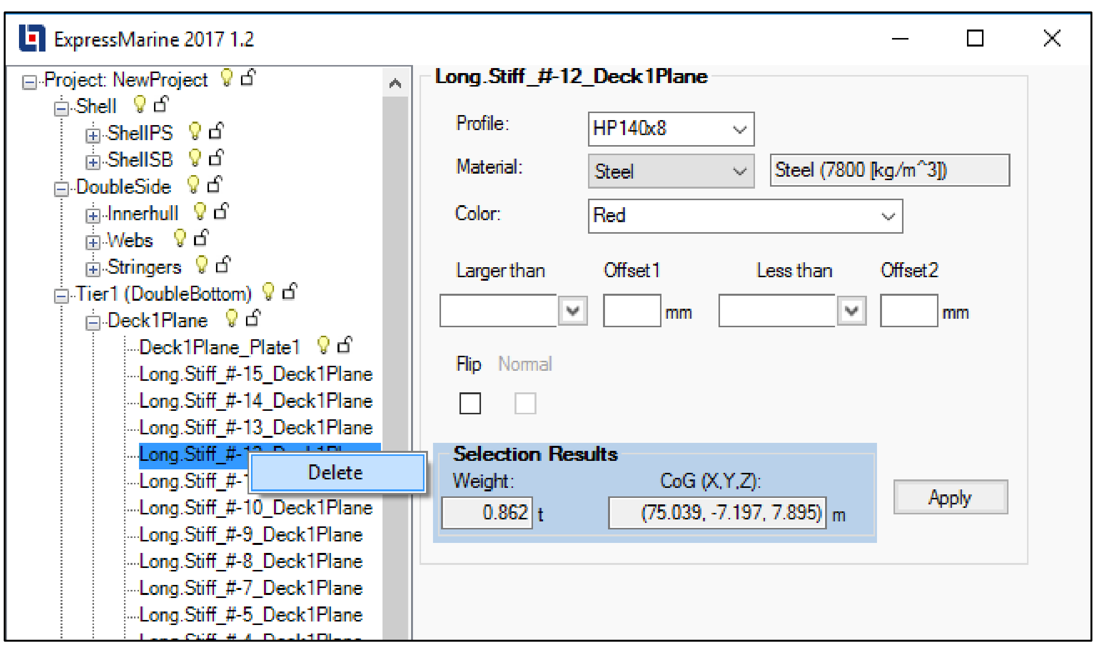
To apply the settings, press 

button.

Resulting plates and stiffeners will be placed under the Element's node. It is possible to change the settings for individual plates:



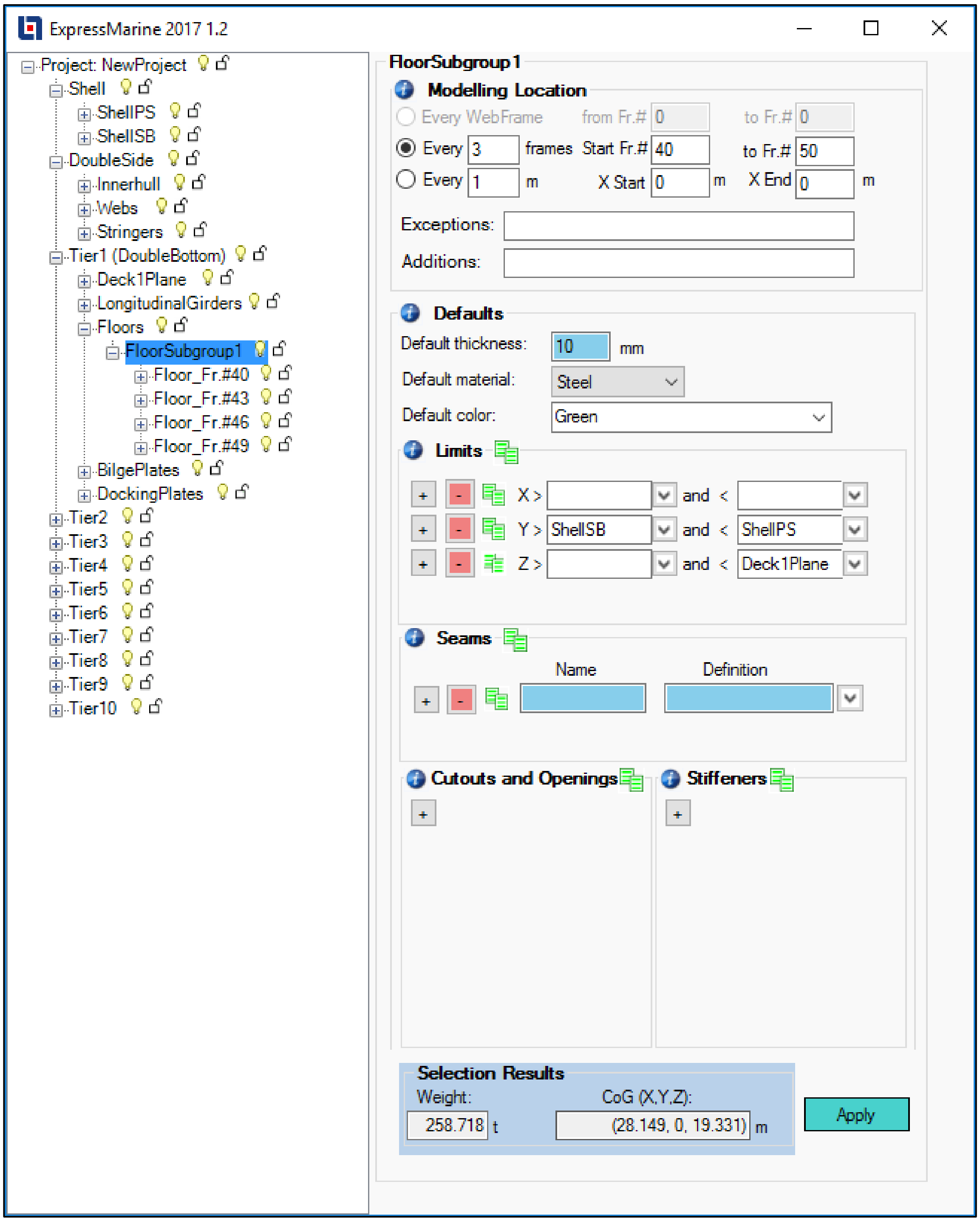
Also certain stiffeners can be deleted by right click/**Delete**:



3.2 Subgroup generation

All subgroups (WebSubgroup, FloorSubgroup, BilgePlatesSubgroup, DockingPlatesSubgroup, X-series, Y-series, Z-series) share the same control panel layout.

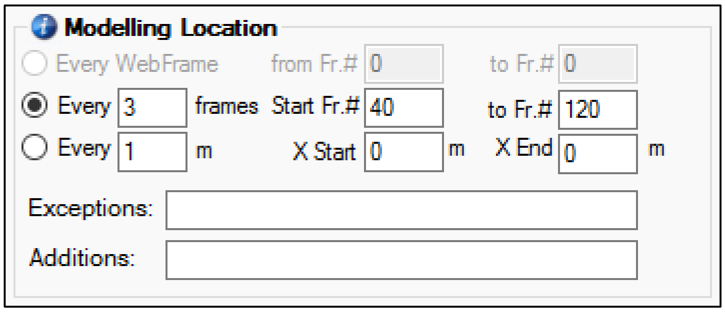
Example of Subgroup's Control Panel layout:



3.2.1 Modelling Location

Create a series of repetitive elements:

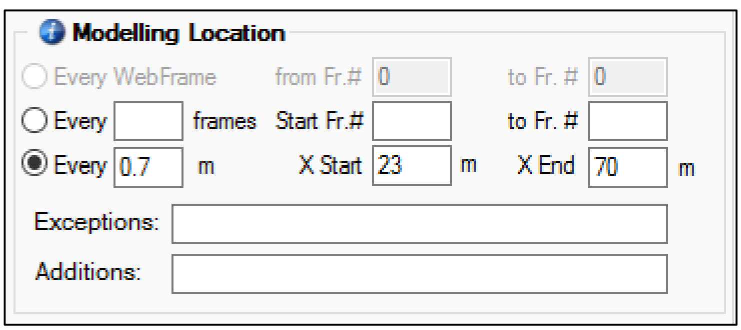
- **By using the framing system**



This will create a series of elements every 3rd frame spacing, starting from frame #40 up to frame #120.

Note: Exceptions and Additions can be specified.

- **By using coordinates**



This will create a series of elements every 0.7 meters, starting from X=23 meters up to X=70 meters. This is called the **main series**.

Note: Exceptions and Additions can be specified.

Exceptions: Fill in locations where you want to remove certain elements created by the series in the Modelling Location.
Format example: #5; #10 [#4 #12 #100]
This will remove frame number 5, 10 and every 4th frame from 12 to 100.
You can use spaces, semicolon or both to separate each exception.

Additions: Fill in locations where you want to add extra elements, one by one or a series.

Format example: #5; #10 [#4 #12 #100]

This will add frame number 5, 10 and every 4th frame from 12 to 100, in addition to those created by the series in the Modelling Method.

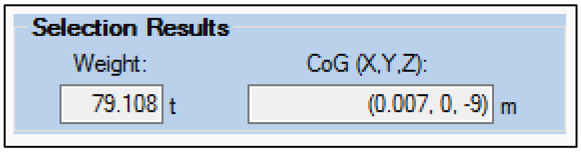
You can use spaces, semicolon or both to separate each addition.

The resulting array will only contain distinct locations, within the model absolute tolerance (I.e. if a certain location is generated by the main series and also specify the additions, only one element will be created at that location).

3.2.2 Defaults, Limits, Seams, Cutouts and Openings, Stiffeners

All the inputs from the Subgroup control panel are transferred to all newly created elements in that particular subgroup.
For more details, please see the **Element generation** chapter.

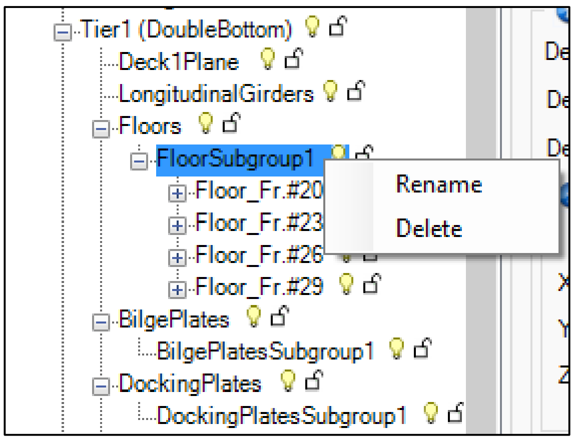
3.2.3 Selection Results



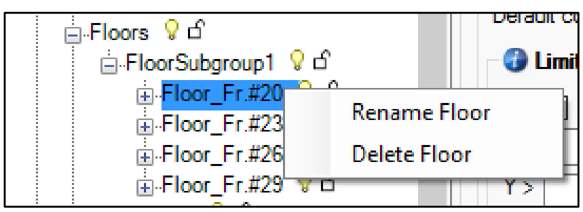
This will show the Weight and Center of Gravity of the selected Subgroup.

To apply the settings, press  button.

Resulting elements will be placed under the Subgroup's node. It is possible to rename or delete the Subgroup by right click and select "**Rename**" or "**Delete**".



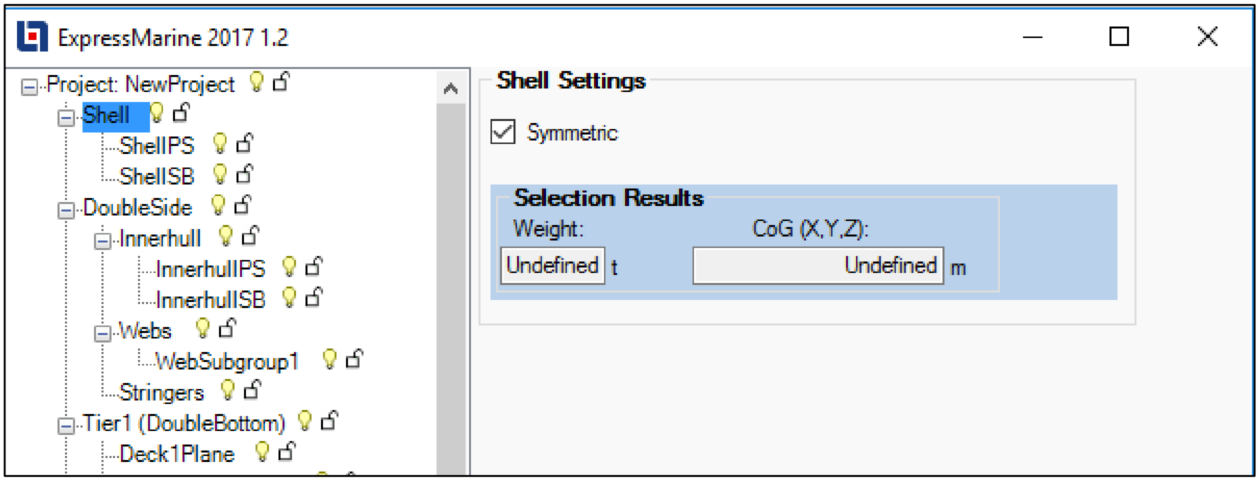
It is possible to change the settings for the subgroup, also certain elements can be renamed or deleted by right click/**Rename** or **Delete**.



3.3 Specialized Groups Particularities

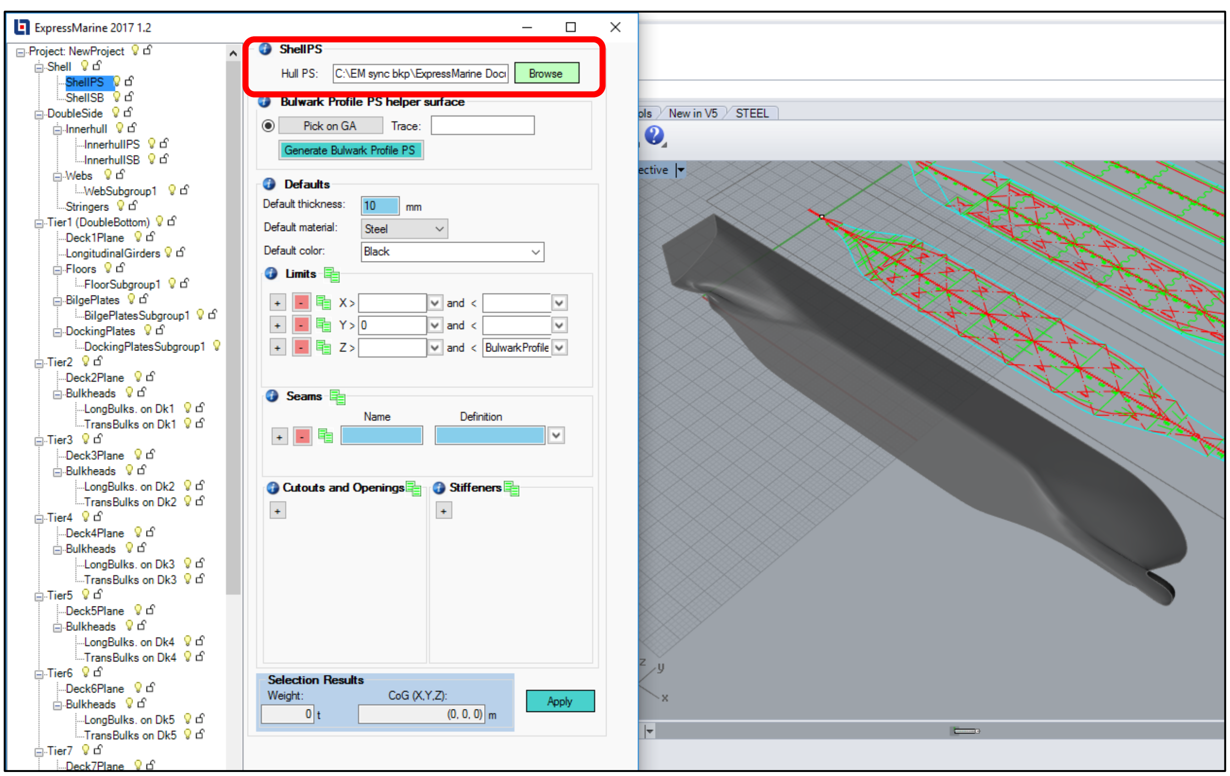
3.3.1 Shell

If the shell will be symmetric, make sure that the Symmetric is checked.



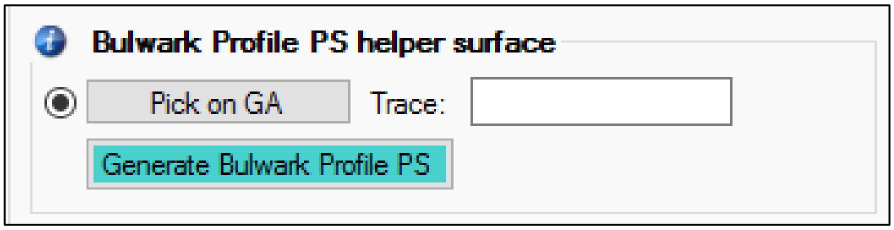
ShellPS

Because the shell is symmetric it is enough only to import the portside half.

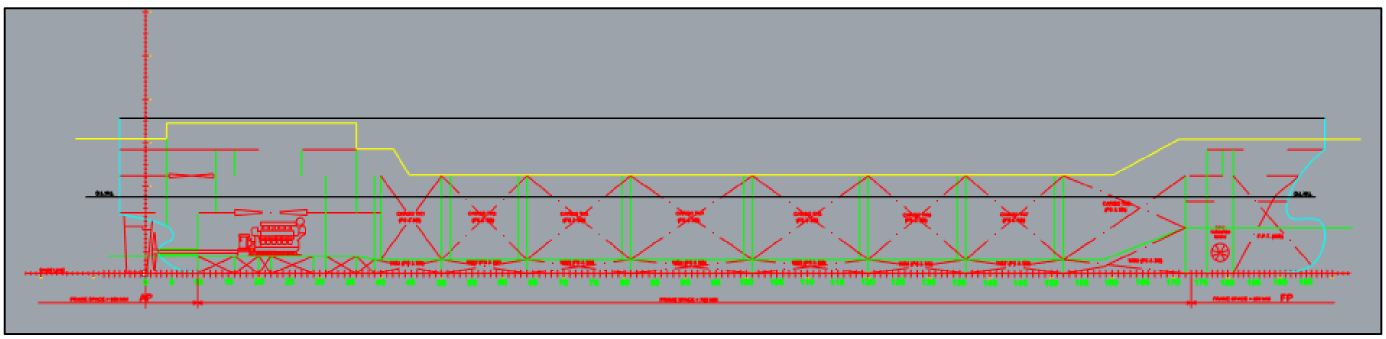


Bulwark Profile PS helper surface:

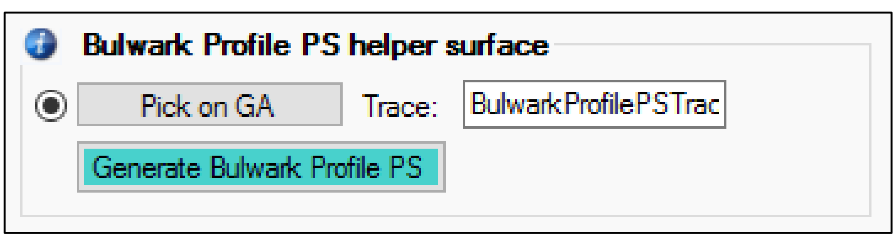
Bulwark profile must be a single curve (or polycurve) and the ends need to be extended outside the hull's aft and fore ends to ensure a successful trim.

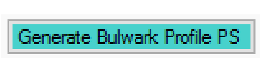


Click **Pick on GA** button to select the curve defining the upper edge of the shell in the profile drawing:

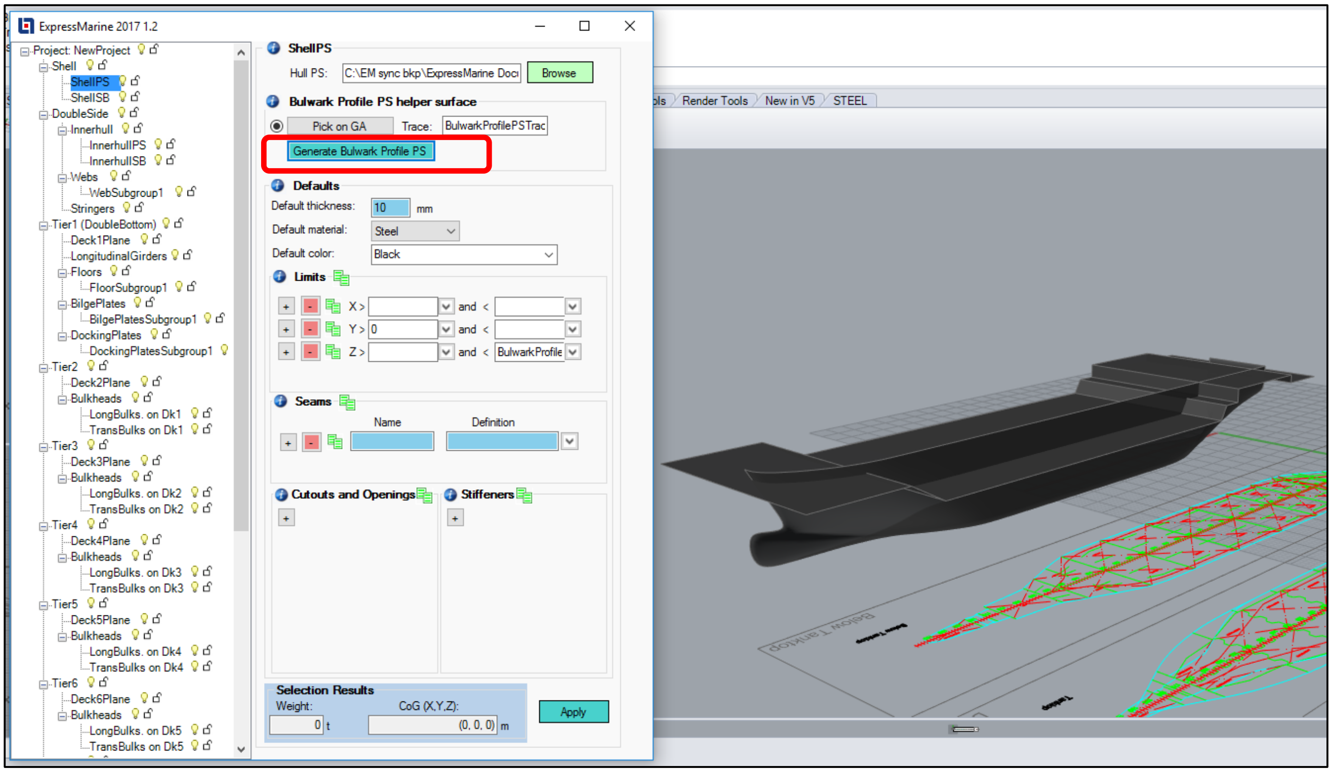


The name of the Trace will automatically be displayed after the bulwark profile curve was selected from the GA:

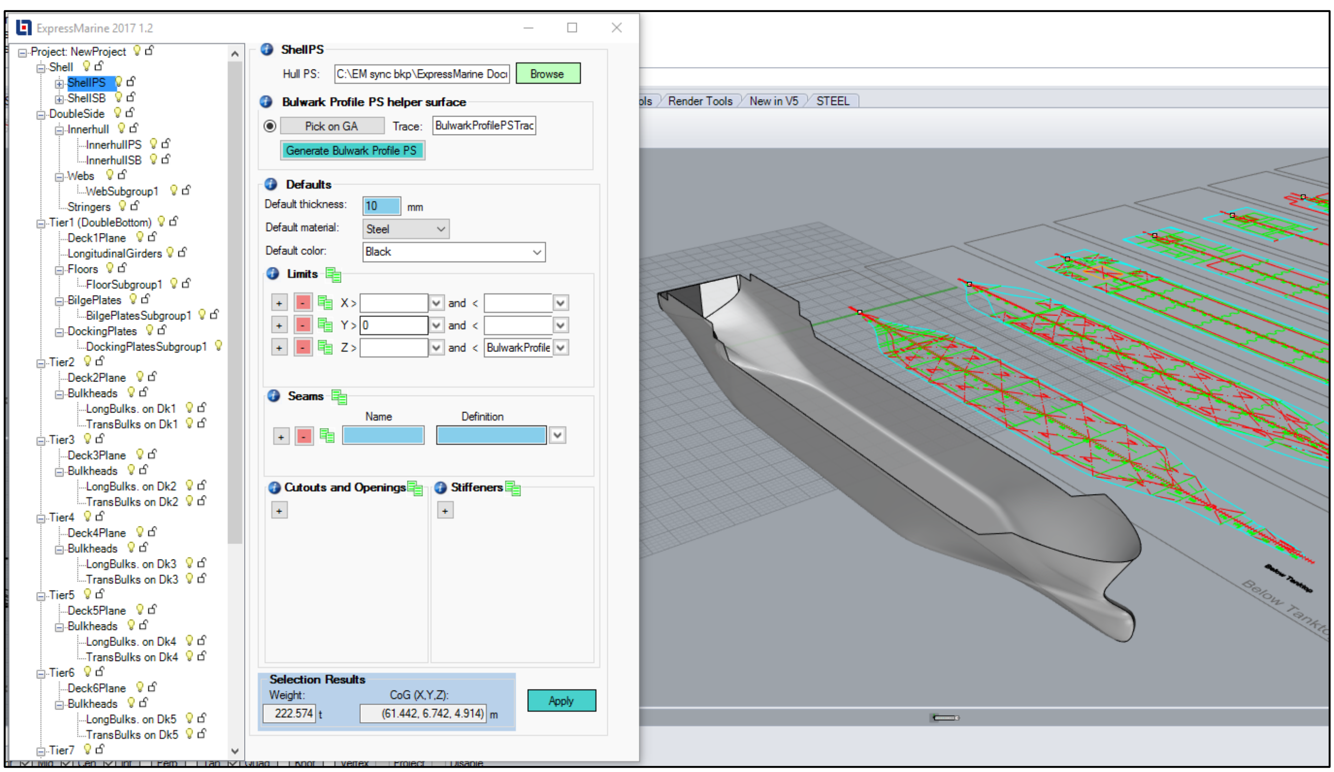


Click the 

button and the Bulwark Profile PS extrusion will be generated and displayed into the model for visual inspection:



Fill in the rest of the relevant settings for your shell (thickness, limits, cutouts, stiffeners), then press Apply button to generate ShellPS and ShellSB:



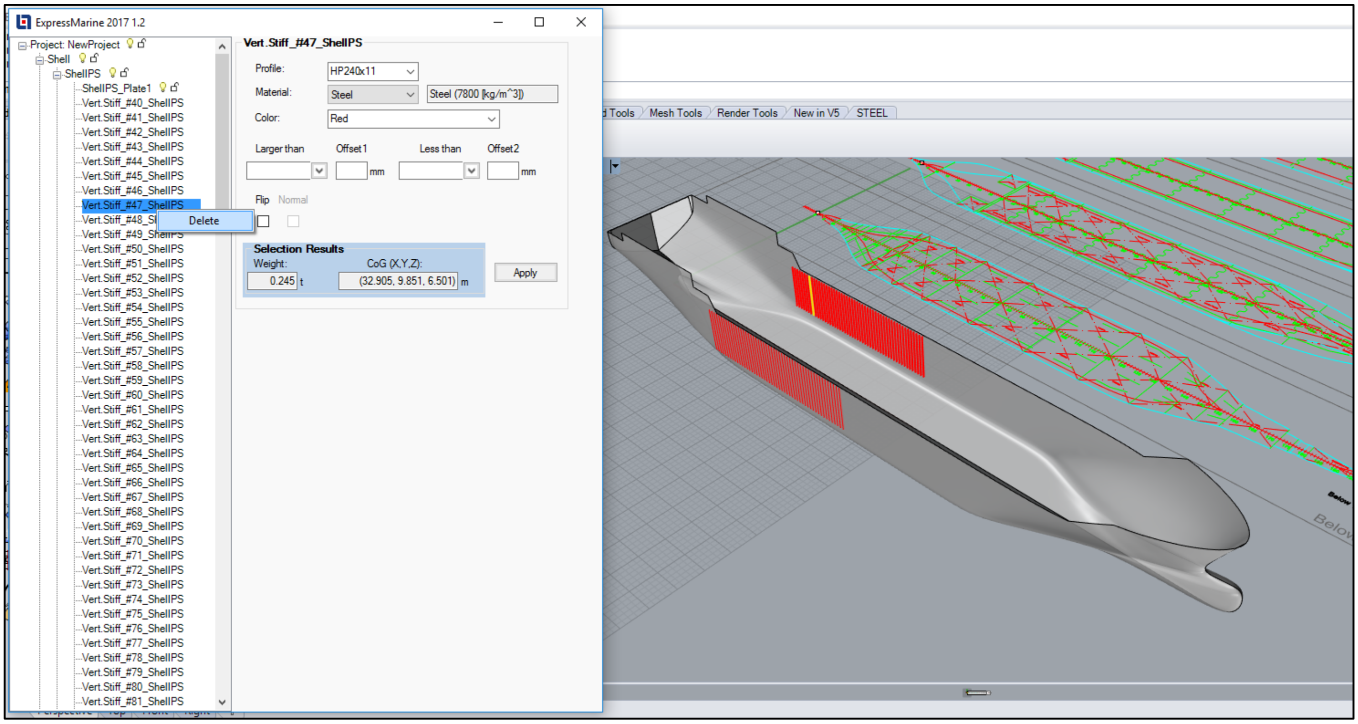
Defaults, Limits, Seams, Cutouts and Openings, Stiffeners

For more details, please see the **Element generation** chapter.

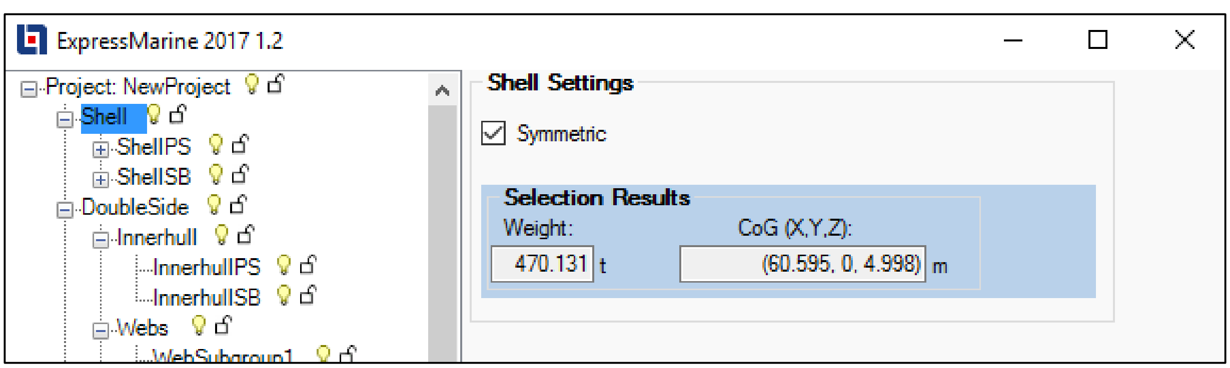
To apply the settings, press 

button.

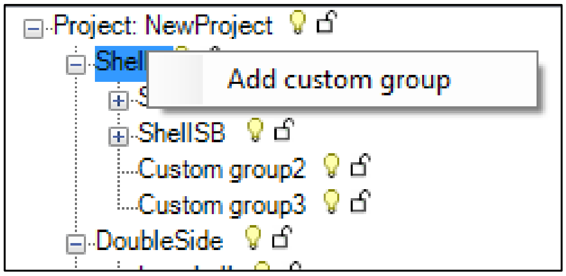
Resulting shell plates and stiffeners will be placed under the ShellPS and ShellSB nodes. It is possible to delete Stiffeners by right click/**Delete**.



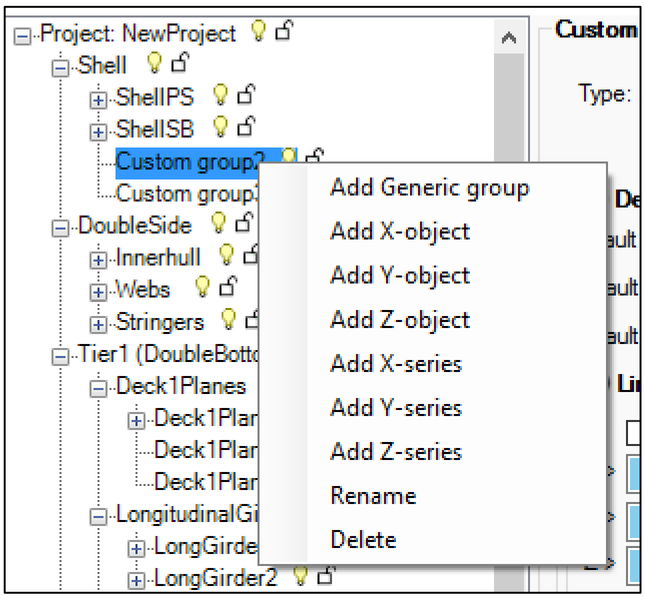
The **total Weight** and **CoG** for the ShellPS and ShellSB will be displayed in **Shell** node:



Custom groups can be added under the Shell node by right click/**Add custom group**:



Custom groups can be renamed or deleted. They can also contain Generic group, X-object, Y-object, Z-object, X-series, Y-series and Z-series:



Shell Troubleshooting

ExpressMarine shell generation works best when all the component surfaces of the hull can be joined into a single polysurface. To ensure that all structural elements touching the shell will succeed, try to avoid the following cases:

Case 1

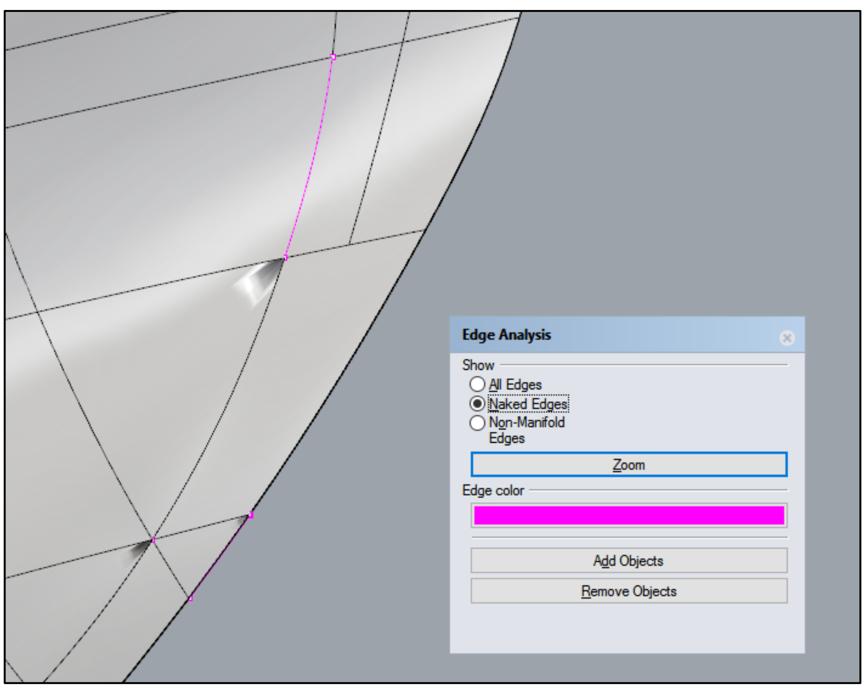
Hull surface quality is not satisfactory (I.e. there are missing patches, holes, low quality edges, etc.). To fix this, before the Hull surface is imported, open it in Rhino, select all the component surfaces and join them into one polysurface by using the command **Join.**

If the join fails, or more than one polysurface is obtained, it is a sign that the hull solid generation will also fail.

If join succeeds, use the Rhino command **ShowEdges** and check that no naked edge is found inside the polysurface.

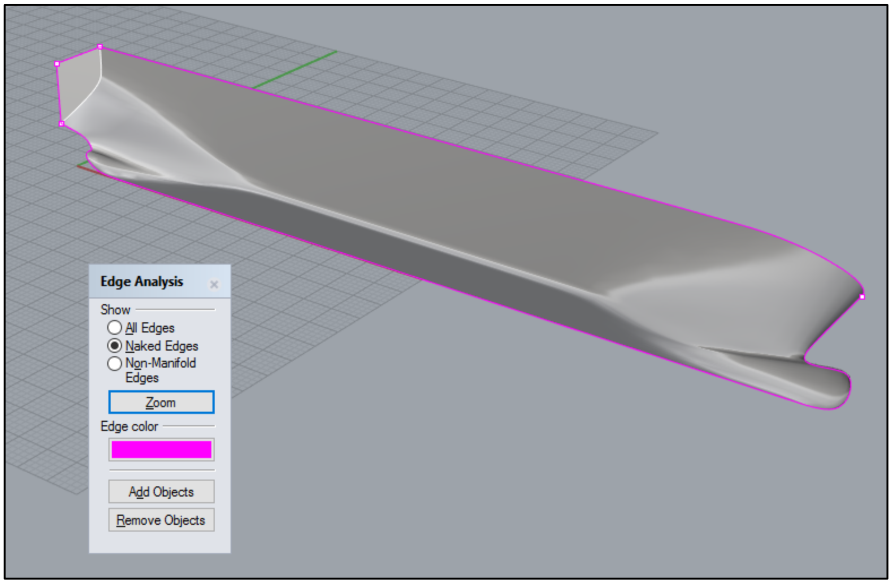
In the following example can be observed two types of issues that may prevent the generation of a single polysurface:

- bad quality edge (the magenta edge)
- bad quality point edge in the case of three edge patches (the magenta points)



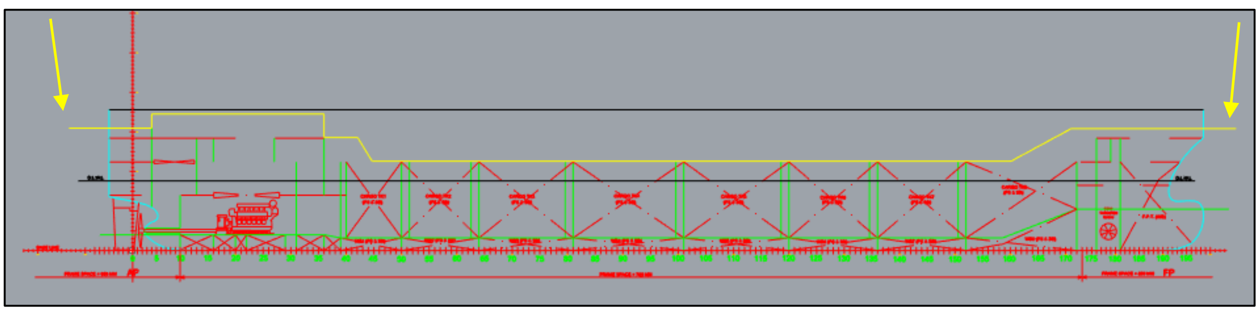
To fix this problem, either export the hull from your initial hull creator tool with higher precision, or use Rhino to create new patches.

In a successful case, only the external edges should be highlighted.



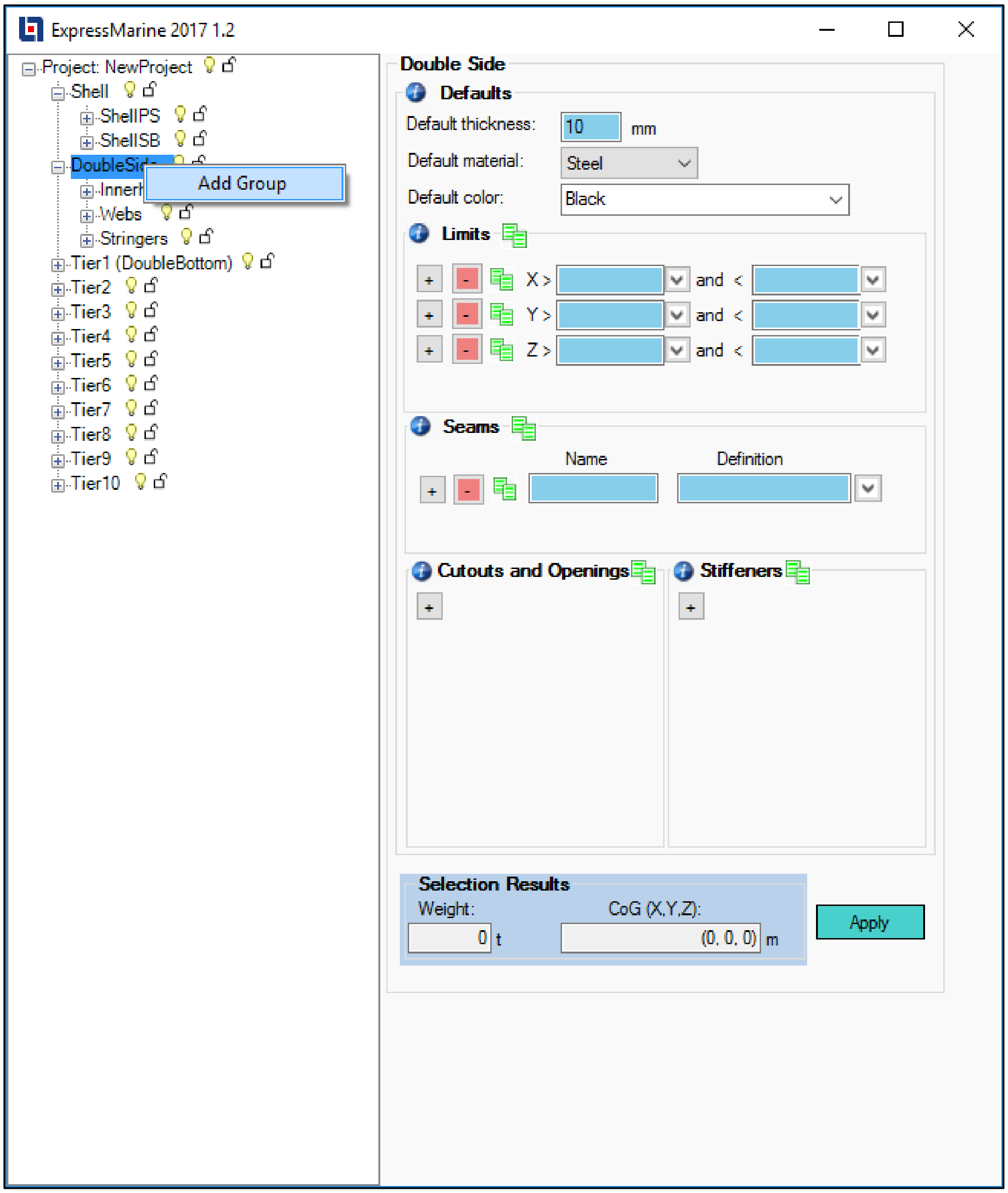
Case 2

Bulwark Profile curve is above the hull surface or it does not extend beyond the Shell profile.



3.3.2 DoubleSide

The DoubleSide node contains the following **specialized** groups: **Innerhull**, **Webs**, **and Stringers.** The user has also the possibility to add **custom** groups by right click/**Add Group.**

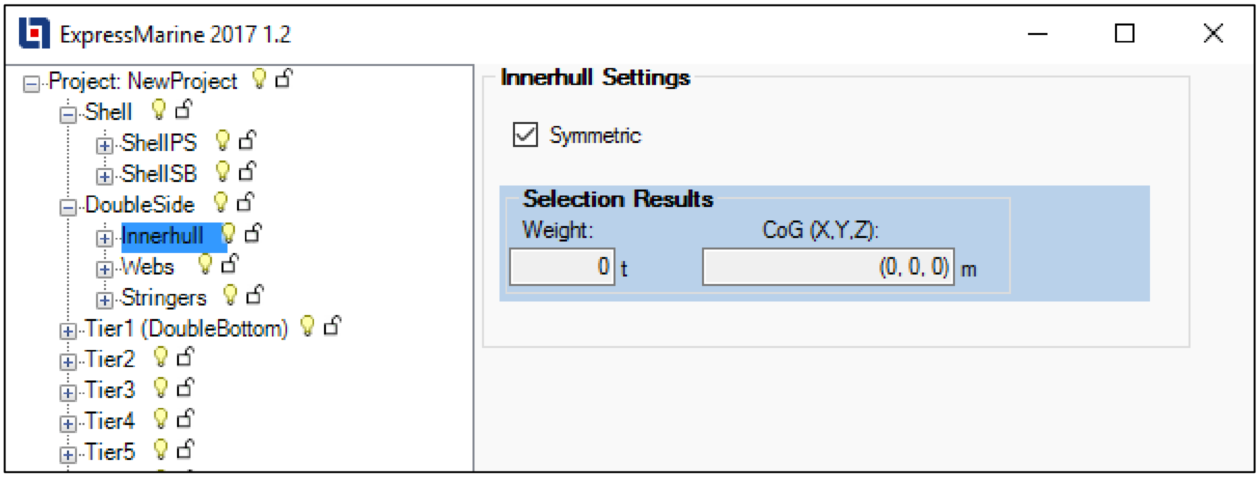


Because the DoubleSide node has children (sub nodes), the **Defaults** settings will be transferred to all children. If the child settings are changed, the parent default settings will not overwrite them.

Default values inherit from the parents, will be displayed in light blue background, or white background after editing.

Innerhull

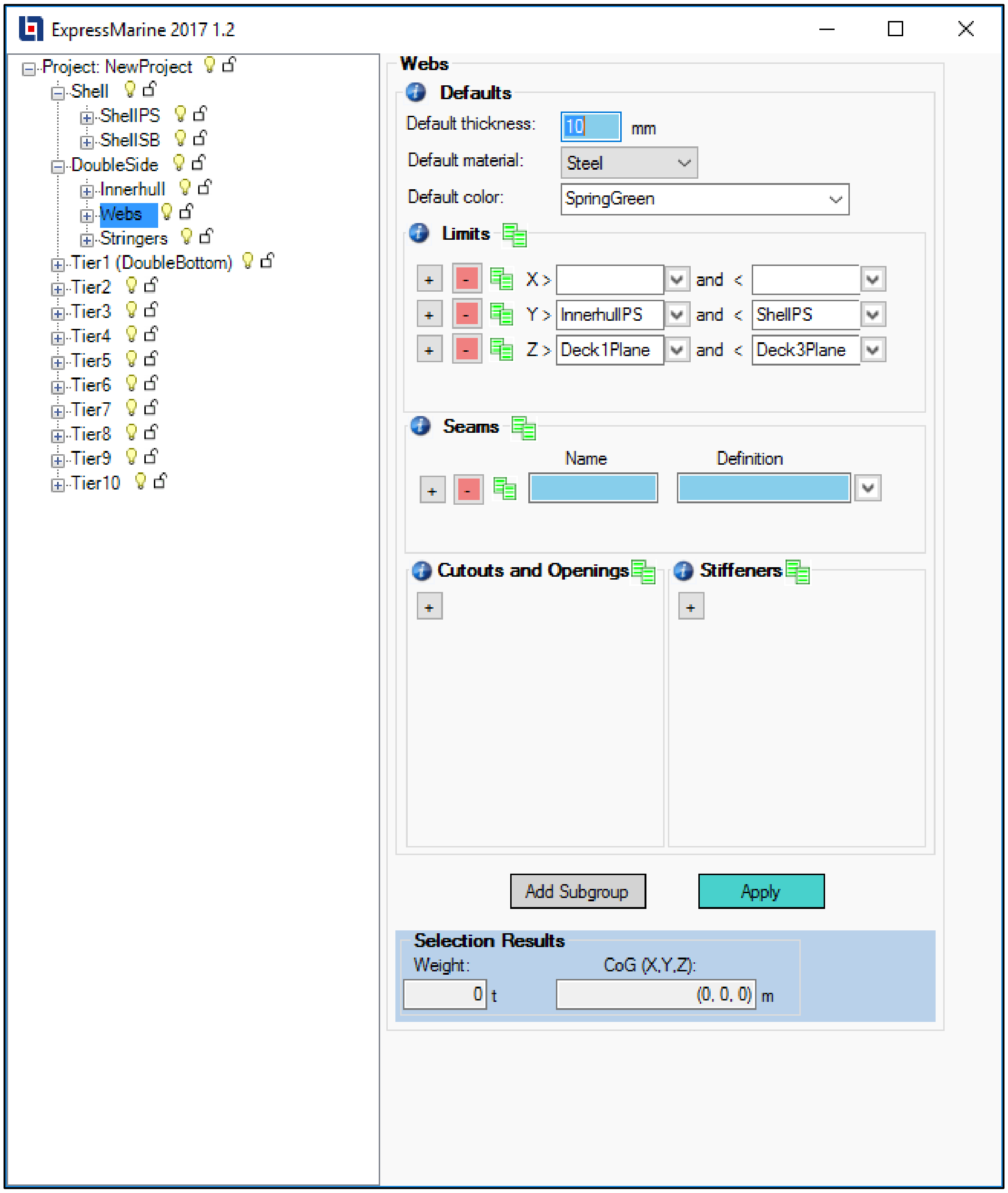
The user can model the innerhull (PS and SB) in this node, or optionally this can be left blank and the innerhull can be created as a longitudinal bulkhead or a custom object in one of the tiers.
If the Innerhull PS and SB are symmetric, make sure the **Symmetric** button is checked.



Note: Other sources may refer to Innerhull as Double Hull, Double Shell, Innershell, etc.

Webs

Webs can be grouped in as many subgroups as necessary. WebSubgroup1 is already implemented as default, and to add more, use right click/**Add Webs Subgroup** or the "**Add Subgroup**" button from the Webs control panel.



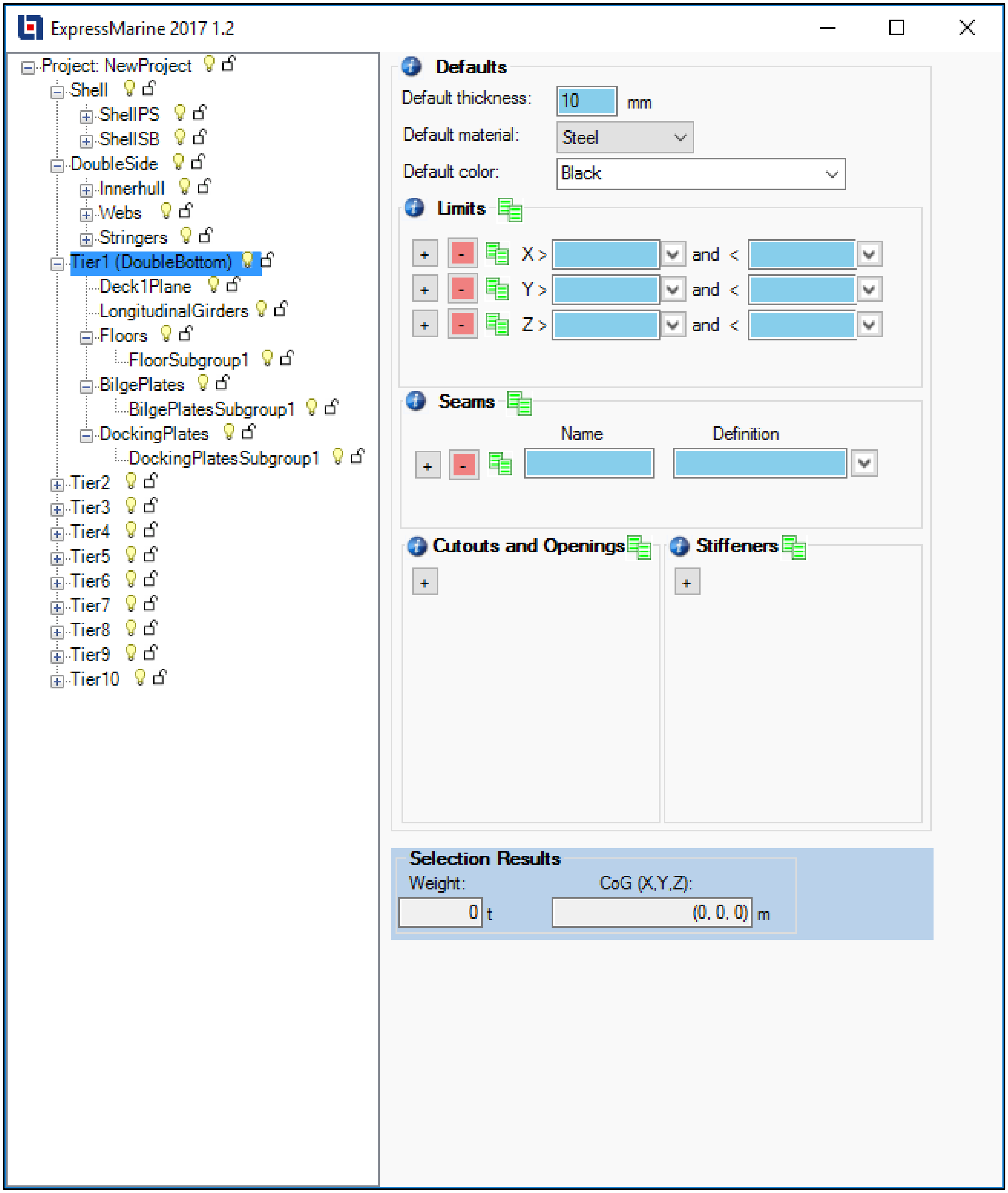
The user also has the possibility to rename or delete any WebSubgroup by right click/**Rename** or **Delete**.

If some structural settings will be common to all web subgroups, it is recommended to fill them in the Webs group node and press **Apply** button to be transferred to the children.

For WebSubgroup node generation, please check the **Subgroup Generation** chapter.

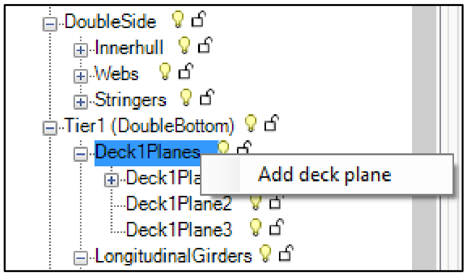
3.3.3 Tier1 (DoubleBottom)

Tier1 represents the Double Bottom. It contains the following **specialized** groups: **Deck1Planes**, **LongitudinalGirders**, **Floors, BilgePlates, DockingPlates.** The user has also the possibility to add **custom** groups by right click/**Add custom group.**

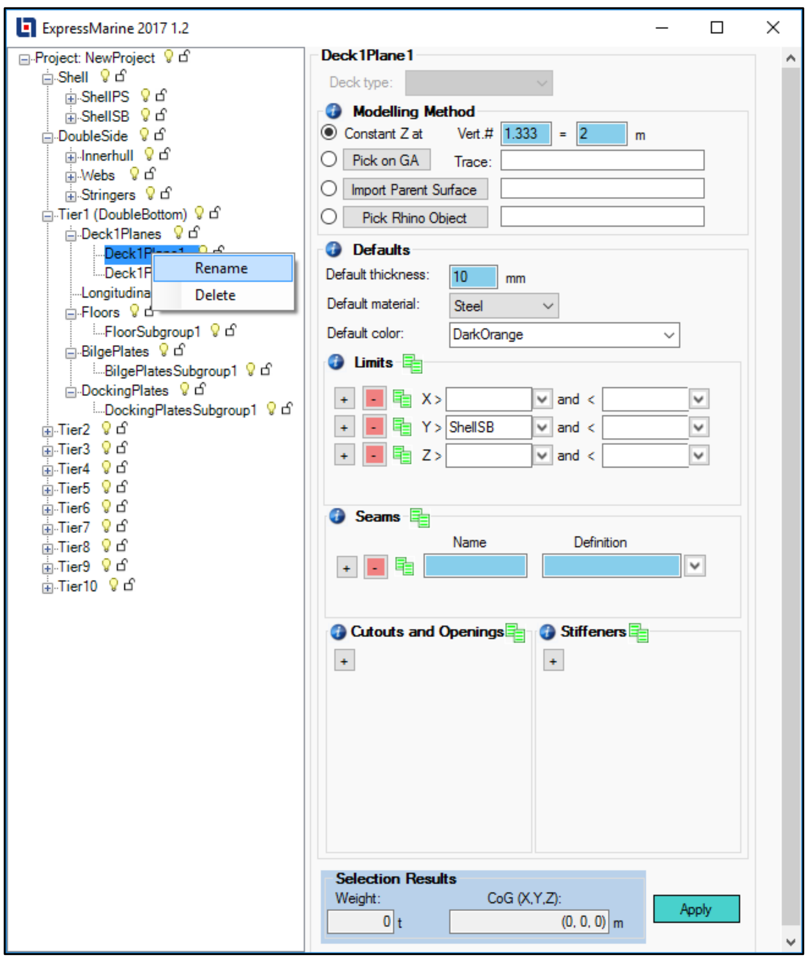


Deck1Plane

If the deck is not one continuous element, then multiple components can be added by right click on the Deck1Plane and select **Add deck plane**.



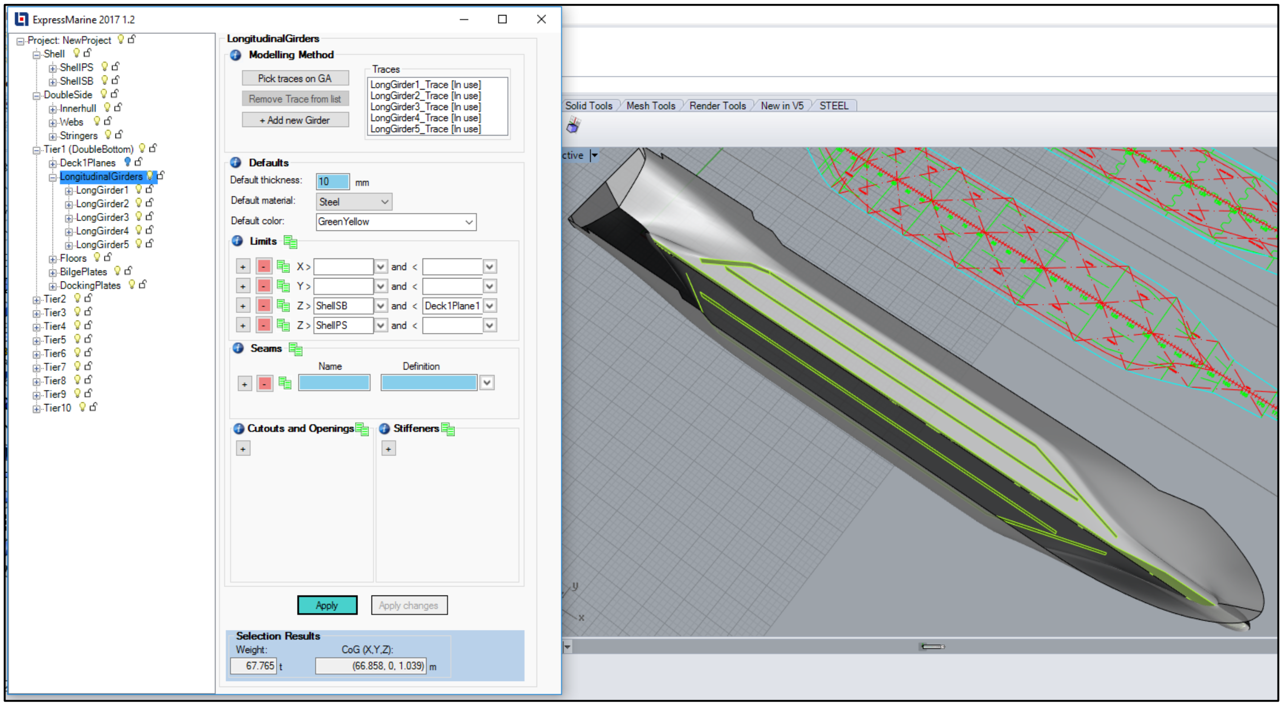
It is possible to Rename or Delete any DeckPlane element by right click:



Deck Plane Modelling method: If **Pick on GA** option is selected, the user needs to select the trace from the Profile box.

LongitudinalGirders

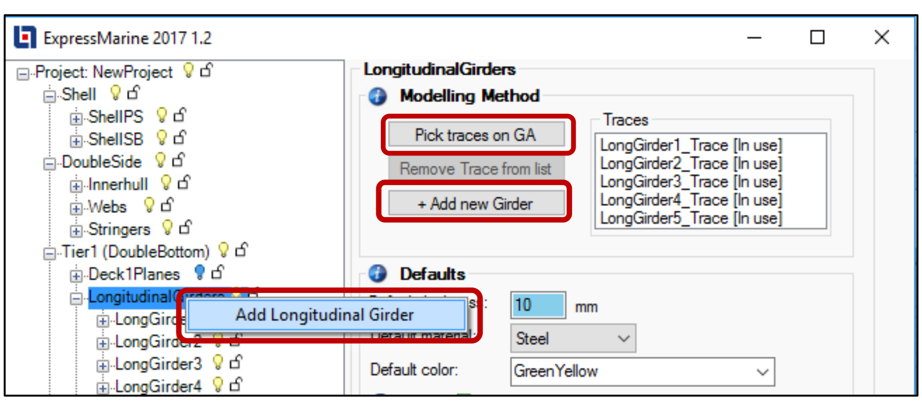
Modelling Method: Curves representing longitudinal girders can be picked from the general arrangement on the appropriate deck section. These will be extruded into 3D longitudinal girders and a link between 2D and 3D will be created.
Editing the traces in the GA, the 3D counterpart will also be modified after reapplying.



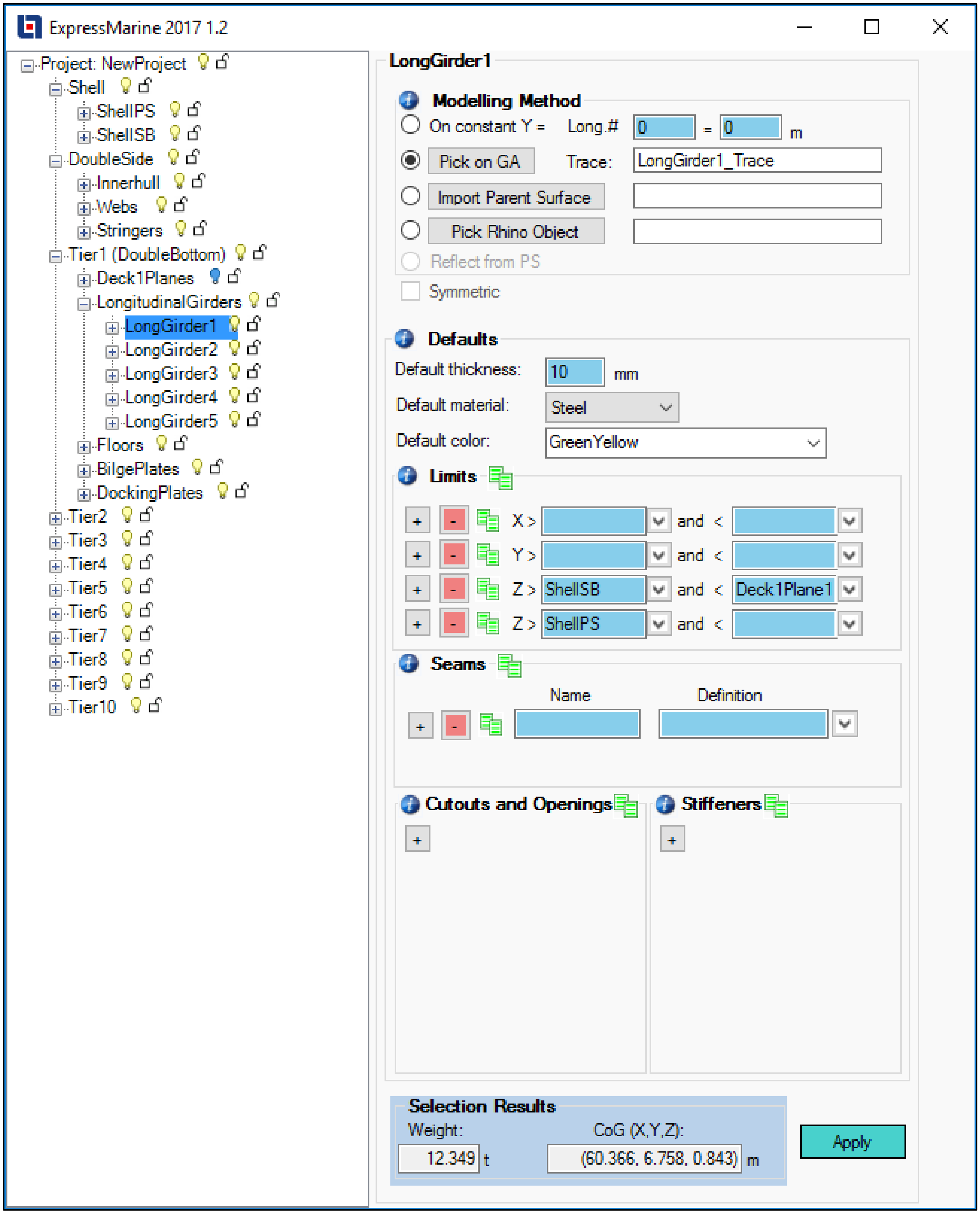
Note that the **3D objects**, the **traces** and the **nodes** are highlighted simultaneously.

If more longitudinal girders are needed, there are several options to create them:

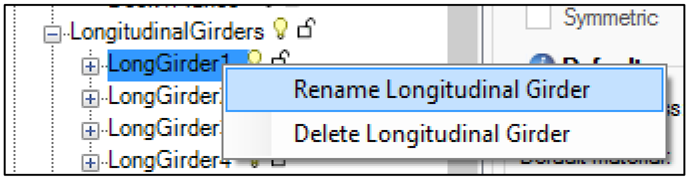
- select again "**Pick traces on GA**" button, edit the settings if necessary and then **Apply** to confirm
- click the "**+ Add new Girder**" button or right click on the LongitudinalGirders node and select **Add Longitudinal Girder** , fill in the settings and **Apply** to confirm



All the default settings will be transferred to the individual girders, but there is always the possibility to navigate at a specific element (Longitudinal Girder) and adjust the structural properties as required and confirm by pressing **Apply** button.



It is also possible to rename or delete any longitudinal girder by right click on the individual node:

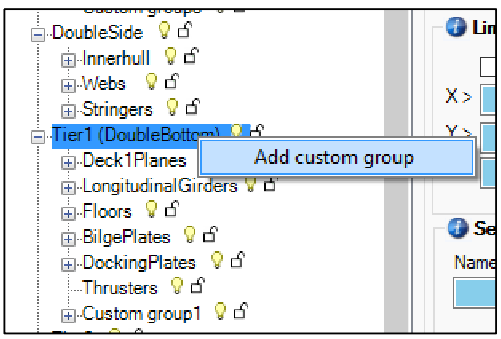


Floors, BilgePlates and Docking Plates

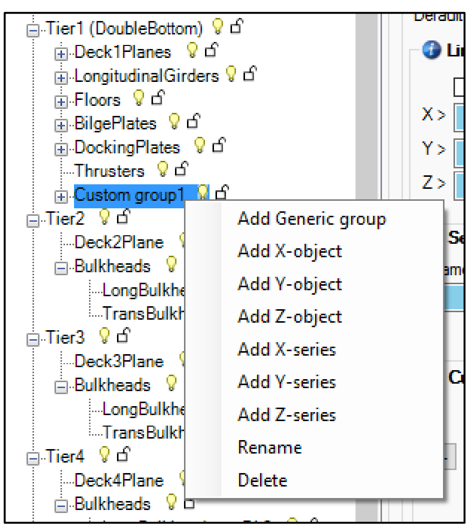
Please follow the same principles as the Webs chapter.

Custom Group

Custom groups can be added under the Tier1(DoubleBottom) node by right click/**Add custom group**:



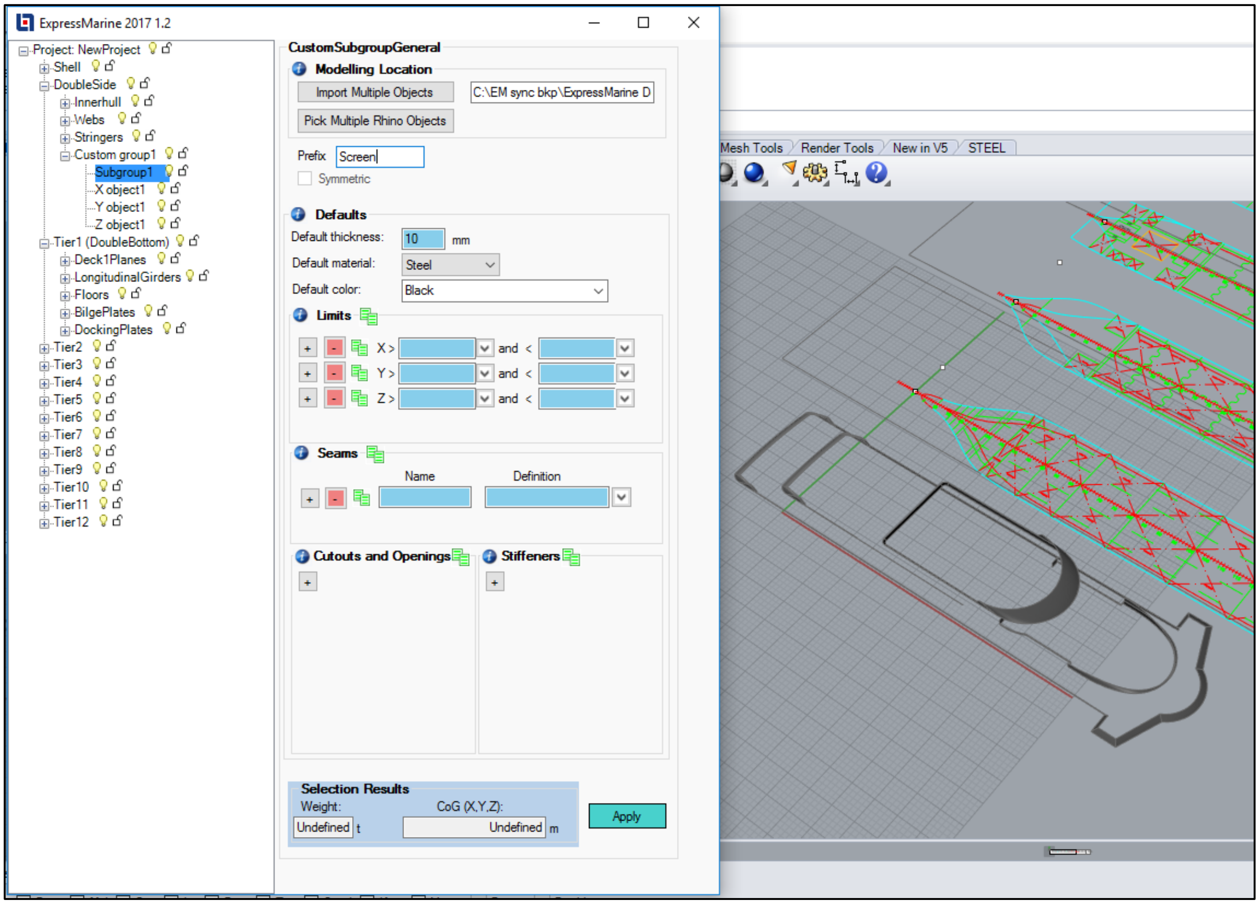
Custom groups can be renamed or deleted. They can also contain Generic group, X-object, Y-object, Z-object, X-series, Y-series and Z-series:



Generic Group:

The user can import a file with multiple objects inside and each surface will become an individual Express Marine element after **Apply**.

Use a suggestive **Prefix** which will become the base for the element name.



The newly created element can be renamed, deleted, and modifications can be made to its structural default settings.

3.3.4 Tier2 and onward

Starting from Tier2 and onward, the modelling principle is the same.

Bulkheads

Modelling Location:

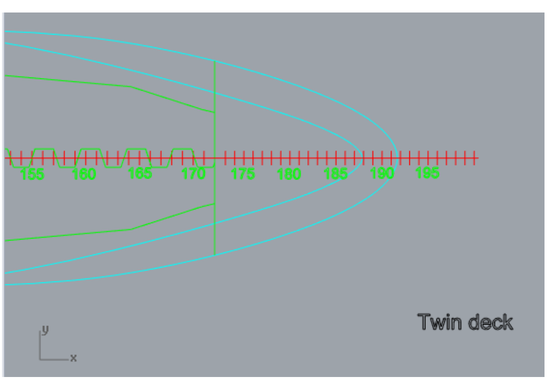
Curves representing bulkheads (both transverse and longitudinal) can be picked from the general arrangement on the appropriate deck section and their direction will be automatically determined. These will be extruded into 3D bulkheads and a link between 2D and 3D will be created.

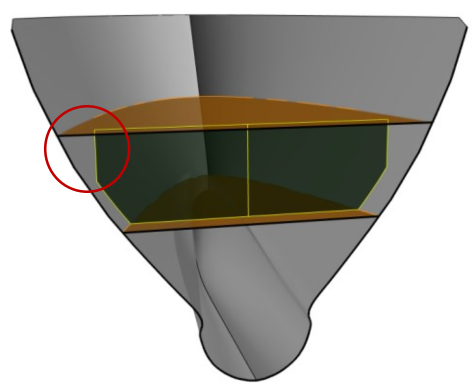
Non-destructive editing of the traces in the GA (general arrangement) will also modify the 3D counterpart after reapplying.

Note: *non-destructive editing represents the use of Rhino commands that do not change the GUID (Rhino unique identification number). Examples of commands* ***not allowed*** *in the editing of traces in use:* ***Trim***, ***Split***.
Commands ***allowed*** *in the editing of traces:* ***Points on – Move curve points***, ***Move***, ***Scale***.

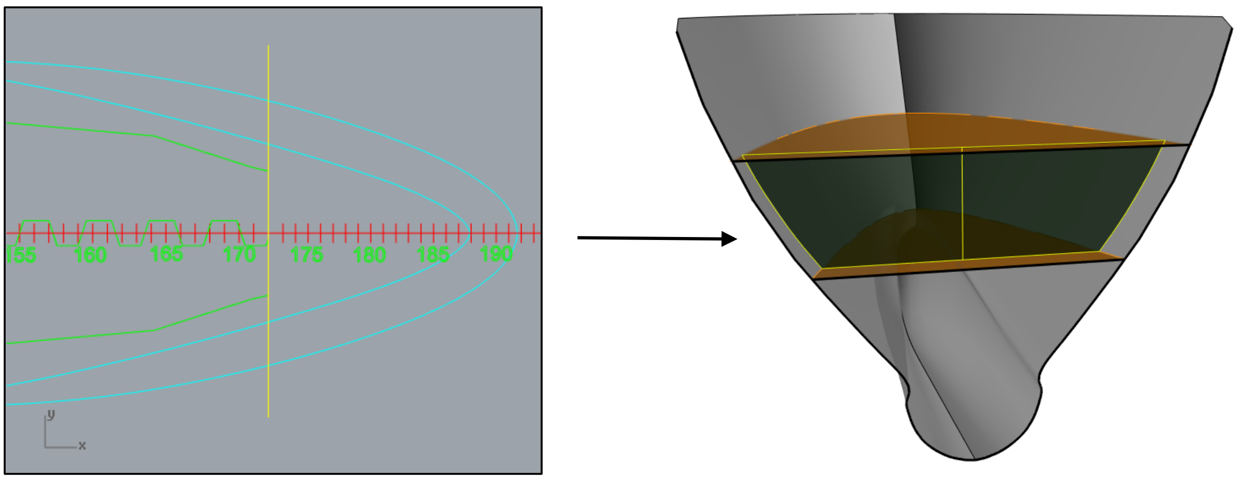
If a bulkhead will be limited by an object with 3D curvature it is recommended to extend the trace end beyond the section of the border to ensure that the bulkhead will extend all the way to the limit. Example: transverse bulkheads touching the hull, especially in the aft and fore areas, should be slightly extended outside the hull.

In the following case, because the deck section is not accurate, the resulting bulkhead is not fully boarded by the hull:

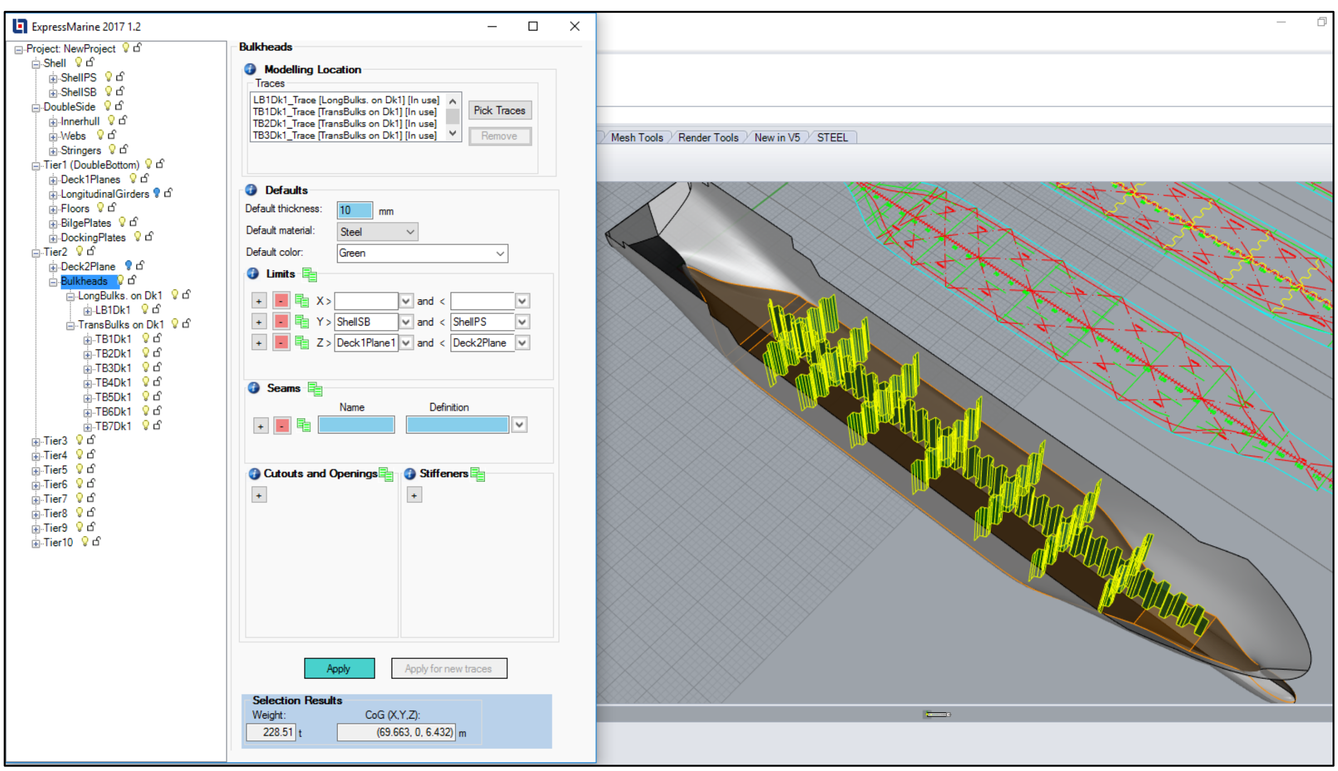




To correct this issue, the user needs to extend the trace ends beyond the section of the border, to ensure that the bulkhead will extend all the way to the limit (shell):

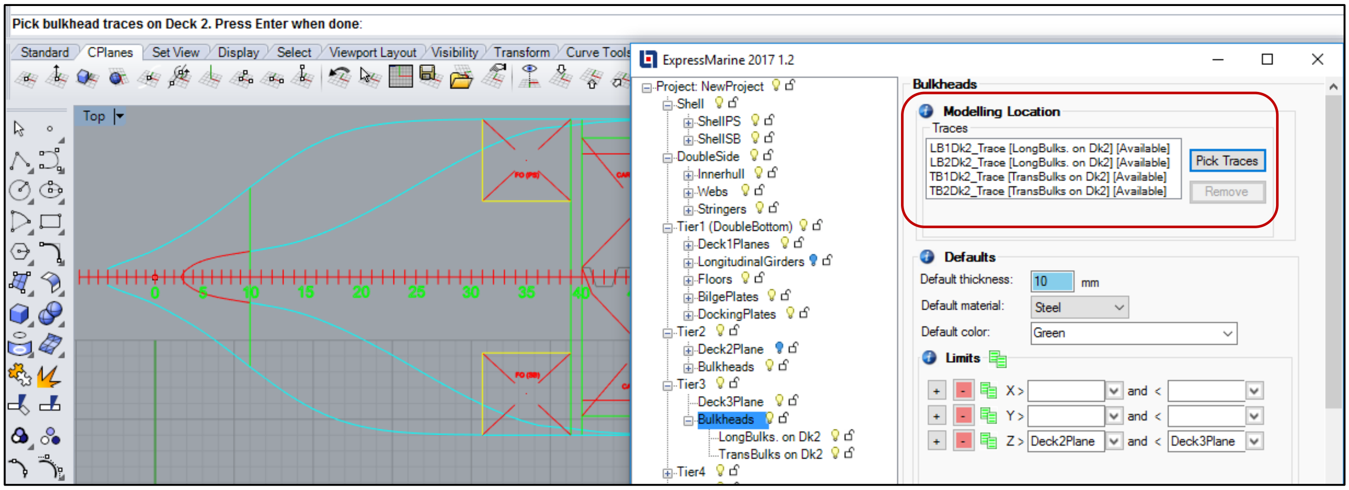


Note that the **3D objects**, the **traces** and the **nodes** are highlighted simultaneously.

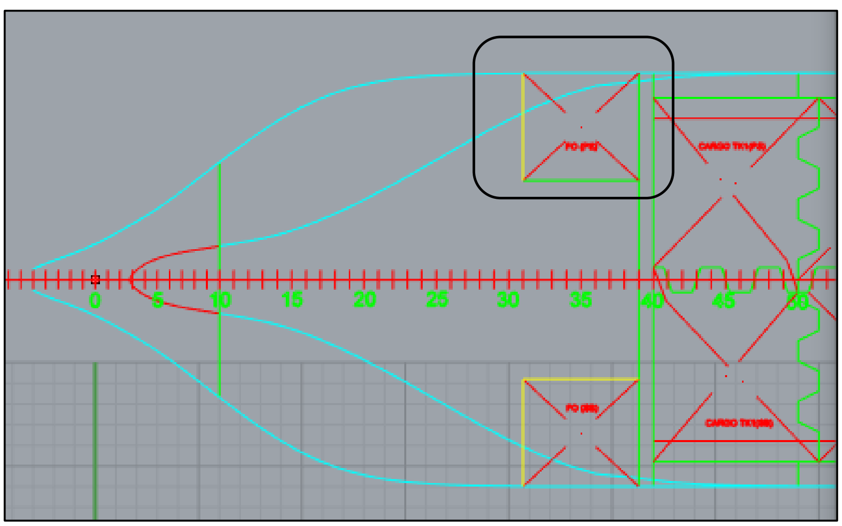


To remove an undesired trace from the Modelling Location/ Traces box, follow the steps:

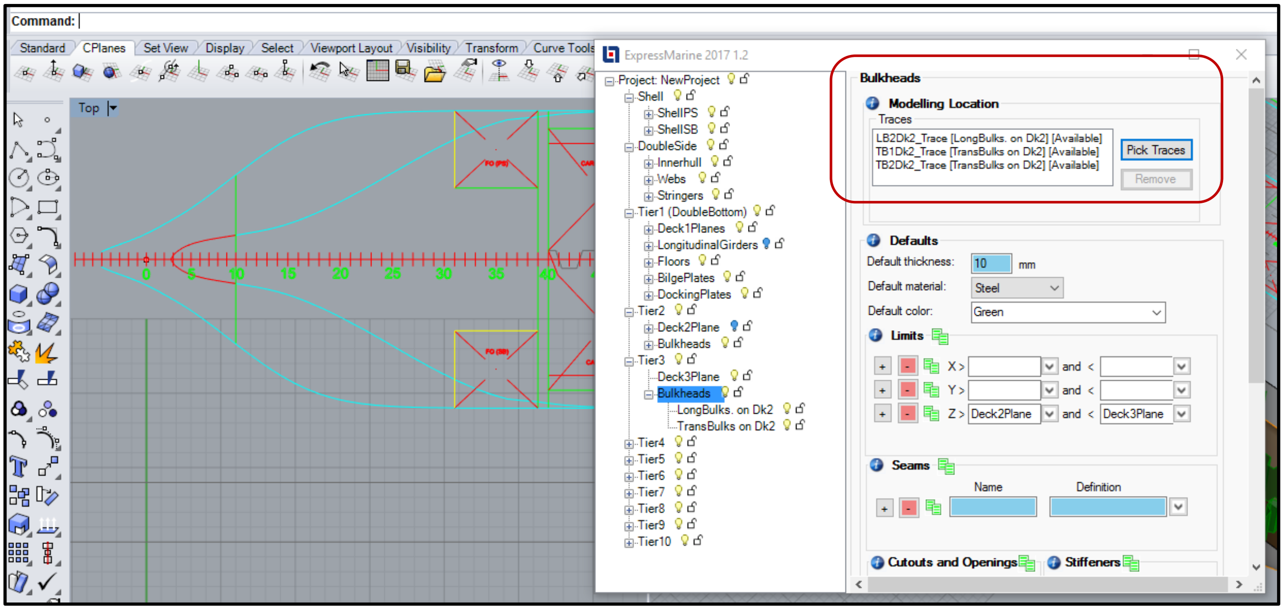
- Click **Pick Traces** button and all the selected traces from before will be highlighted in yellow:



- Hold the **Ctrl Key** and click on the trace that should be removed from the Traces box list:



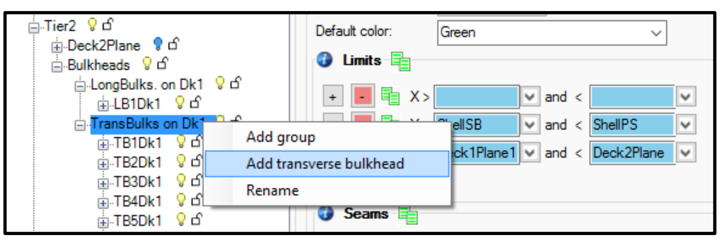
- then press **Enter Key** and the undesired trace (LB1Dk2_Trace [LongBulks. On Dk2] [Available]) will disappear from the Traces box list:



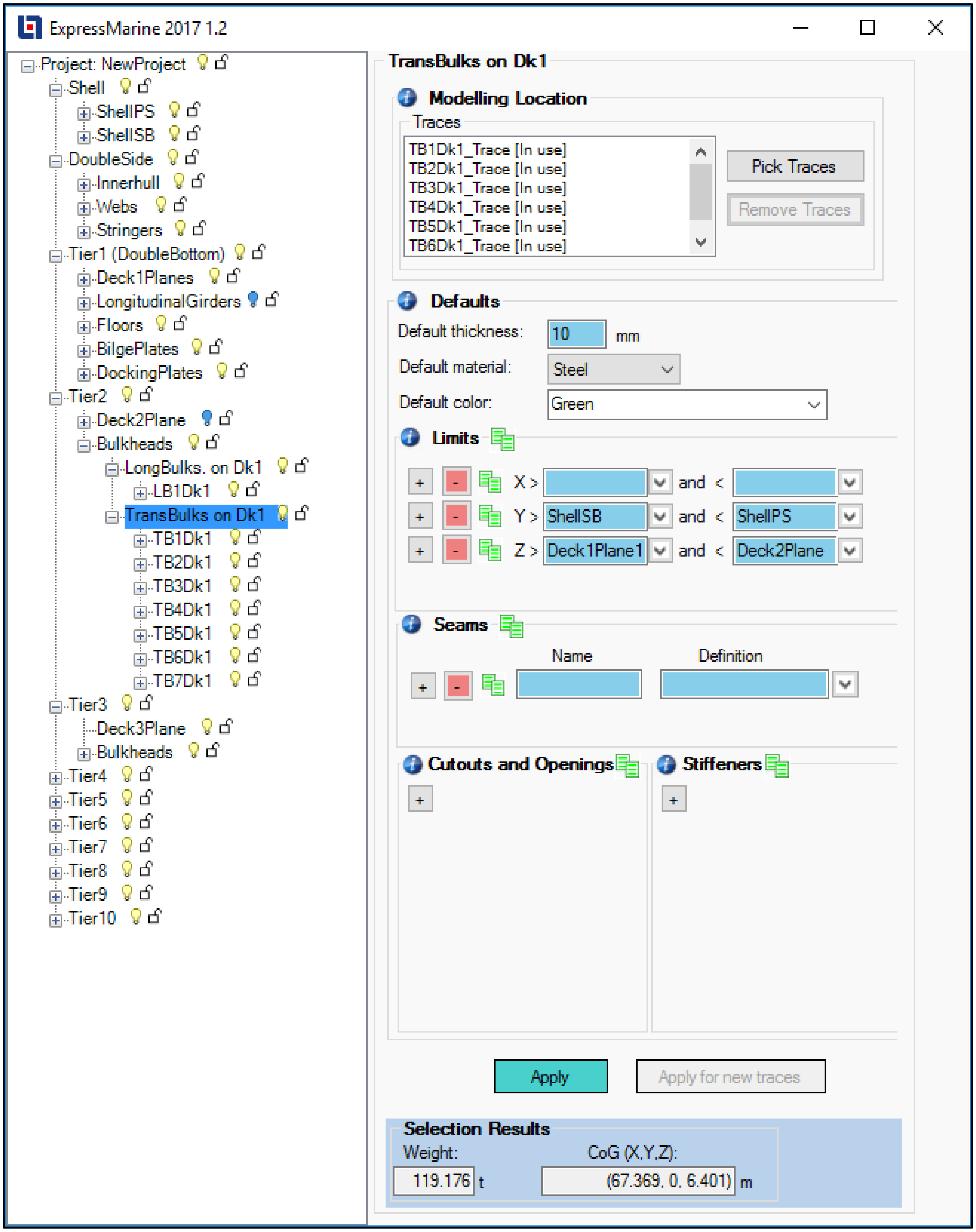
Press  button to generate/regenerate the bulkheads.

If more bulkheads are needed, there are several options to create them:

- select again "**Pick traces**" button, select more traces in the Graphics, edit the settings if necessary and then **Apply** to confirm
- or go to **LongBulks. on Dk1** / **TransBulks. On Dk.1** node and right click, then fill in the settings and **Apply** to confirm



All the default settings from **Bulkheads** node will be transferred to the LongBulks/TransBulks subgroups and also to individual bulkheads, but there is always the possibility to navigate at a specific subgroup or element to adjust the structural properties as required and confirm by pressing **Apply** button.


ExpressMarine 2017 1.2
Project: NewProject
Shell
ShellPS
ShellSB
DoubleSide
Innerhull
Webs
Stringers
Tier1 (DoubleBottom)
Deck1Planes
LongitudinalGirders
Floors
BilgePlates
DockingPlates
Tier2
Deck2Plane
Bulkheads
LongBulks. on Dk1
LB1Dk1
TransBulks on Dk1
TB1Dk1
TB2Dk1
TB3Dk1
TB4Dk1
TB5Dk1
TB6Dk1
TB7Dk1
Tier3
Deck3Plane
Bulkheads
Tier4
Tier5
Tier6
Tier7
Tier8
Tier9
Tier10
TransBulks on Dk1
Modelling Location
Traces
TB1Dk1_Trace [In use]
TB2Dk1_Trace [In use]
TB3Dk1_Trace [In use]
TB4Dk1_Trace [In use]
TB5Dk1_Trace [In use]
TB6Dk1_Trace [In use]
Pick Traces
Remove Traces
Defaults
Default thickness: 10 mm
Default material: Steel
Default color: Green
Limits
X > and <
Y > ShellSB and < ShellPS
Z > Deck1Plane1 and < Deck2Plane
Seams
Name
Definition
Cutouts and Openings
Stiffeners
Apply
Apply for new traces
Selection Results
Weight:
CoG (X,Y,Z):
119.176 t
(67.369, 0, 6.401) m