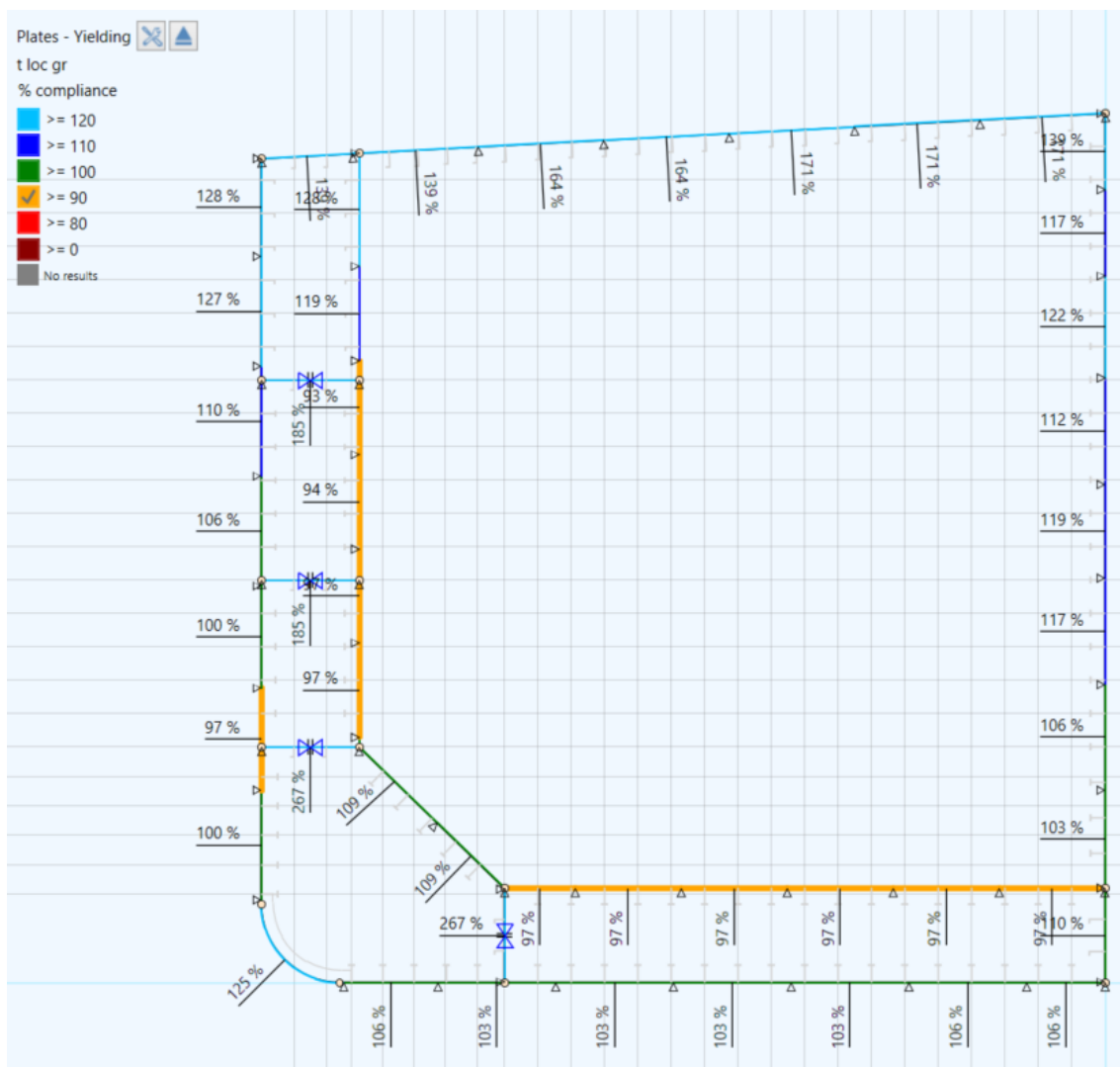


NAUTICUS™ Hull

Tutorial – cross section analysis

Includes use of the Drawing Check tool for transverse bulkhead

Based on program version 20.31



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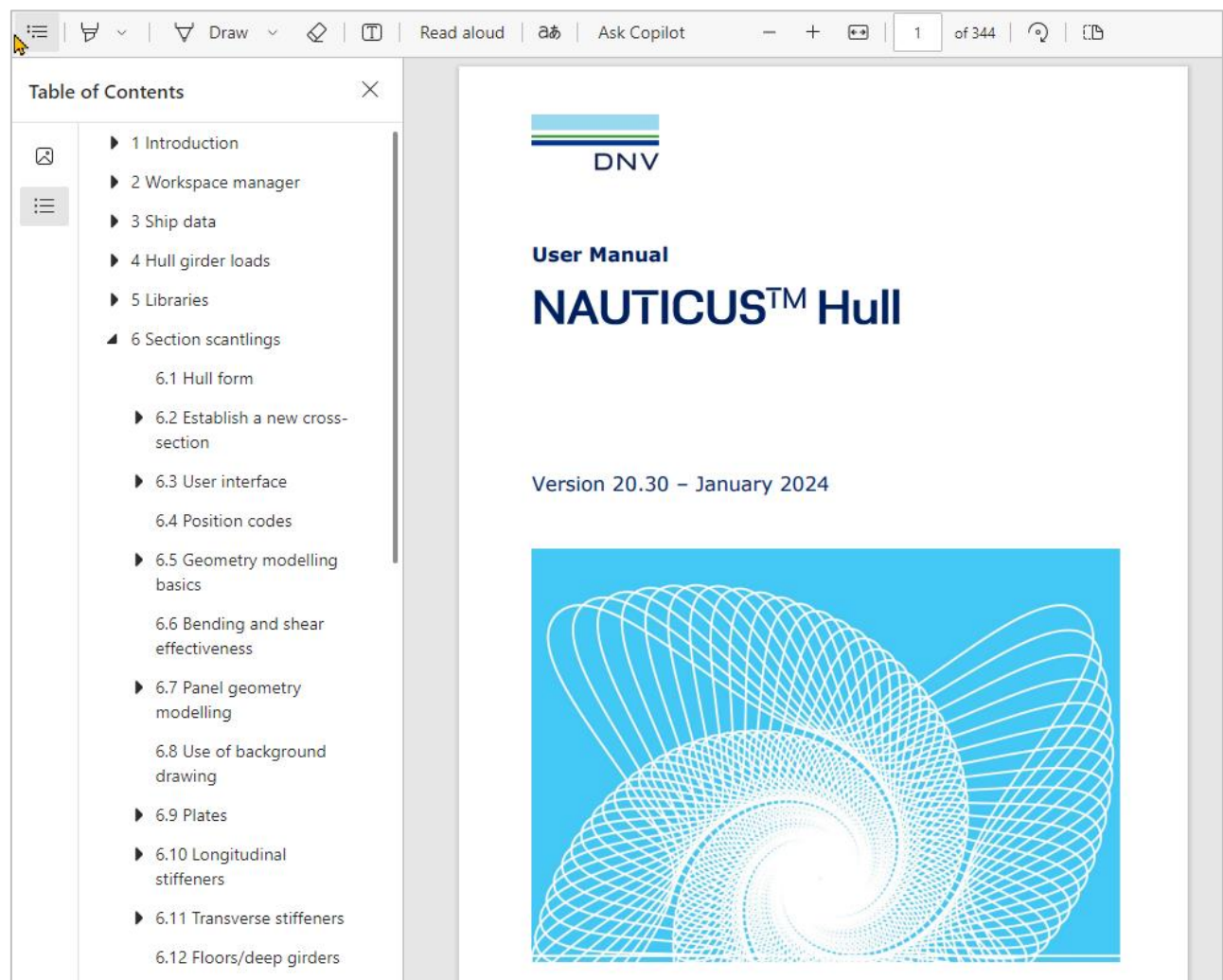
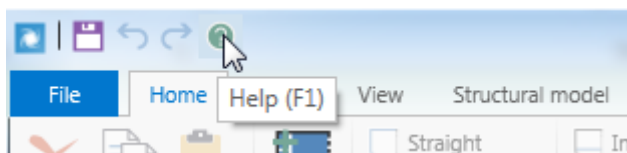
1 Introduction

The purpose of this tutorial is to provide the user with a systematic approach to familiarize her-/himself with Nauticus Hull version 20.0 and newer, on a general level.

The model used in this example is an oil tanker applying IACS Common Structural Rules, **however the intention with this tutorial is not to provide guidance on Rules and the different rule sets or how to approach different vessel types.**

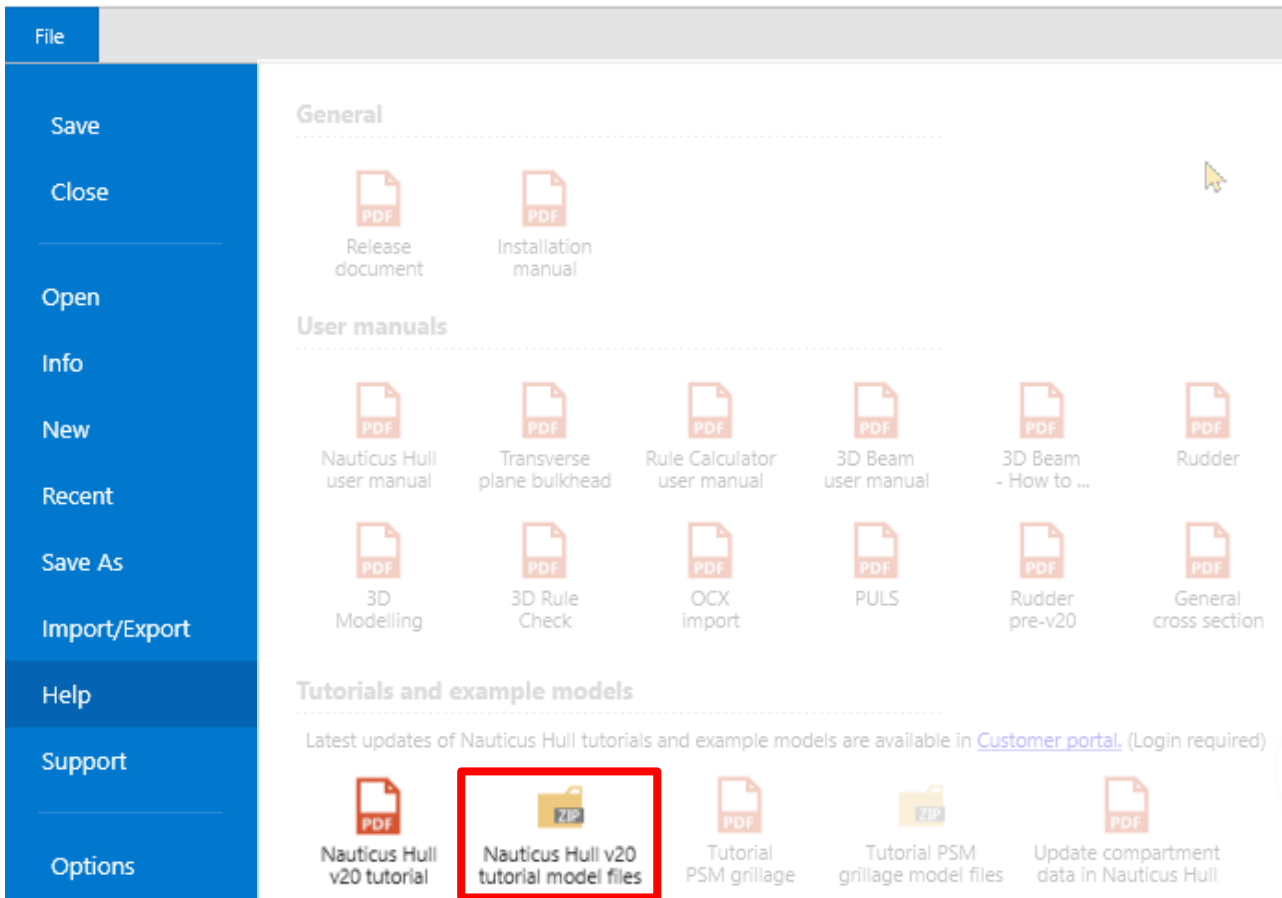
Note that all dimensions are fictitious and may appear far off requirements at places.

For detailed description of the functionality, please consult the user manual. This is accessible from the F1 key or from toolbar:



1.1 Data prepared in advance

Data files for practicing can be extracted from the File | Help:



Click on the archive to download it. Here, it is downloaded to C:\DNV

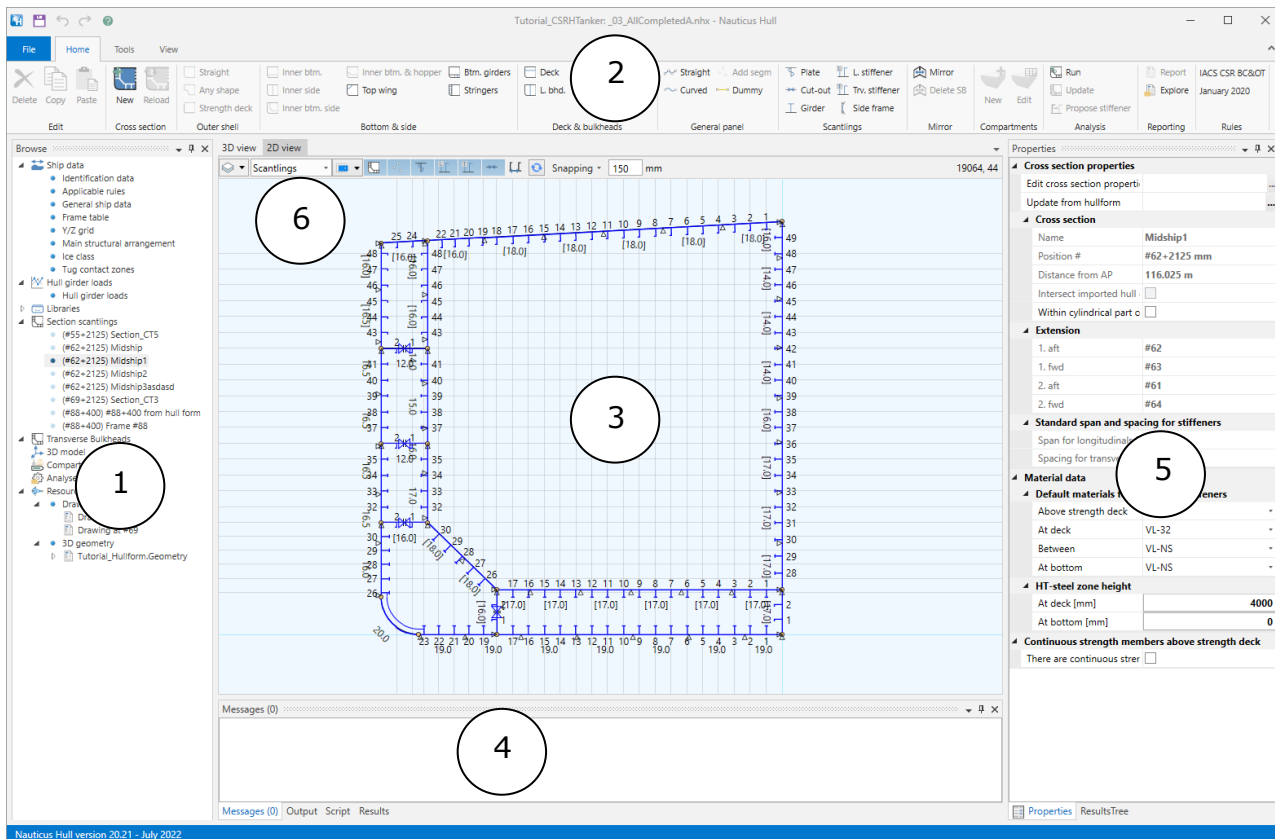
Name	Type	Size	Packed	Date/time	Attributes	Checksum/hash	Full name
 Tutorial_DrawingSketch.pdf	.pdf	292.7 KB	49.8 KB	2020-05-26 08:05:40	A	45DA8062	Tutorial_DrawingSketch.pdf
 Tutorial_Hullform.txt	.txt	14.6 KB	4.3 KB	2020-05-26 07:38:05	A	60DA4237	Tutorial_Hullform.txt
 StiffenerProfiles_Stripped.xml	.xml	641.9 KB	9.2 KB	2017-11-14 13:31:44	A	23EF8E52	StiffenerProfiles_Stripped.xml
 Tutorial_CSRHTanker_01_ShipDataAndGeometry.zip	.zip	157.5 KB	152.1 KB	2020-05-26 08:34:27	A	65BC831F	Tutorial_CSRHTanker_01_ShipDataAnc
 Tutorial_CSRHTanker_02_MidholdCompleted.zip	.zip	490.9 KB	484.6 KB	2020-05-26 08:34:02	A	50C5D8C9	Tutorial_CSRHTanker_02_MidholdCon
 Tutorial_CSRHTanker_03_AllCompleted.zip	.zip	2.0 MB	1.9 MB	2020-05-26 08:20:10	A	B1B10925	Tutorial_CSRHTanker_03_AllComplete

Extract all

Output

The downloaded zip-archive contains three archived workspaces, an illustrative .pdf drawing and the hull form. The StiffenerProfiles_Stripped.xml is not important for practicing and can be ignored.

1.2 User interface



1. Navigation tree
 - Access to main functionality
2. Ribbon/menu
 - Commands depending on selected main functionality
3. Canvas
 - Modelling area
 - Result plots
4. Output
 - Messages from system
 - Log window
 - Script command line interface
 - Detailed results
5. Properties and results
 - Modify and inspect properties for selected object
 - Result tree
6. View case selector
 - Select what's being viewed; geometry, scantlings, compartments or results.

1.3 Hotkeys and mouse

Undo and redo are available from the "Quick Access toolbar" or **Ctrl-Z** (undo) / **Ctrl-Y** (redo).

When switching between cross-sections or other nodes in the tree, **the undo/redo buffer is cleared**. That is; if you delete a plate in one cross-section, it will not be possible to undo this if you in the meantime have selected another cross-section or node in tree.

Ctrl-S will save the workspace. **DEL** key is assigned to the delete function for the currently selected object(s).

When a mouse is available:

Zoom, stepwise:	Mouse wheel
Zoom:	Shift+Right mouse button
Zoom fit:	Doubleclick
Pan:	Right mouse button

When touchpad is available:

Pan:	Right button and touchpad or pointing stick
Zoom:	Shift-right button and touchpad or pointing stick

2 New workspace

A workspace is a collection of files, stored in a folder with the name given as **Workspace name**.

The workspaces are stored in a folder with the name given as **Vessel name**.

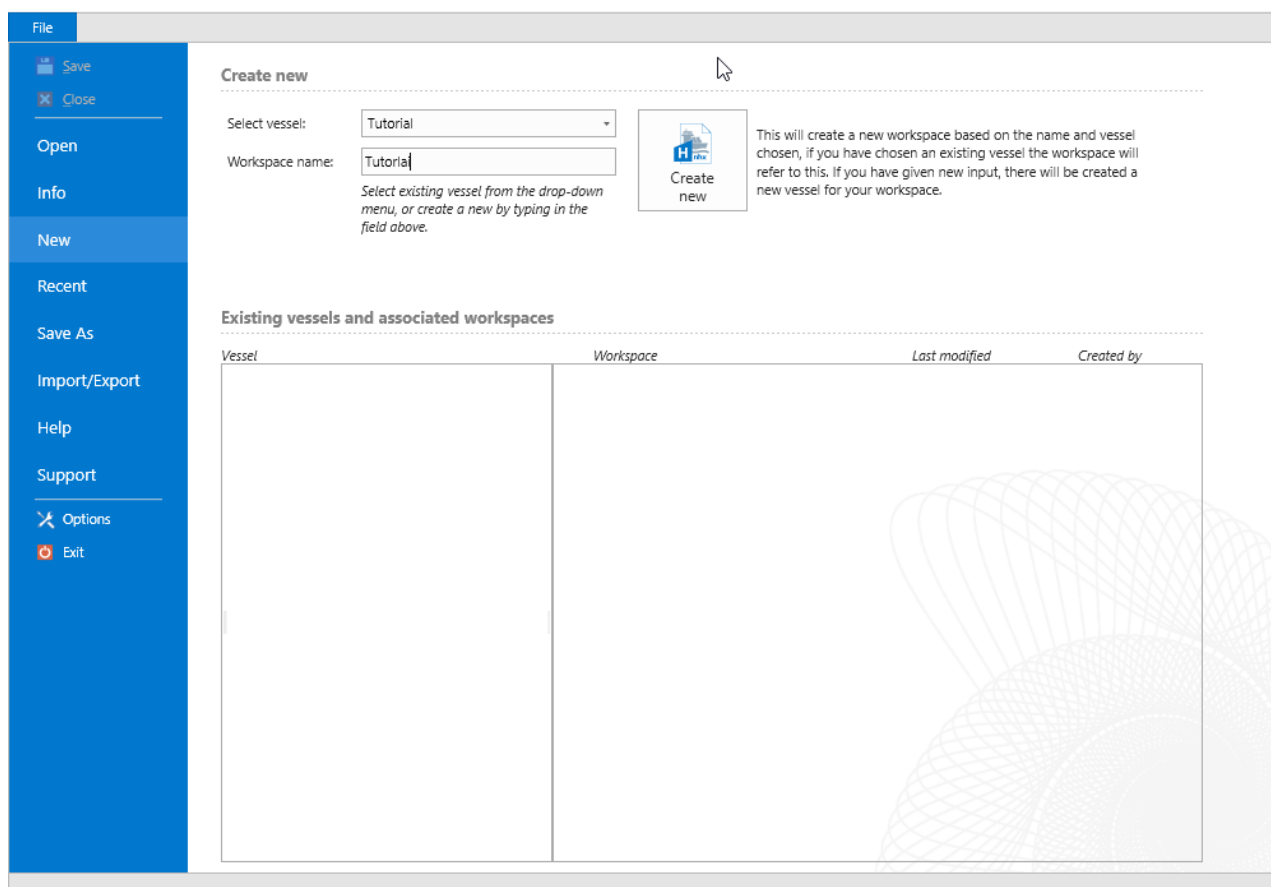
Select **File | Options** to inspect the current workspace folder, default workspace folder is:

C:\DNV\Workspaces\NauticusHull\Vessels

The program will then create a separate folder for each vessel. Typical location for a workspace will then be:

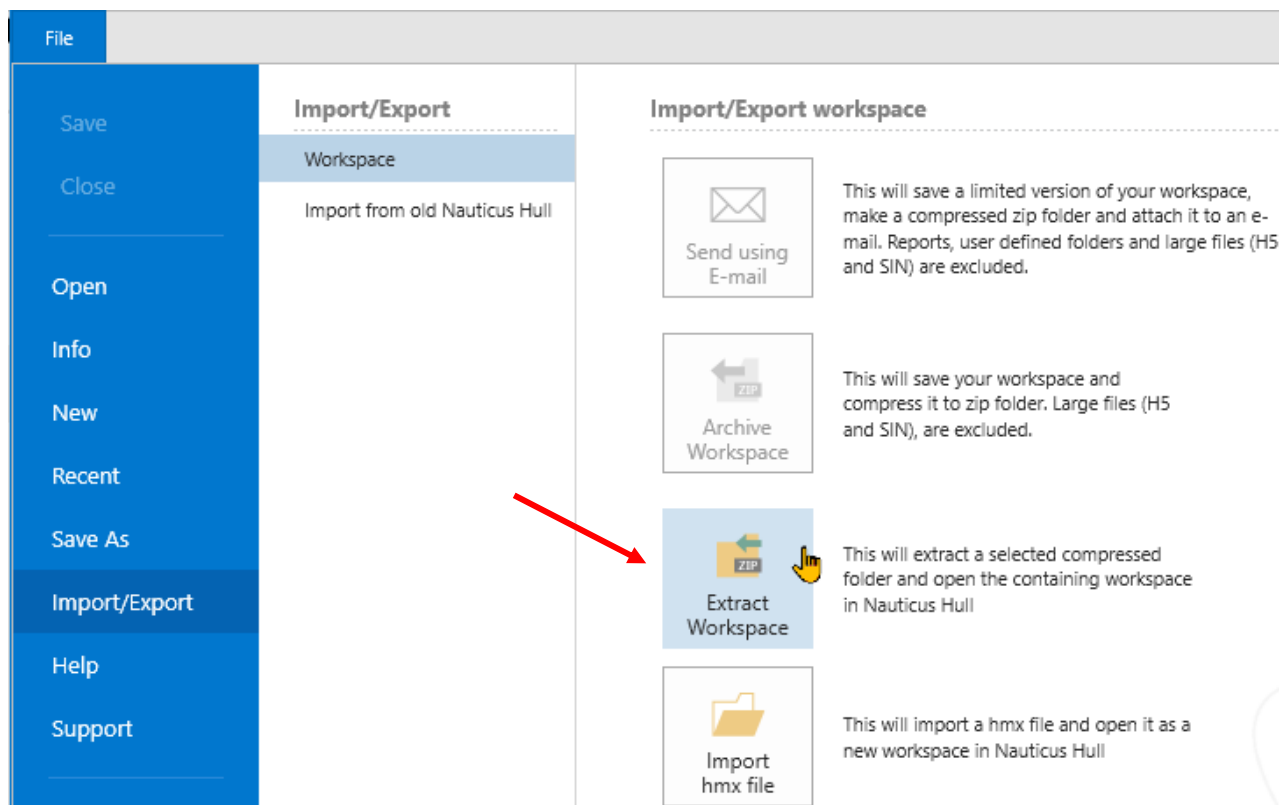
C:\DNV\Workspaces\NauticusHull\Vessels\<vessel name>\<workspace name>

Select **File | New** and enter vessel identification and name of workspace, for instance "Tutorial" and any workspace name:

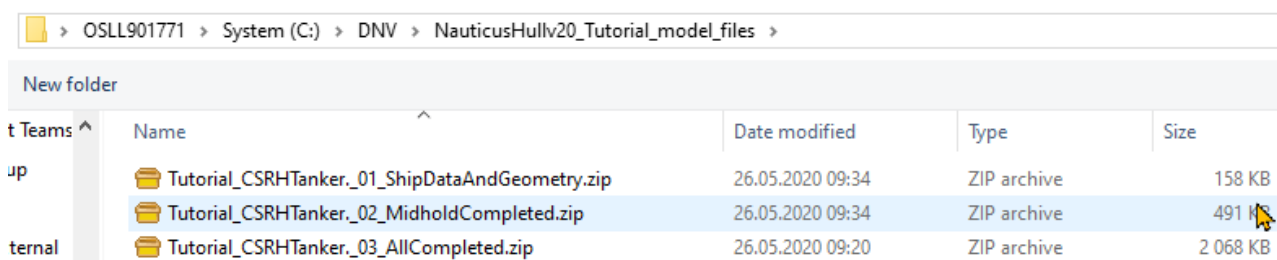


3 Import an existing workspace

If you wish to go straight into a predefined model, one of the archived workspaces can be extracted by File | Extract Workspace:



Select one of the archived workspaces from the extracted tutorial archive:



When prompted for vessel and workspace name, just keep the defaults:

Define new workspace

Select VesselID:

Tutorial_CSRHTanker

Workspace name:

_03_AllCompleted

Define VesselID and name for the new workspace to import.

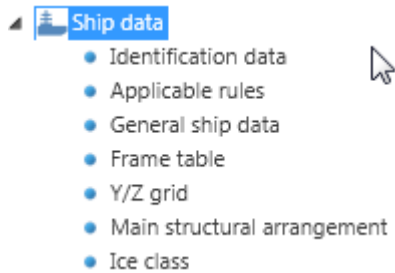
Ok

Cancel

4 Ship data

Ship data is stored on workspace level, and not shared between the workspaces. When you create a second workspace under an existing vessel folder, ship data will be empty. Ship data can be imported to an empty workspace from a workspace where it is defined.

If the ship data for a given vessel needs modification, each workspace must be updated manually.



Enter ship data/vessel parameters as shown in the following sections.

4.1 Identification data

Project name	Training course
Id number of ship	Tanker tutorial
Date	8/11/2017 8:08:36 AM
Signature	NN
Comment	

4.2 Applicable rules

Pick the latest available version of IACS CSR rule set and chose Tanker for Oil:

Applicable rules

- ☐ DNV rules
- ☐ DNV offshore rules
- ☐ DNV HSLC rules
- ☐ DNV RU-NAV rules (only usable in Analyses->Rules)
- ☐ DNV RU-YACHT rules (only usable in Analyses->Rules)
- ☒ IACS CSR for bulk carriers and oil tankers

Rule version:

January 2023 ▼

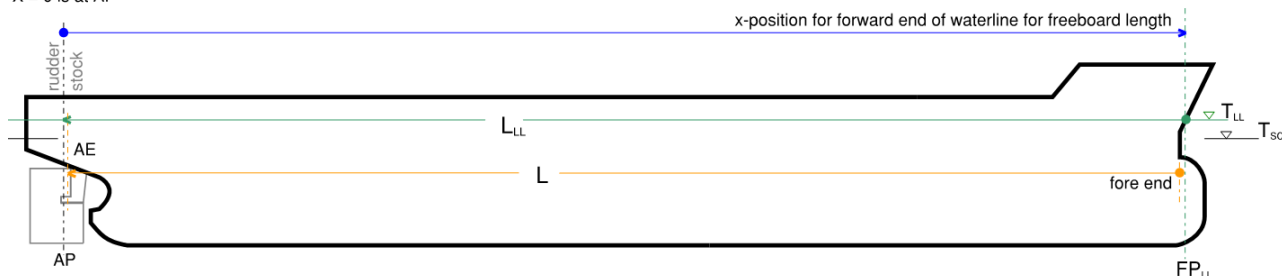
☒ Tanker	for Oil ▼
☐ Bulk carrier	▼
☐ Ice strengthening	None ▼

4.3 General ship data

X-positions which is entered by user and displayed in dialogs and reports always refers to AP.

X-positions used internally in the rule calculations, X_{RULE} , always uses AE (aft end) as the reference.

X = 0 is at AP



For the definition of the position of AP, please refer to the rules.

Position of **AE** is $L_{pp} - L$ forward of AP.

The parameter 'x-position for forward end of waterline for freeboard length' is used to determine the position of X_{LL} in Pt.1 Ch.4 Sec.5 [2.2.3] Table 30:

Table 30 : Minimum pressures on exposed decks for HSM, HSA, FSM load cases

Location	Minimum pressure on exposed deck, P_{D-min} , in kN/m ²	
	$L_{LL} \geq 100m$	$L_{LL} < 100m$
$x_{LL}/L_{LL} \leq 0.75$	34.3	$14.9 + 0.195 L_{LL}$
$x_{LL}/L_{LL} > 0.75$	$34.3 + (14.8 + a(L_{LL} - 100)) \left(4 \frac{x_{LL}}{L_{LL}} - 3 \right)$	$12.2 + \frac{L_{LL}}{9} \left(5 \frac{x_{LL}}{L_{LL}} - 2 \right) + 3.6 \frac{x_{LL}}{L_{LL}}$
a : Coefficient taken equal to: $a = 0.356$ for Type A, Type B-60 and Type B-100 freeboard ships $a = 0.0726$ for Type B freeboard ships.		
x_{LL} : X-coordinate of the load point measured from the aft end of the freeboard length L_{LL} .		

Enter parameters as shown:

Length between perpendiculars	L _{pp}	234.000	[m]	
Rule length	L	232.000	[m]	...
Freeboard length	L _{LL}	235.000	[m]	
X-position for forward end of waterline for freeboard length		235.000	[m]	
Moulded breadth of ship	B	43.000	[m]	
Moulded depth of ship	D	21.000	[m]	
Height of freeboard deck		21.000	[m]	
Scantling draught	T _{SC}	15.000	[m]	
Design draught	T _{Design}	0.000	[m]	
Ballast draught (minimum midship)	T _{BAL}	6.500	[m]	
Heavy ballast draught	T _{BAL-H}	0.000	[m]	
Design slamming draught at FP (any ballast tanks empty)	T _{F-e}	6.500	[m]	
Design slamming draught at FP (all ballast tanks full)	T _{F-f}	5.500	[m]	
Block coefficient at scantling draught	C _B	0.850		...
Moulded displacement at scantling draught		130374	[t]	
Maximum service speed	V	16.0	[knots]	
Number of continuous decks above 0.7 D from baseline		1		
Vessel has more than three continuous decks		☐		
Ship with high speed and/or large flare		☐		
Projected area of upper deck forward 0.2 L	A _{DK}	0.0	[m ²]	...
Area of waterplane forward 0.2 L at T _{SC}	A _{WP}	0.0	[m ²]	
Vertical distance from summer load WL to deckline measured at F.E.	z _f	0.000	[m]	
Area of waterplane at T _{SC}	A _W	0.0	[m ²]	
The ship has a deadweight < 50 000 tonnes		☐		
Freeboard:		☒ A ☐ B ☐ B-60 ☐ B-100		
Bilge keel		☒		
Ship with large deck openings		☐ i		
Distance from AP to the engine room front bulkhead		0	[mm]	
Design still water torsion moment	M _{st}	0	[kNm]	...
Island design		Single island design		

4.4 Frame table

Position of Frame 0

 Aft of AP ▼

Frame spacing variation table

Frame No.	Spacing fwd. [mm]	X [m]	X/L	X _{LL} [m]	X _{LL} /L _{LL}
<i>Stern</i>	850				
44	4250	37.400	0.1526	37.400	0.1591
87	850	220.150	0.9403	220.150	0.9368

The **frame converter** can be used to calculate the actual X-position in mm by giving a frame position or vice versa.

◀ ▶ [mm]

X/L 0.4915

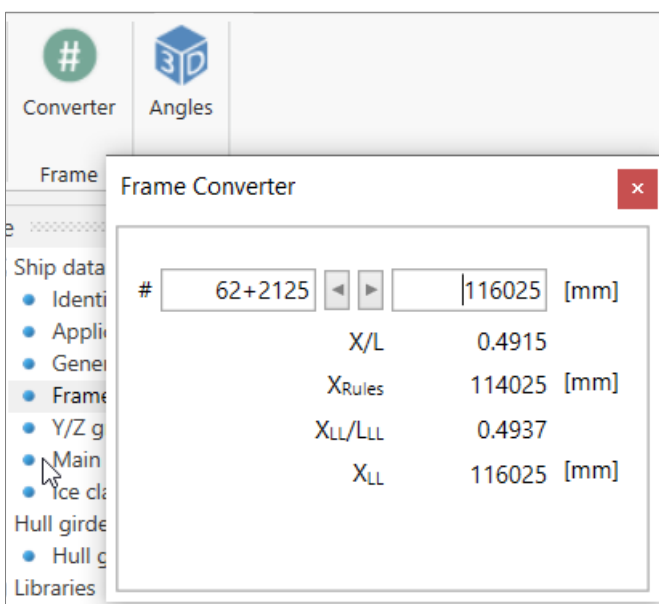
X_{Rules} 114025 [mm]

X_{LL}/L_{LL} 0.4937

X_{LL} 116025 [mm]

Positions are given as a combination of frame numbers and millimeters, e.g. 62+2125 means frame 62 plus 2125 mm.

This tool is also available from **Tools | Converter**:



4.5 Y/Z-grid

Y/Z grid lines may be used as references in modelling phase, for instance during layout of longitudinal stiffeners. The purpose of the Y/Z-grid is to improve the modelling efficiency as input of locations can be done by selecting a grid line rather than entering a value.

Y-grid lines are vertical lines positioned at given Y-coordinates, typically at the positions of girders and longitudinal stiffeners at decks and bottom shell.

Z-grid lines are horizontal lines positioned at given Z-coordinates, typically at the positions of stringers and longitudinal stiffeners on longitudinal structure.

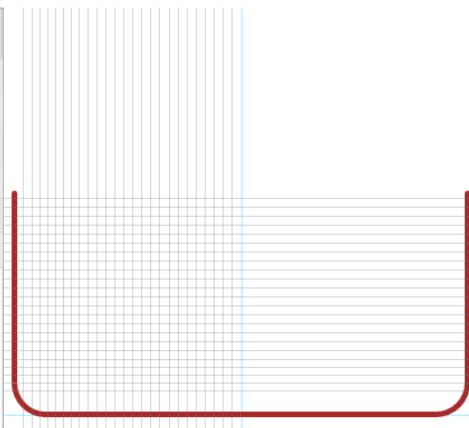
The connection between objects defined by use of Y/Z-grid and the Y/Z-grid definition is not dynamic, i.e. modifying Y/Z-grid will not affect any objects already defined.

For this vessel, define reference lines according to this:

The Y and Z columns denote the start positions from where the Y and Z grid lines will be distributed.

Collapse/Expand 

Name	Count	Spacing [mm]	Y [mm]	Z [mm]	Symmetry
Y_1	18	850	850		P 
Y_19	5	740	16040		P 
DBS_1	2	830	19830		P 
Z_26	6	750		2250	
Z_32	17	850		6850	
					



The horizontal grid lines are according to the stiffener and stringer locations on outer shell side.

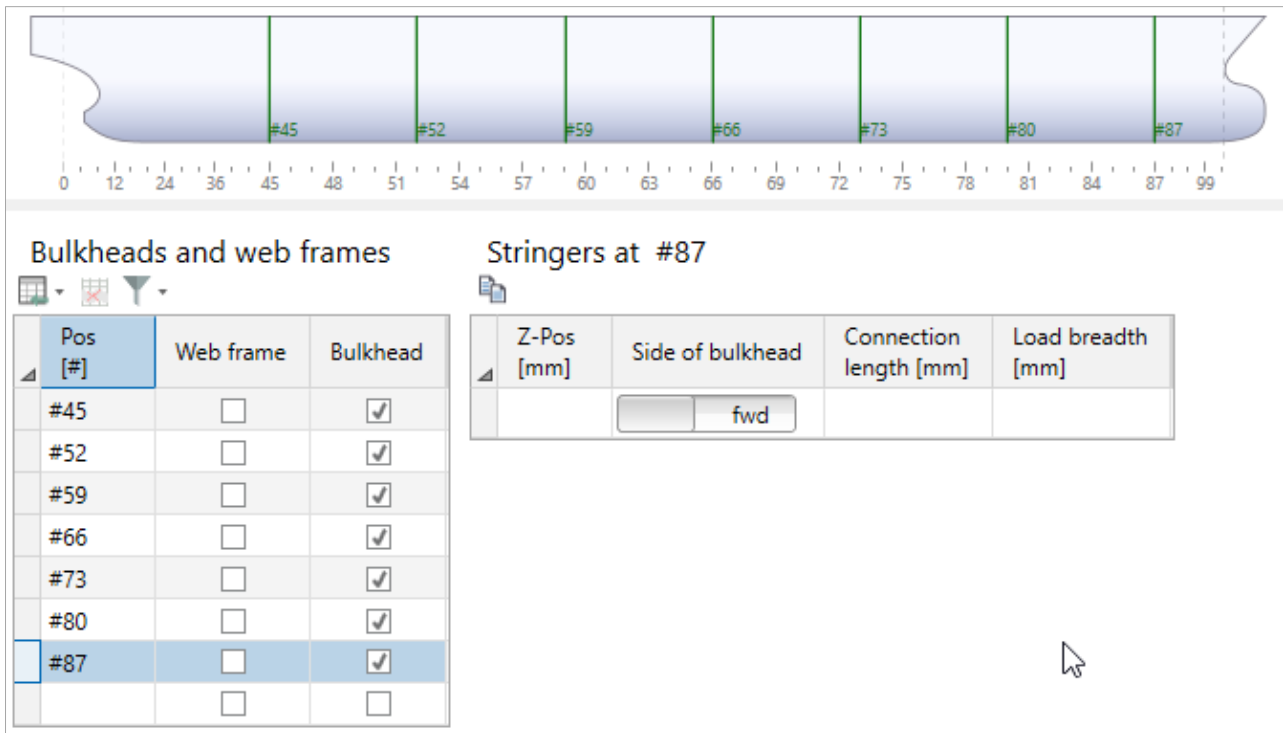
4.6 Main structural arrangement

Main structural arrangement shall be defined for the region subject to the modelling and rule calculation.

The structural arrangement definition is used to determine default stiffener spans and compartment boundaries as well as providing other data for checking local and global rule requirements.

4.6.1 Bulkheads

Add bulkhead positions as shown:



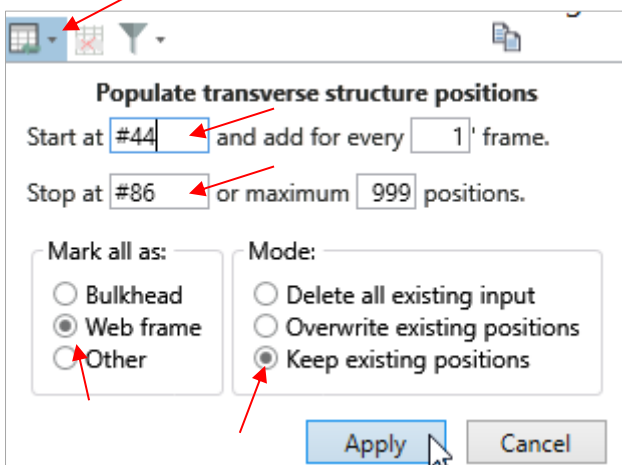
The screenshot shows a cross-section of a ship's hull with bulkhead positions marked at #45, #52, #59, #66, #73, #80, and #87. Below the hull diagram is a table titled "Bulkheads and web frames" and a section titled "Stringers at #87".

Pos [#]	Web frame	Bulkhead
#45	☐	☒
#52	☐	☒
#59	☐	☒
#66	☐	☒
#73	☐	☒
#80	☐	☒
#87	☐	☒

The "Stringers at #87" section shows a table with columns: Z-Pos [mm], Side of bulkhead, Connection length [mm], and Load breadth [mm]. The "Side of bulkhead" dropdown is set to "fwd".

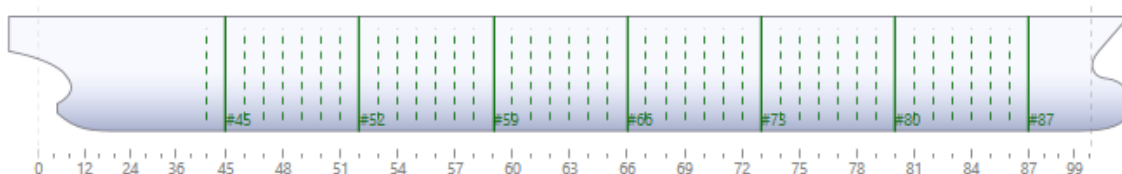
4.6.2 Frames

Describe webframe positions within the cargo area, from #44 to #86:



The dialog box "Populate transverse structure positions" has the following fields and options:

- Start at: #44 (indicated by a red arrow)
- and add for every: 1' frame.
- Stop at: #86 (indicated by a red arrow) or maximum: 999 positions.
- Mark all as:
 - ☐ Bulkhead
 - ☒ Web frame (indicated by a red arrow)
 - ☐ Other
- Mode:
 - ☐ Delete all existing input
 - ☐ Overwrite existing positions
 - ☒ Keep existing positions (indicated by a red arrow)
- Buttons: Apply (indicated by a mouse cursor), Cancel

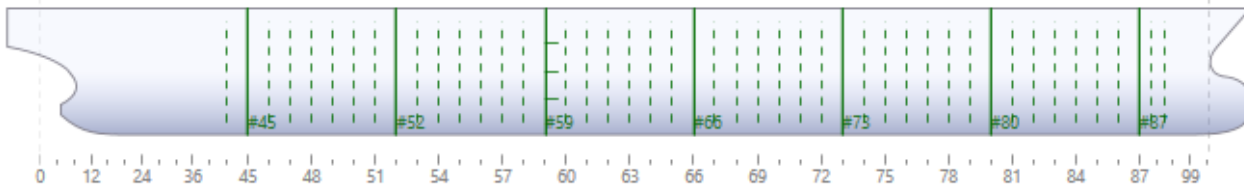


4.6.3 Stringers – for shear force correction

According to CSR BC&OT Pt.1 Ch.5 Sec.1 [3.5], the effective net thickness for longitudinal bulkheads between cargo tanks shall be **corrected due to loads from transverse bulkhead stringers**.

Therefore, stringer information must be applied to the bulkheads as we are not modelling any transverse PSMs.

Select a bulkhead, for instance #59. Enter stringer data as indicated:



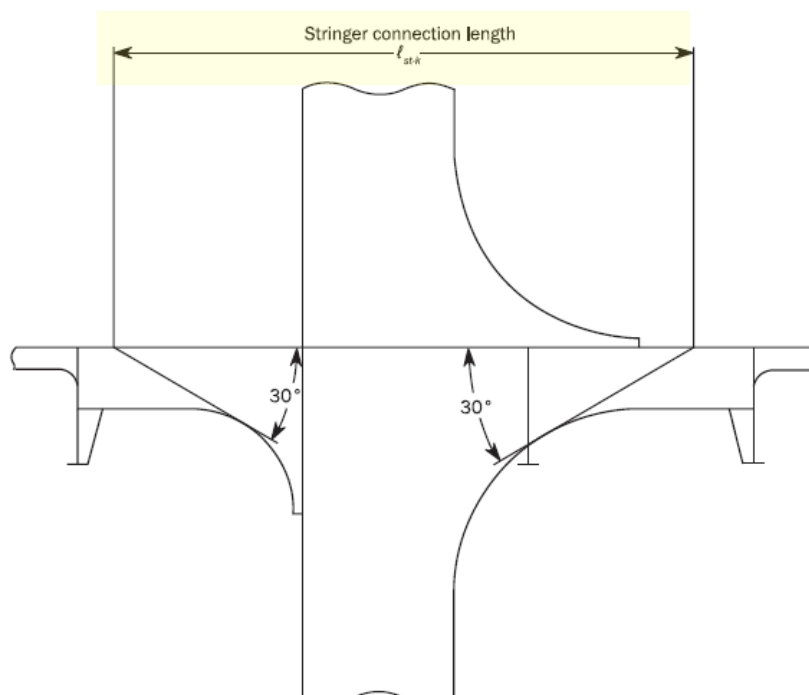
Bulkheads and web frames

Pos [#]	Web frame	Bulkhead
#55	☒	☐
#56	☒	☐
#57	☒	☐
#58	☒	☐
#59	☐	☒

Stringers at #59

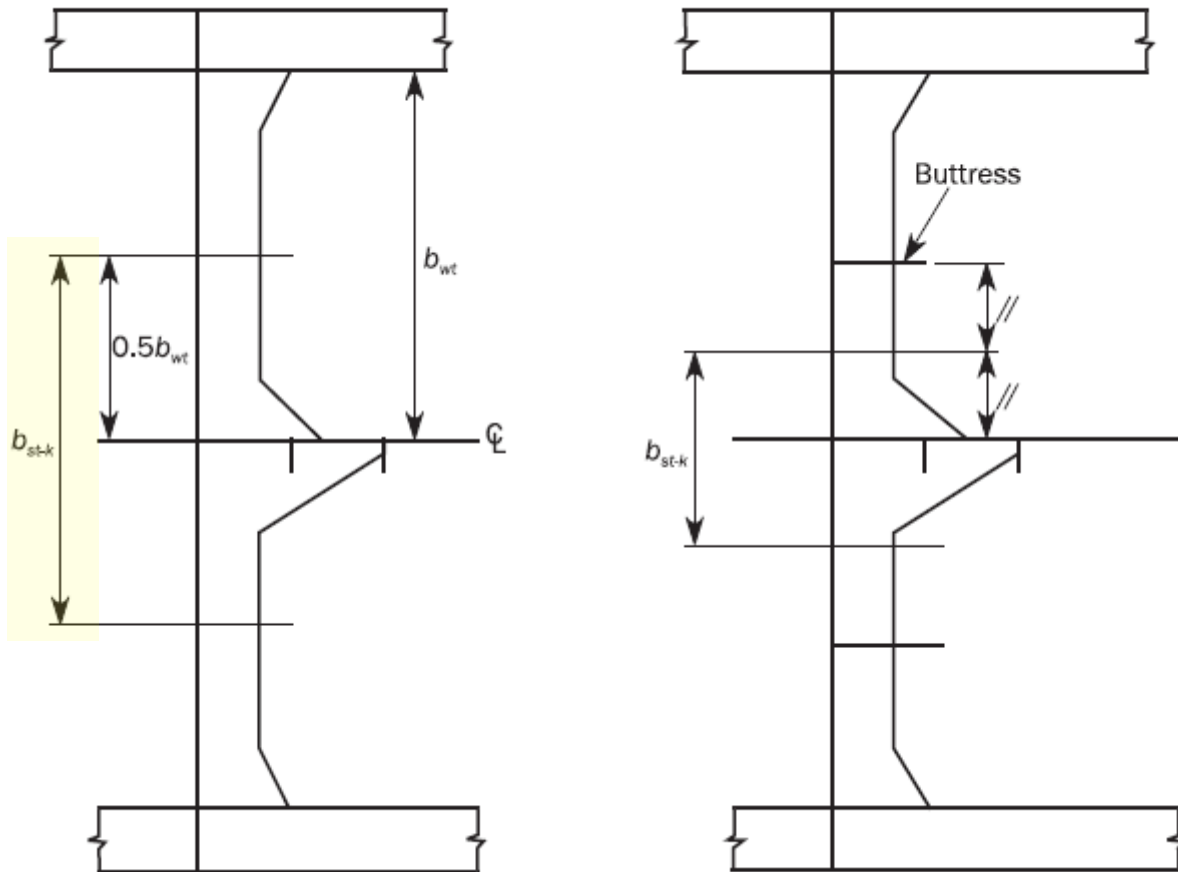
Z-Pos [mm]	Side of bulkhead	Connection length [mm]	Load breadth [mm]
15350	fwd	2000	9500
10250	fwd	2000	9500
6000	fwd	2000	9500
	fwd		

Connection length, l_{st-k} is the length of the connection between stringer and longitudinal bulkhead, ref. CSR BC&OT Pt.1 Ch.5 Sec.1 [3.5.1] Figure 7:



Load breadth, b_{st-k}

Figure 9 : Load breadth of stringers for ships with a centreline bulkhead



The stringer information can be copied to all other transverse bulkheads. After they are copied, they may be edited:

Copy these stringers to all other bulkheads			Load breadth [mm]	
Length [mm]				
15350		fwd	2000	9500
10250		fwd	2000	9500
6000		fwd	2000	9500
		fwd		

It is not necessary to copy the stringer information for this example project.

The stringer correction will be applied to cross-sections positioned between 1st webframe aft of and 2nd webframe forward of the bulkhead.

4.7 Ice class

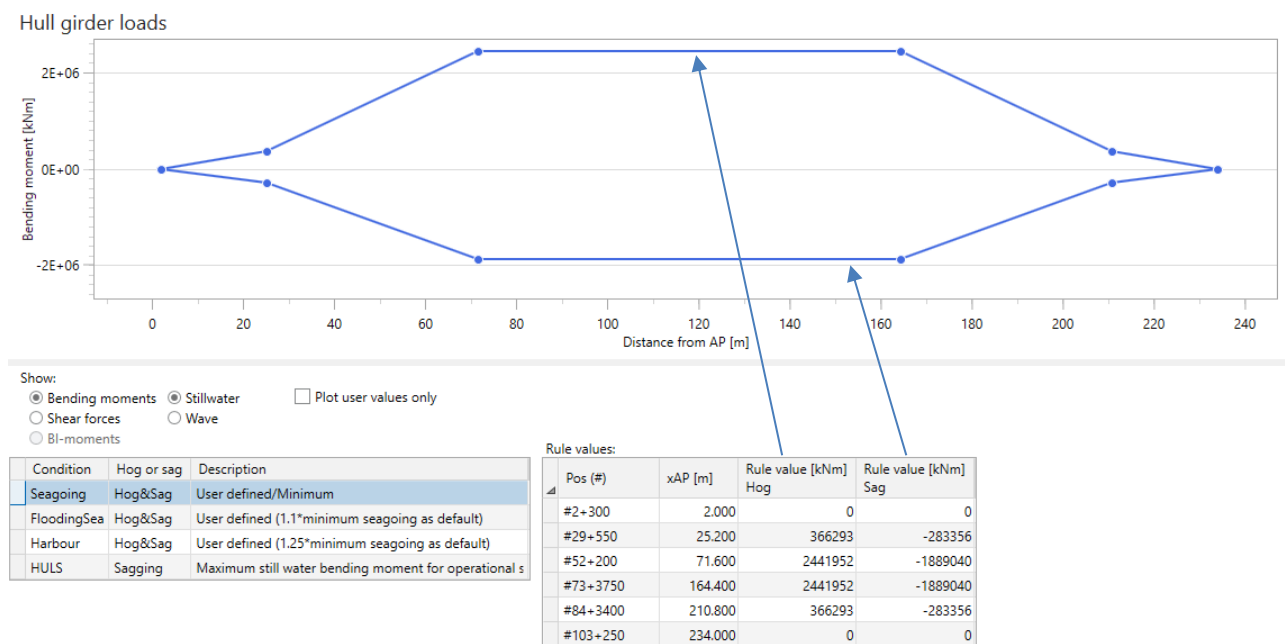
This vessel does not have any ice class notations, leave as is.

5 Hull girder loads

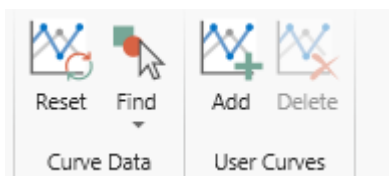
5.1 Permissible hull girder bending moments

Reference: CSR BC&OT Pt.1 Ch.4 Sec.4 [2.3.1] and [2.3.2].

Minimum hull girder bending moments are initially defined as the CSR BC&OT Rule values. When no user curve is defined, the rule values will be used as permissible limits:



Modification of the permissible limits can be done on the user-defined curve that may be defined by tools available in the ribbon bar:



5.2 HULS

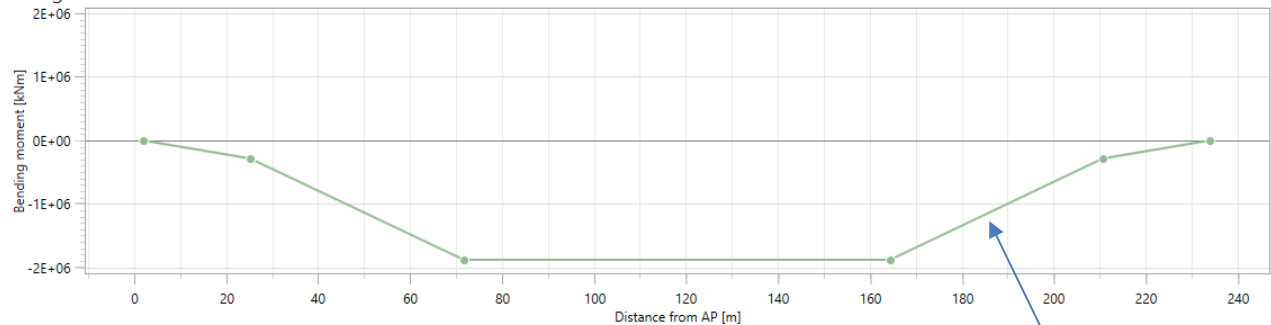
Ref. CSR BC&OT Pt.1 Ch.5 Sec.2 – Hull girder ultimate strength.

Maximum still water sagging moment for operational seagoing homogeneous full load condition shall be given. This is used in the check of the vertical hull girder ultimate bending capacity.

This moment is typically taken from the loading manual. For this example, we use the stillwater permissible sagging moment.

You can copy the values in the stillwater bending moment table to the table for user values for HULS moment.

Hull girder loads



Show:

- ☒ Bending moments
- ☒ Stillwater
- ☐ Plot user values only
- ☐ Shear forces
- ☐ Wave
- ☐ BI-moments

Condition	Hog or sag	Description
Seagoing	Hog&Sag	User defined/Minimum
FloodingSea	Hog&Sag	User defined (1.1*minimum seagoing as default)
Harbour	Hog&Sag	User defined (1.25*minimum seagoing as default)
HULS	Sagging	Maximum still water bending moment for operational s

User values:

Pos (#)	xAP [m]	User value [kNm]
#2+300	2.000	0
#29+550	25.200	-283356
#52+200	71.600	-1889040
#73+3750	164.400	-1889040
#84+3400	210.800	-283356
#103+250	234.000	0

5.3 Permissible hull girder shear forces

Reference: CSR BC&OT Pt.1 Ch.4 Sec.4 [2.3.3] and [2.3.4].

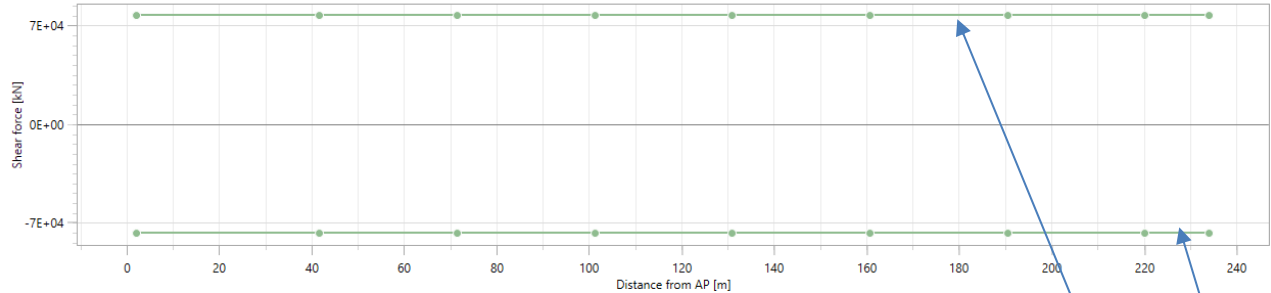
Enter permissible hull girder shear forces for seagoing and harbour, constant value over the vessel length:

Seagoing: +/- **77180** kN

Harbour: +/- **86830** kN

SEAGOING

Hull girder loads



Show:
☐ Bending moments ☒ Stillwater ☐ Plot user values only
☒ Shear forces ☐ Wave
☐ BI-moments

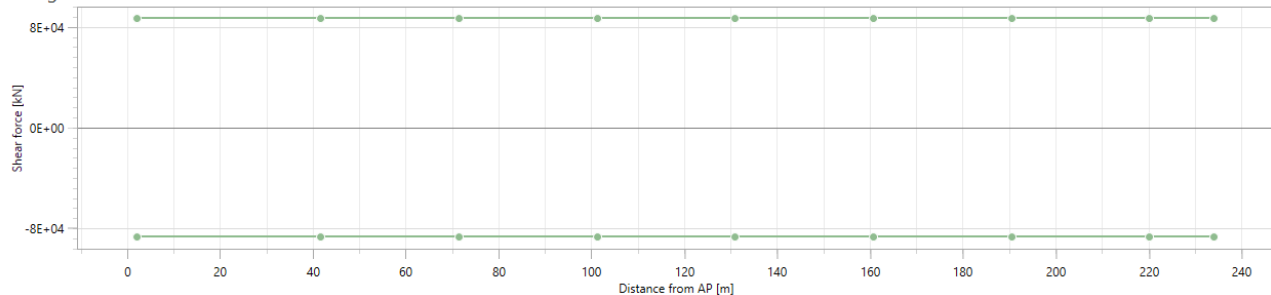
Condition	Pos or neg	Description
Seagoing	Pos&Neg	User defined permissible/Minimum
FloodingSea	Pos&Neg	User defined permissible
Harbour	Pos&Neg	User defined permissible/Minimum

User values:

Pos (#)	xAP [m]	User value [kN] Pos	User value [kN] Neg
#2+300	2.000	77180	-77180
#45	41.650	77180	-77180
#52	71.400	77180	-77180
#59	101.150	77180	-77180
#66	130.900	77180	-77180
#73	160.650	77180	-77180
#80	190.400	77180	-77180
#87	220.150	77180	-77180
#103+250	234.000	77180	-77180

HARBOUR

Hull girder loads



Show:
☐ Bending moments ☒ Stillwater ☐ Plot user values only
☒ Shear forces ☐ Wave
☐ BI-moments

Condition	Pos or neg	Description
Seagoing	Pos&Neg	User defined permissible/Minimum
FloodingSea	Pos&Neg	User defined permissible
Harbour	Pos&Neg	User defined permissible/Minimum

User values:

Pos (#)	xAP [m]	User value [kN] Pos	User value [kN] Neg
#2+300	2.000	86830	-86830
#45	41.650	86830	-86830
#52	71.400	86830	-86830
#59	101.150	86830	-86830
#66	130.900	86830	-86830
#73	160.650	86830	-86830
#80	190.400	86830	-86830
#87	220.150	86830	-86830
#103+250	234.000	86830	-86830

6 Library

6.1 Materials

Any material used for plates and stiffeners shall be defined in the material library. Initially, six standard DNV materials are defined:

Name	Density (kg/m3)	Yield stress (N/mm2)	Material factor, k (-)	Tensile strength (N/mm2)	Young's modulus (N/mm2)	Shear modulus (N/mm2)	Material type
VL-NS	7850	235	1	400	206000	79231	Standard steel ▼
VL-32	7850	315	0.78	440	206000	79231	Standard steel ▼
VL-36	7850	355	0.72	490	206000	79231	Standard steel ▼
VL-40	7850	390	0.68	510	206000	79231	Standard steel ▼
VL-47	7850	460	0.68	570	206000	79231	Standard steel ▼
VL-40FA	7850	390	0.68	510	206000	79231	Standard steel ▼
							▼

These material definitions are read-only. Any other material may be defined by adding to the table.

During modelling, default material applied to plates and stiffeners can be specified depending on the location of the structure.

For this tutorial, specify that VL-32 shall be used as default material at deck and downwards to 4000 mm below deck. Default material will always be VL-NS when nothing else is specified for the zones.

Selection criterias

Default material
▼

Midship section steel material

	Material	HS-steel zone height
Above strength deck	VL-NS ▼	
At deck	VL-32 ▼	4000 [mm]
Between	VL-NS ▼	
At bottom	VL-NS ▼	0 [mm]

Longitudinal extension of HS-steel

☒ Entire ship length

☐ From frame No
to

6.2 Profiles

Standard profile types and dimensions are available in the library. They can be inspected in detail by expanding the table rows. No actions are necessary.

Libraries X										
☐ Add standard plate size										
Selection	Profile type	Dimensions	h [mm]	h _w [mm]	t _w [mm]	b _f [mm]	t _f [mm]	Area [cm ²]	Z [cm ³]	I [cm ⁴]
>	WeldedAngle									
>	AngleFlangeOnTop									
>	AngleFlangeOnWeb									
>	JapaneseAngle									
>	BuiltUpTbar									
>	TheadOnSlab									
>	WeldedTbar									
>	InexaJumboBulb									

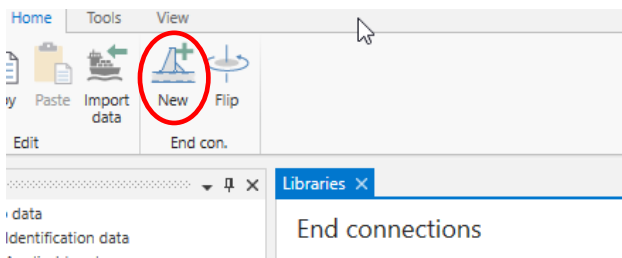
During stiffener definition, you will need to choose different profile types. To limit the list of profiles, you may tick off the **Selection** checkbox for the profiles that will be used.

Selection	Profile type	Dimensions	h [mm]	h _w [mm]	t _w [mm]	b _f [mm]	t _f [mm]	Area [cm ²]	Z [cm ³]	I [cm ⁴]
☐	Japanese L	150 x 90 x 12.0 / 12.0	150	138	12.0	90	12.0	27.5	64.1	633
☐	Japanese L	200 x 90 x 9.0 / 14.0	200	186	9.0	90	14.0	29.7	88.7	1210
☒	Japanese L	250 x 90 x 10.0 / 15.0	250	235	10.0	90	15.0	37.5	149.1	2444
☒	Japanese L	250 x 90 x 12.0 / 16.0	250	234	12.0	90	16.0	42.9	174.5	2794
☐	Japanese L	300 x 90 x 11.0 / 16.0	300	284	11.0	90	16.0	46.2	229.2	4365
☒	Japanese L	300 x 90 x 13.0 / 17.0	300	283	13.0	90	17.0	52.7	264.7	4938
☒	Japanese L	350 x 100 x 12.0 / 17.0	350	333	12.0	100	17.0	57.7	337.8	7437
☐	Japanese L	400 x 100 x 11.5 / 16.0	400	384	11.5	100	16.0	61.1	416.1	10284
☒	Japanese L	400 x 100 x 13.0 / 18.0	400	382	13.0	100	18.0	68.6	466.8	11482

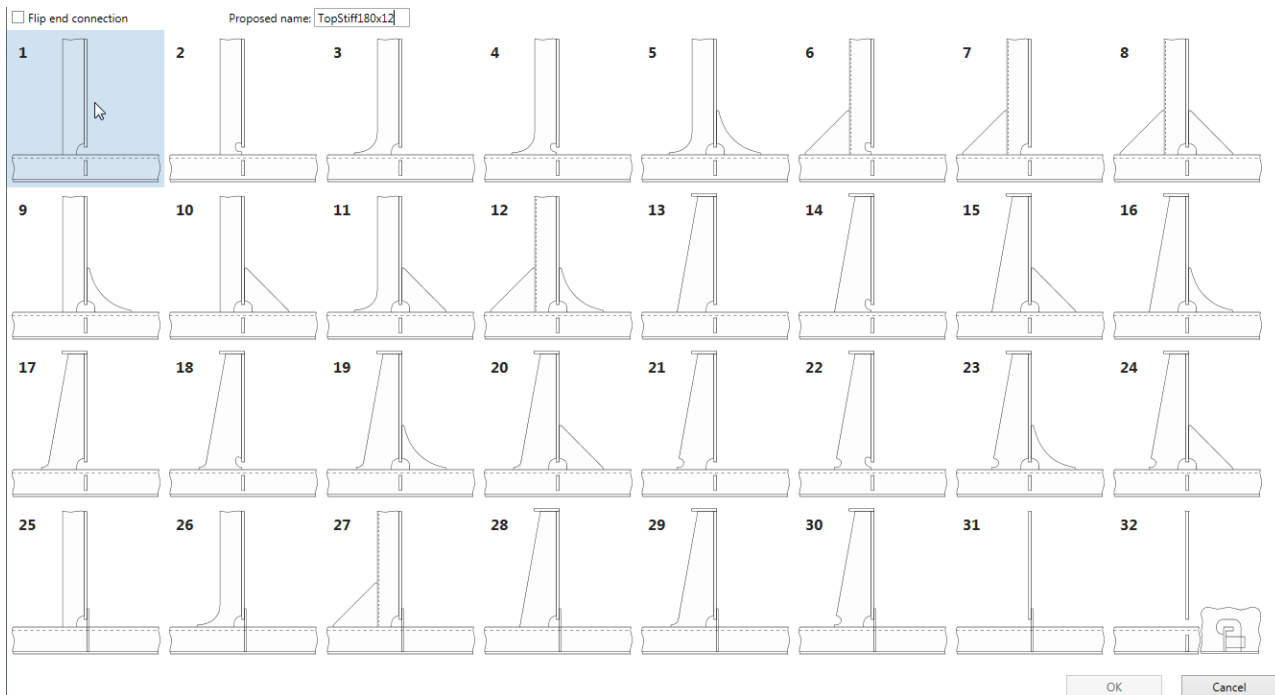
6.3 End connections

Available end connection designs are according to CSR BC&OT Pt.1 Ch.9 Sec.4 [5.2]. Details for the end connections may be defined before you start modelling or as you proceed with the modelling.

End connection data will be used in fatigue calculations and determination of effective spans for local strength assessment. End connection details are also used in the calculation of **connection strength**.

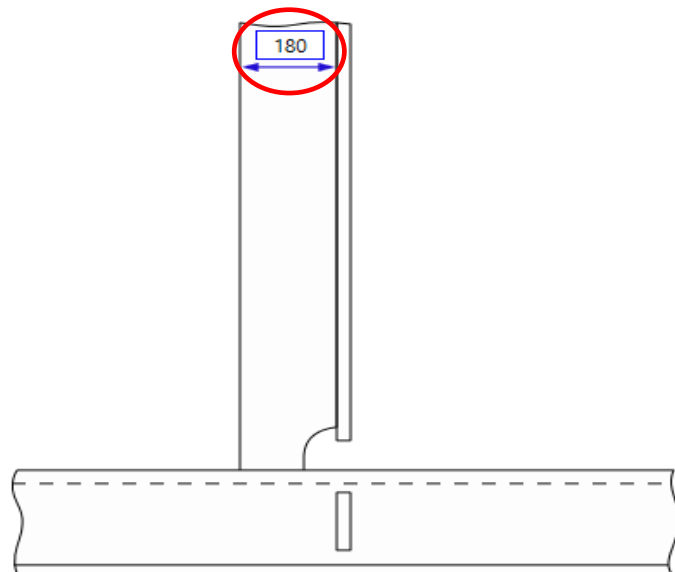


For this vessel, define one end connection, base it on detail give name **TopStiff180x12**:



Type	Name
1	TopStiff180x12

☐ Show input needed for connection area calculation



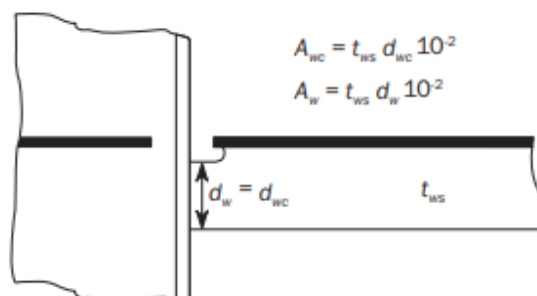
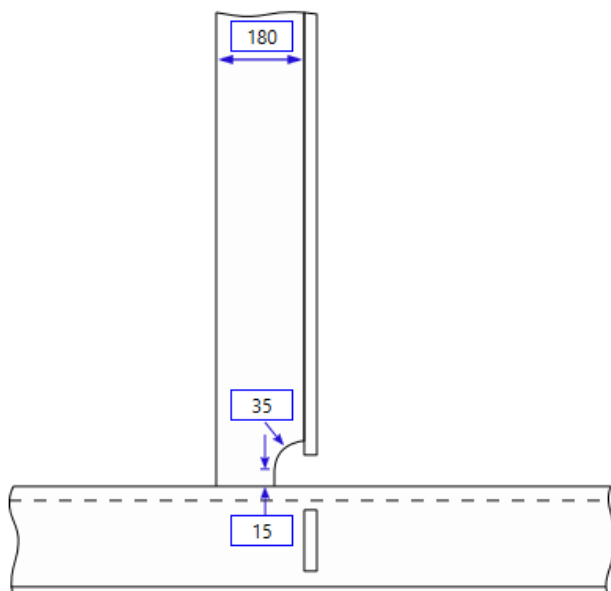
Initially, data necessary for simplified fatigue assessment is shown. To allow for calculation of connection strength, check **Show input needed for connection area calculation**.

This will reveal the parameters necessary for calculation of the strength of the connection between top stiffener and the longitudinal stiffener. Enter dimensions [mm] and material as indicated:

☒ Show input needed for connection area calculation

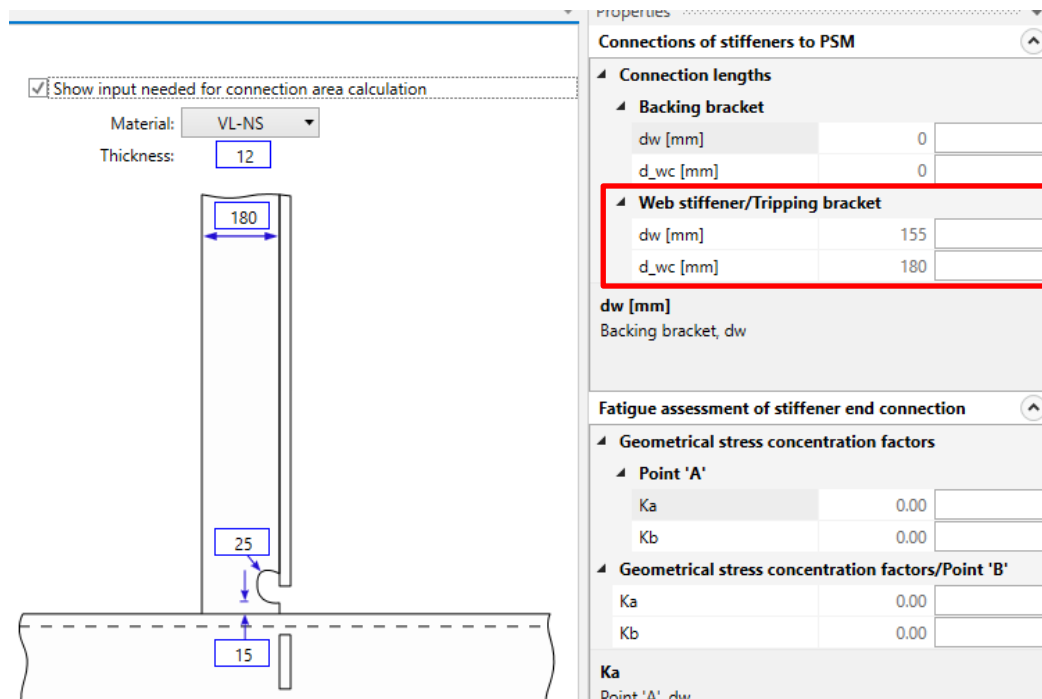
Material: VL_NS

Thickness: 12

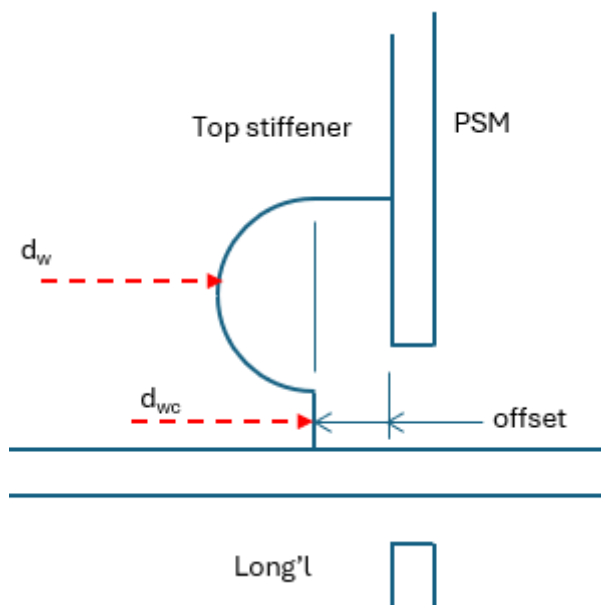


(a) Straight heel no bracket

The d_w and d_{wc} can be overridden, here a soft heel is shown:



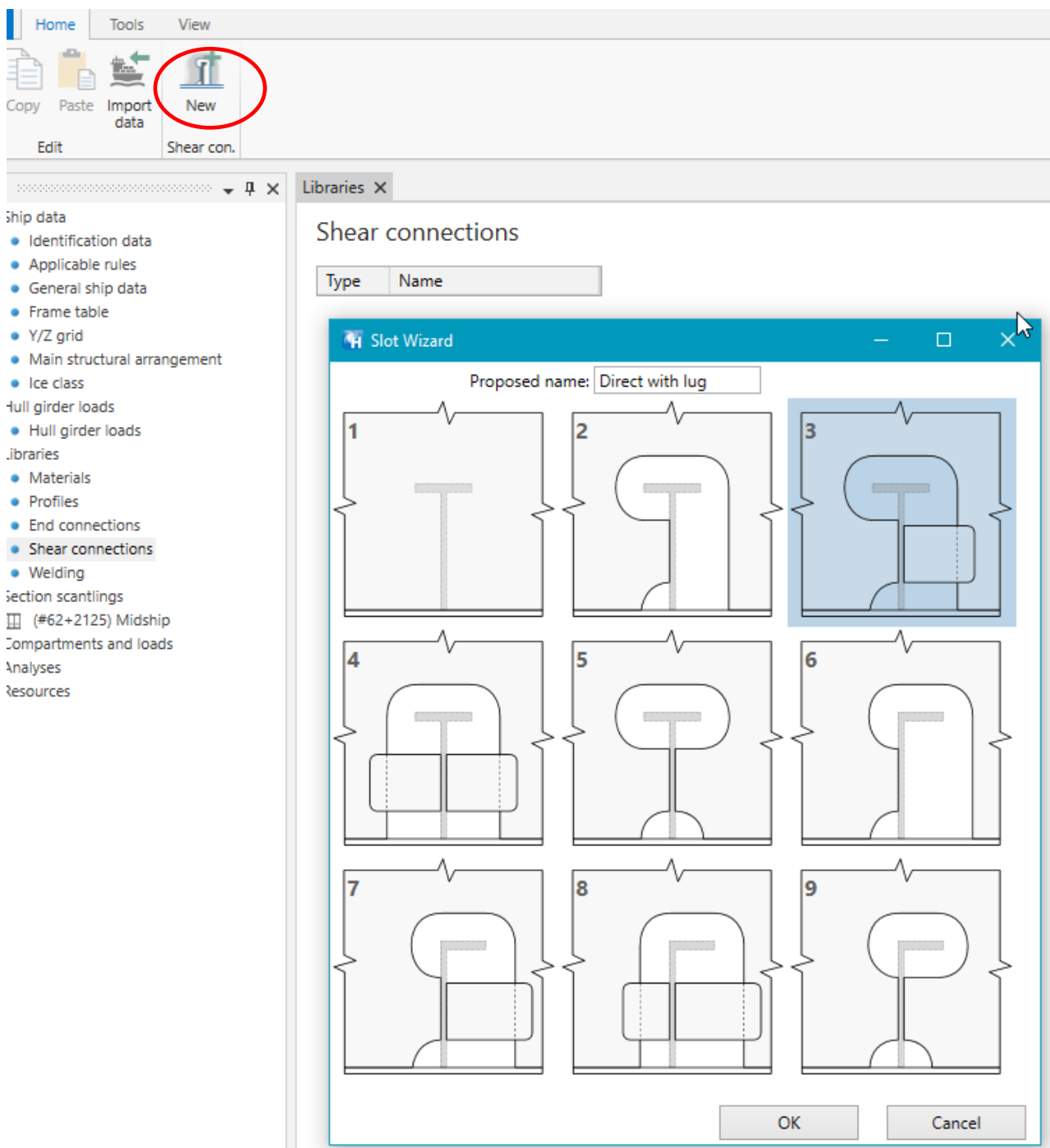
For instance, to apply actual d_w and d_{wc} for a soft detail as shown below, overriding is necessary as the offset cannot be defined on the detail:



6.4 Shear connections

To calculate the shear connection part of the connection strength, cut-outs and lugs need to be defined. Select **New** to and chose detail #3 from the available configurations:

Proposed name may be edited.



Enter parameters as indicated:

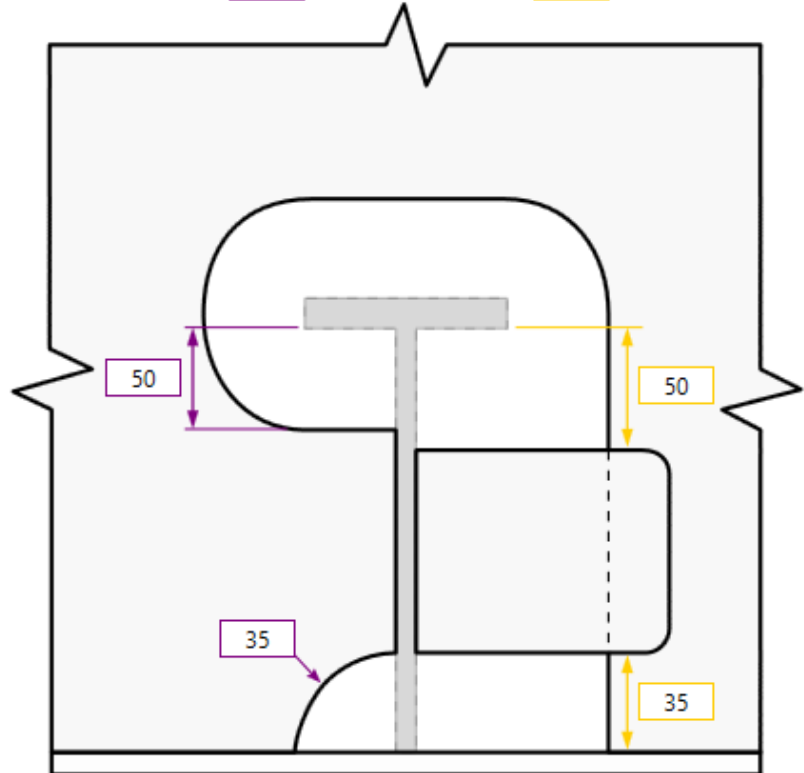
Type	Name
DL	Direct with lug

Material: VL_NS

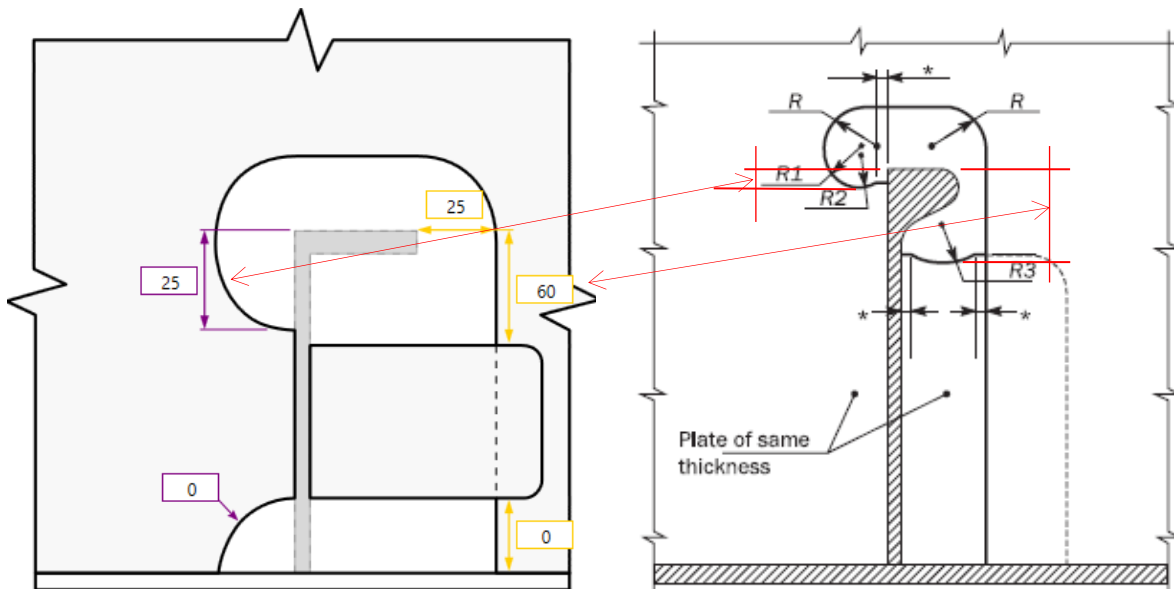
VL_NS

Thickness: 18

18



Cut-outs as described in Pt.1 Ch.9 Sec.6 [2.2.2] Table 1 ('apple type') is not directly selectable. To represent this cutout, select the corresponding detail and enter parameters accordingly:



This will imply that the results of the connection strength calculation will be marginally conservative.

(The values given above are fictitious and must of course correspond to the actual design).

6.5 Welding

The welding parameters found in this setup will be used when checking welding requirements in the connection strength calculation. For CSR BC&OT, t_{gap} is fixed at 2mm.

The minimum yield stress of weld deposit, R_{eH_weld} , can be modified. R_{eH_weld} will be chosen from this table depending on the yield strength of base material. The default values are according to the rules and you can leave them as is.

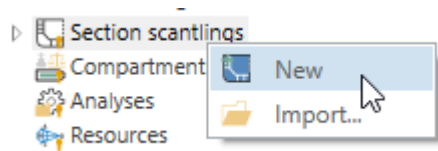
t_{gap} [mm]

R_{eH}	R_{eH_weld}
235	305
265 to 355	375
390	400

7 Section Scantlings

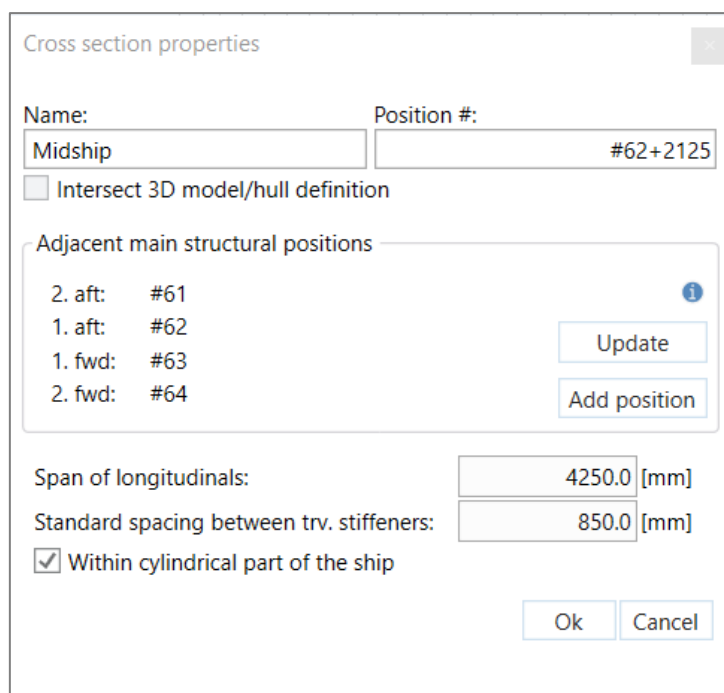
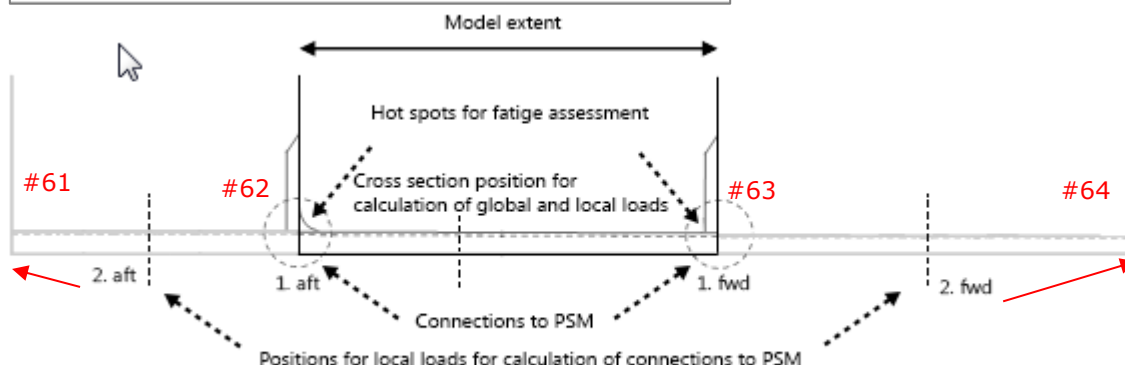
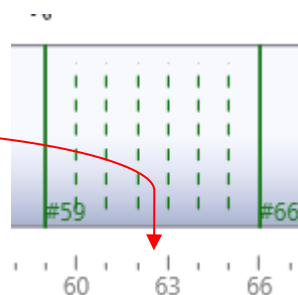
7.1 Establish the cross-section

The term 'cross-section' will refer to an extruded part starting at the nearest structural position aft of the given position and ending at the nearest structural position forward of the given position. Analysis will be carried out at the given cross-section position.



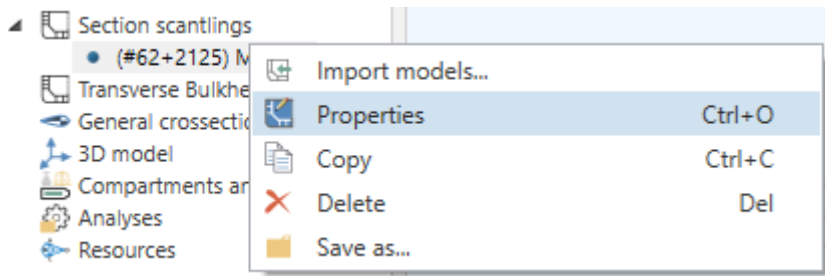
Give name **Midship** and position **#62+2125** which will be at the midspan between #62 and #63.

Give **850** as default spacing between transverse stiffeners.

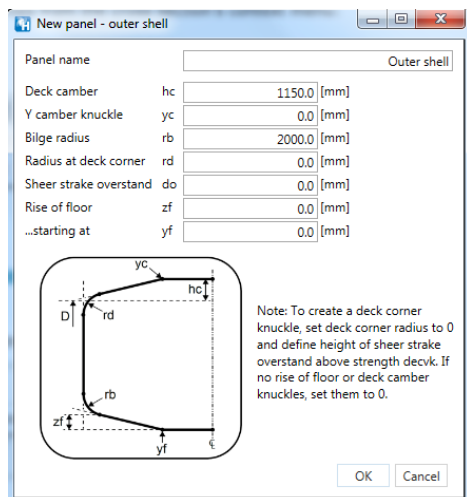
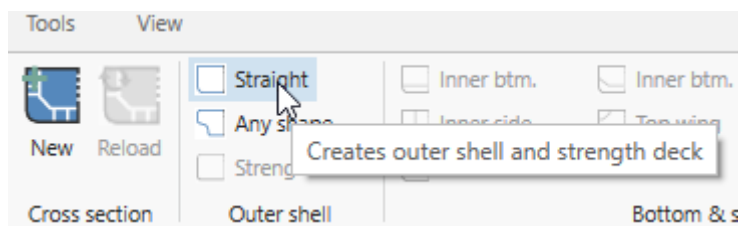
Raw span of longitudinals will be the distance between #62 and #63.

You may modify properties from the cross-section's context menu:



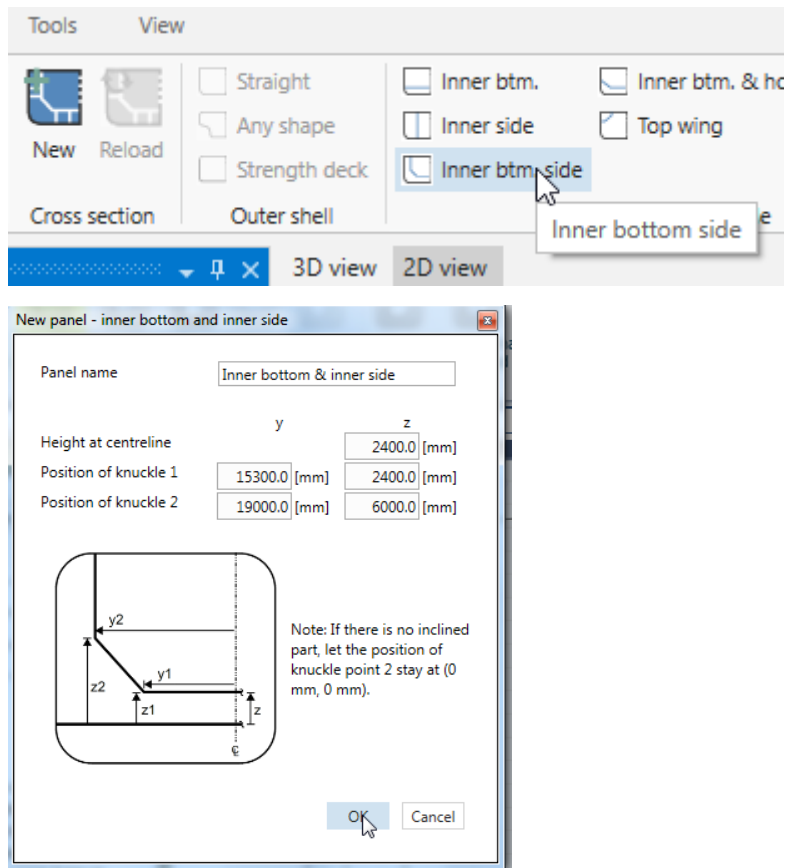
7.2 Create outer shell panel

Create outer shell and strength deck panels:

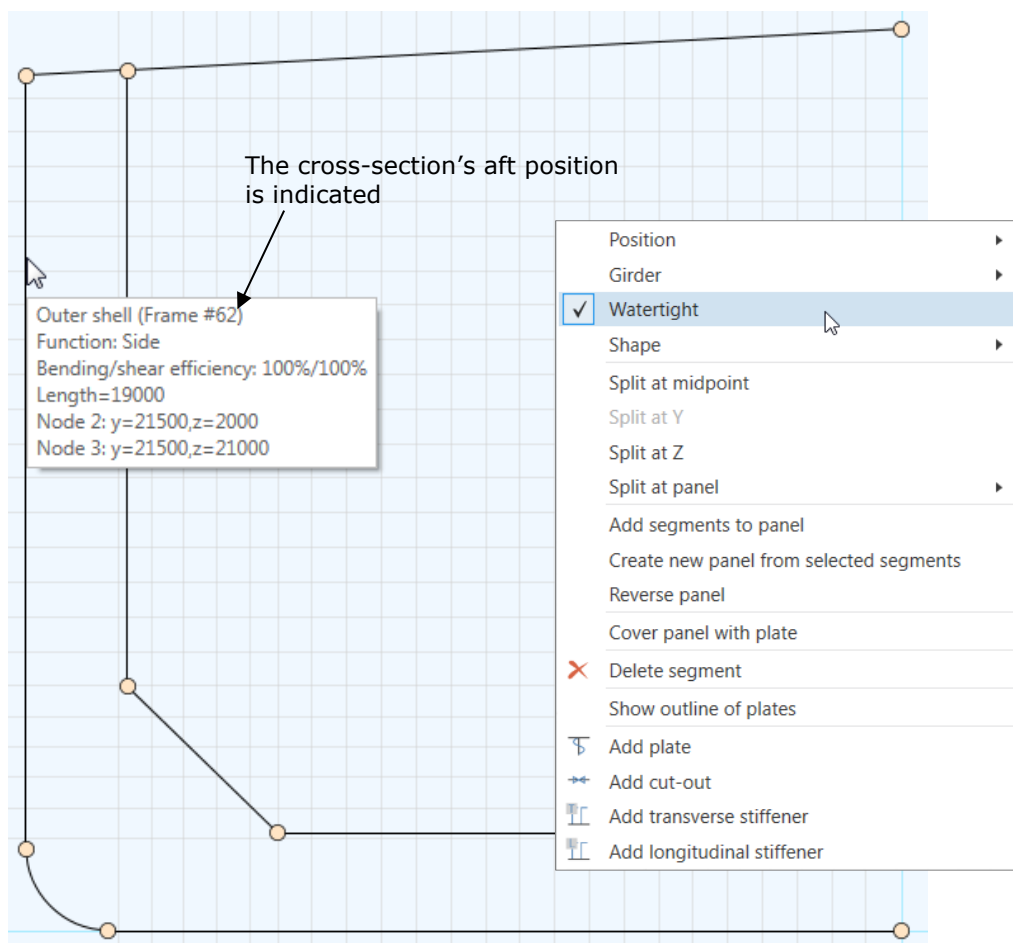


7.3 Create internal panels

Continue with inner bottom and side:



Save the workspace.



Tooltip are shown when hovering the various objects. Properties can be modified from the segment context menu when one or more segments are selected.

Note the different colors of the nodes describing connectivity:

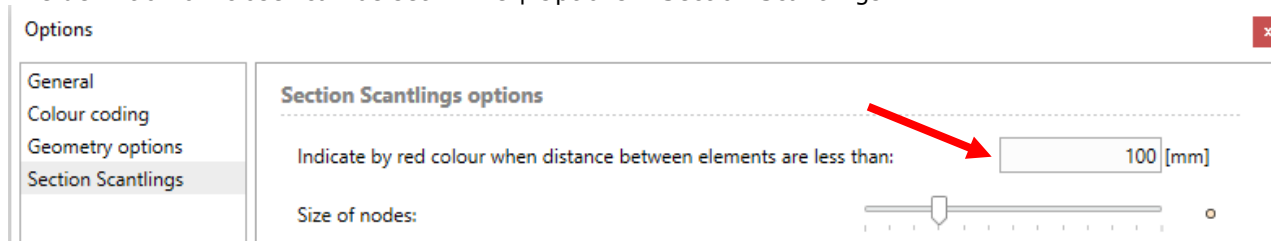
White nodes indicates that this is a free endpoint of the segment, not connected to anything else.

Yellow nodes are nodes shared by multiple segments.

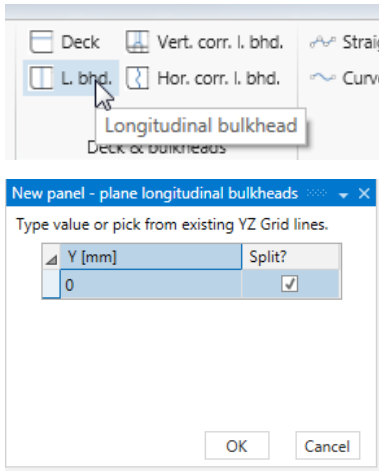
Blue (blue green) nodes are nodes connected to other segments by reference. These nodes don't split the segment they are connected to.

Red nodes - this is not related to connectivity and it is not necessarily indicating an error. A red node indicates that there are either two or more nodes at the same place or that the node is close to another node or object.

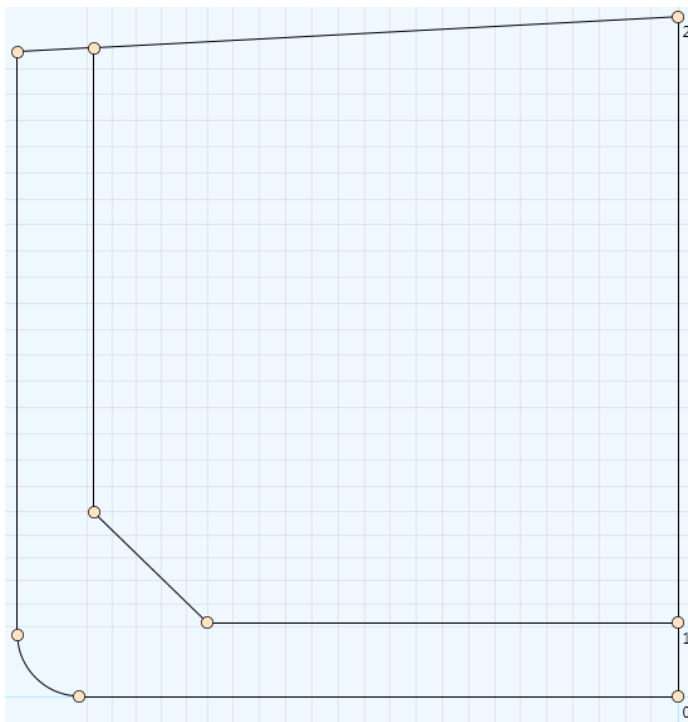
The definition of "close" can be set in File | Options – Section Scantlings:



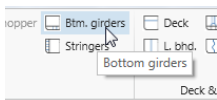
Create longitudinal bulkhead in CL:



"Split" will decide if intersecting segment shall be split into two or node just connected by reference. In the case below, this will not make any difference as the bulkhead is defined at CL.



Add double bottom girder:



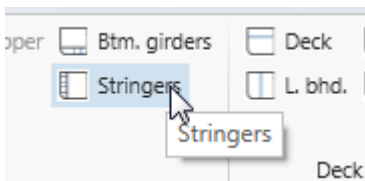
New girders

Type value or pick from existing YZ Grid lines.

Y [mm]	Panel name	Watertight?	Split?
15300	Girder15300	☐	☒

OK Cancel

Add side stringers:

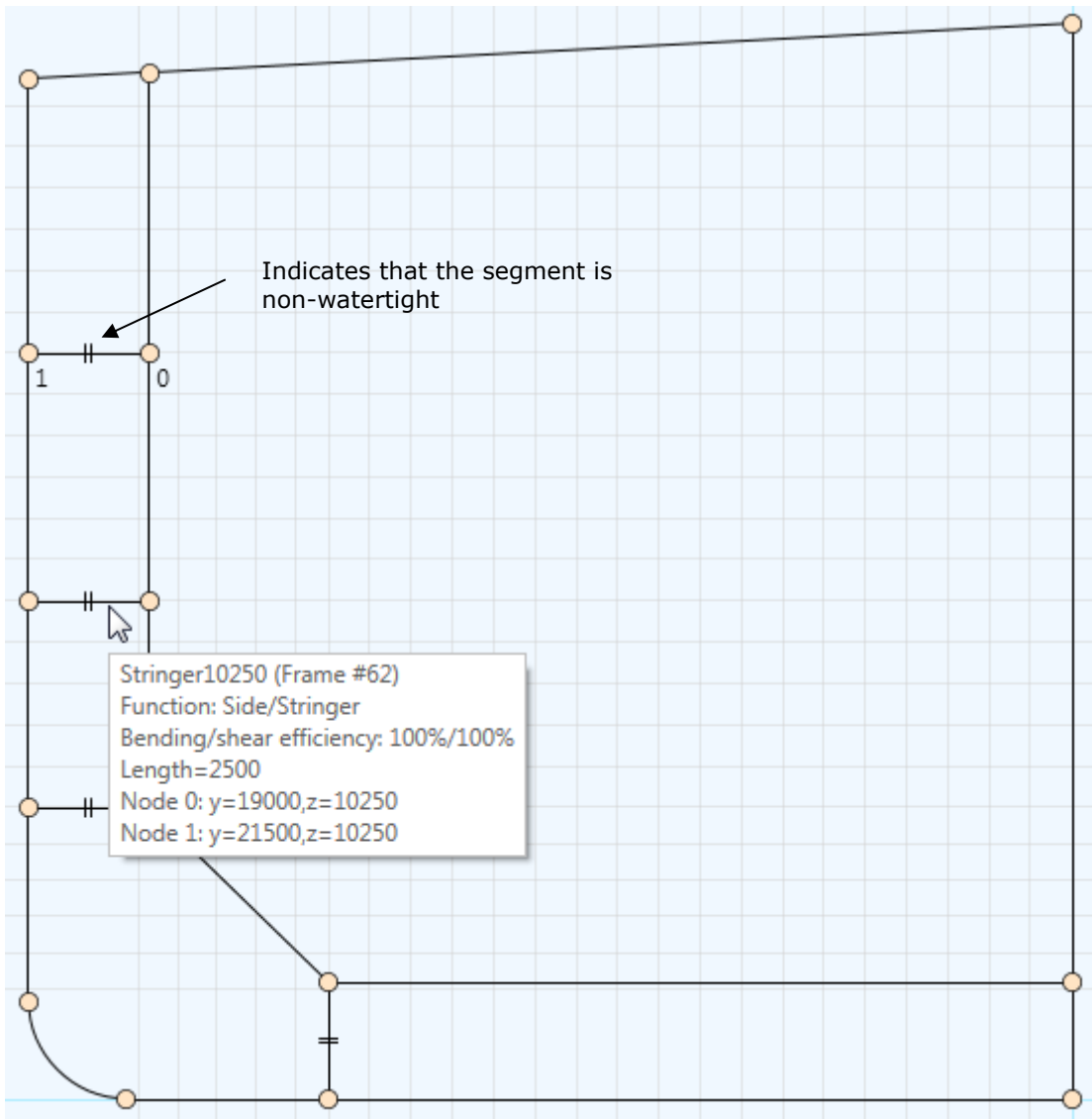


New stringers

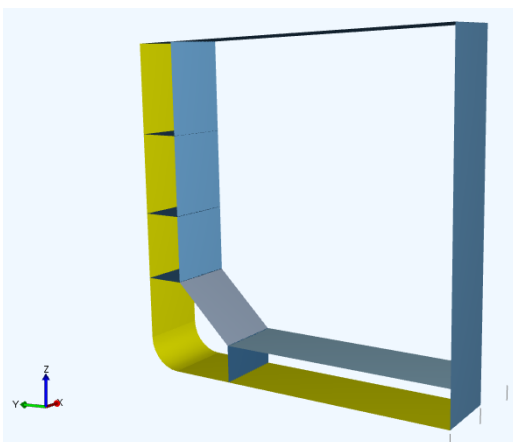
Type value or pick from existing YZ Grid lines.

Z [mm]	Panel name	Watertight?	Split?
6000	Stringer6000	☒	☒
10250	Stringer10250	☐	☒
15350	Stringer15350	☐	☒
		☐	☐

OK Cancel



Model may be inspected in 3D view:



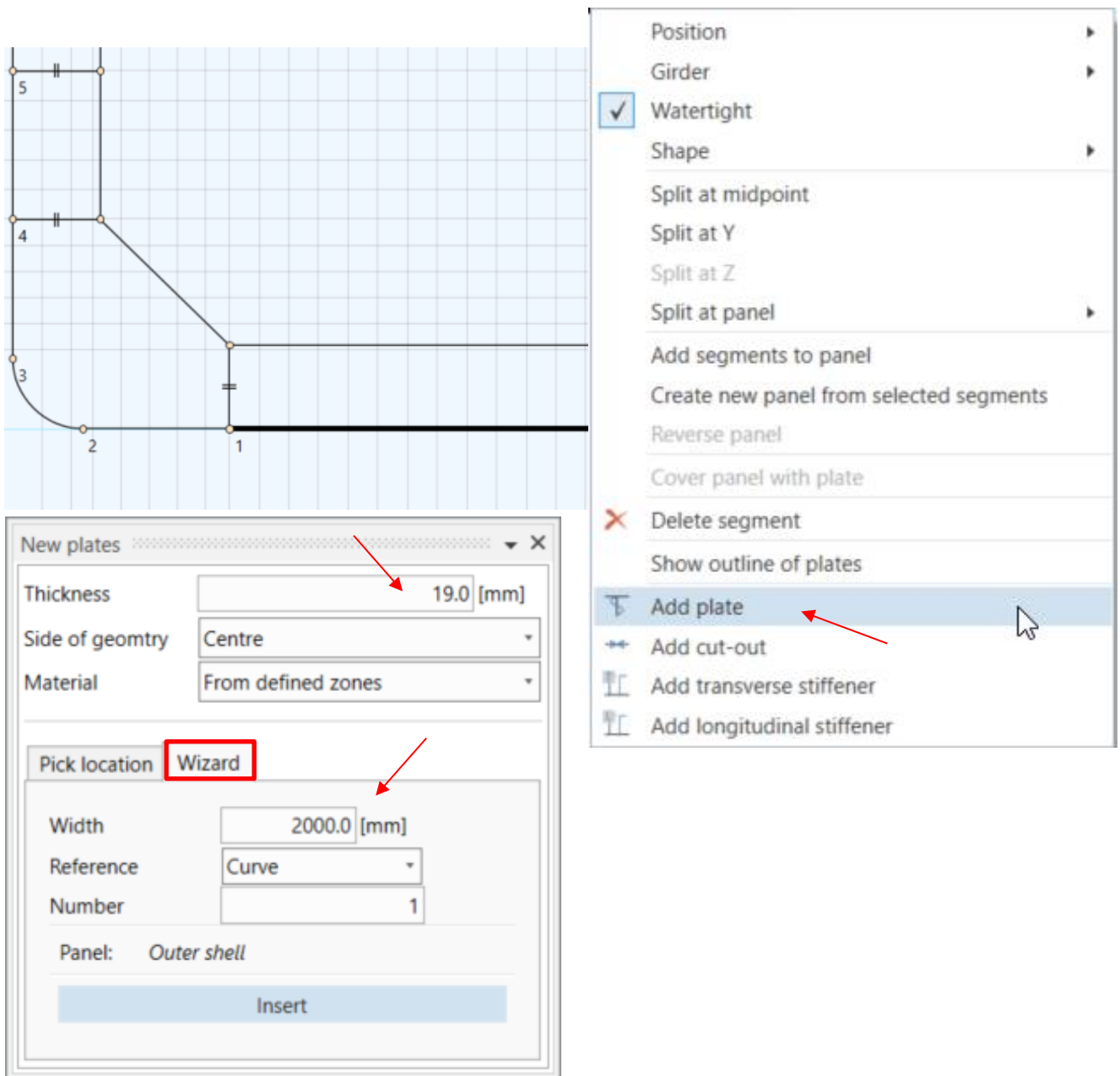
Save the workspace.

7.4 Plates

Plate layout follows the direction of the panel. Direction of the panel is decided by the node numbers. Node number '0' indicates start of panel.

Start with outer shell. Select the segment – which will set the panel current - and select **Add plate** from the context menu (or from ribbon bar):

Chose tab **Wizard**, specify width 2000mm, thickness 19mm:



Width	Along	Thickn	Material	No. of
3000	Curve	19	From def...	5
2400	Curve	19	From def...	1

Insert the bilge plate:

Width	Along	Thickn	Material	No. of
2100	GlobalZ	20	From def...	1

Insert the side plates:

Width	Along	Thickn	Material	No. of
2800	Curve	16	From def...	1
2600	Curve	16.5	From def...	2
2800	Curve	16.5	From def...	3
2500	Curve	16	From def...	1

Note the two upper plates on side shell will get high-strength material assigned. This is indicated by thicknesses enclosed by [], e.g. [16.5]. This is according to what is defined in HS-steel zone for the current cross-section.

7.4.1 Strength deck

Select strength deck panel and insert plates:

Width	Along	Thickn	Material	No. of
3200	Curve	18	From def...	5
3200	Curve	16	From def...	1
2700	Curve	16	From def...	1

7.4.2 Inner bottom

Width	Along	Thickn	Material	No. of
2700	Curve	17	VL-32	5
1800	Curve	17	VL-32	1

7.4.3 Hopper tank top

Width	Along	Thickn	Material	No. of
2400	Curve	18	VL-32	1
6250	Global Z	18	VL-32	1

7.4.4 Inner side

Width	Along	Thickn	Material	No. of
2400	Curve	17	From def...	1
2400	Curve	16	From def...	1
2400	Curve	15	From def...	1
2400	Curve	14	From def...	1
2400	Curve	16	From def...	1
3500 *	Curve	16	From def...	1

* The width of the last plate will automatically be reduced to end exactly at the deck.

7.4.5 Bulkhead, girders and stringers

Longitudinal bulkhead:

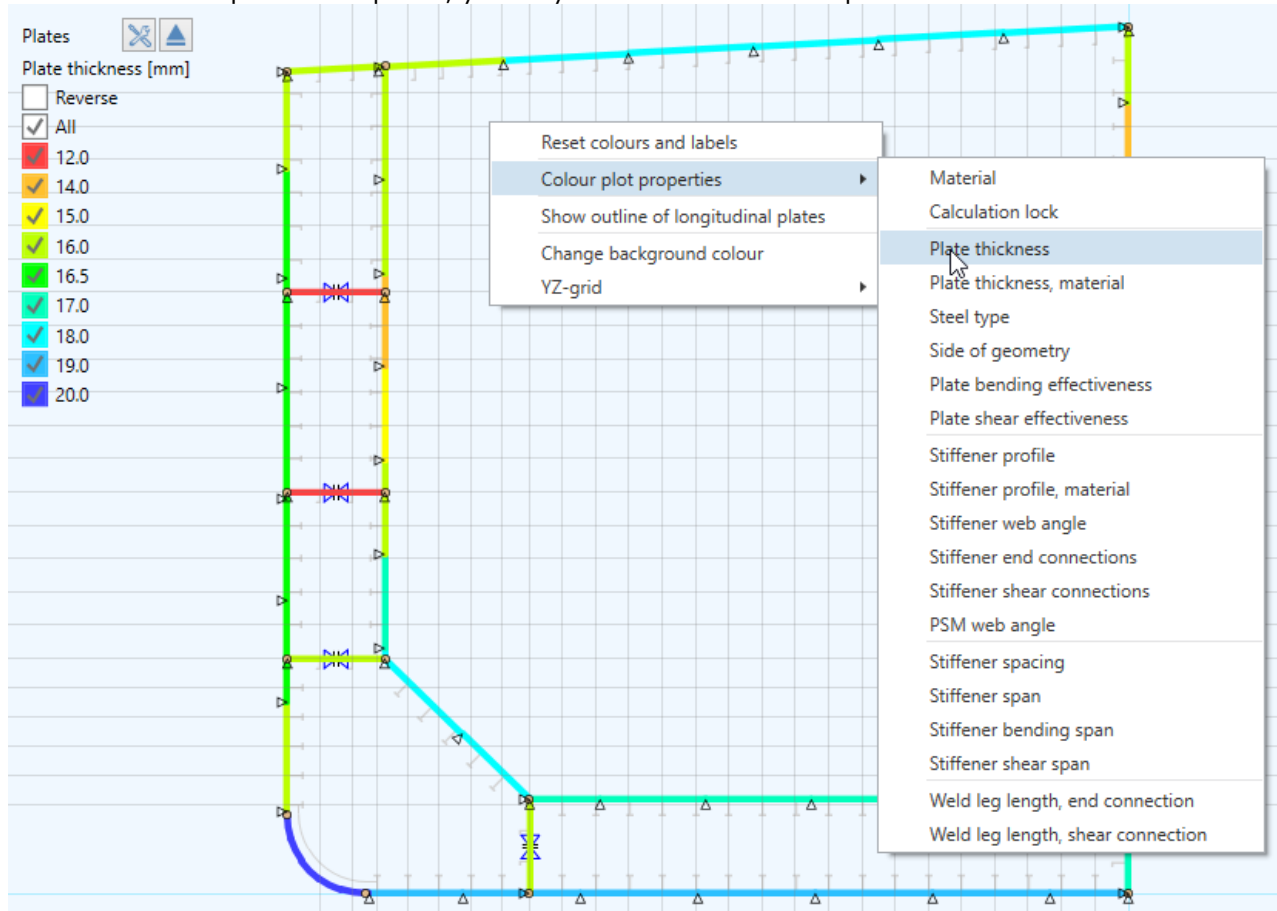
Width	Along	Thickn	Material	No. of
2400	Curve	17	VL-32	1
2500	Curve	17	VL-32	1
2700	Curve	17	VL-32	2
2400	Curve	16	VL-32	1
2700	Curve	14	VL-32	1
2600	Curve	14	VL-32	1
2200	Curve	14	VL-32	1
1950	Curve	16	VL-32	1

Girders and stringers:

Panel	Width	along	Thickn	Material	No. of
Girder 15300	2400	Curve	16	VL-32	1
Stringer 6000	2500	Curve	16	VL-32	1
Stringer 10250	2500	Curve	12	From def...	1
Stringer 15350	2500	Curve	12	From def...	1

7.4.6 Plates completed, verify modelled plates

Cross-section completed with plates, you may chose to show a color plot of the modelled thicknesses:

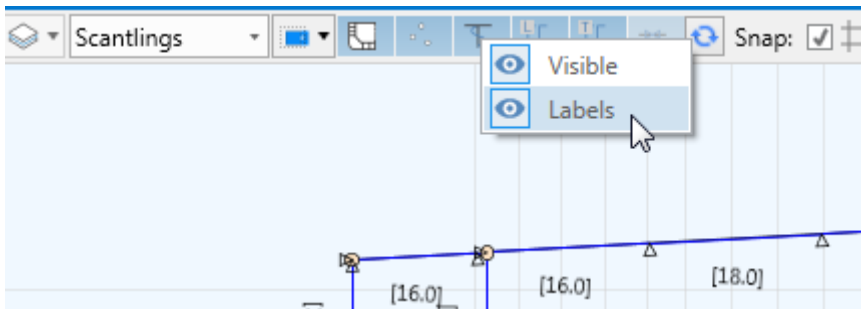


The square colored boxes in the legend are check-boxes. Click on the check-box in the legend to highlight the structure for that particular item.

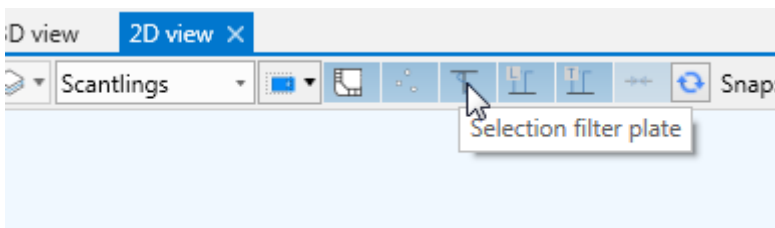
7.5 Longitudinal stiffeners

Stiffeners may be inserted by three different methods. Either by specifying a distribution of a given number of stiffeners, by clicking at the location of the insertion point or by letting the program create a stiffener at every intersection between a selected segment and Y- or Z-gridline.

You may turn off the plate thickness labels to reduce the information on the screen. Right-click the plate seam icon and select Labels:

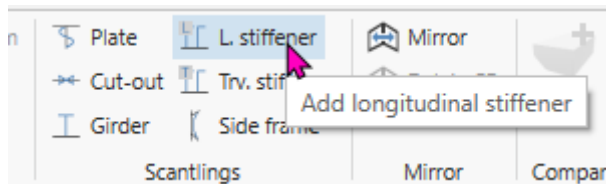


Also, turn off selection of plates by clicking the plate seam icon:

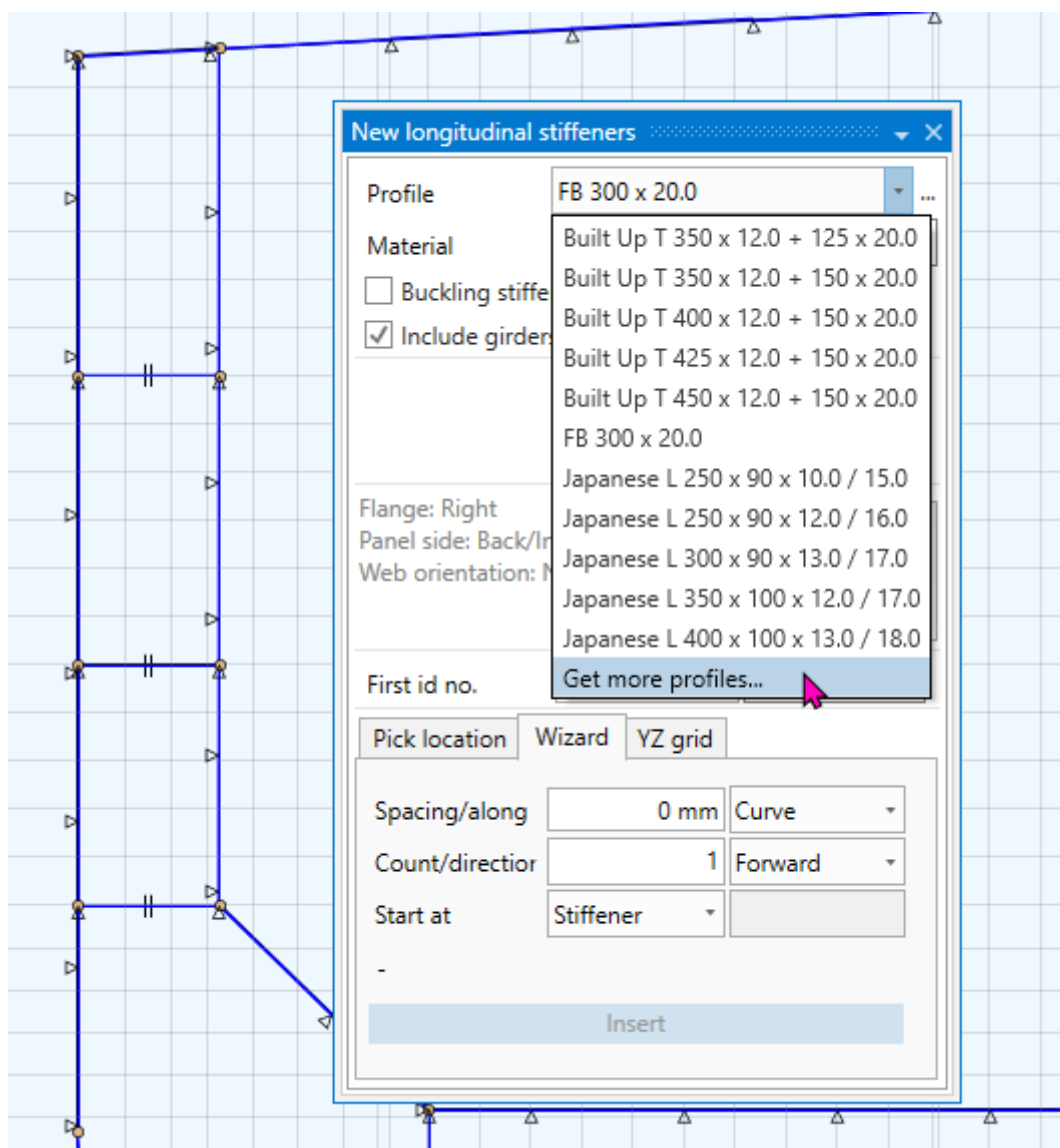


7.5.1 Outer shell

Select outer shell panel. Right-click and chose **Add longitudinal stiffener** from the context menu, or click the L. Stiffener button in ribbon:

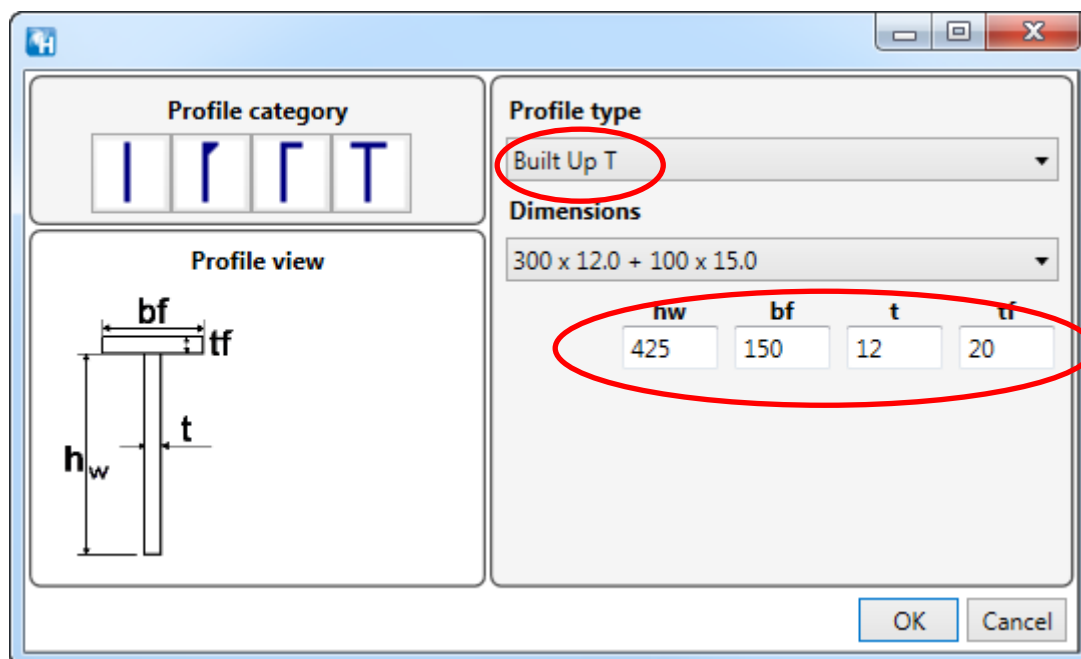


In the Profile drop-down list, select **Get more profiles**:



Specify profile type **Built Up T** and give dimensions **425x12/150x20**.

Note sequence of dimensions.



Profile category

Profile type
Built Up T

Dimensions
300 x 12.0 + 100 x 15.0

hw	bw	t	tf
425	150	12	20

Profile view

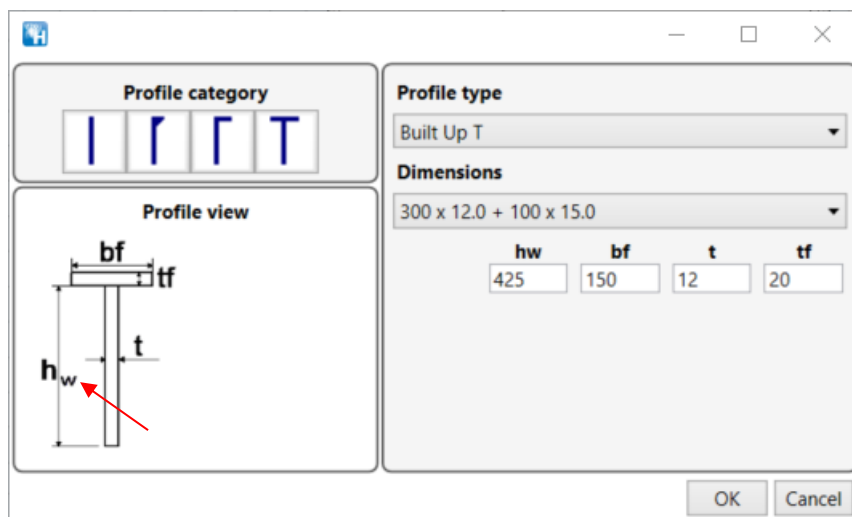
Diagram showing a T-section with dimensions: bw , tf , hw , and t .

OK Cancel

NOTE:

The profile types **Built Up T** and **Welded T** differs in the way web height is given.

For **Built-up T**, the h_w denotes the actual web height, i.e. **excluding thickness of flange**:

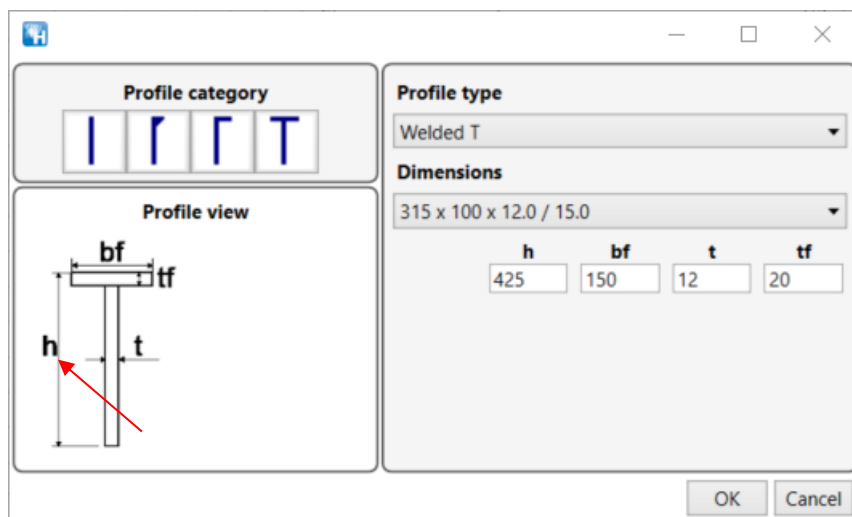


The screenshot shows a software window with the following elements:

- Profile category:** Four icons representing different profile shapes, with the last one (a T-shape) selected.
- Profile type:** A dropdown menu set to "Built Up T".
- Dimensions:** A dropdown menu showing "300 x 12.0 + 100 x 15.0". Below it, four input fields are populated: h_w (425), bf (150), t (12), and tf (20).
- Profile view:** A diagram of a T-profile with dimensions bf , tf , h_w , and t . A red arrow points to the h_w dimension, indicating it is the web height excluding flange thickness.
- Buttons:** "OK" and "Cancel" buttons at the bottom right.

It is recommended to use Built-up T for consistency with common practice.

For **Welded T**, the height of the profile **includes flange thickness**:



The screenshot shows a software window with the following elements:

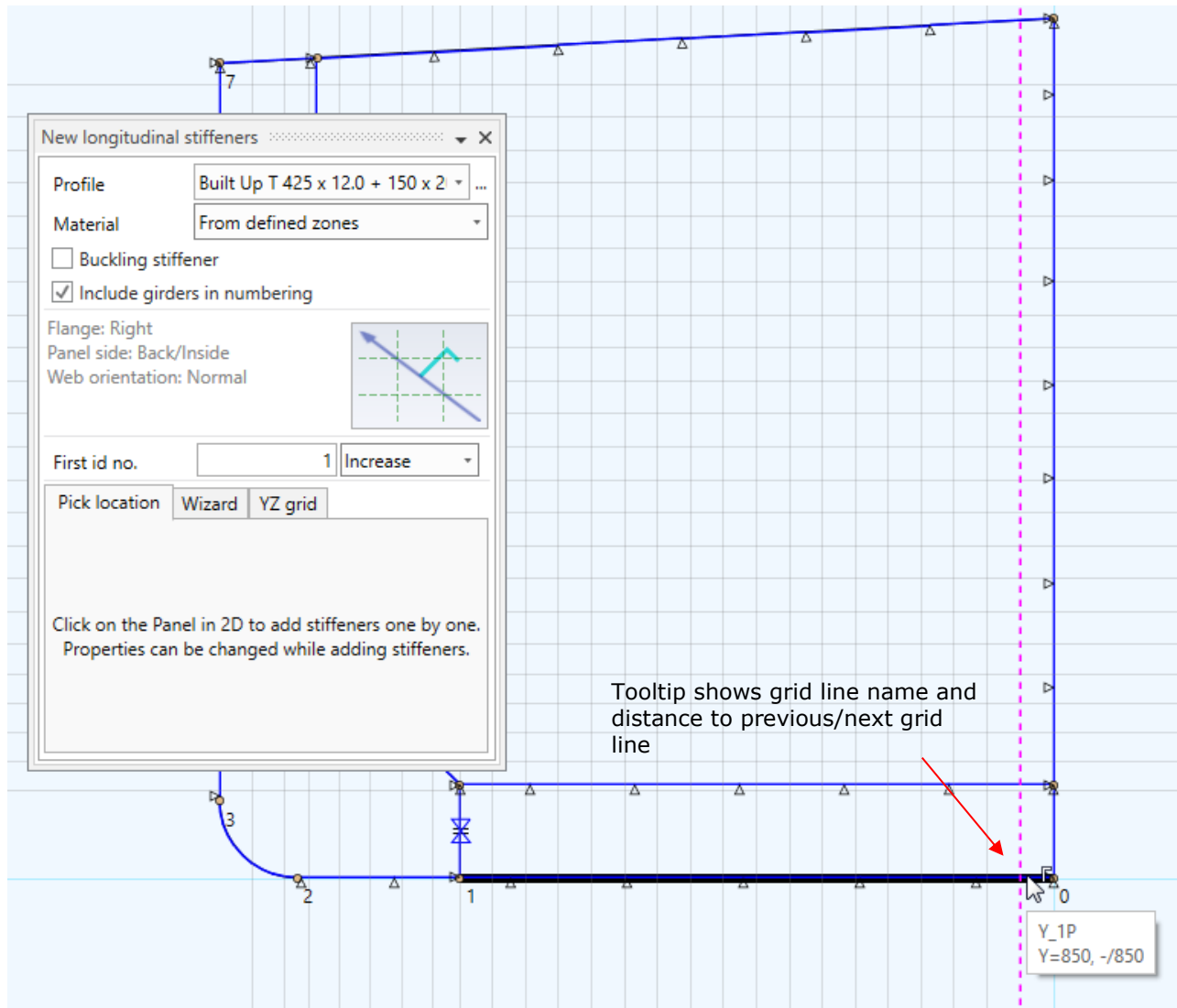
- Profile category:** Four icons representing different profile shapes, with the last one (a T-shape) selected.
- Profile type:** A dropdown menu set to "Welded T".
- Dimensions:** A dropdown menu showing "315 x 100 x 12.0 / 15.0". Below it, four input fields are populated: h (425), bf (150), t (12), and tf (20).
- Profile view:** A diagram of a T-profile with dimensions bf , tf , h , and t . A red arrow points to the h dimension, indicating it is the total height including flange thickness.
- Buttons:** "OK" and "Cancel" buttons at the bottom right.

Similar applies for **Welded L**, however no corresponding Built-up L is available as a selection.

As you go on with selecting of different profiles, the profile library will be updated with a **checkmark** for the profile type. After completing the modelling of stiffener, you may see something like this if you open the profile library and select 'Japanese L':

Selection	Profile type	Dimensions	h [mm]	h _w [mm]	t _w [mm]	b _f [mm]	t _f [mm]	Area [cm ²]	Z [cm ³]	I [cm ⁴]	
☐	Japanese L	150 x 90 x 12.0 / 12.0	150	138	12.0	90	12.0	27.5	64.1	633	▲
☐	Japanese L	200 x 90 x 9.0 / 14.0	200	186	9.0	90	14.0	29.7	88.7	1210	
☒	Japanese L	250 x 90 x 10.0 / 15.0	250	235	10.0	90	15.0	37.5	149.1	2444	
☒	Japanese L	250 x 90 x 12.0 / 16.0	250	234	12.0	90	16.0	42.9	174.5	2794	
☐	Japanese L	300 x 90 x 11.0 / 16.0	300	284	11.0	90	16.0	46.2	229.2	4365	
☒	Japanese L	300 x 90 x 13.0 / 17.0	300	283	13.0	90	17.0	52.7	264.7	4938	
☒	Japanese L	350 x 100 x 12.0 / 17.0	350	333	12.0	100	17.0	57.7	337.8	7437	
☐	Japanese L	400 x 100 x 11.5 / 16.0	400	384	11.5	100	16.0	61.1	416.1	10284	
☒	Japanese L	400 x 100 x 13.0 / 18.0	400	382	13.0	100	18.0	68.6	466.8	11482	

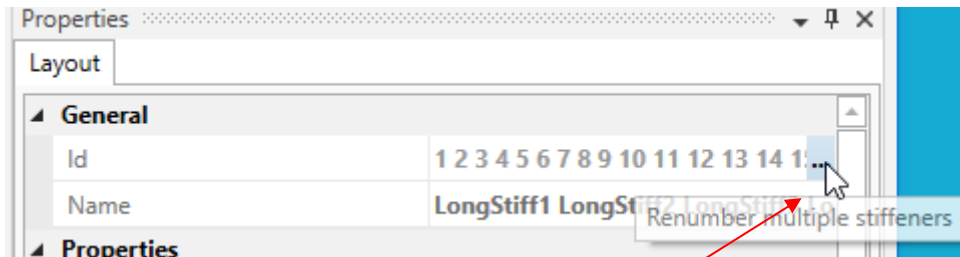
When method is set to **Pick location**, stiffener insertion point can be selected by hitting close to the intersection between an YZ-grid line and the panel:



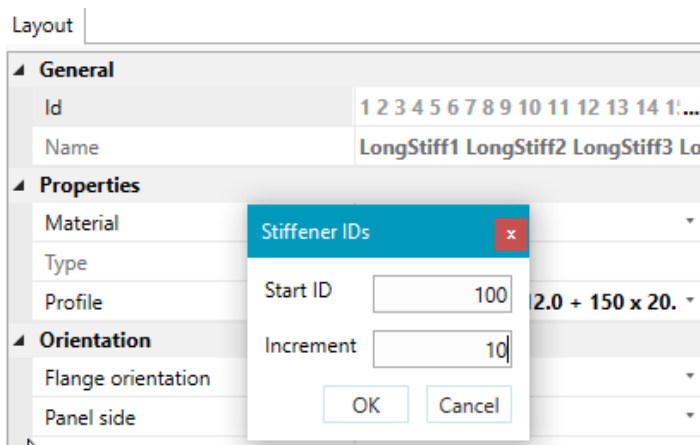
All longitudinals at bottom can be defined by this method.

7.5.2 Renumbering stiffener IDs

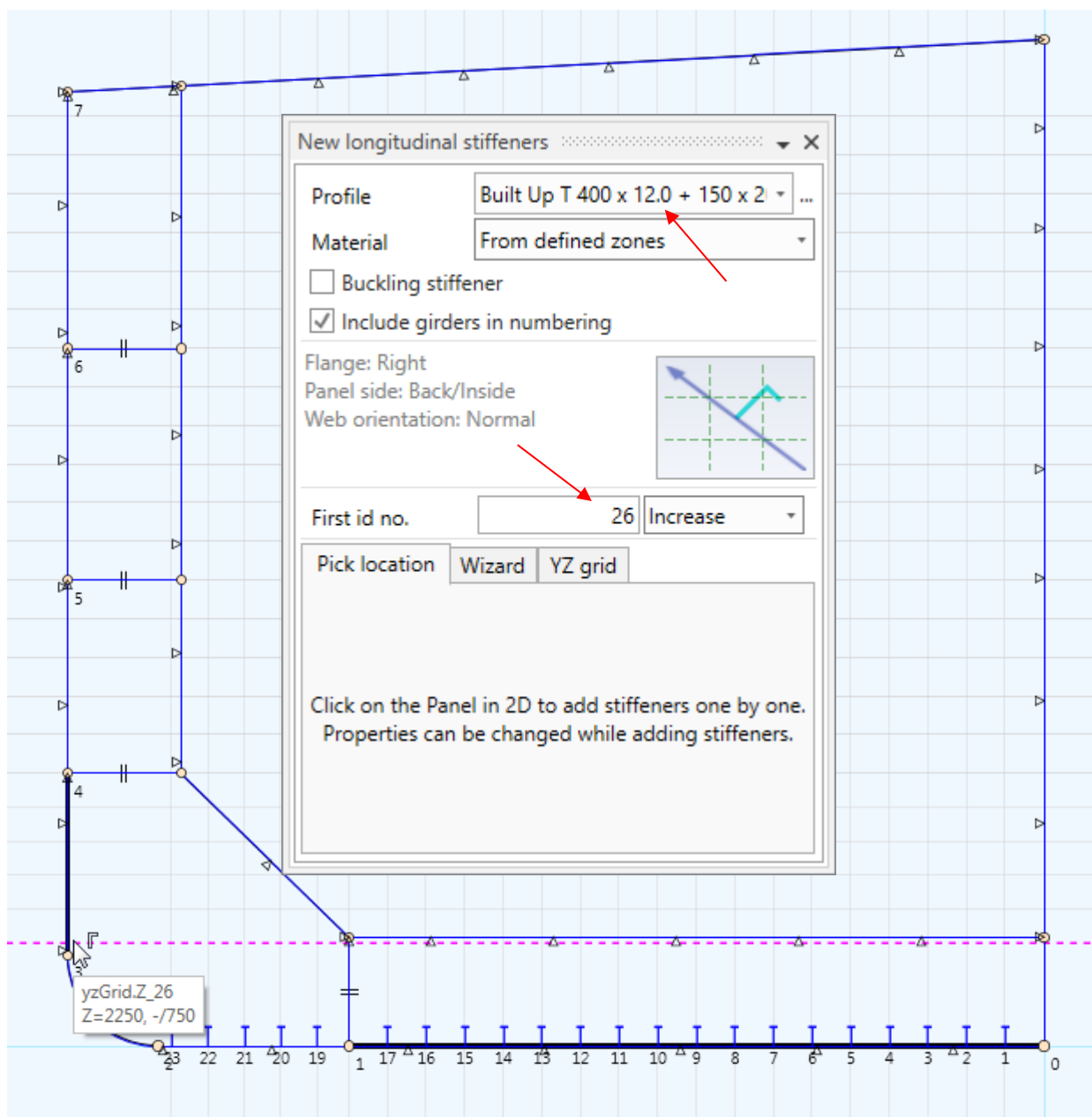
You may renumber IDs of multiple stiffeners in one operation:



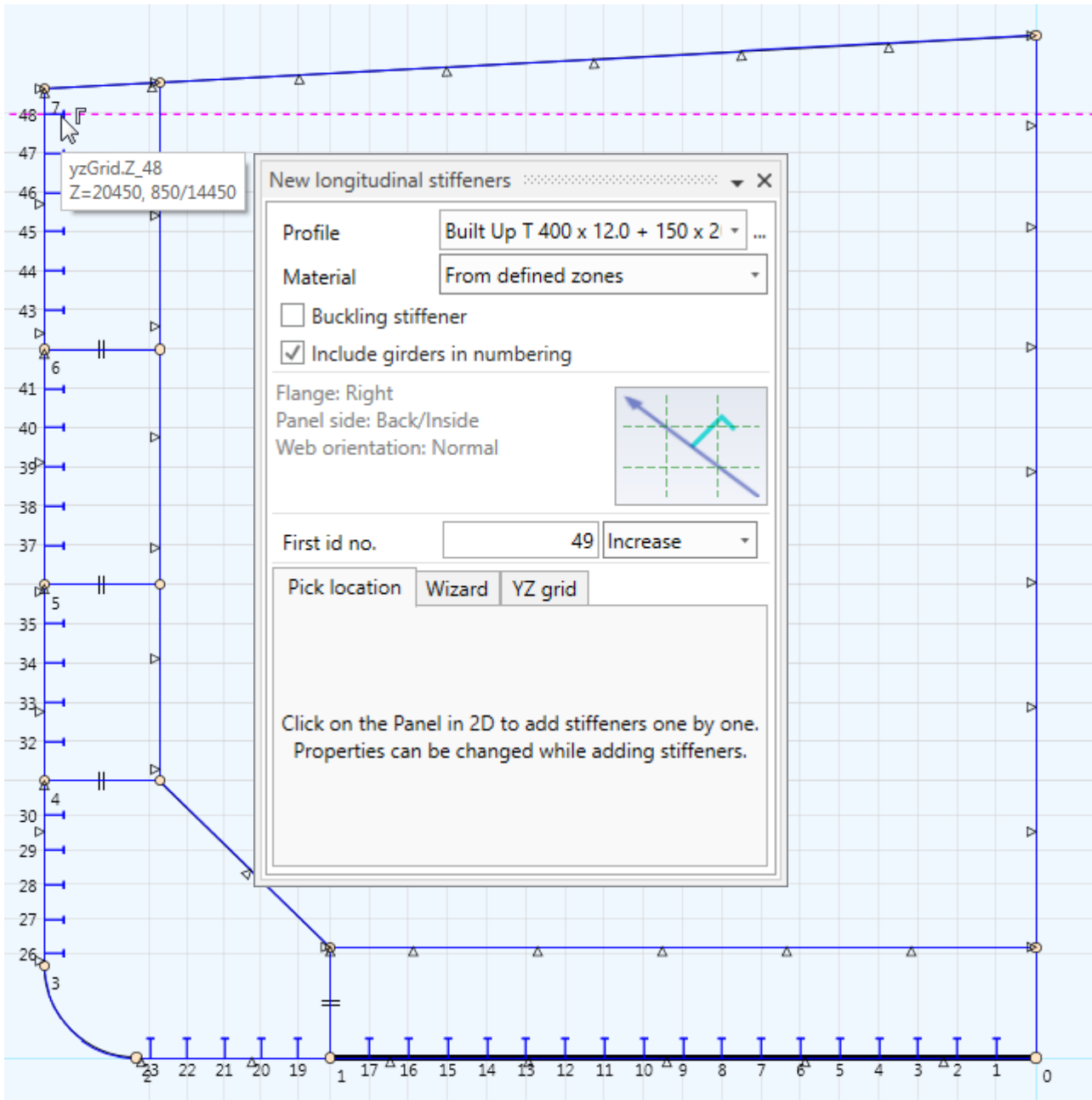
Enter Start ID and increment. You can enter a negative number for increment.



Switch web direction, change profile to **400x12/150x20** and **First id. no** to **26** and continue with outer shell side:



Forget the variations in profile dimensions along side for now, this can be modified later.



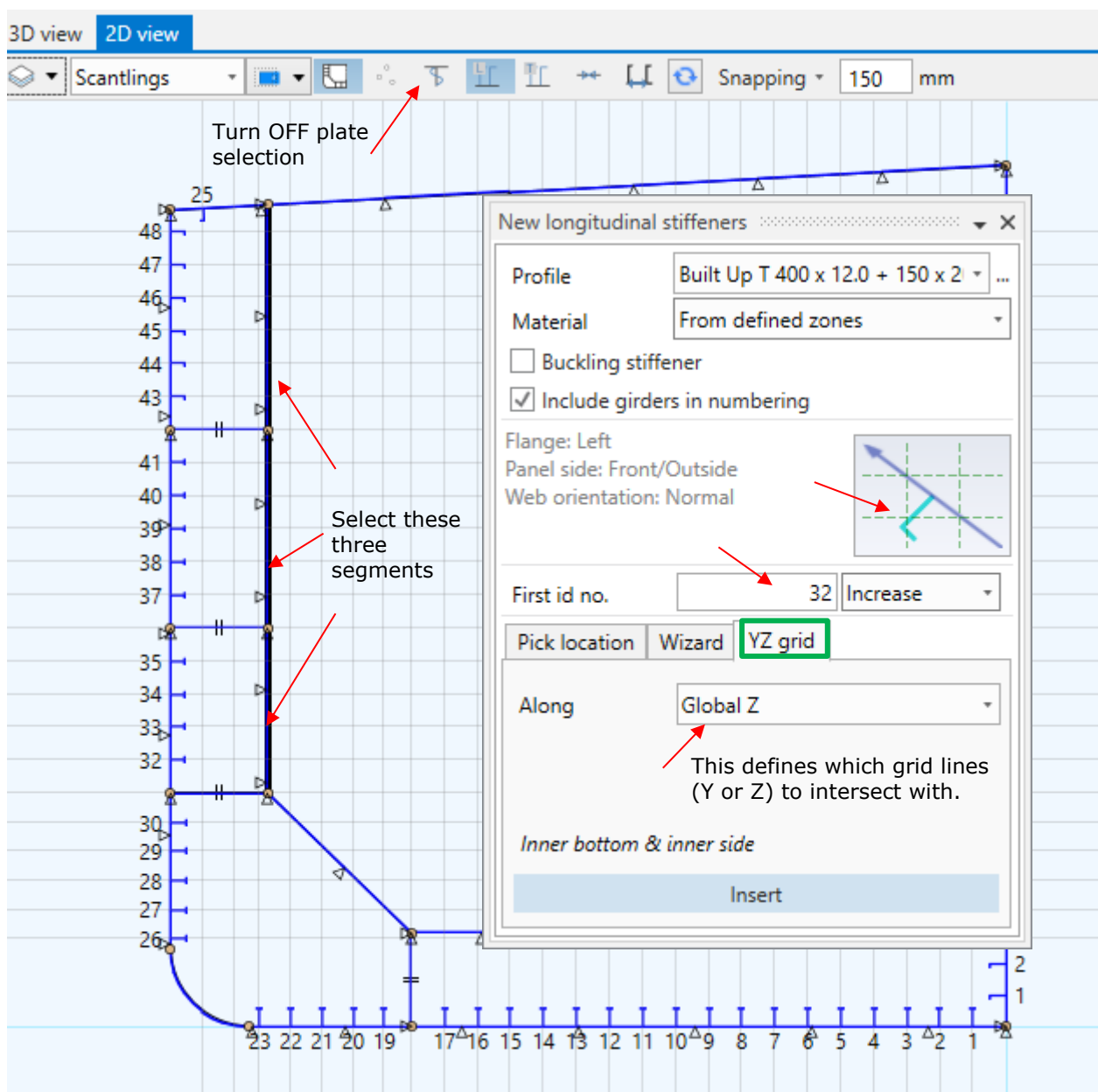
7.5.3 Inner side

To cover inner side, try out the YZ-grid approach. This will define stiffeners at every intersection between selected segment and YZ-grid line.

Change **First id. no** to **32** and **switch web direction**. Turn OFF plate selection.

Set **Along** to **Global Z**. Global Z refers to the horizontal lines distributed in the z-direction.

Select the three segments describing inner side in the sequence lower to higher (hold down Ctrl-button while clicking segment to accumulate the segments into the selection).

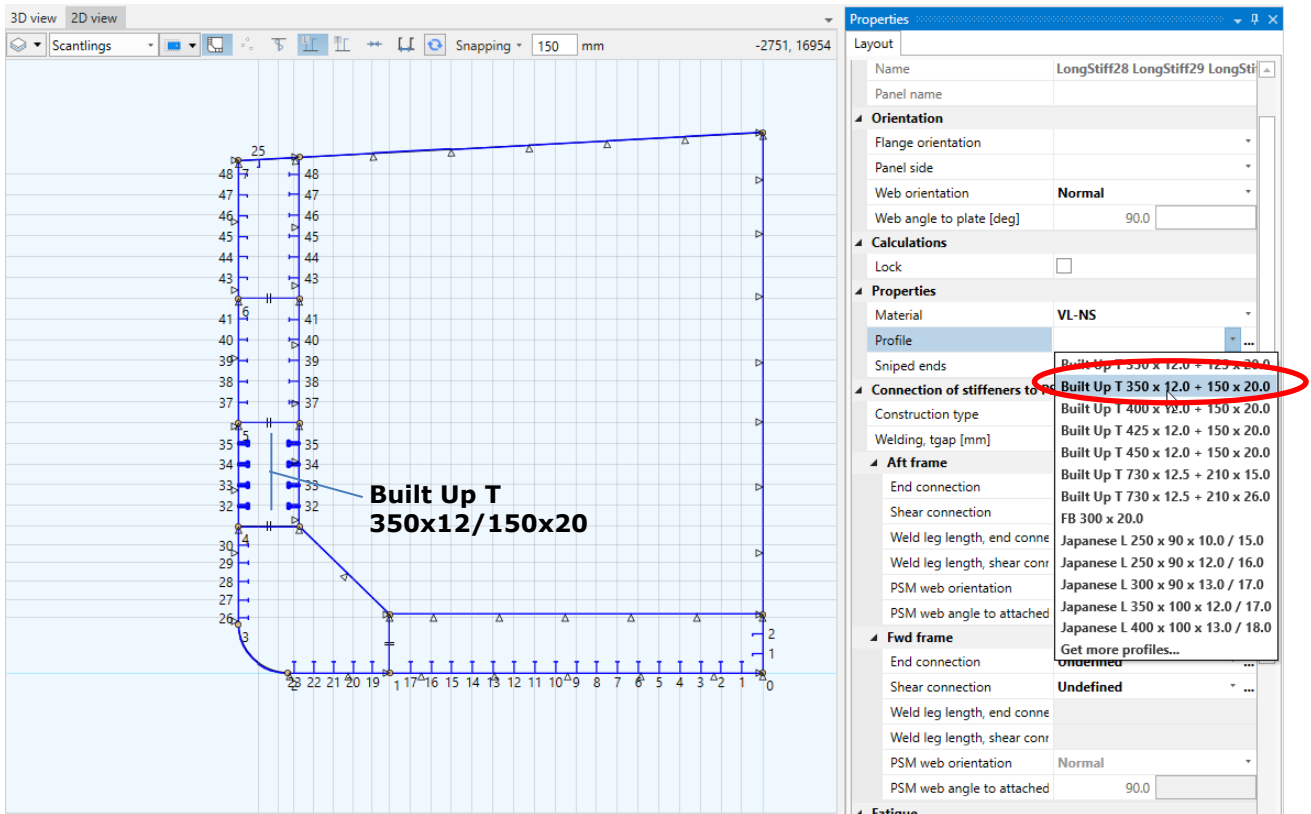


Click **Insert** to define the stiffeners.

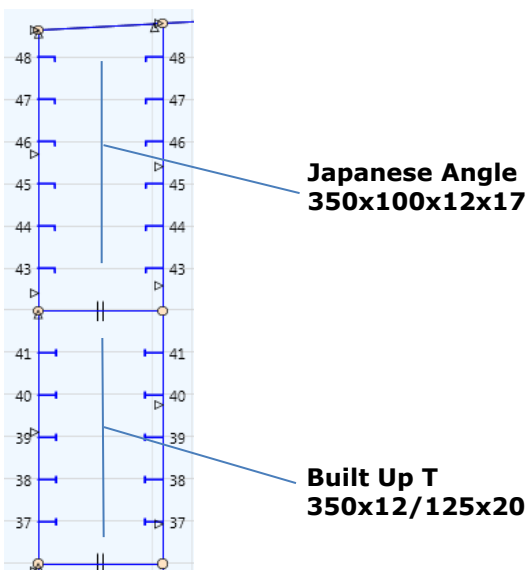
Modify stiffener profile type on inner side and outer shell side. Turn off selection of plates and segments:



Select stiffeners on outer shell side and inner side by a rubber-band box, then modify profile:



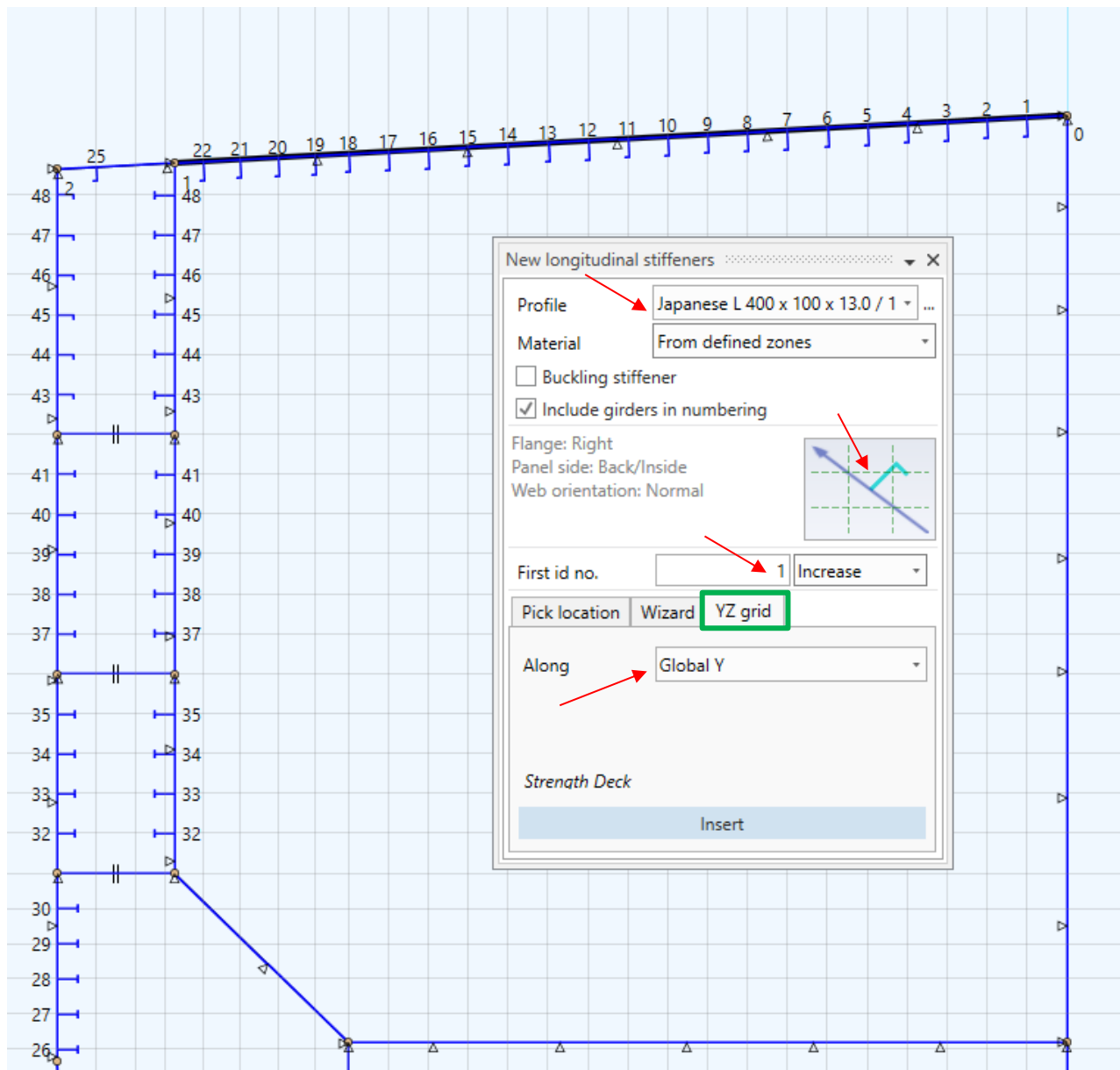
Remaining parts of double side:



7.5.4 Strength deck and stringers

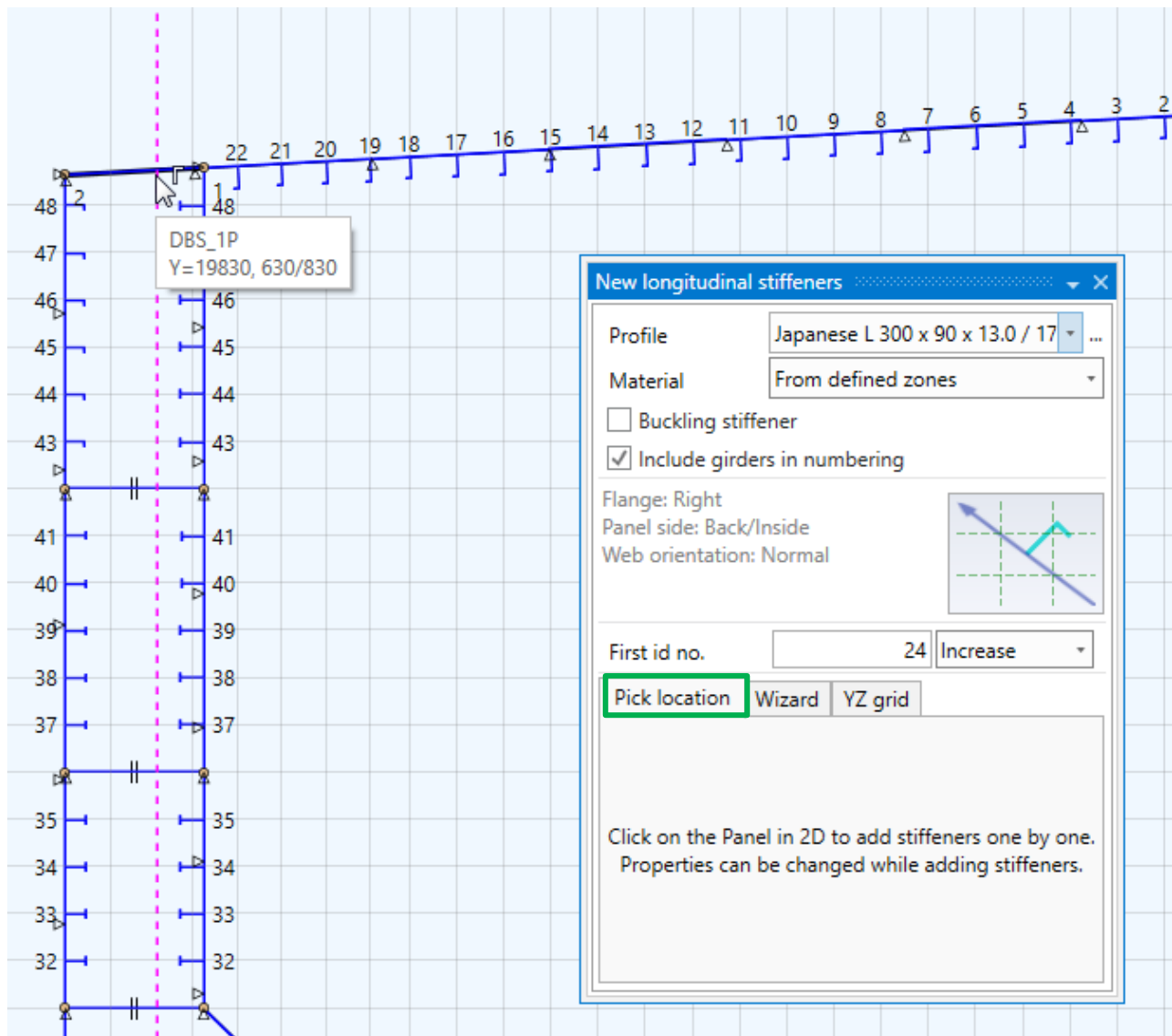
Select strength deck segment.

Define stiffeners on strength deck by **YZ-grid** approach, this time with **Along** set to **Global Y**:

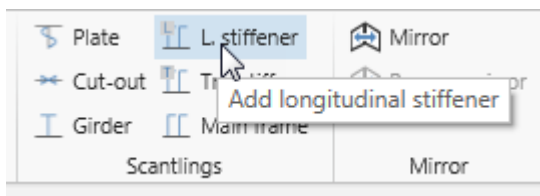


Complete deck by adding the two longs in double side by **Pick location**.

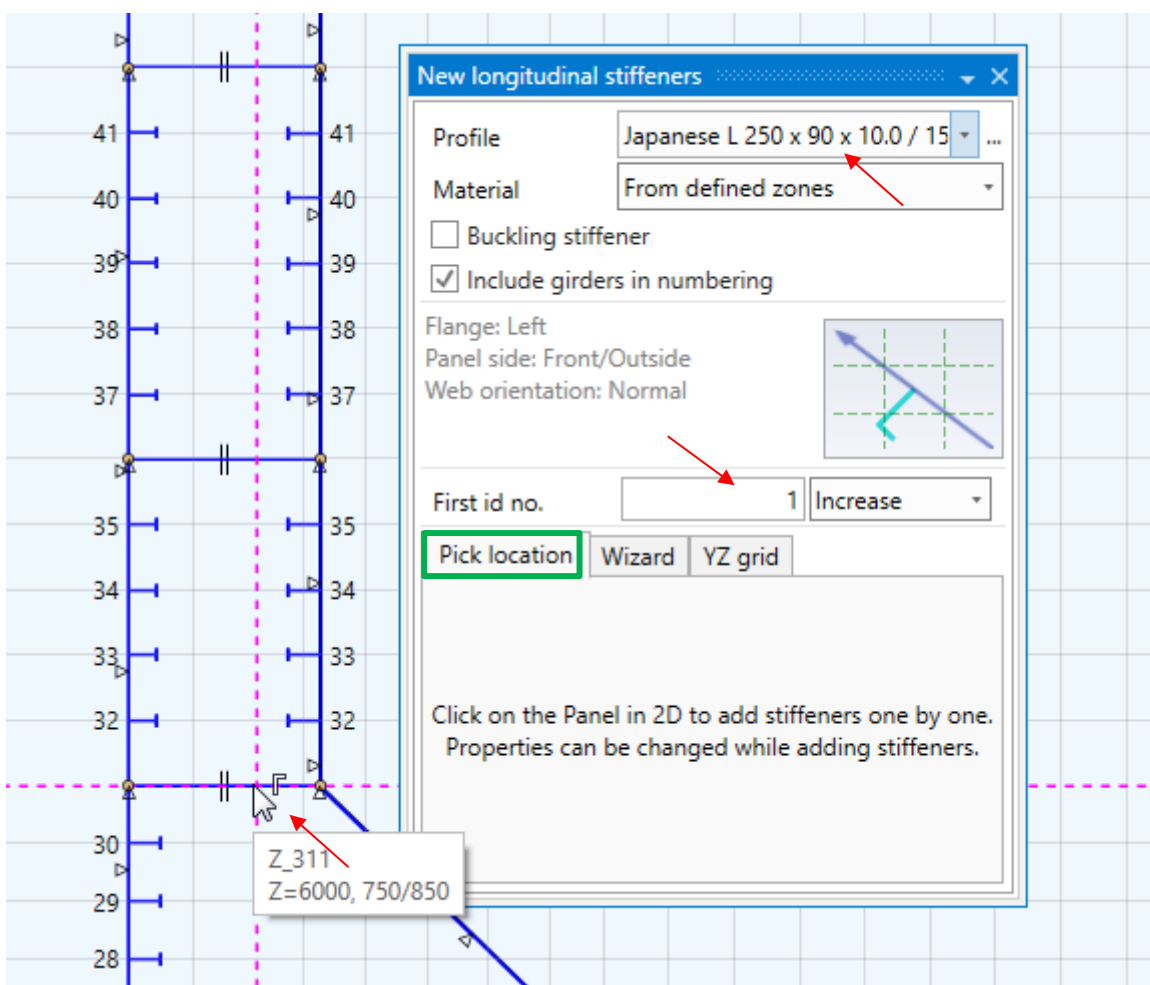
Set first id number to 24.

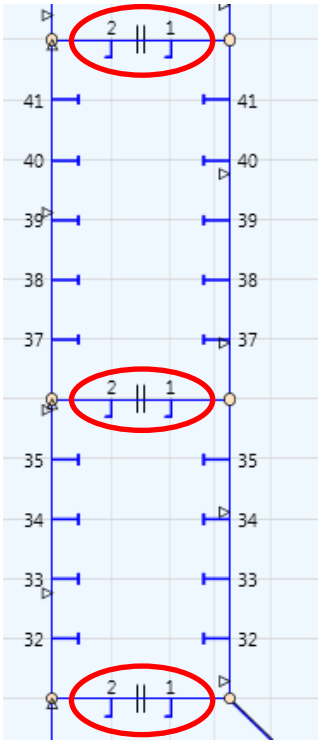


Without selecting any panel, you may add stiffener directly by the pick-mode. When a panel is not selected, the automatic incrementation of stiffener **ids** may not give desired result so pay attention to the **First id no.** value and modify accordingly.



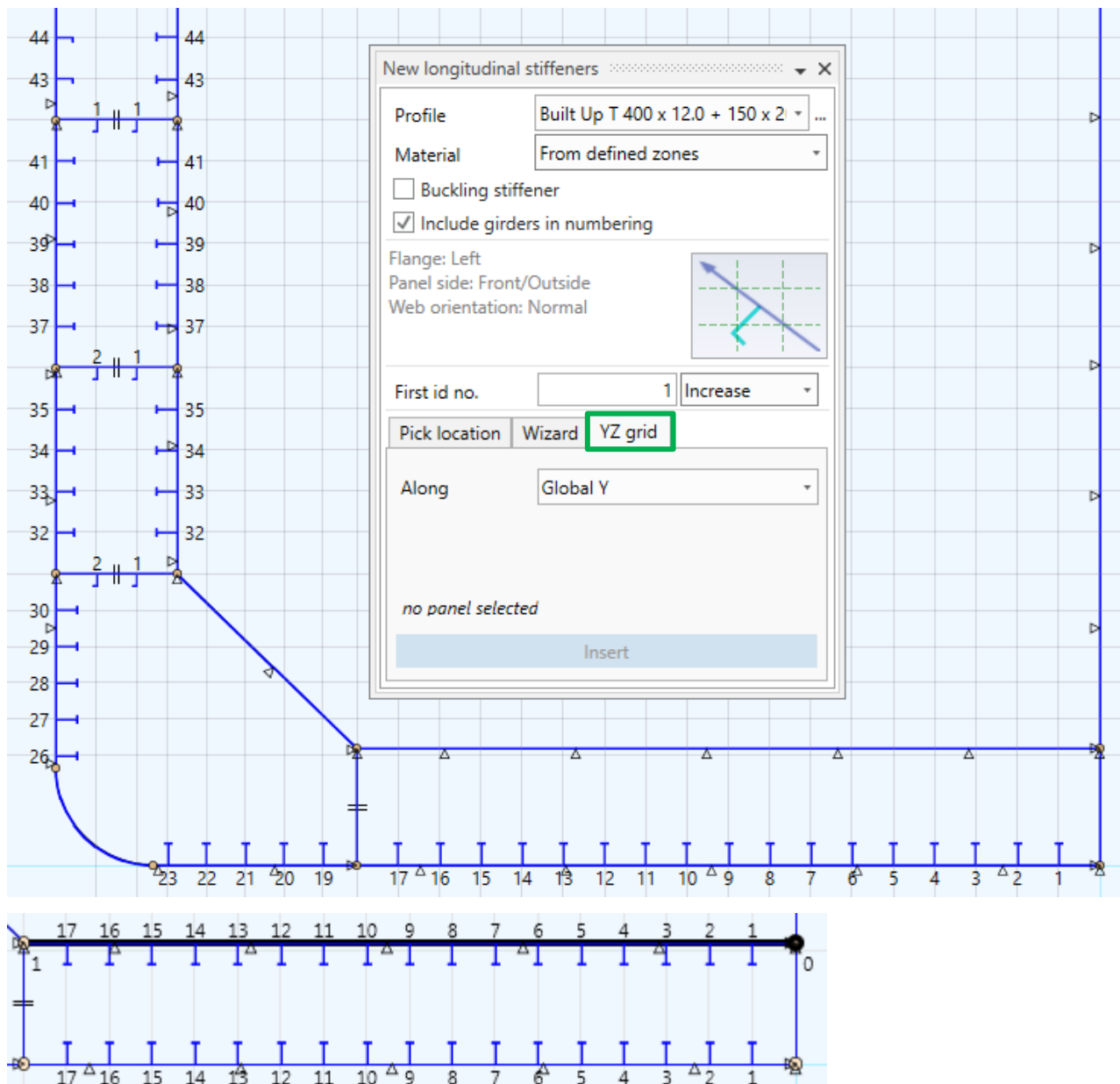
Similarly, define two stiffeners on each of the stringers:



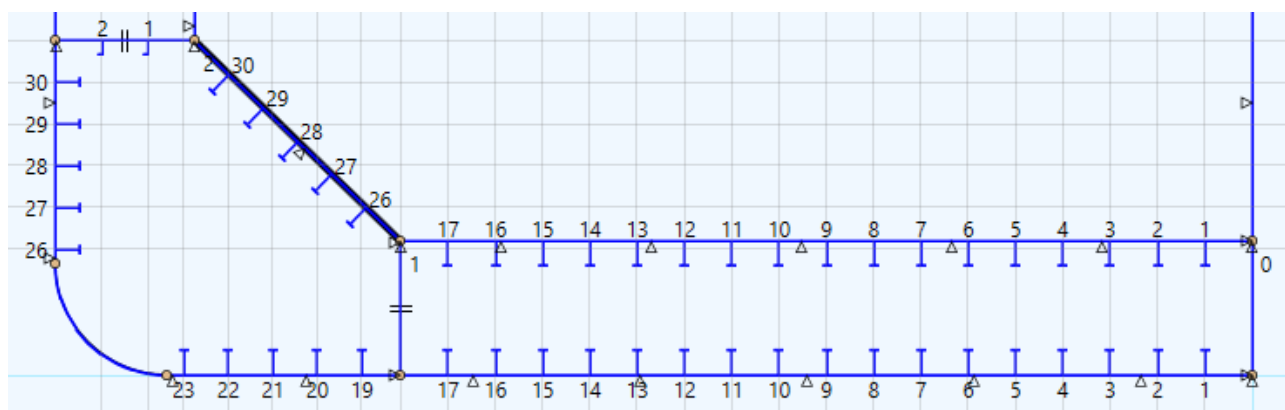
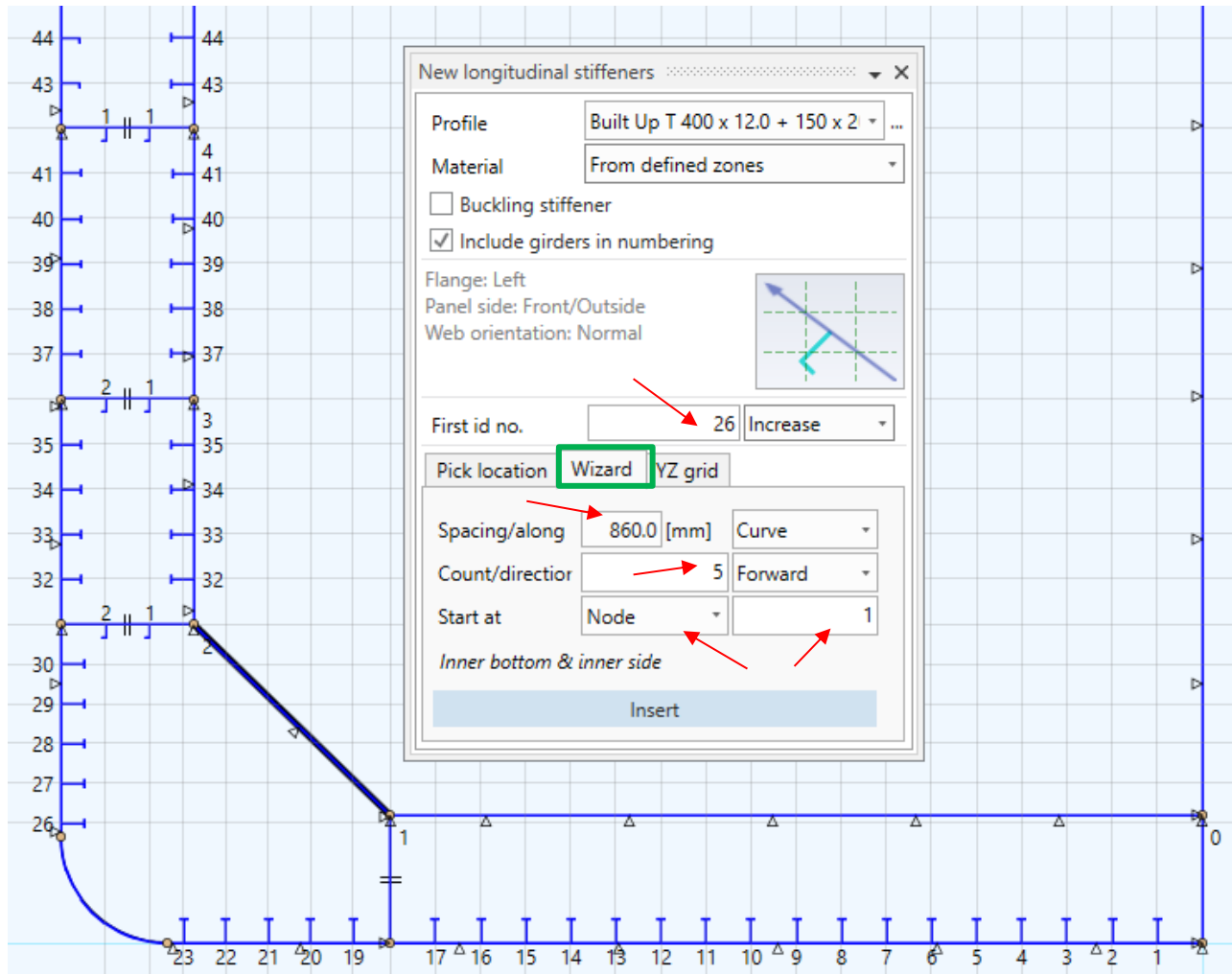


7.5.5 Inner bottom and hopper tank top

For the inner bottom segment, use the YZ-grid approach:

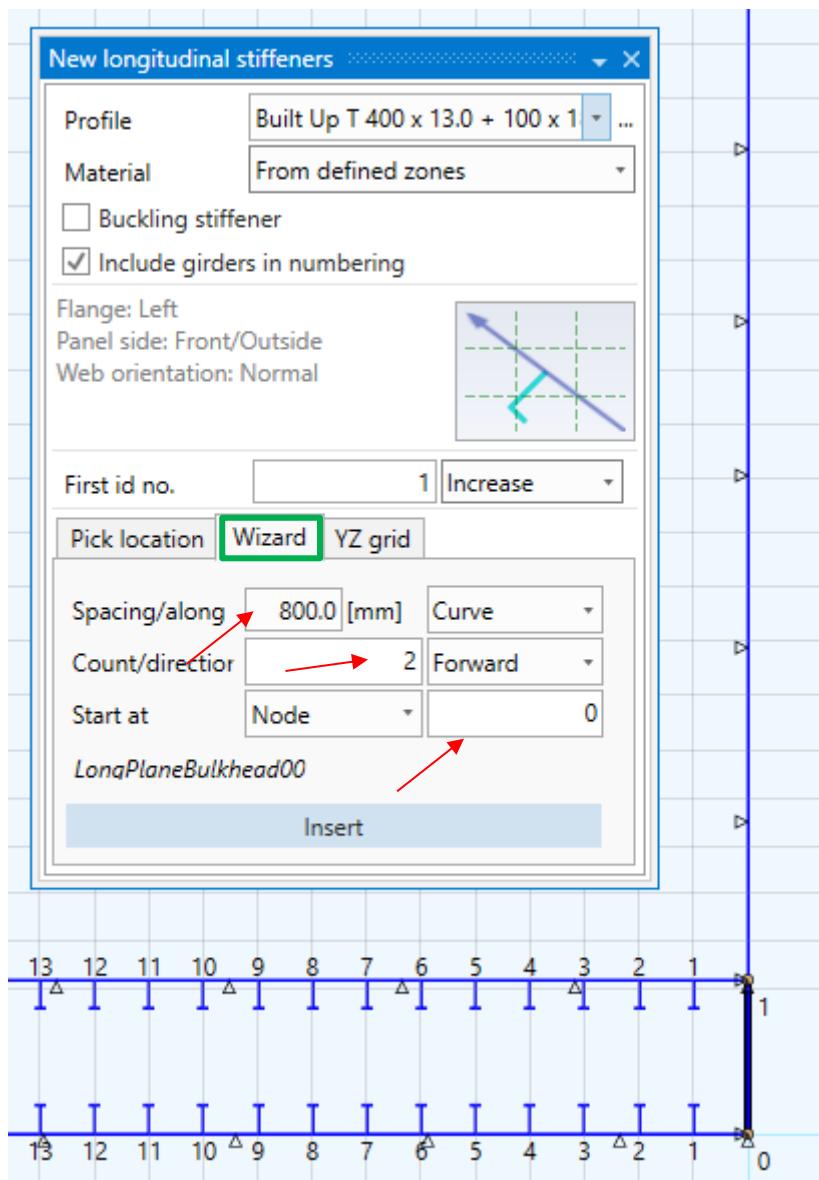


Continue with hopper tank:

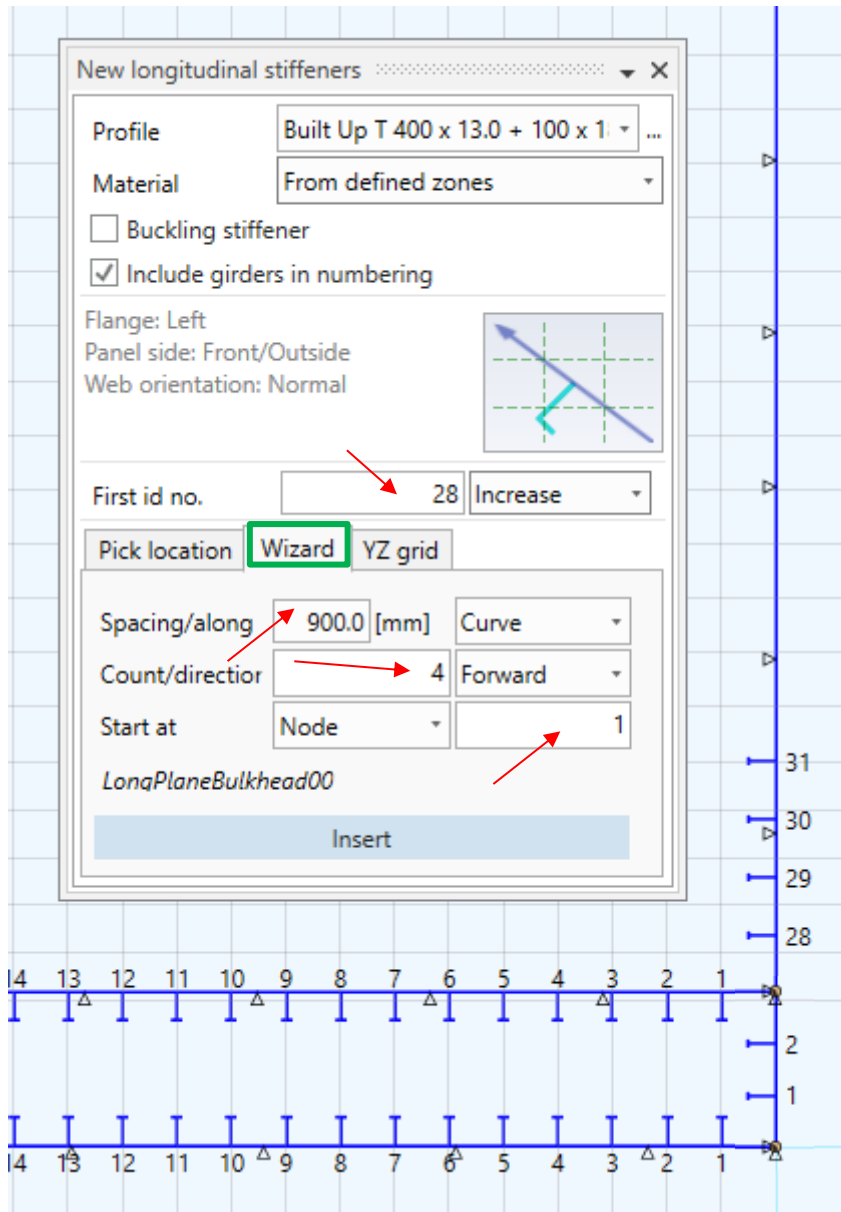


7.5.6 Longitudinal bulkhead

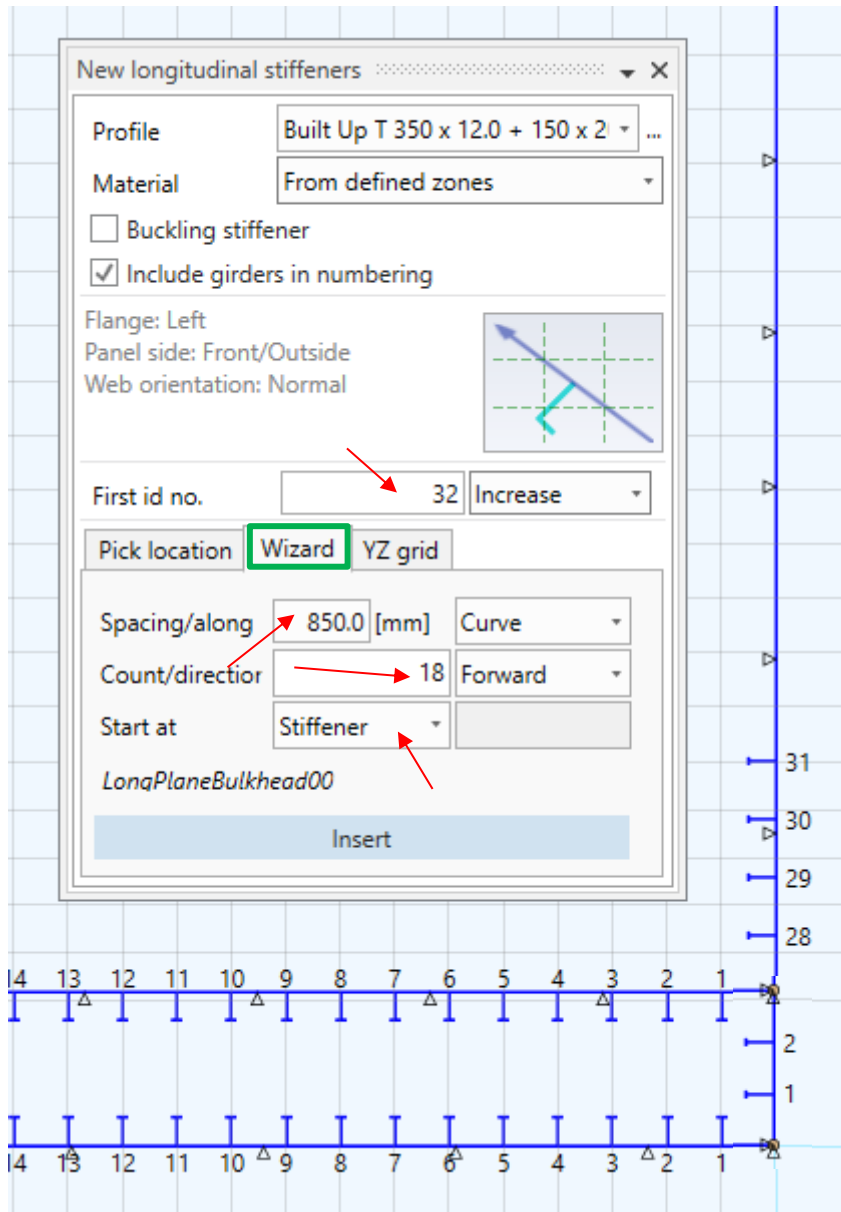
Below inner bottom:



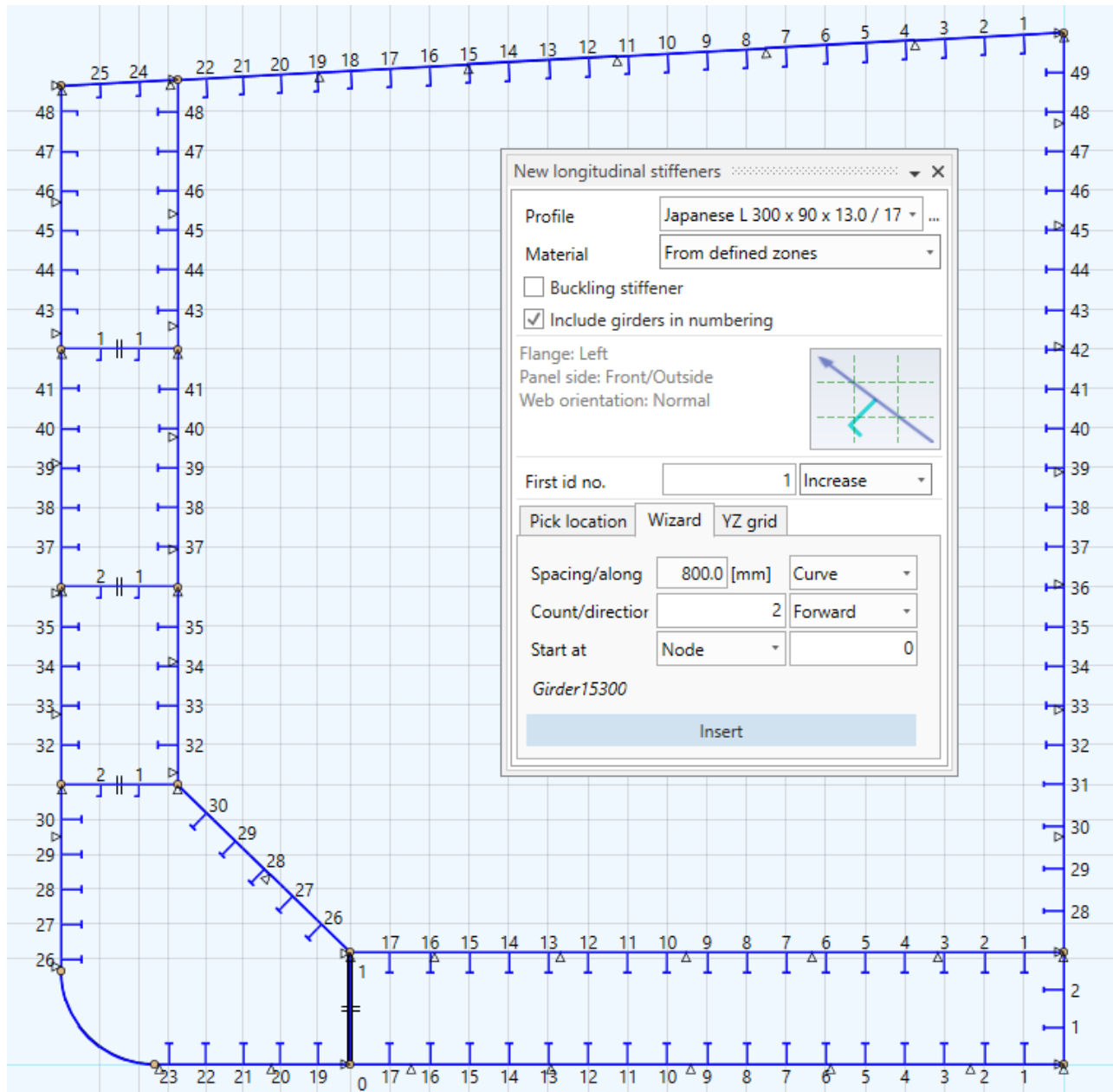
Lower four stiffeners above inner bottom, spacing 900:



Remaining stiffeners. Spacing 850, Start at Stiffener:

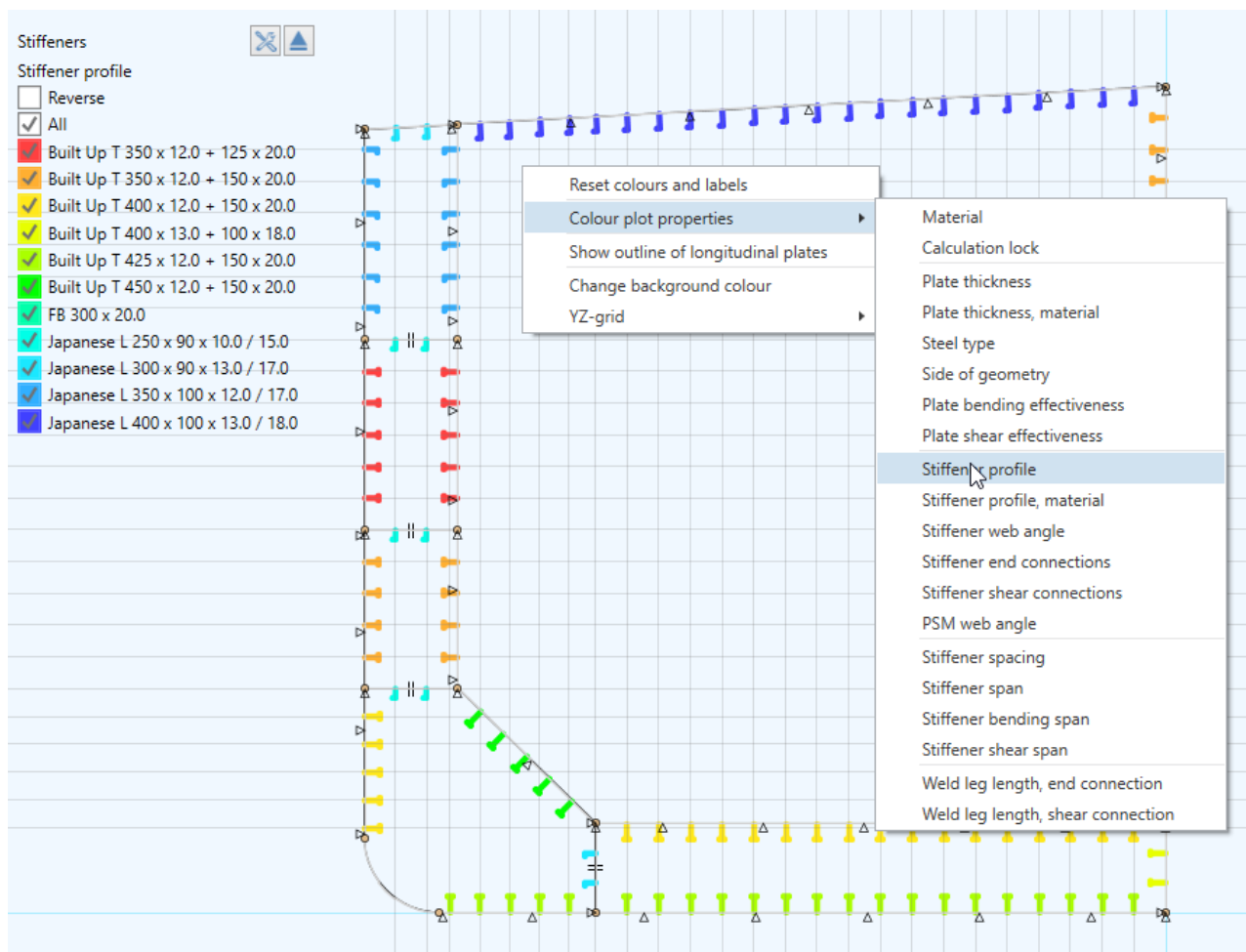


Finally, insert the stiffeners at the margin girder:



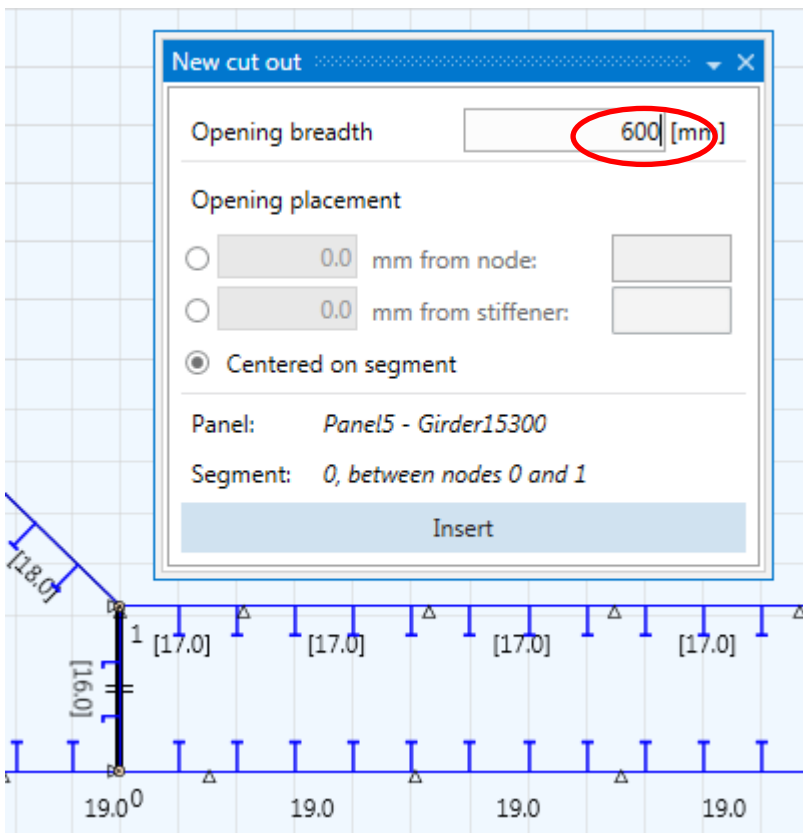
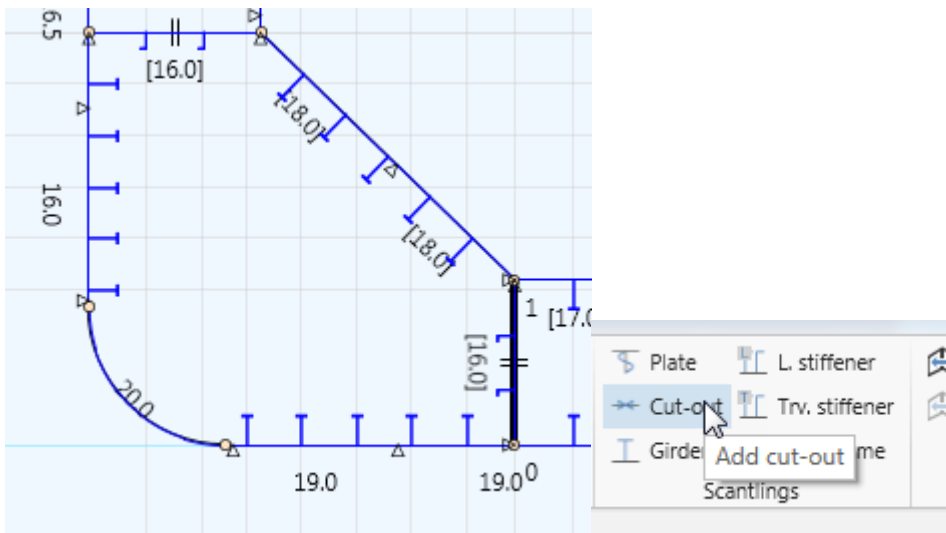
7.5.7 Verify modelled stiffeners

Layout of longitudinals completed, you may chose to show a color plot of the applied profiles. Note that the viewing of labels for longitudinal stiffeners is turned off in this picture:

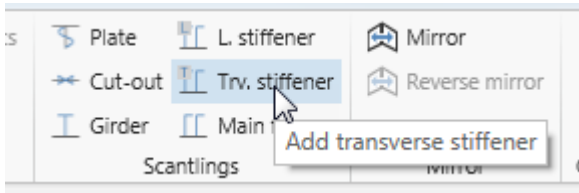


7.6 Openings (cut-outs)

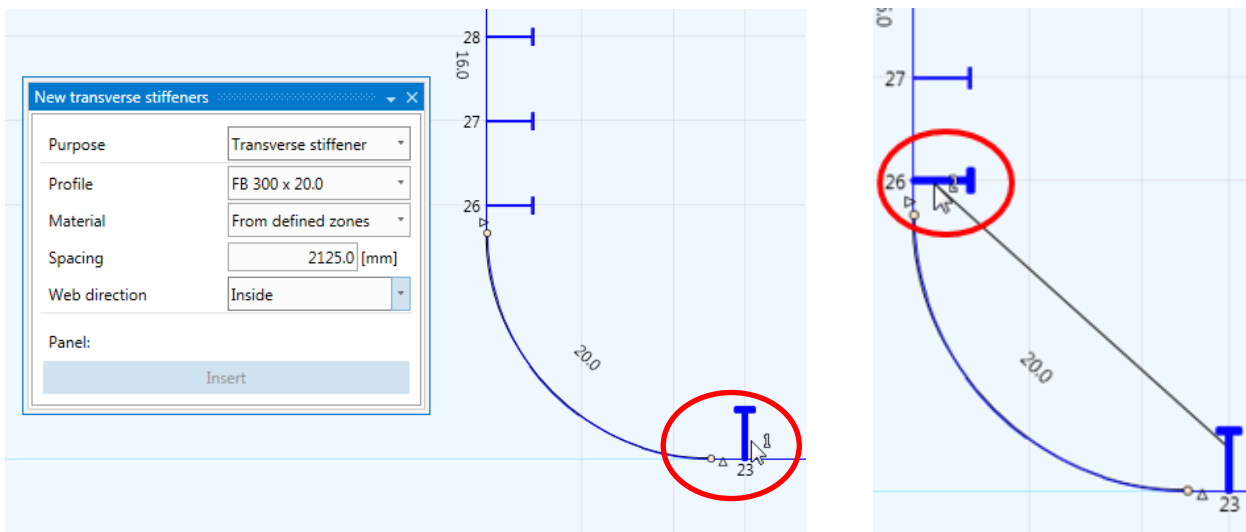
Even though the segment defined as non-watertight will ensure proper compartment definition, define inspection openings in the margin girder and stringers.



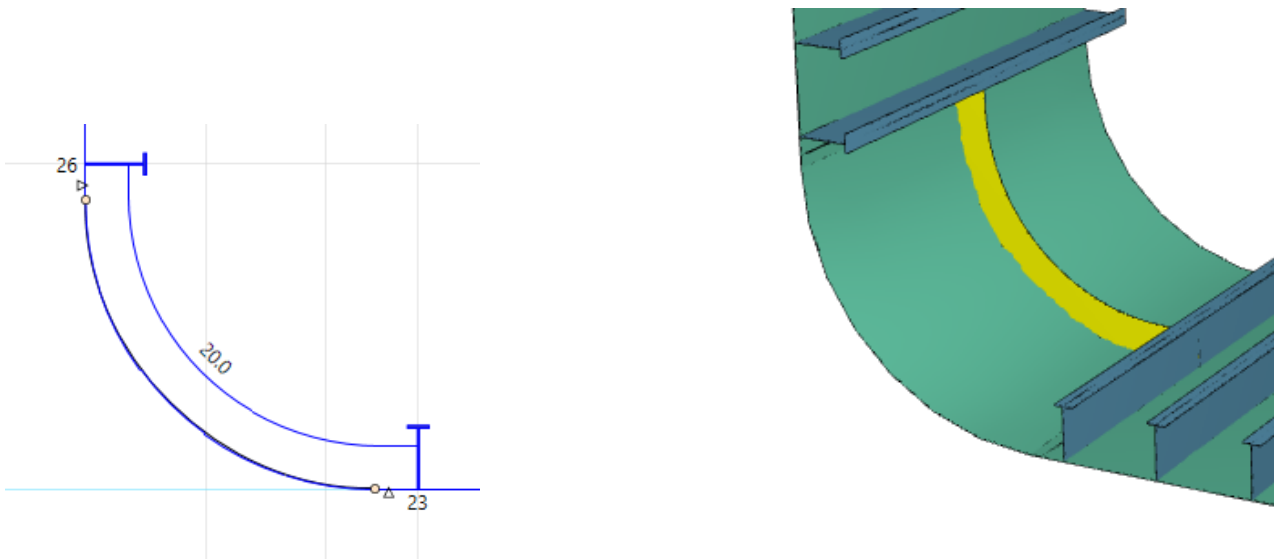
7.7 Transverse stiffener in bilge



Specify **FB 300x20** and **spacing 2125**:

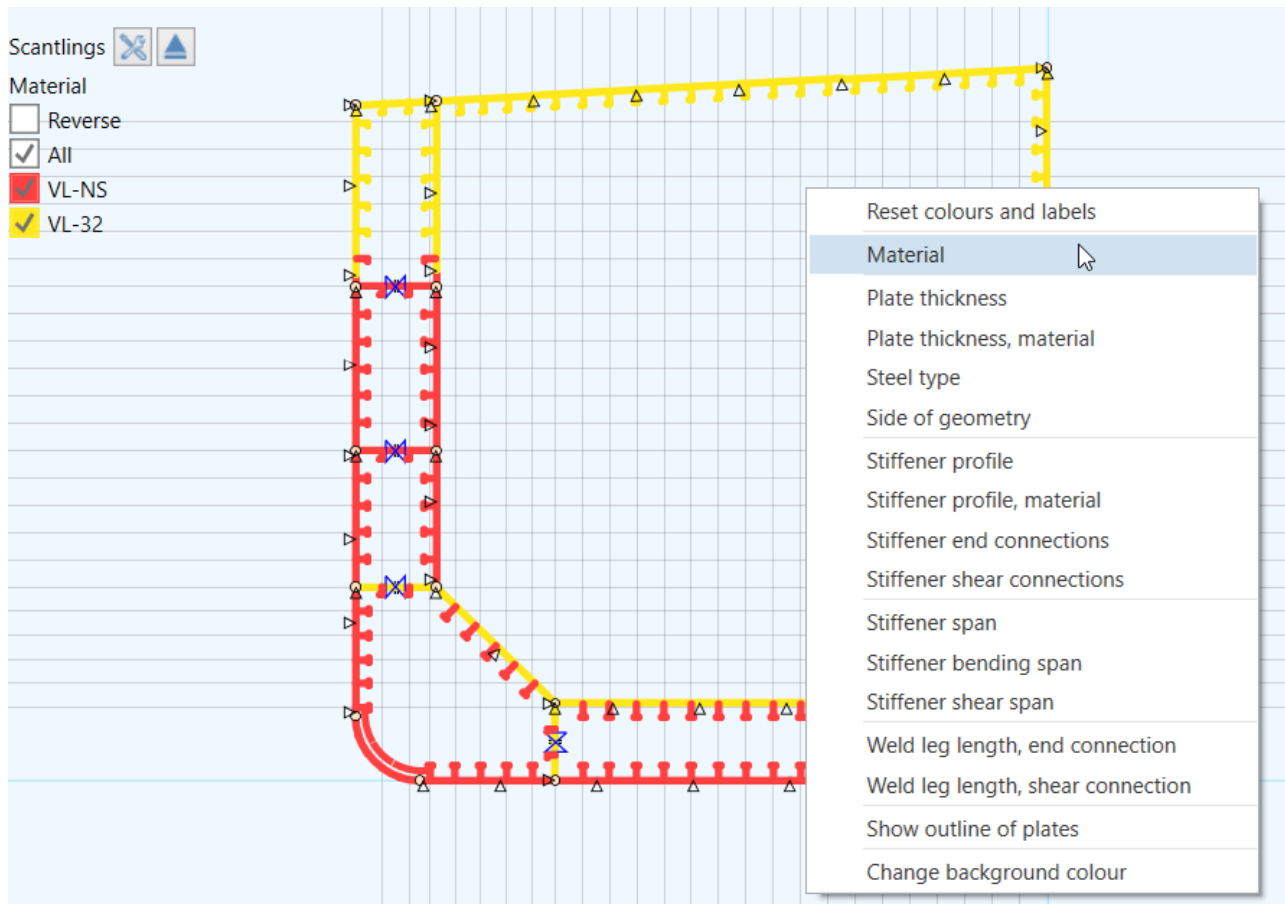


Ignore the Insert button, click 1st and 2nd point to establish start- and end of stiffener. Pay attention to the indication at the cursor.



7.8 Completed structure

Completed structure, here shown with material color plot:



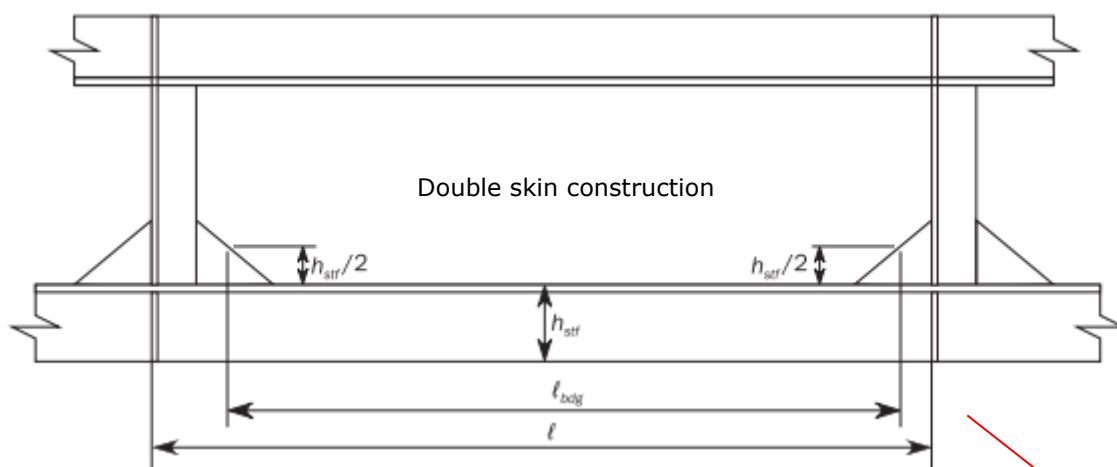
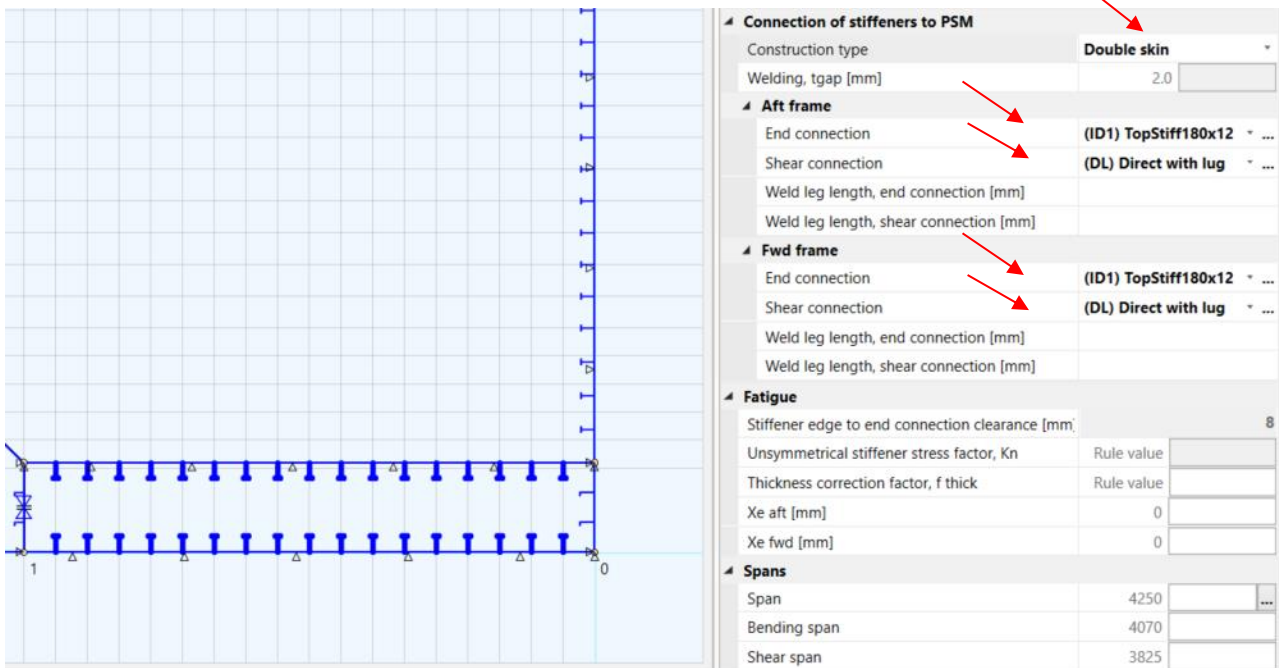
7.9 Apply end connection details

Check that the selection of plates and segments is turned off:



For this vessel, longitudinals in double bottom are connected to the floors with a top stiffener. Shear connection detail is 'direct with lug'. Select stiffeners and apply end connection and shear connection details.

Select **Double skin** as the construction type.

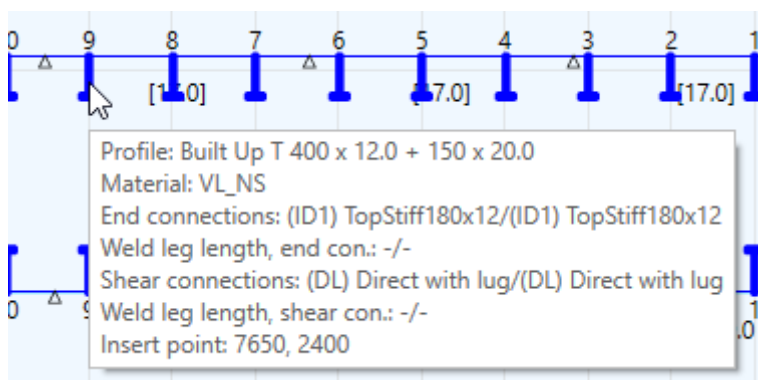
Connection of stiffeners to PSM	
Construction type	Double skin
Welding, tgap [mm]	2.0
Aft frame	
End connection	(ID1) TopStiff180x12
Shear connection	(DL) Direct with lug
Weld leg length, end connection [mm]	
Weld leg length, shear connection [mm]	
Fwd frame	
End connection	(ID1) TopStiff180x12
Shear connection	(DL) Direct with lug
Weld leg length, end connection [mm]	
Weld leg length, shear connection [mm]	
Fatigue	
Stiffener edge to end connection clearance [mm]	8
Unsymmetrical stiffener stress factor, Kn	Rule value
Thickness correction factor, f thick	Rule value
Xe aft [mm]	0
Xe fwd [mm]	0
Spans	
Span	4250
Bending span	4070
Shear span	3825

You may inspect the definition of the end-connection by clicking the '...' button. The spans are recalculated according the rules.

Fwd frame		
End connection	(ID1) TopStiff180x12	...
Shear connection	(DL) Direct with lug	...
Weld leg length, end conne		
Weld leg length, shear con		

Inspect, edit or define new end-connection or shear connection detail.

The applied details are shown in the tooltip for each stiffener:



The **weld leg length** for direct and shear connections can be left empty. During calculation of end connection strength, any values given here are compared with the results from the calculation and status OK/Not OK is based on this comparison.

Leave the parameters related to **fatigue** as is. For an explanation of the different parameters, please refer to CSR BC&OT Pt.1. Ch.9 Sec.3.

Fatigue		
Stiffener edge to end connection clearance [mm]		8
Unsymmetrical stiffener stress factor, Kn	Rule value	
Thickness correction factor, f thick	Rule value	
Xe aft [mm]	0	
Xe fwd [mm]	0	

Spans are calculated according to the applied end connection detail and construction type:

Spans		
Span	4250	...
Bending span	4070	
Shear span	3825	

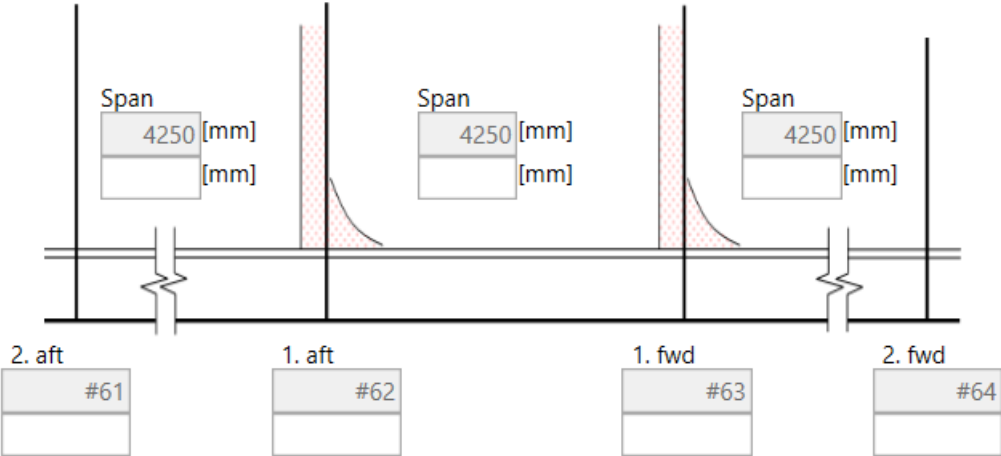
Span is taken from the cross-section, distance between 1st and 1st forward.

All spans may be overridden. When modifying Span, the bending span and shear span will use the override value as basis, **unless they also are overridden**.

Spans for individual stiffeners may be modified:

4250	
4070	
3825	

PSM Positions



Span

4250 [mm]

[mm]

Span

4250 [mm]

[mm]

Span

4250 [mm]

[mm]

2. aft

#61

1. aft

#62

1. fwd

#63

2. fwd

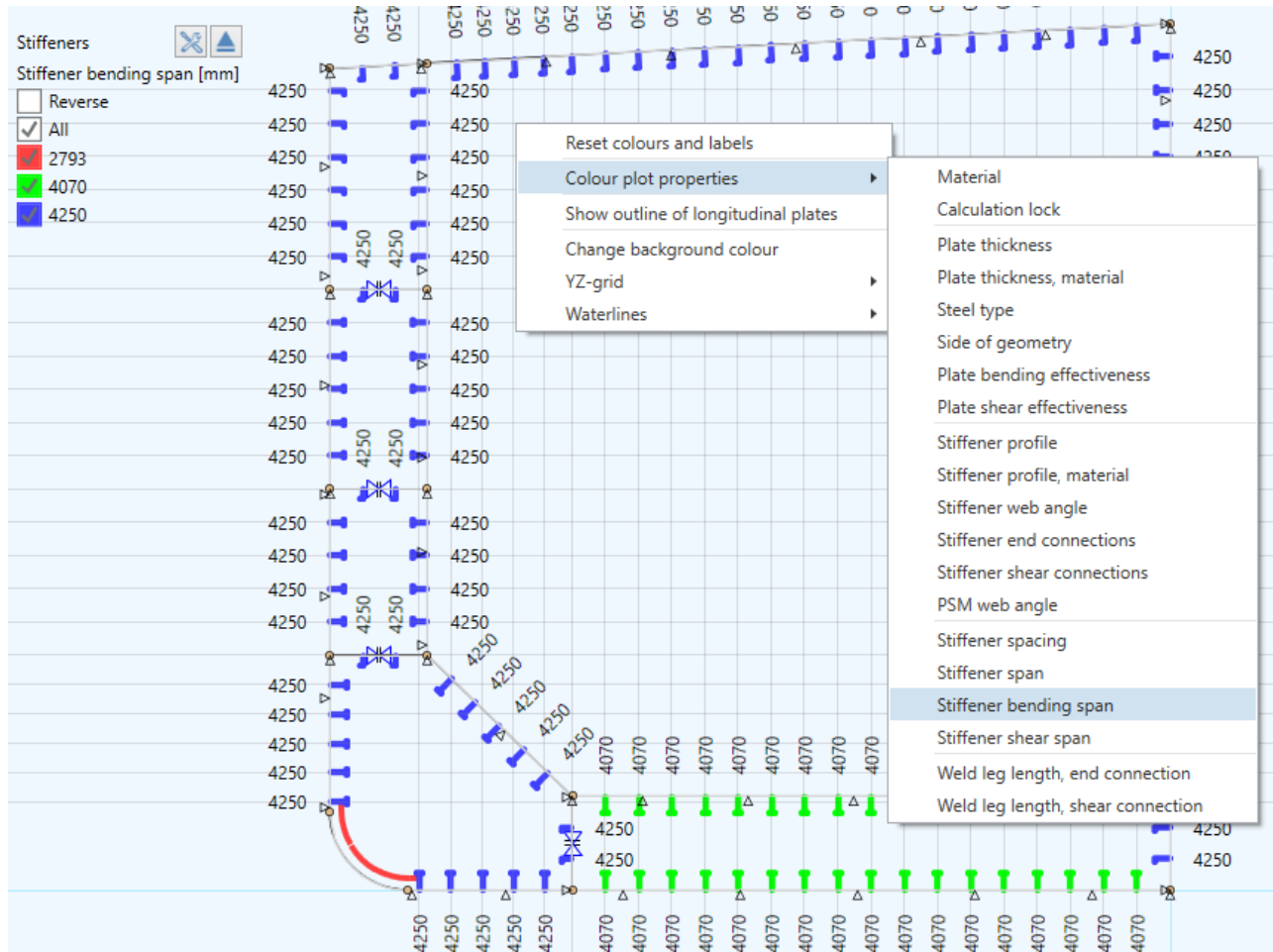
#64

Ok

Cancel

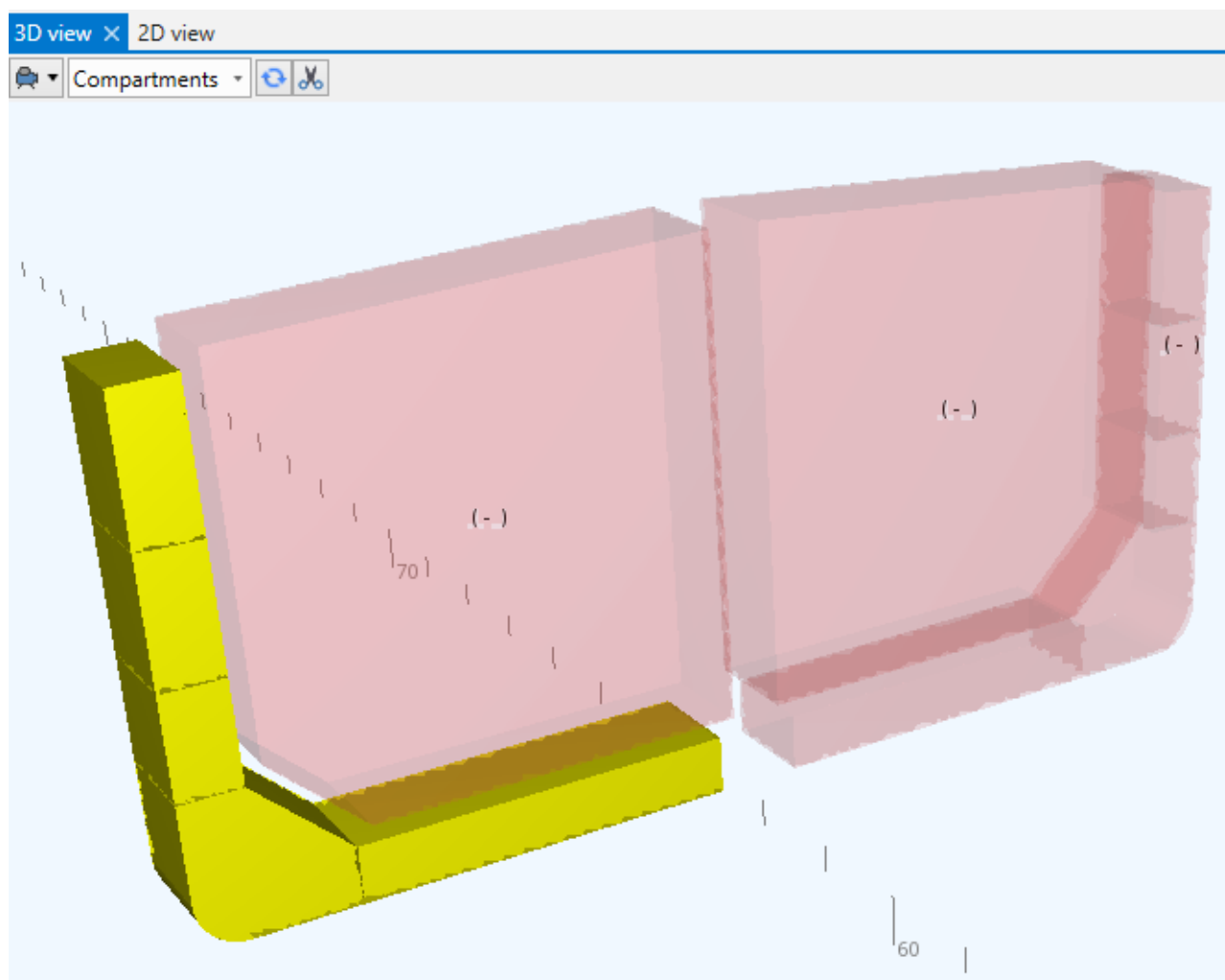
7.9.1 Verify bending spans

To verify the actual bending spans, considering applied end connection, you may chose **Stiffener bending span** from the context menu. Similar for the **span** (i.e. the distance between PSMs) and **shear span**:



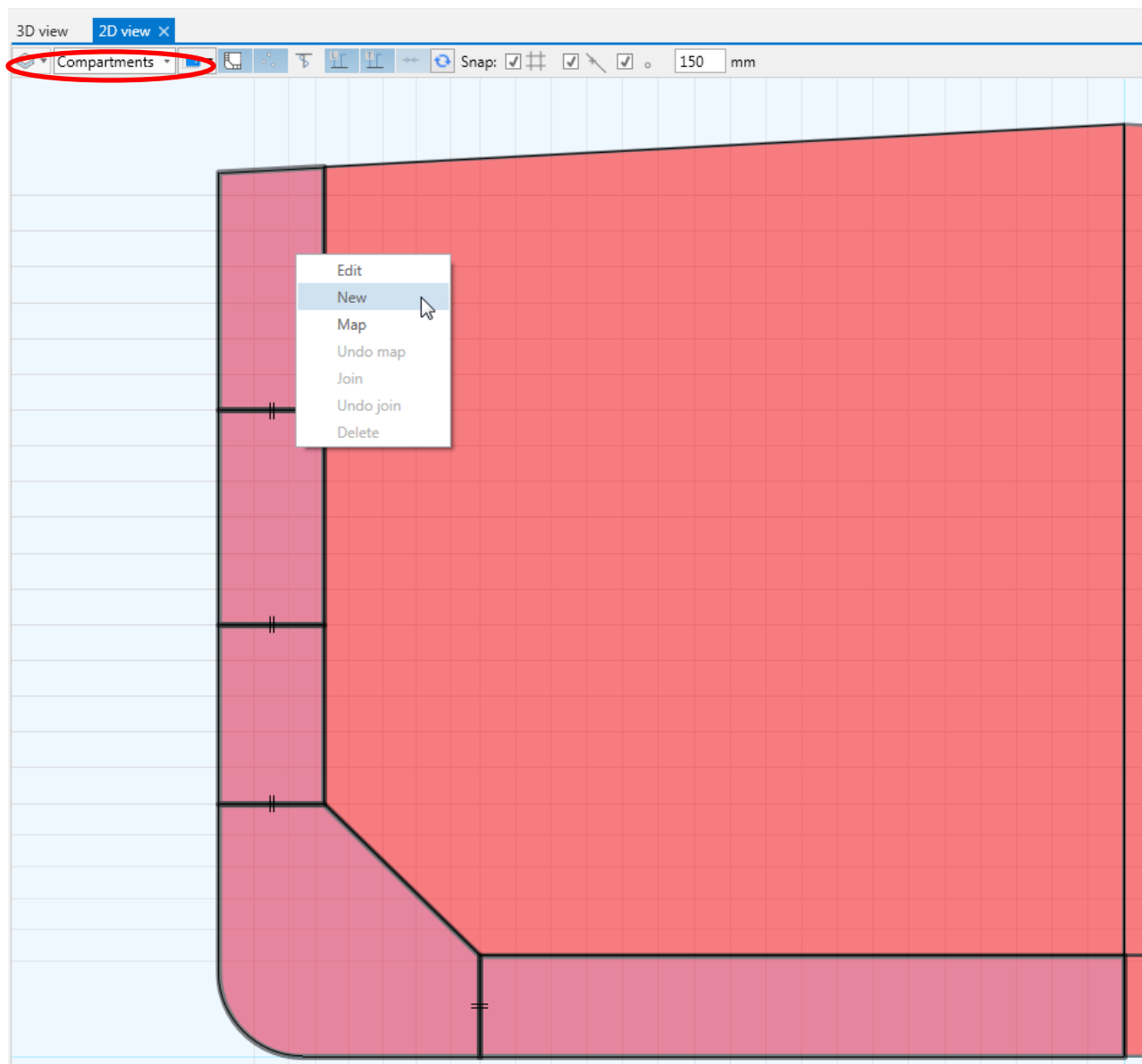
7.10 Compartments and loads

Compartment topology (cells) is defined on-the-fly in a background process as you approach with the panel definition.

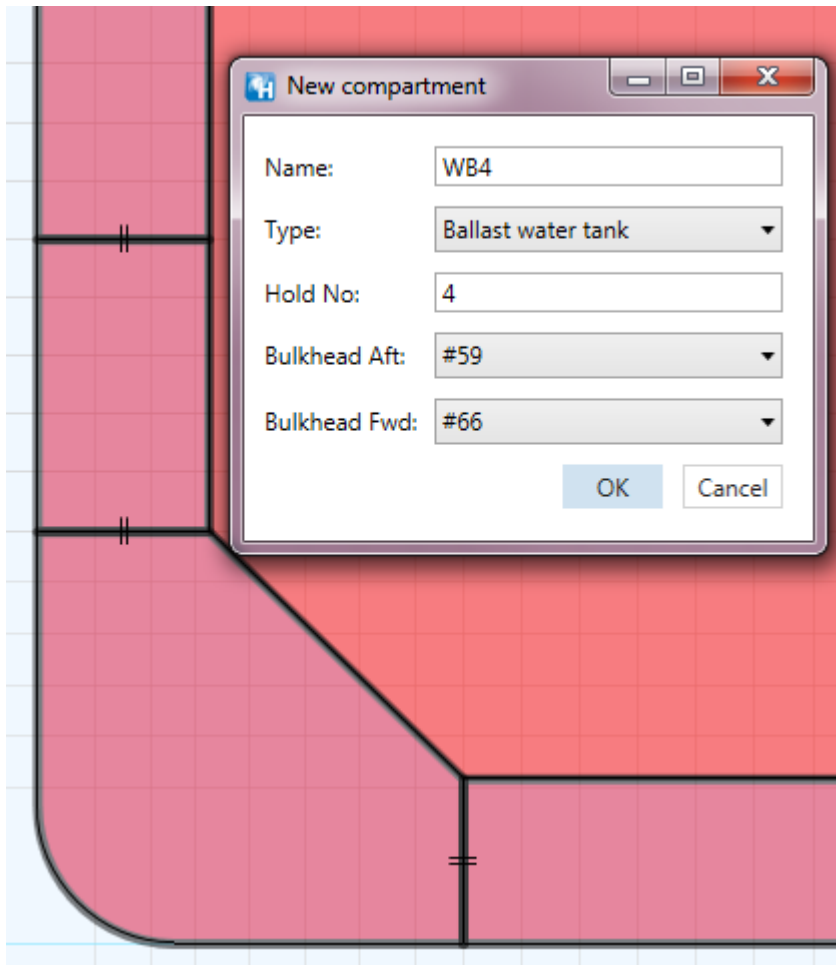


Initially, the compartments does not have any parameters assigned (indicated by the red color). Parameters have to be defined on the compartments before they can be used in any calculations.

In 2D view, select view mode **Compartments**. Initially, the cells do not have any data that defines them as a compartment. To assign the compartment concept to a cell, select the cell and chose **New** from the context menu.



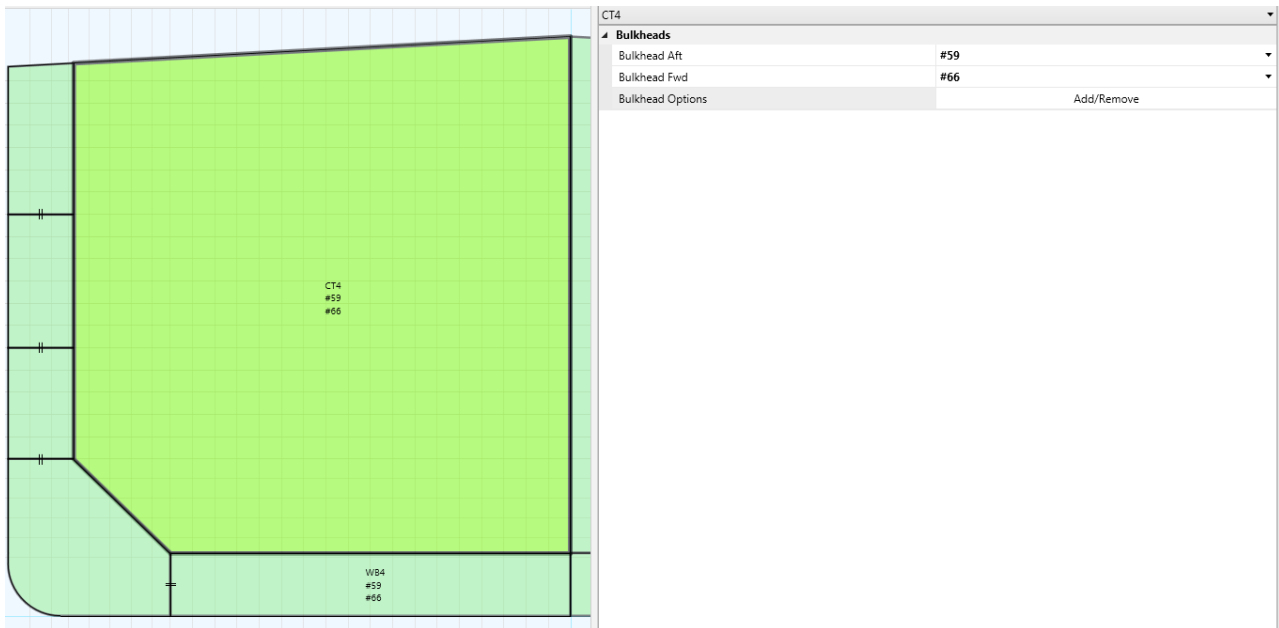
Specify name **WB4**, hold no **4**. The Hold no. is used in FE cargo hold analyses.



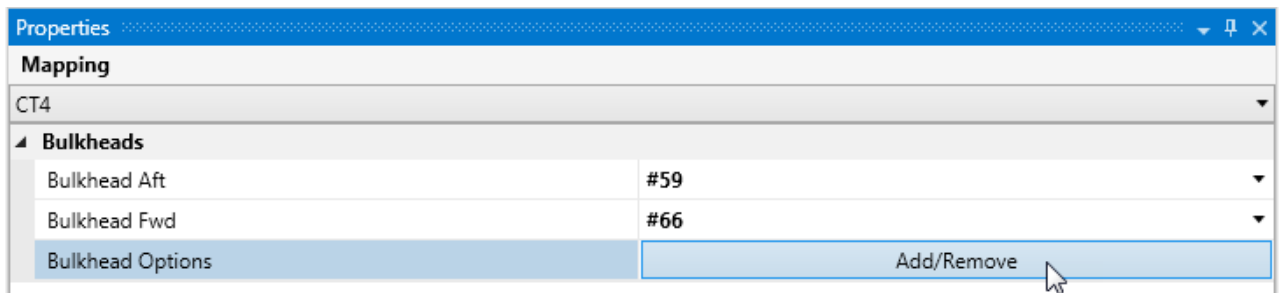
Bulkhead aft and forward is taken from the **Main structural arrangement** and the aft- and forward positions nearest to the current cross-section position is chosen by default. This can be changed from the drop-down list of available positions.

Repeat for cargo tank, specify name **CT4**, hold no **4**.

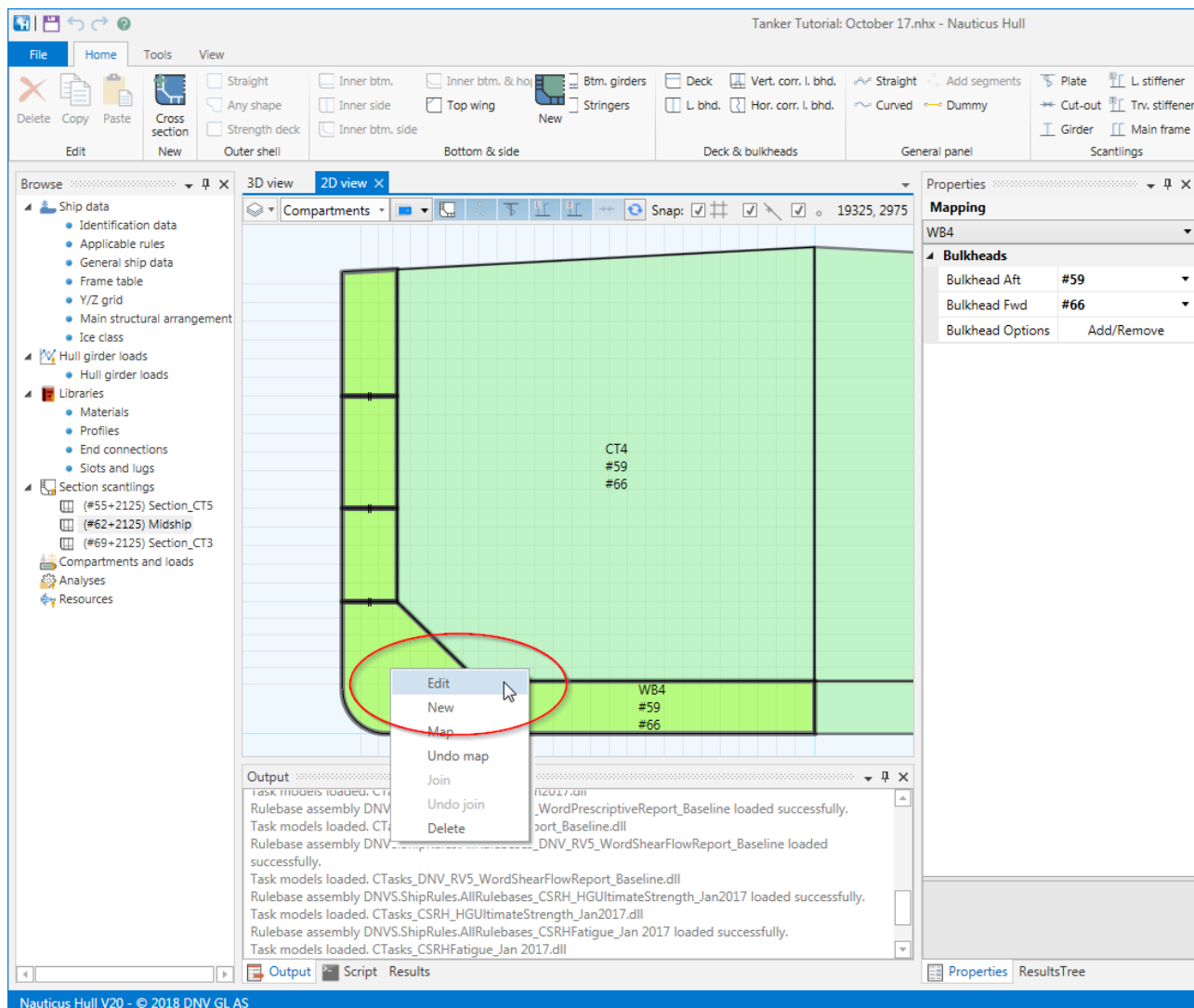
Positions for aft and forward compartment boundaries can be modified from compartment property window:



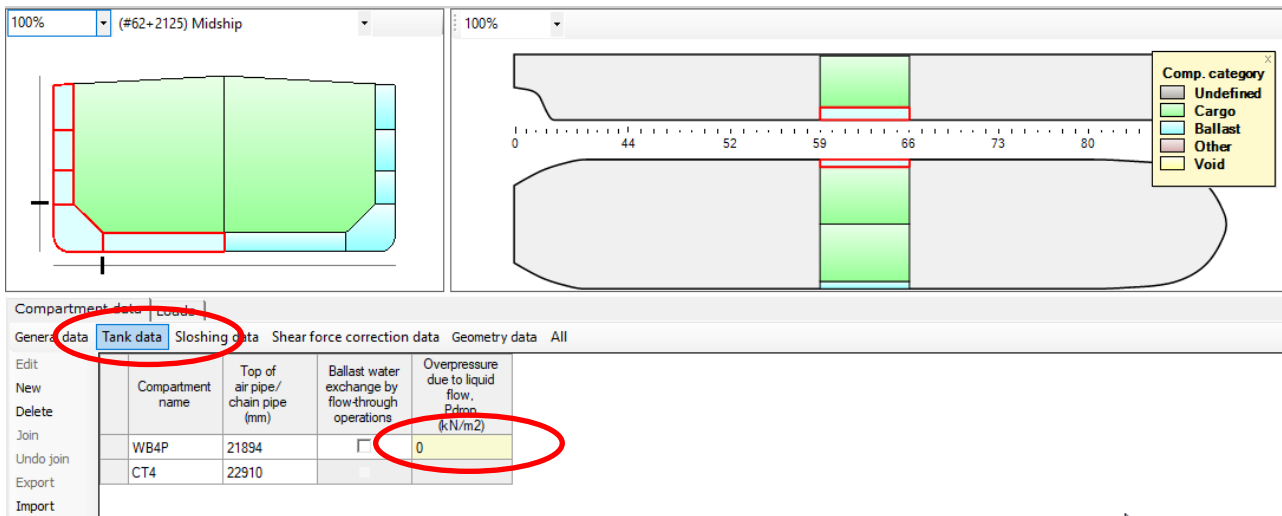
You may add positions directly from the compartment property window, alternatively modify the definition of Main structural arrangement in Ship data.



For a correct rule load application please activate tank WB4 and make a right mouse click on it. Choose **Edit** from context menu:



This will launch the following **Edit Compartments and Loads** mask where we switch to the **Tank data** immediately. The value for the **Overpressure due to liquid flow, Pdrop (kN/m2)** has to be changed for this design to 0. See below picture.



Compartment data | Loads |

General data | **Tank data** | Sloshing data | Shear force correction data | Geometry data | All

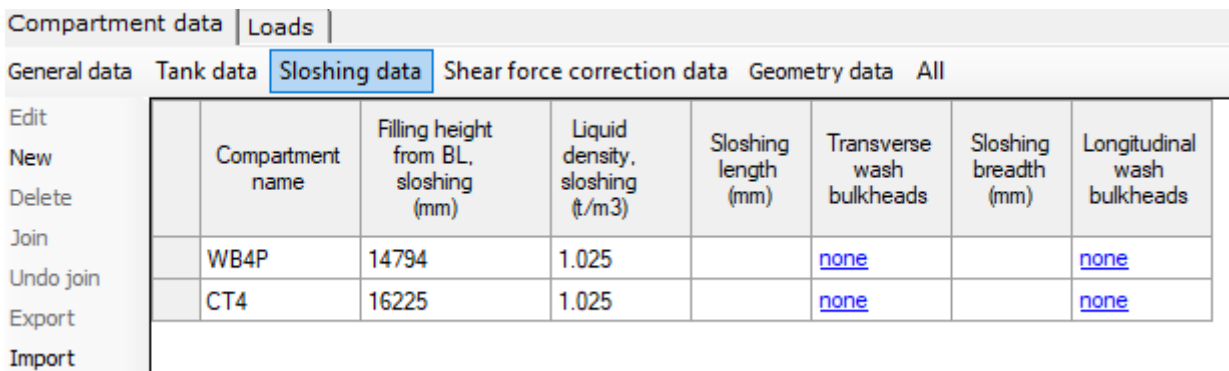
Edit	Compartment name	Top of air pipe/chain pipe (mm)	Ballast water exchange by flow-through operations	Overpressure due to liquid flow, Pslon (kN/m2)
New	WB4P	21894	☐	0
Delete	CT4	22910	☐	
Join				
Undo join				
Export				
Import				

7.10.1 Sloshing data

If no sloshing lengths or breadths are specified, the **minimum sloshing pressures are applied**.

For cargo tanks, this minimum pressure (20 kN/m²) is likely to be far below the actual sloshing pressure. To be on the conservative side, specify actual tank length and breadth for the cargo tanks. Minimum sloshing lengths and breadths can be determined according to CSR BC&OT Pt.1 Ch.4 Sec.6.

Typical sloshing length for waterballast tanks is the distance between webframes. Minimum sloshing pressure for such double hull construction with internal structures is 12 kN/m².



Compartment data | Loads |

General data | Tank data | **Sloshing data** | Shear force correction data | Geometry data | All

Edit	Compartment name	Filling height from BL, sloshing (mm)	Liquid density, sloshing (t/m ³)	Sloshing length (mm)	Transverse wash bulkheads	Sloshing breadth (mm)	Longitudinal wash bulkheads
New	WB4P	14794	1.025		none		none
Delete	CT4	16225	1.025		none		none
Join							
Undo join							
Export							
Import							

7.10.2 Shear force correction data (CSR Oil Tankers)

According to CSR BC&OT Pt.1 Ch.5 Sec.1 [3.4], the effective net thickness for longitudinal bulkheads between cargo tanks shall be **corrected for loads from double bottom**. To provide sufficient information for this check, as the floors are not modelled, number of floors between transverse bulkheads shall to be given. This vessel has **6 floors** within cargo tank no 4.

Further, when the hold is not prismatic, breadth at midlength of cargo tanks and volume inboard from inner side for water ballast tanks shall be given to establish necessary data for shear force correction calculation. Please refer to the rules for detiled information.

Compartment data		Loads		
General data		Tank data	Sloshing data	Shear force correction data
Edit				
New				
Delete				
Join				
Undo join				
Export				
	Compartment name	Number of floors	Breadth at midlength of tank (m)	Volume inboard from inner side (m3)
	WB4			
	CT4P	6		

3.4.3 Shear force correction for a ship with a centreline longitudinal bulkhead

For ships with a centreline longitudinal bulkhead, the shear force correction in way of transverse bulkhead, δQ_3 , in kN, is to be obtained from the following formula:

$$\delta Q_3 = 0.5 K_3 F_{db}$$

where:

F_{db} : Maximum resulting force on the double bottom in a tank, in kN, as defined in [3.4.5].

K_3 : Correction factor, to be taken equal to:

$$K_3 = 0.4 \cdot \left(1 - \frac{1}{1+n} \right) - f_3$$

n : Number of floors between transverse bulkheads.

f_3 : Shear force distribution factor, as defined in Table 7.

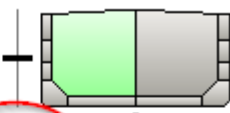
7.10.3 Loading conditions

In the **Loads tab**, create **standard prescriptive loads** and **fatigue loads**.

We are able to adjust the densities and/or the Pressure Valve Setting. Inspect the prescriptive and fatigue loading conditions and assigned compartments through clicking the different loading conditions.

Edit Compartments and Loads

100%
(#62+2125) Midship
100%



Compartment data
Loads

Prescriptive loads
Flooding loads
Fatigue loads

Prescriptive loading conditions

Create standard
Create new
Edit
Duplicate
Delete
Reset sorting

Name	Condition	Draught (m)	Kr (m)	GM (m)
Full load	Full load	15	15.05	5.16
Partial load	Partial load	9	17.2	10.32
Ballast	Ballast	6.5	19.35	14.19

Compartment loads
Deck loads
Loading condition: **Full load**

Create standard
Create new
Edit
Delete
Reset sorting

Compartment name	Load type	Density (t/m3)	Filling height from BL (mm)	Pressure valve setting (kN/m2)
CT4	Oil cargo	1.025	22150	25

The activated loading condition shows the linked compartment. Default parameters are provided, however this should of course be inspected and modified according to design if needed.

Inspect the different loading conditions to confirm that all is OK. Close the Compartment and Load tool.

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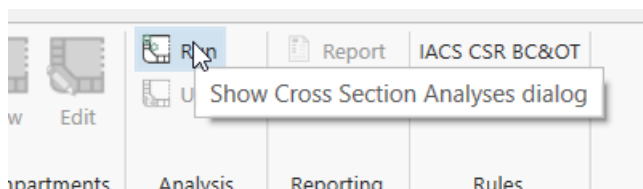
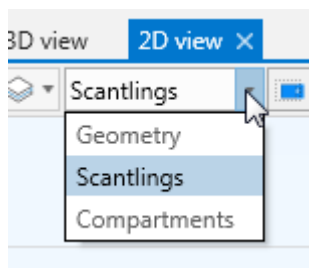
8 Cross-section analysis

Cross-section analysis is carried out for the currently selected cross-section.

Cross-section properties

8.1 Running analysis

Check that you are currently in scantlings view mode:



8.2 Analysis options

Positions	Prescriptive	HULS	Fatigue
#83+2125	☒	☐	☒
	☐	☐	☐

4 of 4 compartment cells mapped

- Prescriptive**
 - Grouping of stiffeners**
 - Apply grouping principle ☐
- Fatigue**
 - Relative displacements**
 - Relative displacements
 - Stress factors
 - Import FE result file

Calculate

Select Prescriptive and Fatigue.

For Prescriptive, the following option is available:

Apply grouping principle: Check this for applying the grouping principle for longitudinal stiffeners. This may have limited benefit for the subject cross-section. Please refer to rules Pt.1 Ch6. Sec.5 [1.1.3].

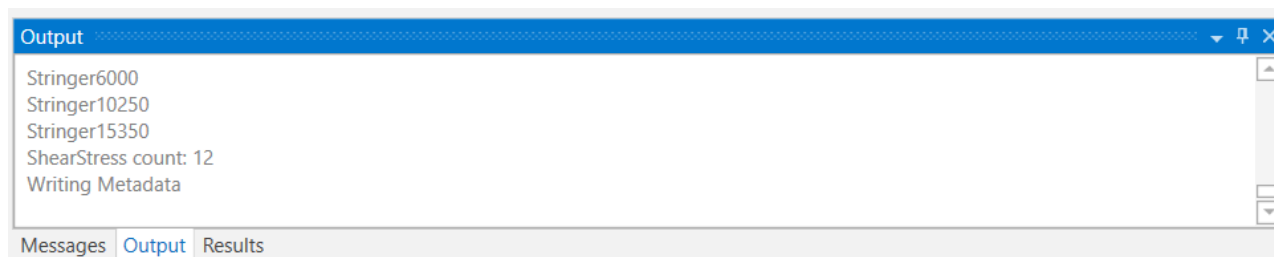
For fatigue, the following applies for consideration of relative displacement:

Blank: No relative displacements will be considered. Use this option for the current cross-section.

Stress factors: For oil tankers according to CSR BC&OT, the rules allow for use of prescriptive bending stress factors to account for relative displacements between transverse bulkhead and adjacent web frames, ref. Pt.1 Ch.9 Sec.4 [4.2.4]. This is available in the program by selecting Stress factors in the pull-down menu for Relative displacements.

Import FE result file: Relative displacements can be imported from a FE cargo hold model. This will be used to determine the additional stiffener stress component due to relative displacements between transverse bulkhead and adjacent web frame.

Press **Calculate** button. Pay attention to the **Messages** and **Output** window as this window may contain messages relevant for the cross-section analysis. Any errors or problems will be indicated here:

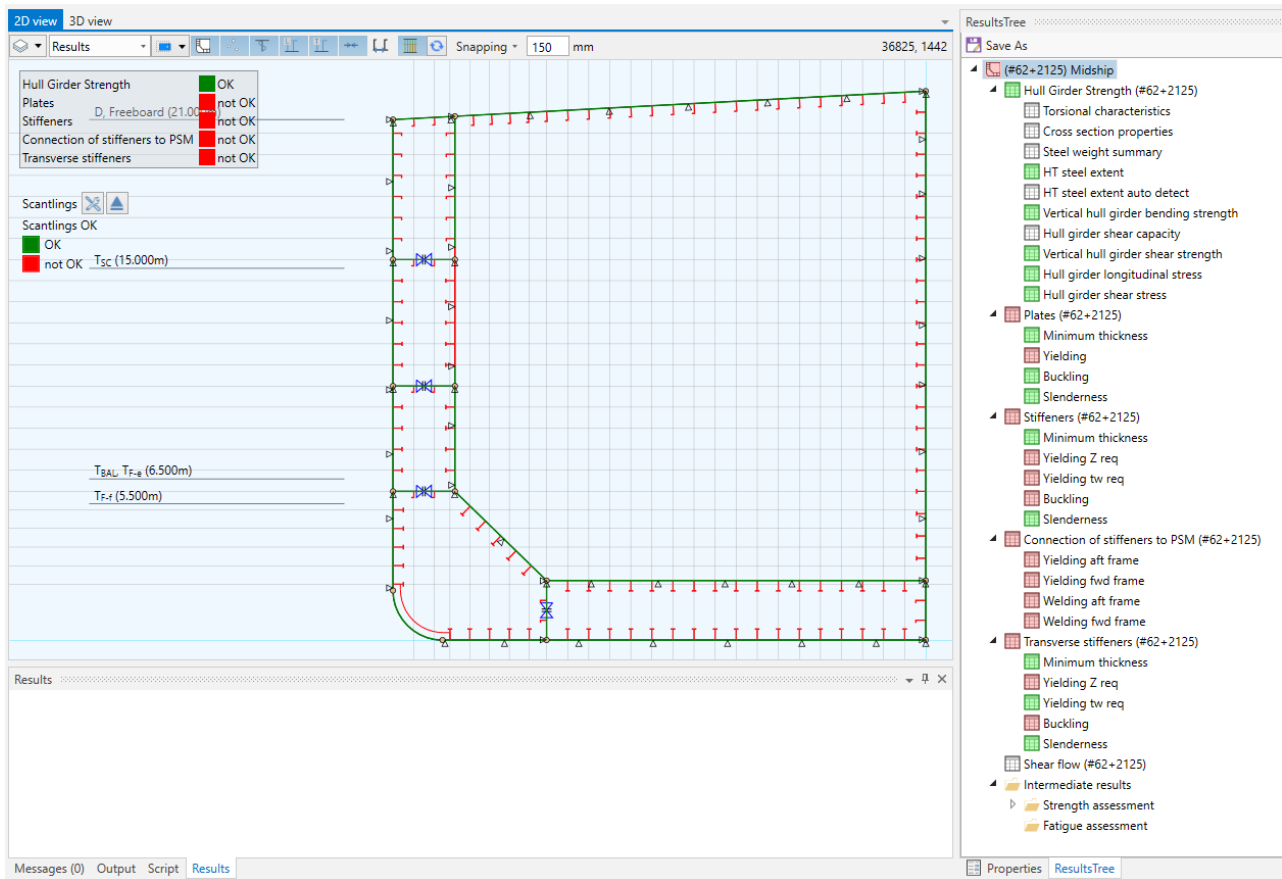


Cross-section analysis may be carried out for **several positions in the same run**, with aggregated results. This requires that these positions are inside the same compartment configuration as the modelled cross-section. See Nauticus Hull User Manual for more information.

8.3 Results - hull girder strength

When calculation is complete, the summary status of all requirements for plates will be shown.

Select the Hull Girder Strength folder to inspect the results applying to hull girder strength:



Presentation of results from the cross-section analysis is split into three main categories:

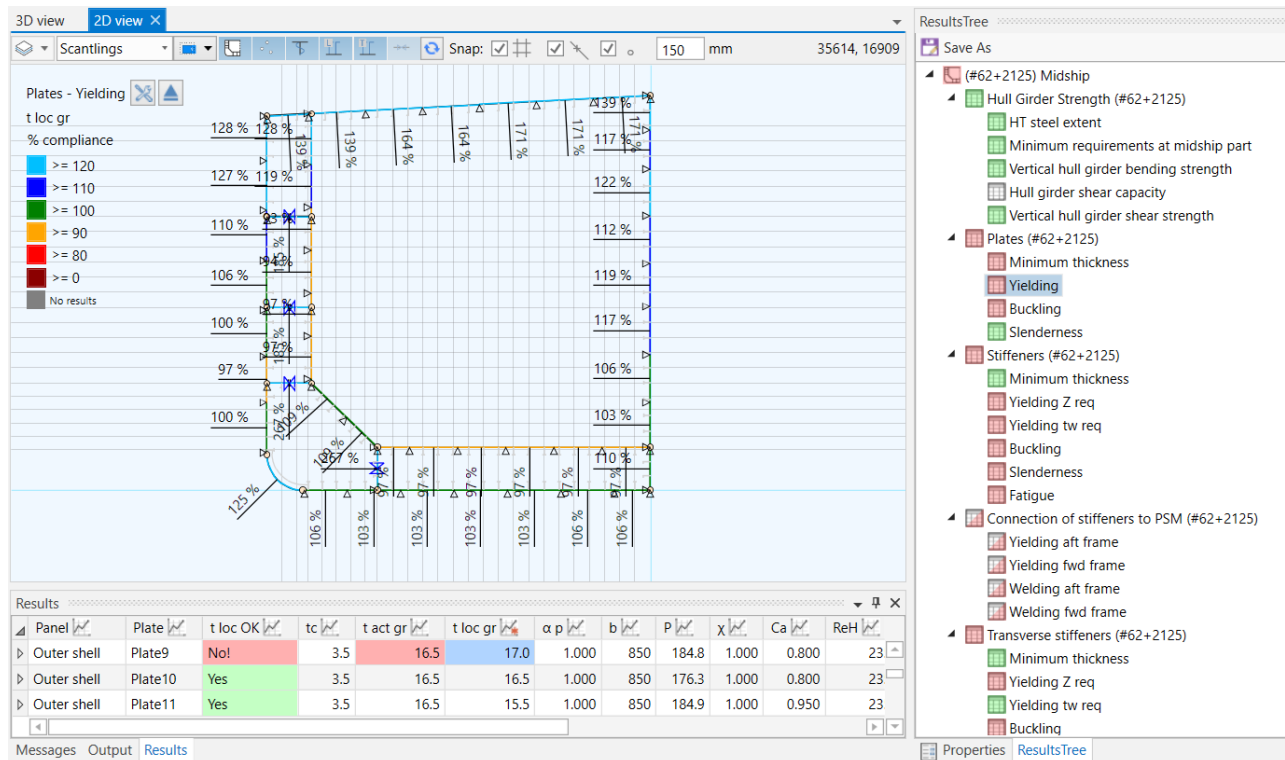
- Hull girder strength requirements
- Local requirements
- Intermediate results

8.4 Results – local requirements

Navigate in the result tree to familiarize with the different results. Results are stored temporarily in memory.

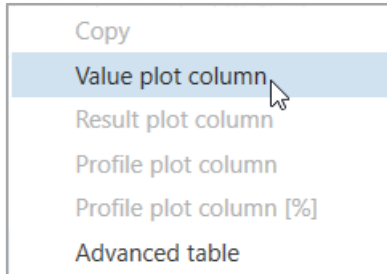
The detailed results, for instance yield check results, can be found below the Plates folder.

Select Plates | Yielding:

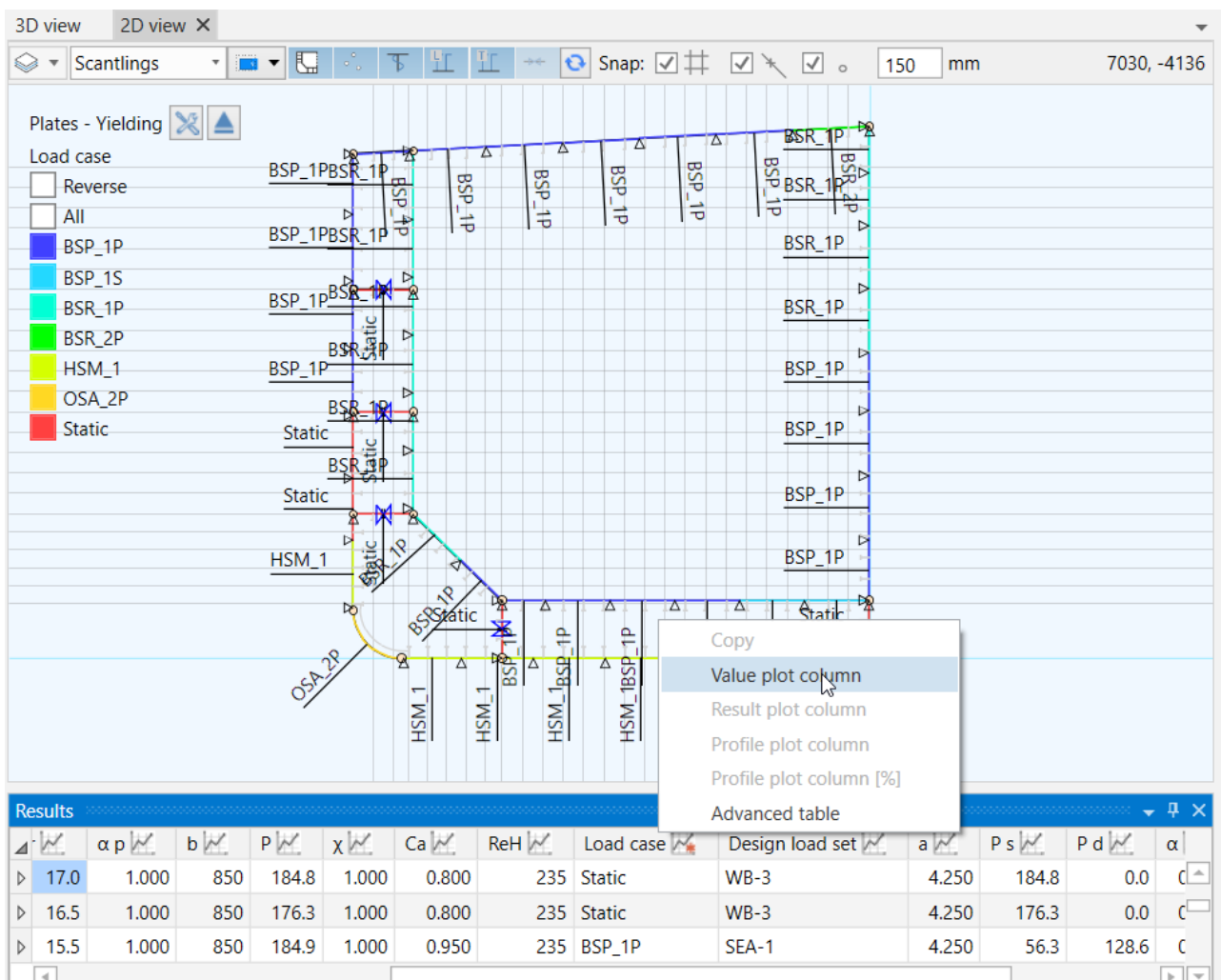


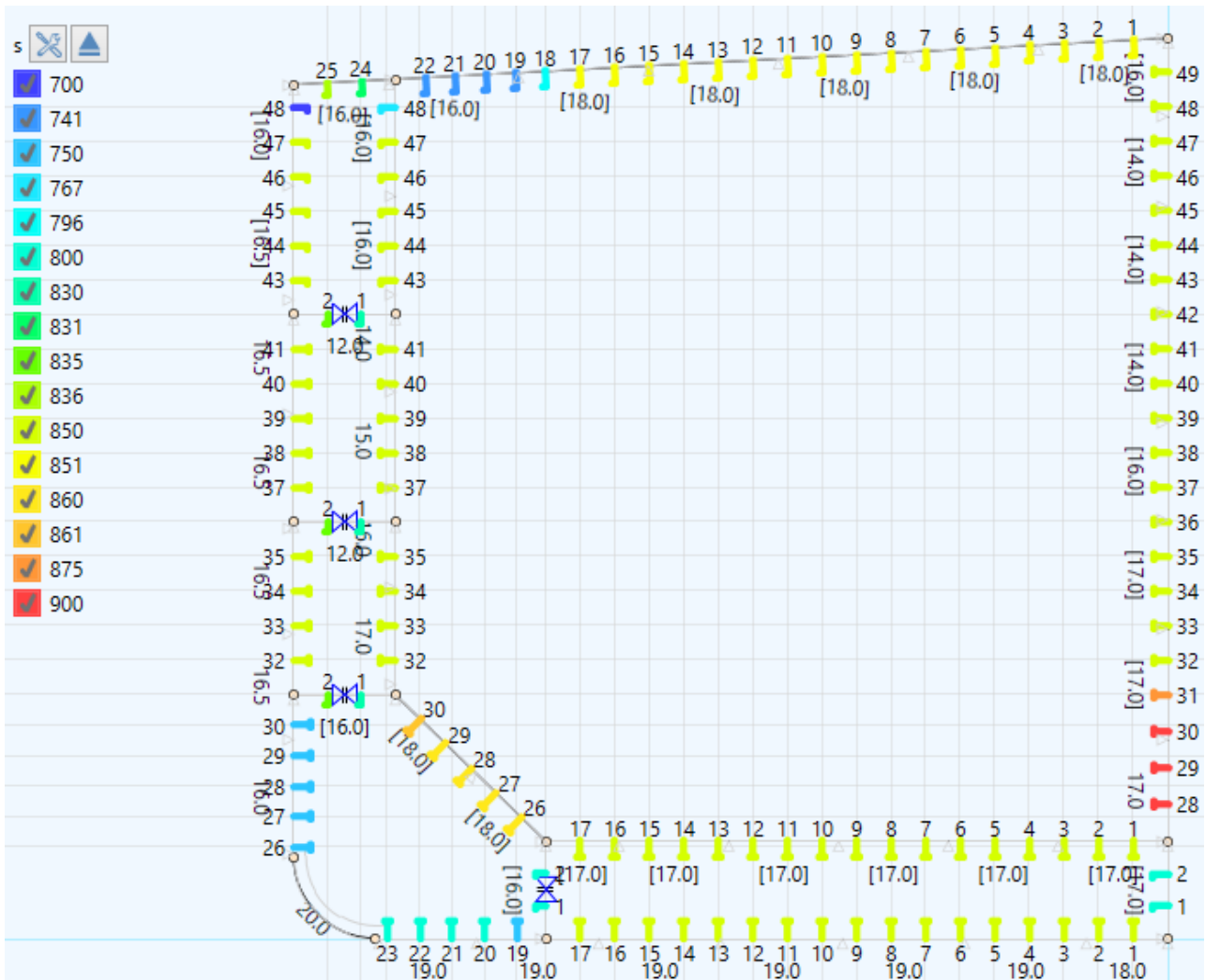
This will show a color plot of the gross thickness status, based on percent compliance (see Nauticus Hull User Manual for how to modify the the color ranges).

Whenever a column has the icon  you may right-click the column and chose **Color plot column**:



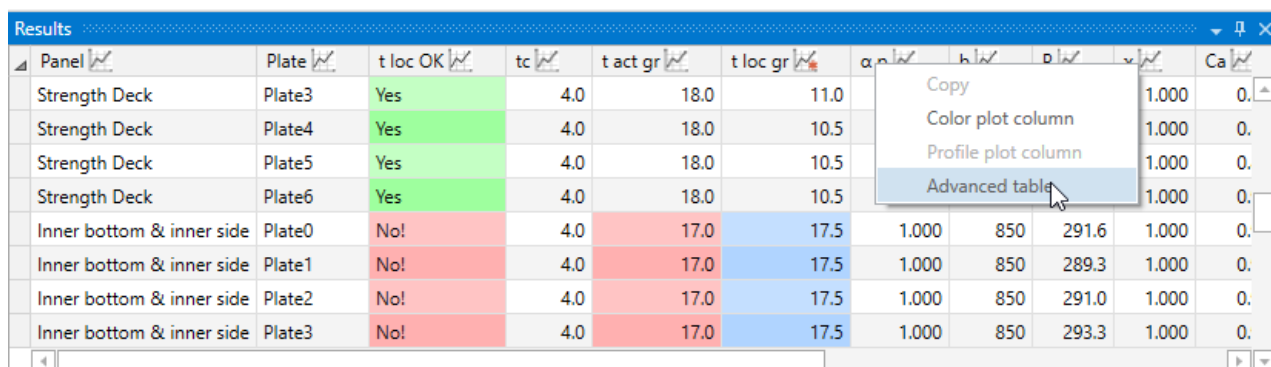
You may utilize the result grid to plot several parameters and intermediate results for verification of applied values and intermediate results, for instance the governing load case:





8.5 Advanced table – show intermediate results

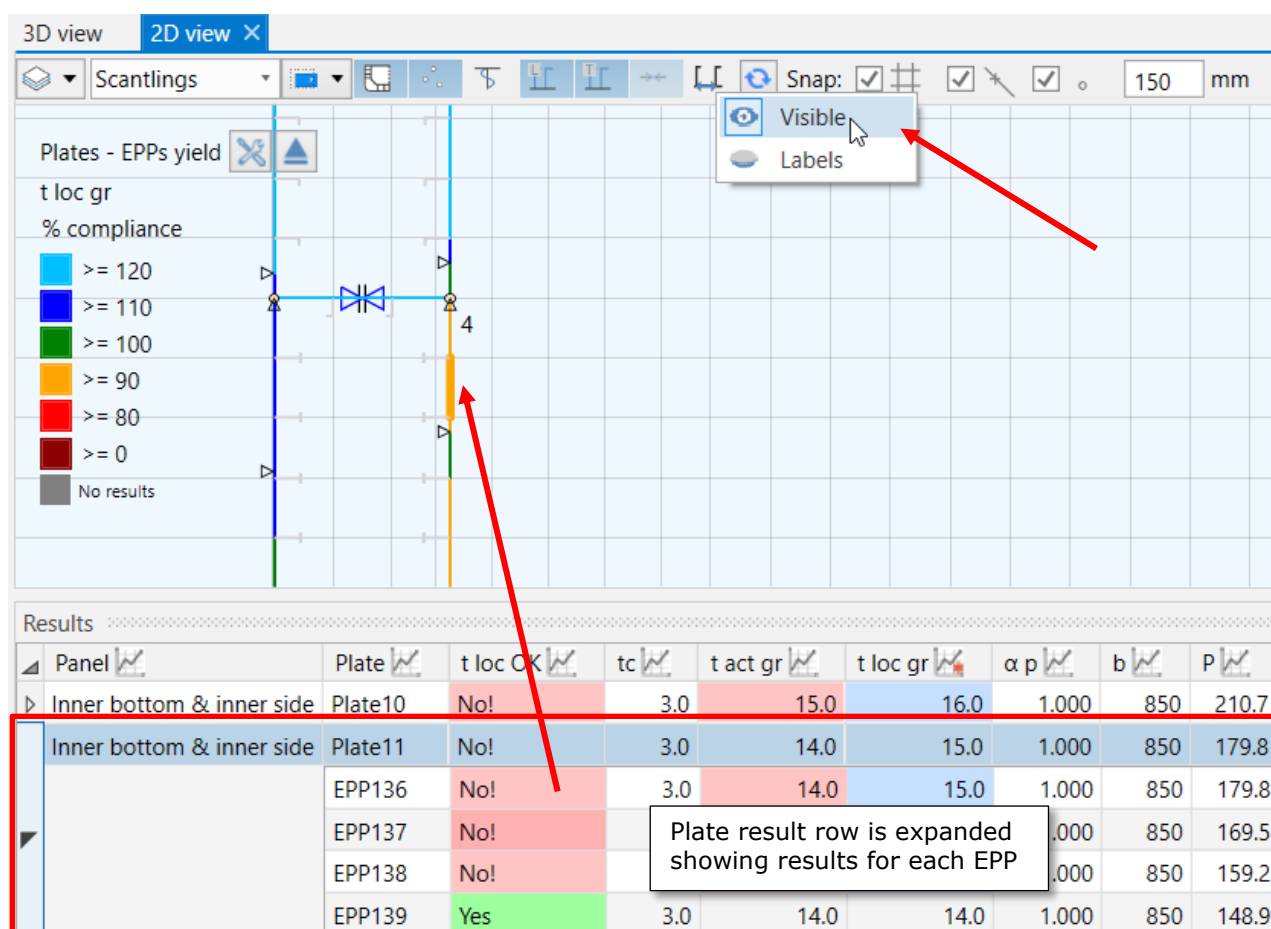
Right-click in any column headers of the result grid and select **Advanced table** to see detailed intermediate results.



Panel	Plate	t loc OK	tc	t act gr	t loc gr	α	b	P	Ca
Strength Deck	Plate3	Yes	4.0	18.0	11.0				
Strength Deck	Plate4	Yes	4.0	18.0	10.5				
Strength Deck	Plate5	Yes	4.0	18.0	10.5				
Strength Deck	Plate6	Yes	4.0	18.0	10.5				
Inner bottom & inner side	Plate0	No!	4.0	17.0	17.5	1.000	850	291.6	1.000
Inner bottom & inner side	Plate1	No!	4.0	17.0	17.5	1.000	850	289.3	1.000
Inner bottom & inner side	Plate2	No!	4.0	17.0	17.5	1.000	850	291.0	1.000
Inner bottom & inner side	Plate3	No!	4.0	17.0	17.5	1.000	850	293.3	1.000

8.6 Showing plate results on EPP level

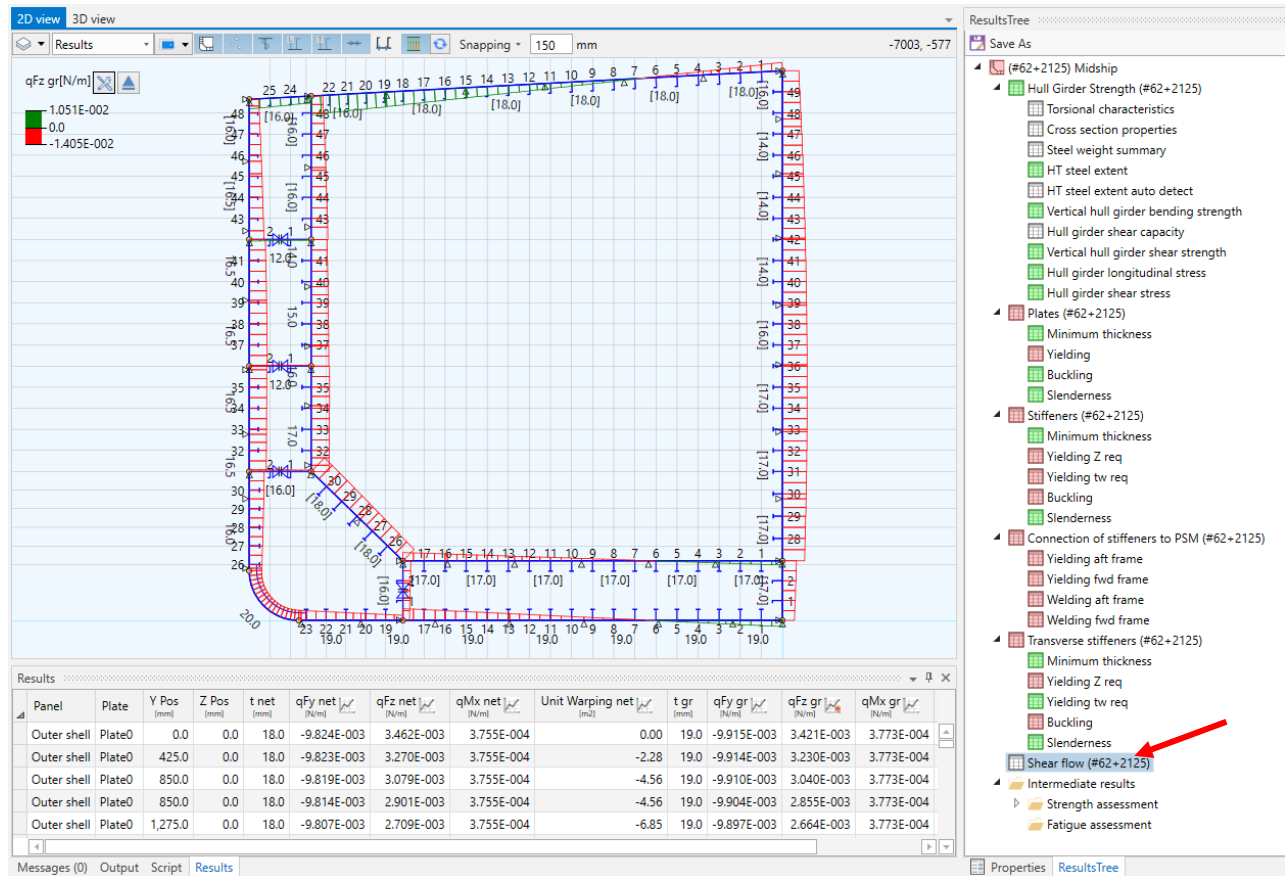
Results for each EPP for a subject plate may be displayed. Chose visibility of EPP by selecting Visible from the EPP dropdown:



Note that plate display is automatically turned Off when EPP display is On. To return to plate selection and view mode, turn Off EPP display and turn On Plate display and selection.

8.7 Plotting of shear flow

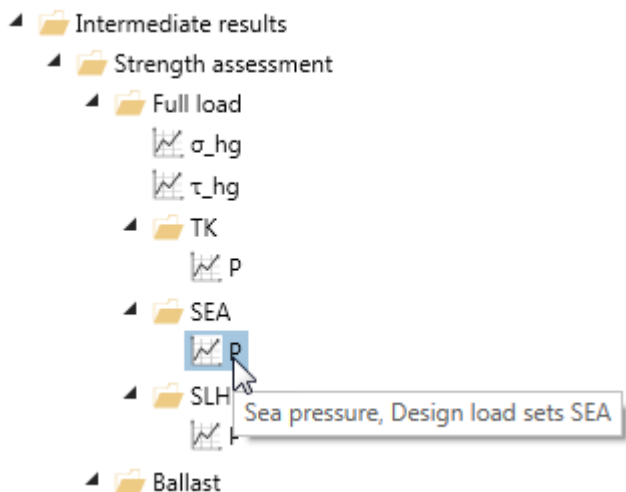
The shear flow can be plotted. Right-click a column to plot the value, for instance qFz:



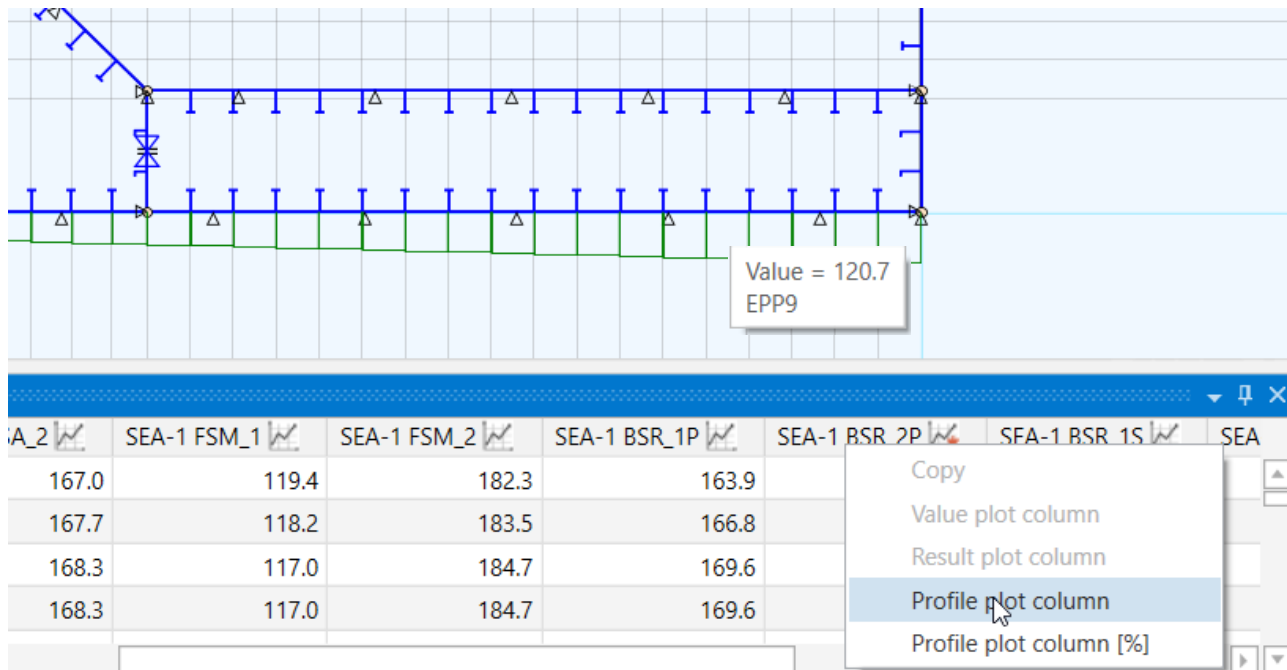
8.8 Plotting of pressures and hull girder stresses

You may plot pressures and other results directly on the cross-section.

Example – inspect sea pressure for an EDW:



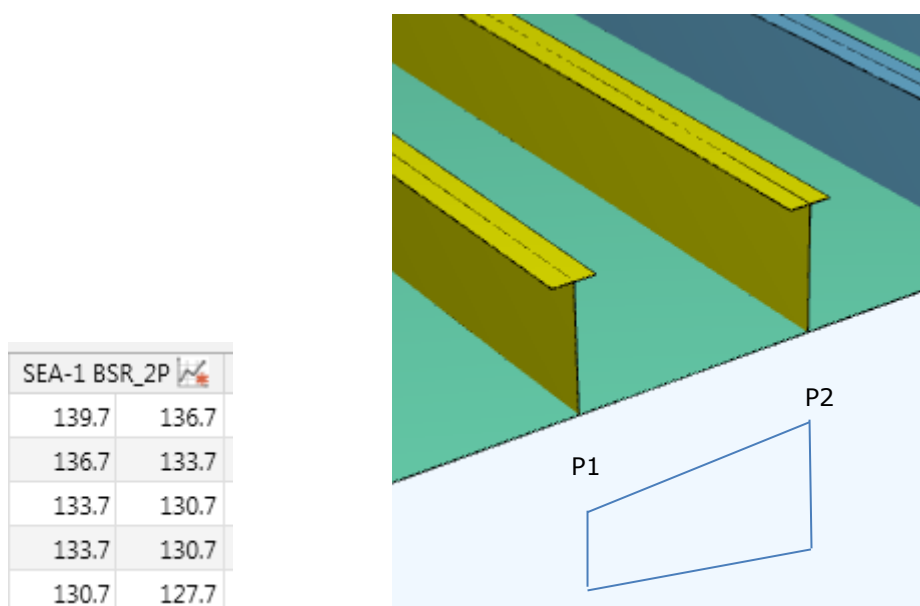
Plot of sea pressure for selected full load condition, for instance SEA-1 BSR 2P and design load set SEA:



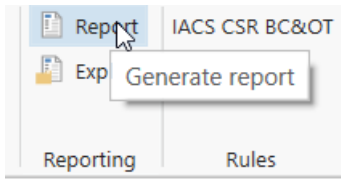
Right-click the EDW column and select **Profile plot column** to see the graphical presentation of the intermediate result.

Each EDW has two result columns, showing value at start and end of EPP (Elementary Plate Panel, see CSR BC&OT Pt.1 Ch.3 Sec.7 [2.1.1]). These values are used to for plotting purpose to present the variation over each EPP.

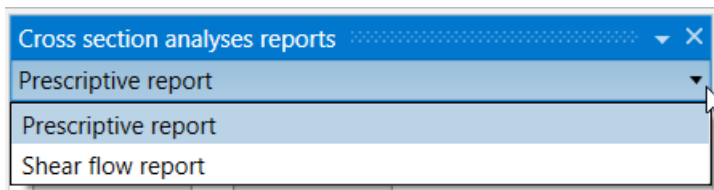
Note that the EPP number will be displayed on hovering the pressure profile. The EPP itself is not selectable.



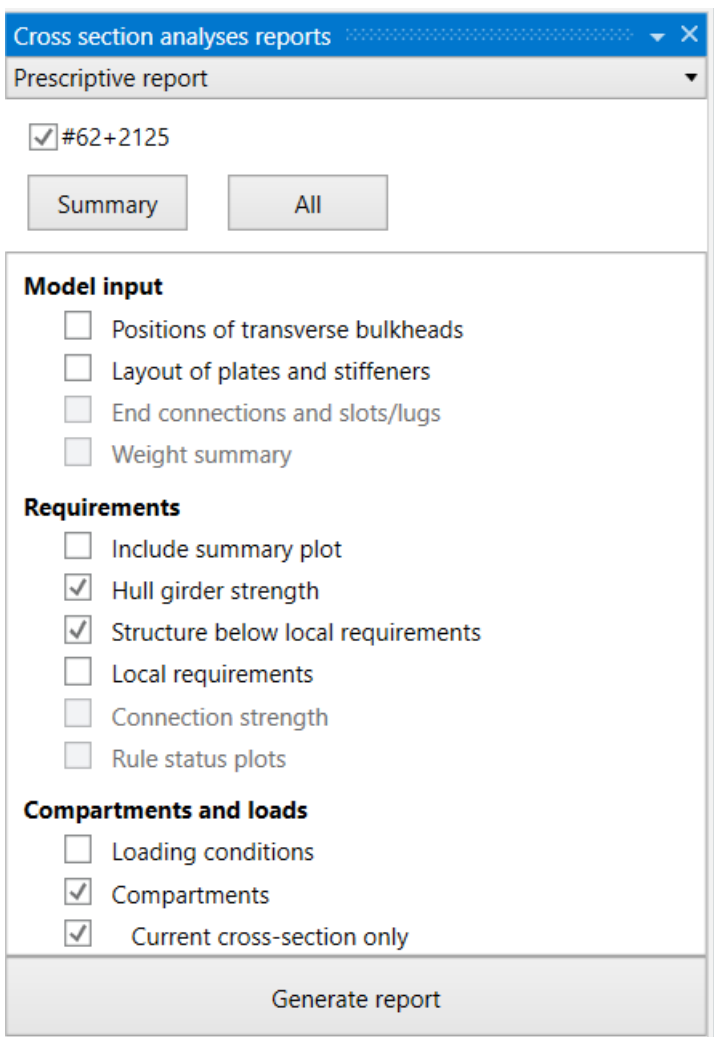
8.9 Reporting



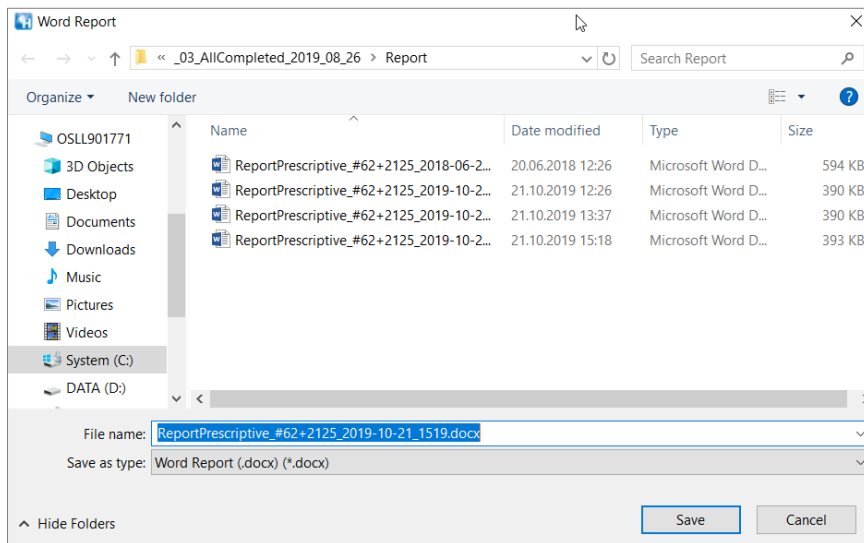
Chose report type **Prescriptive report**:



Check the desired content of the report and press **Generate report**:

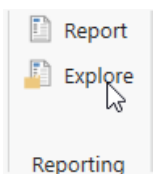


The report will be stored in the current workspace's Report folder by default:



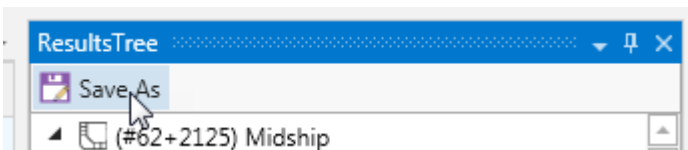
Pressing Save will generate the report and open it in Word.

To access the report folder at any time, click **Explore**:



8.10 Saving result details to file (.h5)

Results are stored in memory. To write the results for the current cross-section to a HDF5 file (.h5), select **Save As** found at the top of the result tree window:



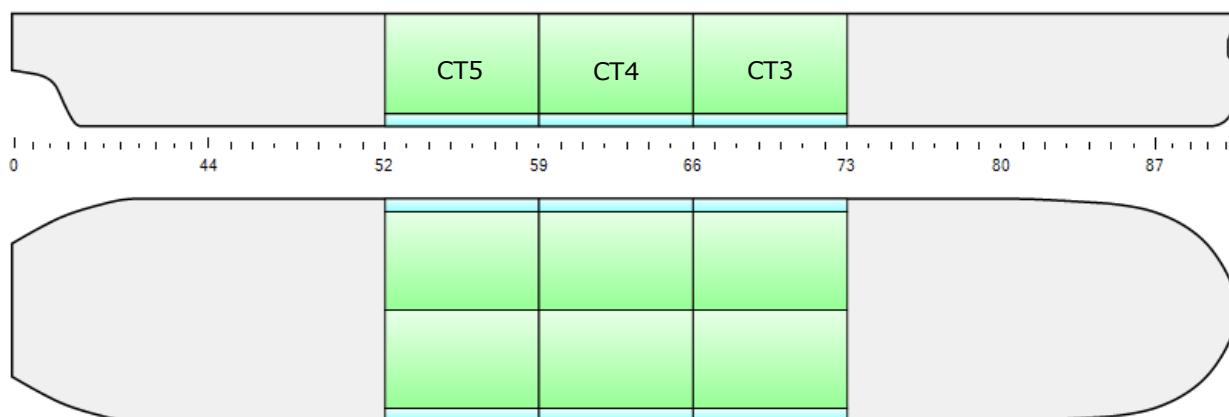
The .h5 file can be viewed with the HDF5 viewer, this can be downloaded free of charge from:

<https://support.hdfgroup.org/HDF5/>

8.11 Re-use cross-section in other holds – copy/paste

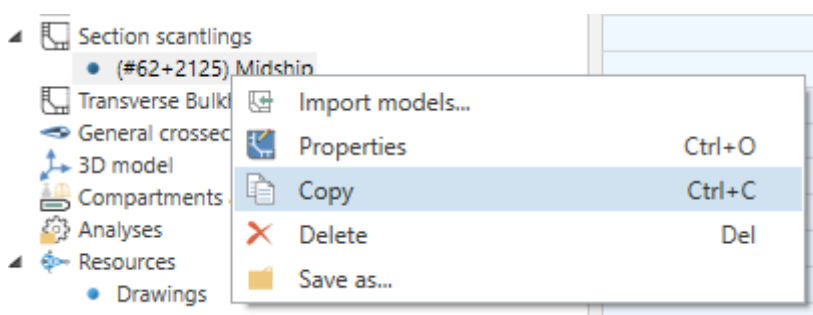
Contrary to old Nauticus Hull where one cross-section could describe geometry of several compartments at different longitudinal extension, a cross-section in NH 20 can only describe the geometry of the compartments at the cross-section position.

For a compartment configuration shown below, three cross-sections need to be defined:

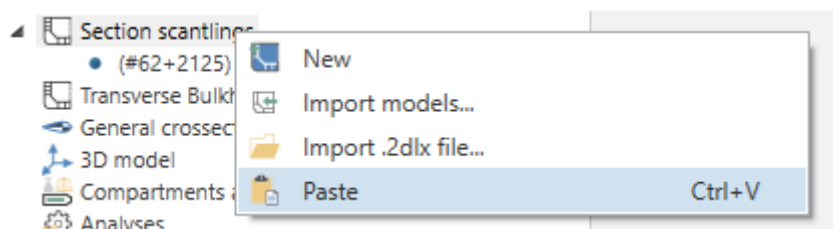


The definition of the sections in CT5 and CT3 can be based on the Midship section defined above.

Return to Section scantlings node in the browse tree, select **Copy** from the context menu of the Midship section:



-and **paste**:



The property window for the pasted cross-section will appear, change name to **Section_CT5** and position to **#55+2125**.

Cross section properties

Name: **Section_CT5** Position #: **#55+2125**

☐ Intersect 3D model/hull definition

Adjacent main structural positions

2. aft: #54
1. aft: #55
1. fwd: #56
2. fwd: #57

The positions are selected based on the available main structural positions

Update
Add position

Span of longitudinals: 4250.0 [mm]
Standard spacing between trv. stiffeners: 800.0 [mm]

☒ Within cylindrical part of the ship

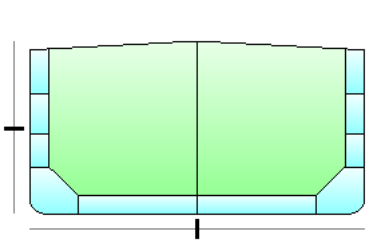
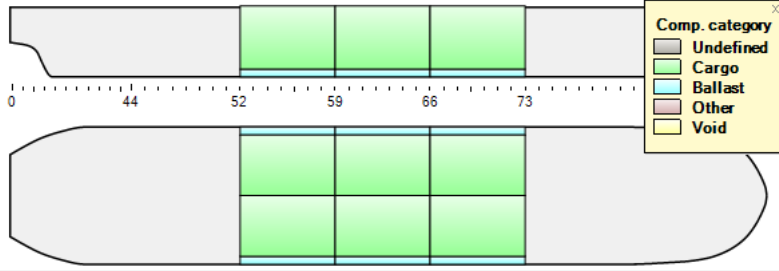
Ok Cancel

Repeat for cross-section inside CT3, giving name **Section_CT3** position **#69+2125**.

When the cross-sections are established, compartments shall be created using the same procedure as described for the Midship section in the previous chapter. Please check the result with the following picture.

Compartments and loads X

100% (#55+2125) Section_CT5

Comp. category

- Undefined
- Cargo
- Ballast
- Other
- Void

Compartment data | Loads

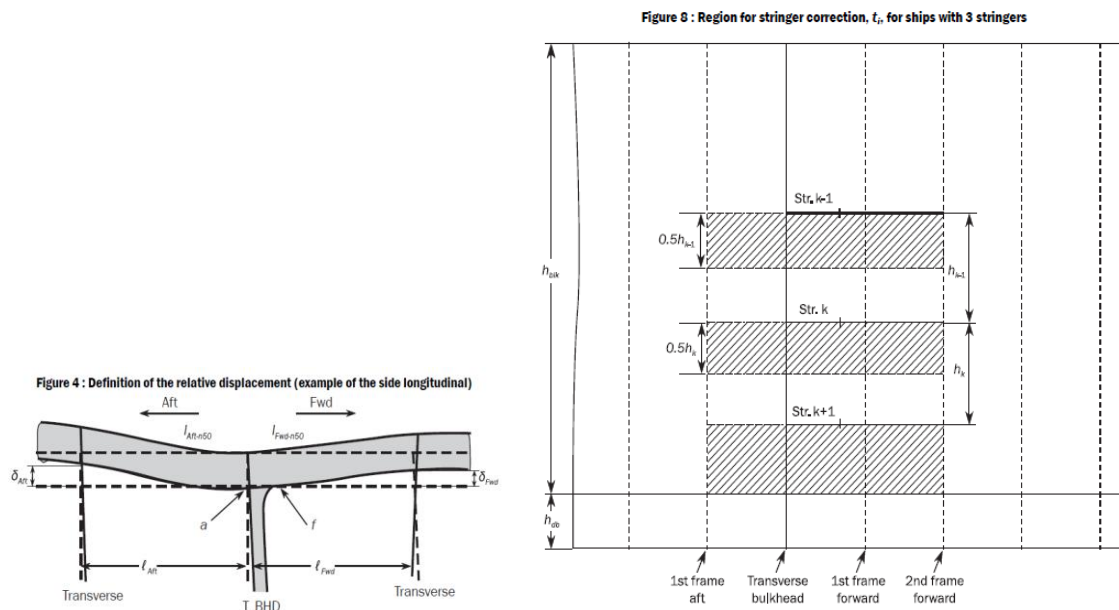
General data | Tank data | Sloshing data | Shear force correction data | Geometry data | All

Edit	Compartment name	Compartment type	Side	Vessel area	Tank/Hold No	Length (mm)	Volume (m3)	CG distance from AP (mm)	CG distance from CL (mm)	CG distance from BL (mm)	Heated cargo/fuel oil tank	Testing load height, Zst (mm)
New	WB4	Ballast water tank	PS and SB	Cargo area	4	29750	3062.1	116025	15315	6142		
Delete	CT4	Oil cargo tank	PS and SB	Cargo area	4	29750	10678.3	116025	9261	12179	☐	
Join	WB3P	Ballast water tank	PS and SB	Cargo area	3	29750	3062.1	145775	15315	6142		
Undo join	CT3P	Oil cargo tank	PS and SB	Cargo area	3	29750	10678.3	145775	9261	12179	☐	
Export	WB5P	Ballast water tank	PS and SB	Cargo area	5	29750	3062.1	86275	15315	6142		
Import	CT5P	Oil cargo tank	PS and SB	Cargo area	5	29750	10678.3	86275	9261	12179	☐	

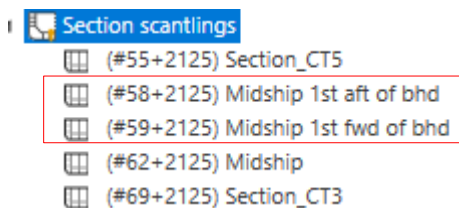
8.12 Analysis in way of transverse bulkheads

Separate cross-section analyses in way of transverse bulkheads are needed

- to assess reduction in effective thickness for longitudinal bulkhead plating due to loads from stringers (Shear strength assessment, Pt.1 Ch.5 Sec.1 [3.5])
- to address relative displacement of stiffeners in way of transverse bulkheads (Fatigue, Pt.1 Ch.9 Sec.4 [4.2])



Copy/paste Midship section to a location somewhere between first frame aft and first frame forward of bulkhead at #59:



Check compartment view and map compartments if needed. End connections needs to be set according to the arrangement, it may look like this:

Position aft of transverse bulkhead:

Connection of stiffeners to PSM	
PSM positions	...
Construction type	Double skin
Welding, tgap [mm]	2.0
Aft frame	
End connection	(ID32) EC32
Shear connection	(DL) Direct with lug
Weld leg length, end connection [mm]	
Weld leg length, shear connection [mm]	
Fwd frame	
End connection	(ID1) TopStiff180x12
Shear connection	(DL) Direct with lug
Weld leg length, end connection [mm]	
Weld leg length, shear connection [mm]	

Position forward of transverse bulkhead:

Connection of stiffeners to PSM	
PSM positions	...
Construction type	Double skin
Welding, tgap [mm]	2.0
Aft frame	
End connection	(ID1) TopStiff180x12
Shear connection	(DL) Direct with lug
Weld leg length, end connection [mm]	
Weld leg length, shear connection [mm]	
Fwd frame	
End connection	(ID32) EC32
Shear connection	(DL) Direct with lug
Weld leg length, end connection [mm]	
Weld leg length, shear connection [mm]	

When running analyses, specify **Stress factors** for a simplified approach to relative displacements:

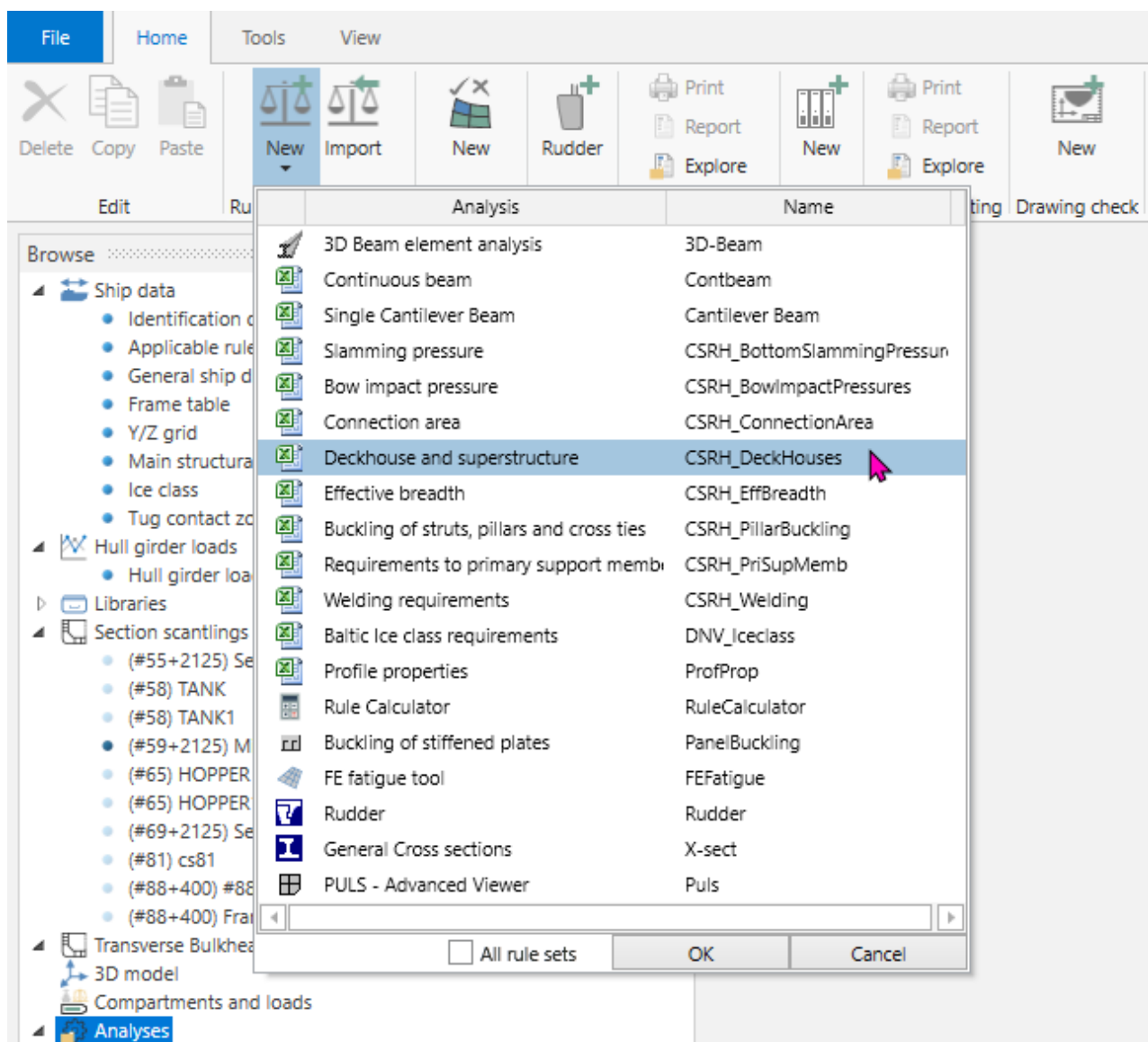
Cross Section Analyses			
Position	Prescriptive	ULS	Fatigue
#59+2125 mm	☒	☐	☒
Fatigue			
Relative displacements			
Relative displacements	Stress factors		
Calculate			

Stringer corrections will be applied without need for any further interaction if stringer information is specified for the bulkhead in Main structural arrangement.

9 Deckhouse and superstructure

The rule section Pt.1 Ch.11 Sec.1 SUPERSTRUCTURES, DECKHOUSES AND COMPANIONWAYS is in general not incorporated in the cross-section analysis for CSR and therefore shall not be modelled. Superstructure where superstructure side is part of side and superstructure top attached to this structure may be calculated.

For calculation of mentioned structure, please refer to the spreadsheet **Deckhouse and superstructure**:



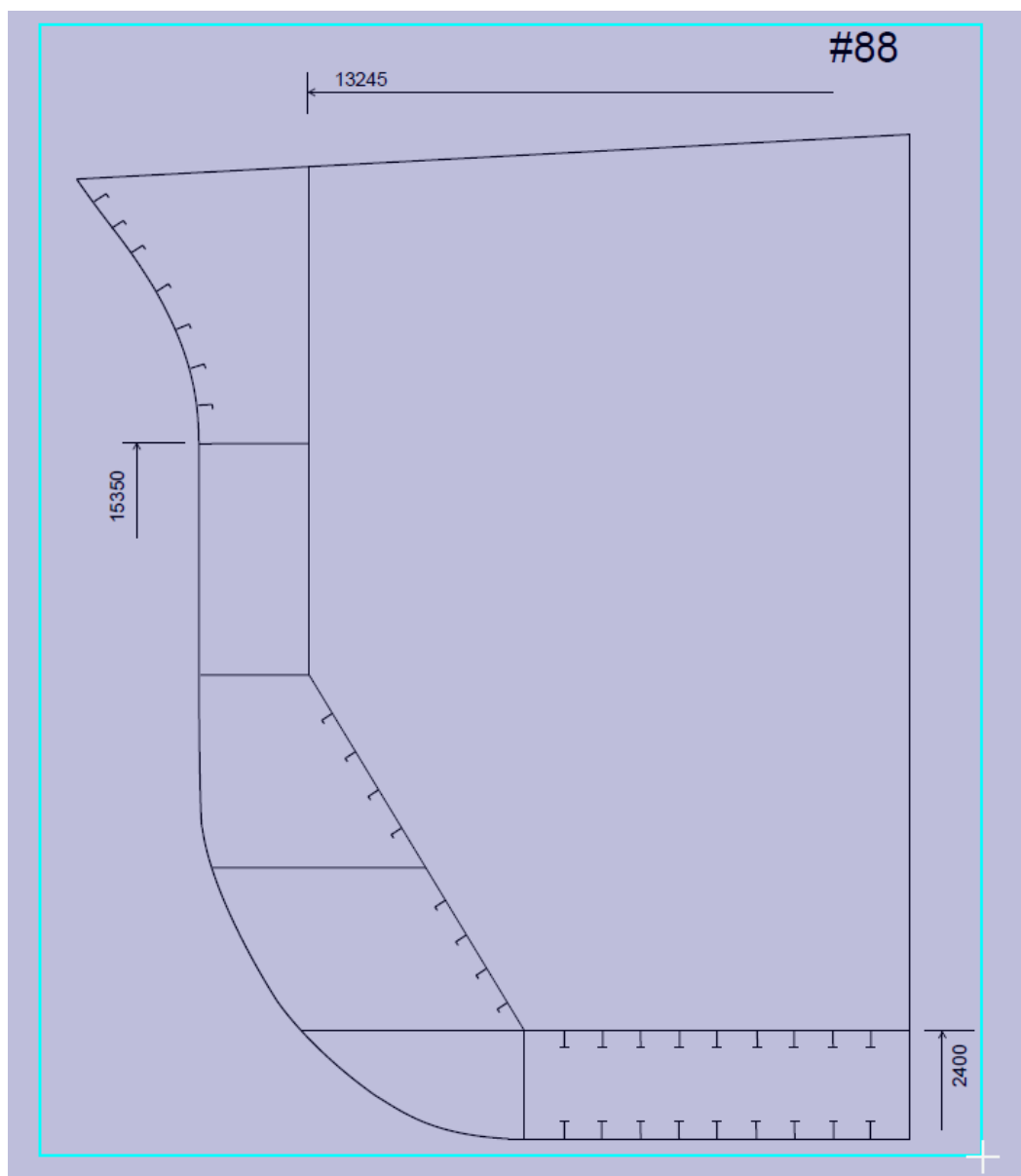
10 Use of drawings

While modelling a cross-section, you may benefit from displaying a drawing in the background, representing the X-location at which the cross-section is defined. This is particularly useful when working in the non-prismatic area of the vessel.

The background drawing is typically a screenshot from a full drawing and is stored as a .jpg or .png image file. You can either create this image file independent of NH, or you can utilize **Screen clipping**:

Open the file **Tutorial_DrawingSketch.pdf** in Acrobat Reader (or whatever you chose).

Go to **Resources | Drawings**, select Screen clipping:

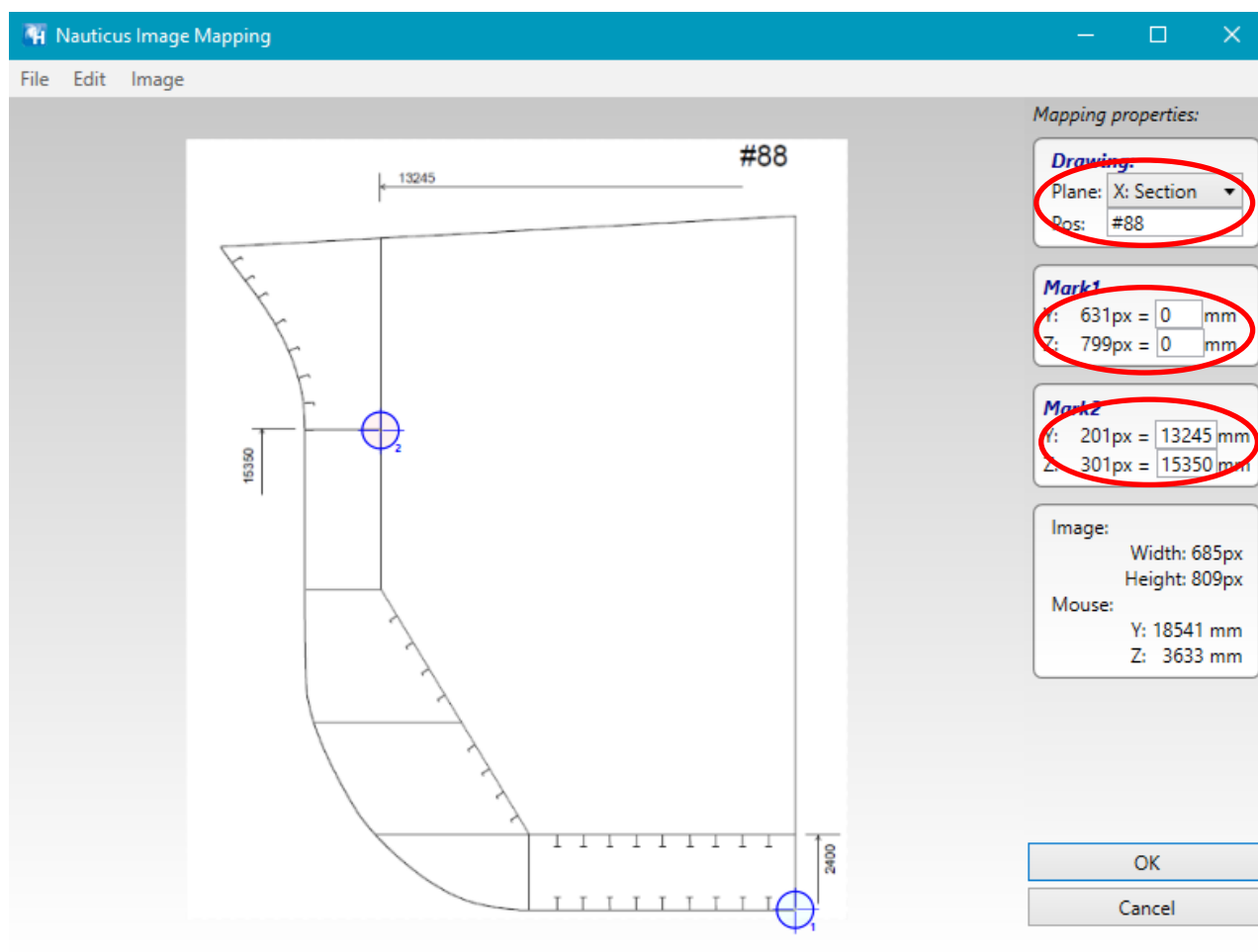


To calibrate the drawing for use, you will need to specify the position (X-position for transverse drawings) and **two points with known coordinates**.

Move the circle numbered '1' down to CL/BL.

Move the circle numbered '2' to the intersection between inner side and upper stringer.

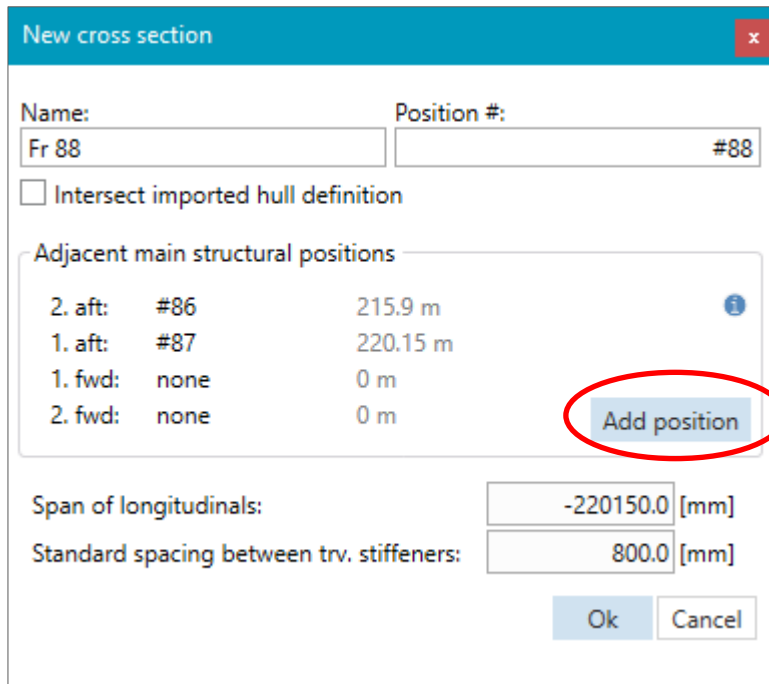
Specify coordinates as shown, X-position **#88** (note the **#** which is necessary):



Press OK, to store the drawing and the calibration.

10.1 Example of use of background drawing

As an example of how to use, create a new cross-section at **#88**:



New cross section

Name: Position #:

☐ Intersect imported hull definition

Adjacent main structural positions

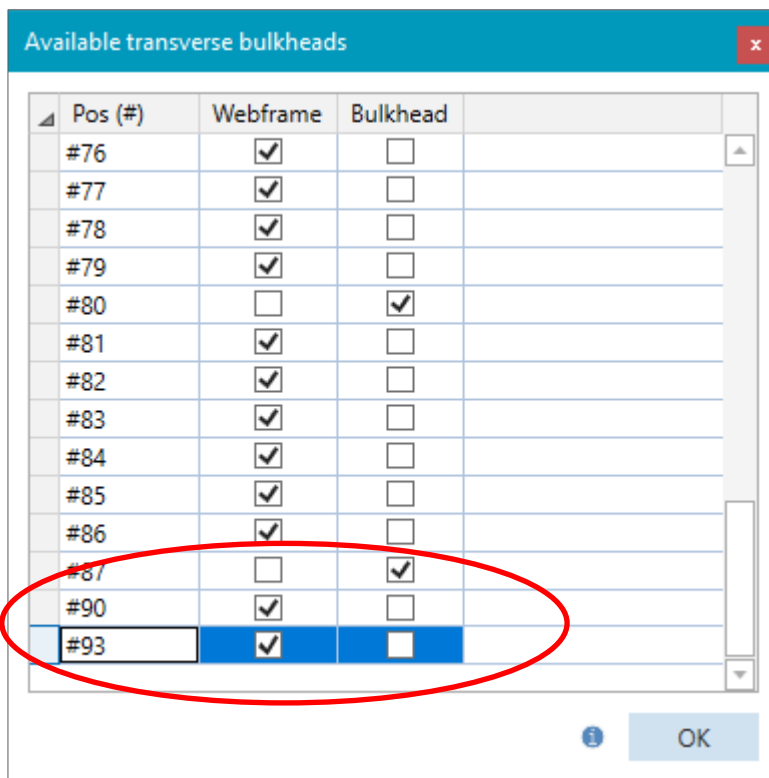
2. aft:	#86	215.9 m
1. aft:	#87	220.15 m
1. fwd:	none	0 m
2. fwd:	none	0 m

Span of longitudinals: [mm]

Standard spacing between trv. stiffeners: [mm]

You will need to add structural positions aft and forward of this position.

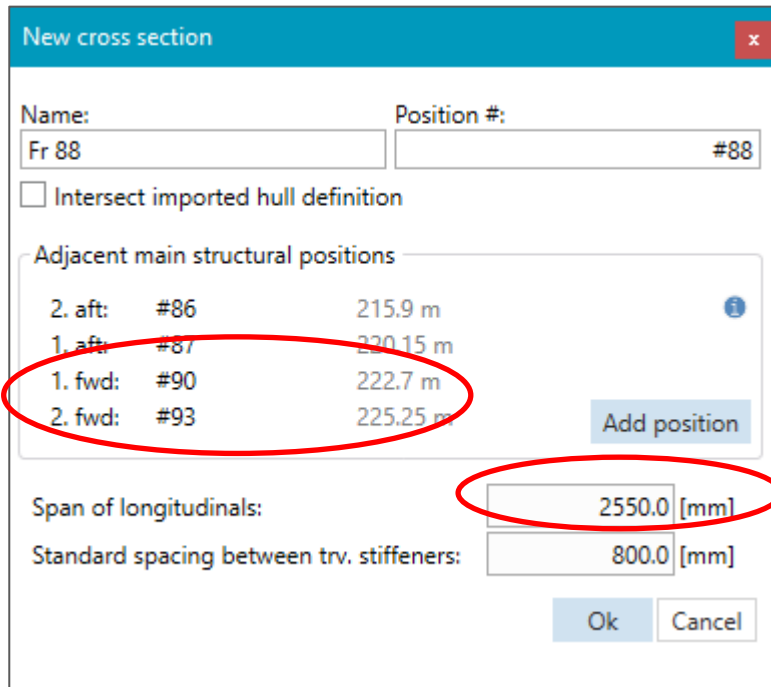
Add webframe at **#90** and **#93**:



Available transverse bulkheads

Pos (#)	Webframe	Bulkhead
#76	☒	☐
#77	☒	☐
#78	☒	☐
#79	☒	☐
#80	☐	☒
#81	☒	☐
#82	☒	☐
#83	☒	☐
#84	☒	☐
#85	☒	☐
#86	☒	☐
#87	☐	☒
#90	☒	☐
#93	☒	☐

Positions are updated and default stiffener span is calculated:



New cross section

Name: Fr 88 Position #: 88

☐ Intersect imported hull definition

Adjacent main structural positions

2. aft:	#86	215.9 m
1. aft:	#87	220.15 m
1. fwd:	#90	222.7 m
2. fwd:	#93	225.25 m

Add position

Span of longitudinals: 2550.0 [mm]

Standard spacing between trv. stiffeners: 800.0 [mm]

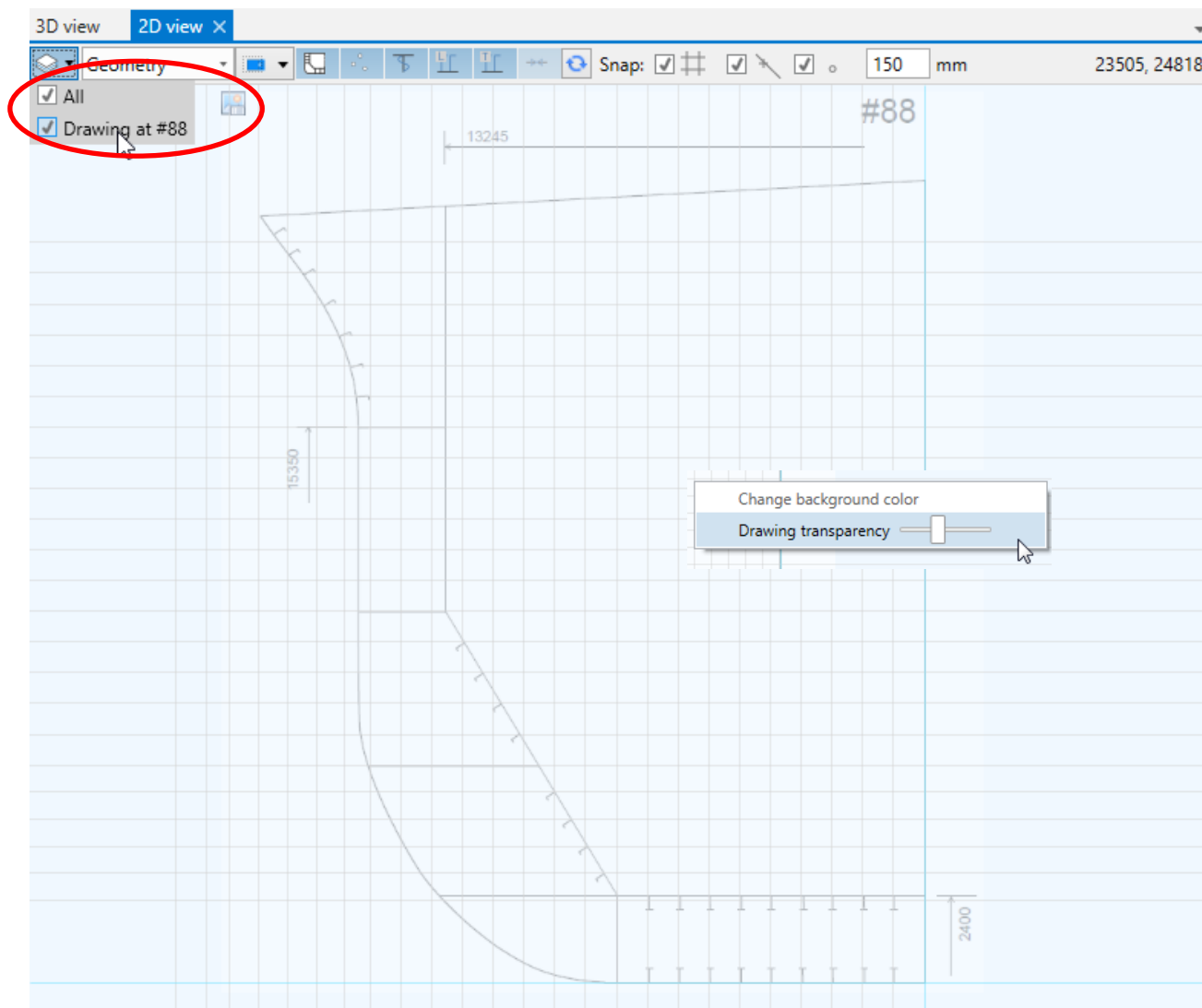
Ok Cancel

Give default spacing between transverse stiffeners.

Cross-section view is initially empty. Select the drawing from the drop-down list in the upper left corner of the 2d viewer.

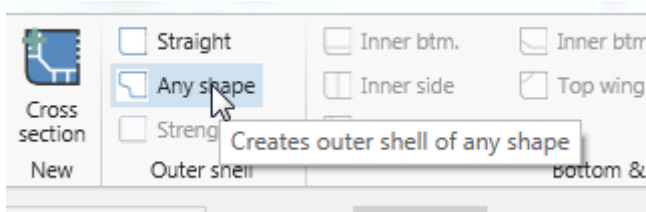
To show the YZ-grid, refresh 2D viewer by switching to Midship section and back again.

Double-click in the drawing area to zoom out.



Right-click in the window to modify transparency.

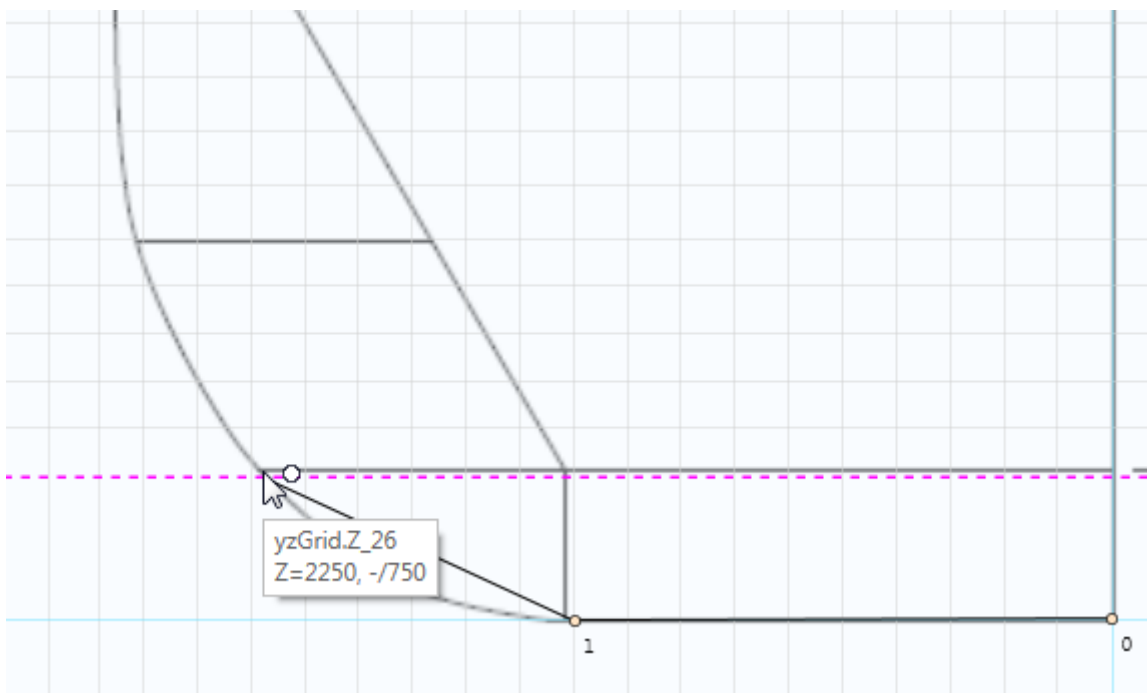
Create outer shell while having the background visible:



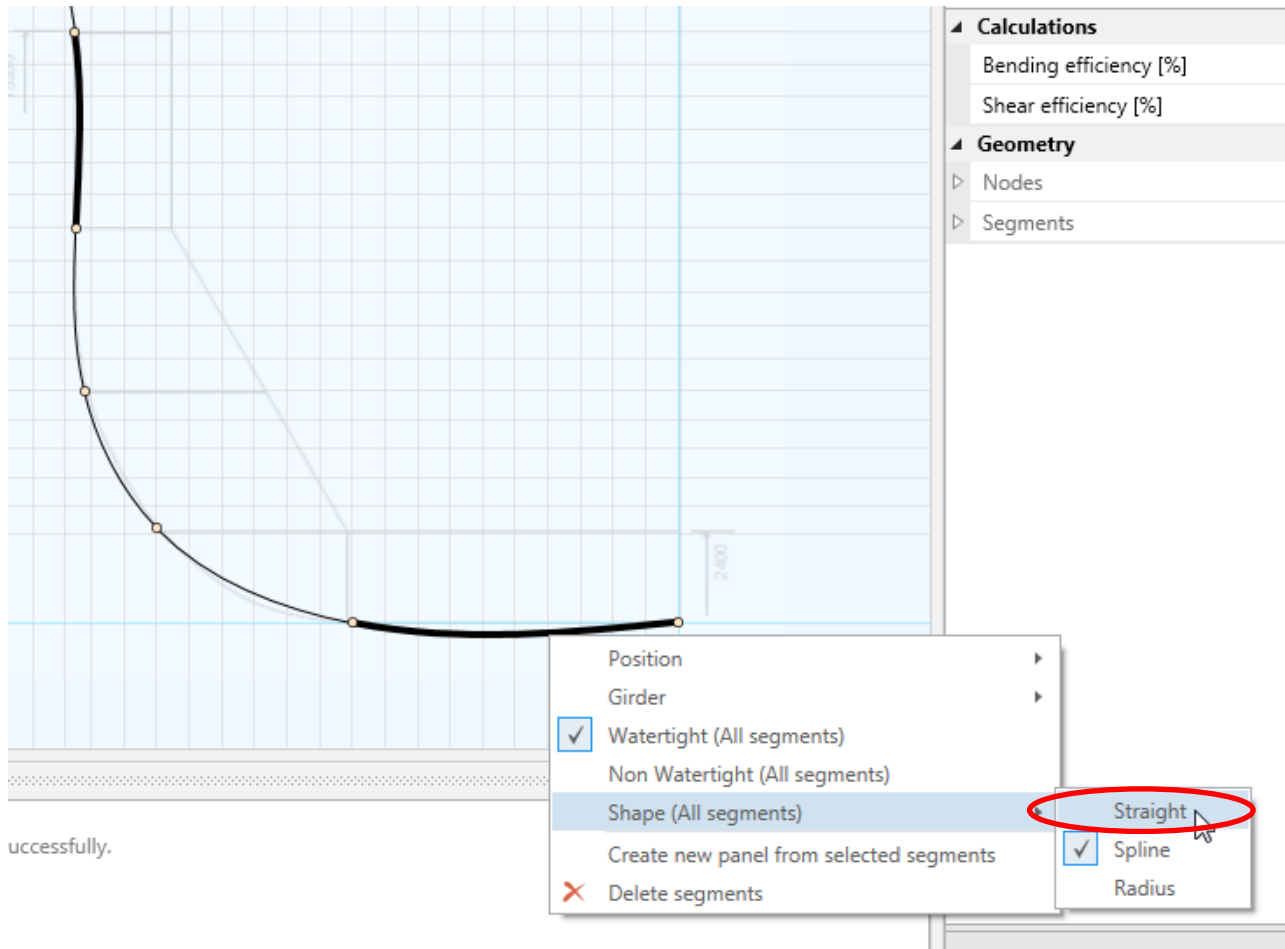
Click out the shape to define outer shell panel. Background drawing is just a bitmap and does not support snapping.

Normally, you will adjust the nodes after the panel is completed - do not bother with getting a perfect location of the nodes at this stage.

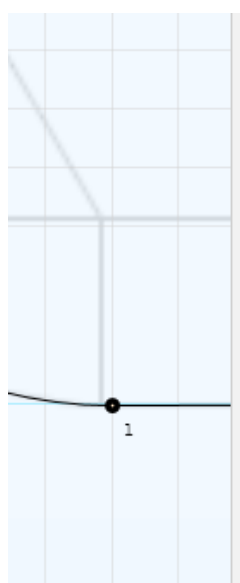
You may hold **Ctrl**-key down to prevent from snapping to the grid, or turn off snapping to grid.



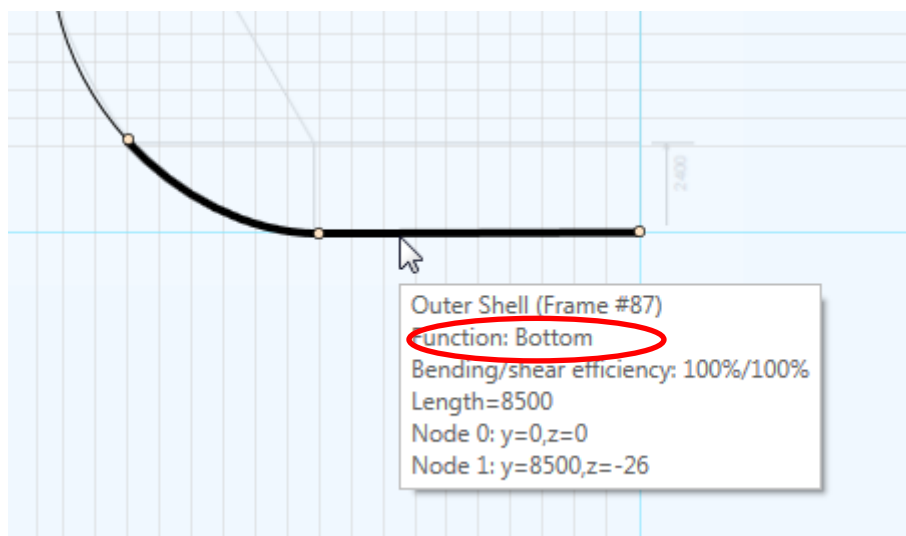
Segment shape may be adjusted:



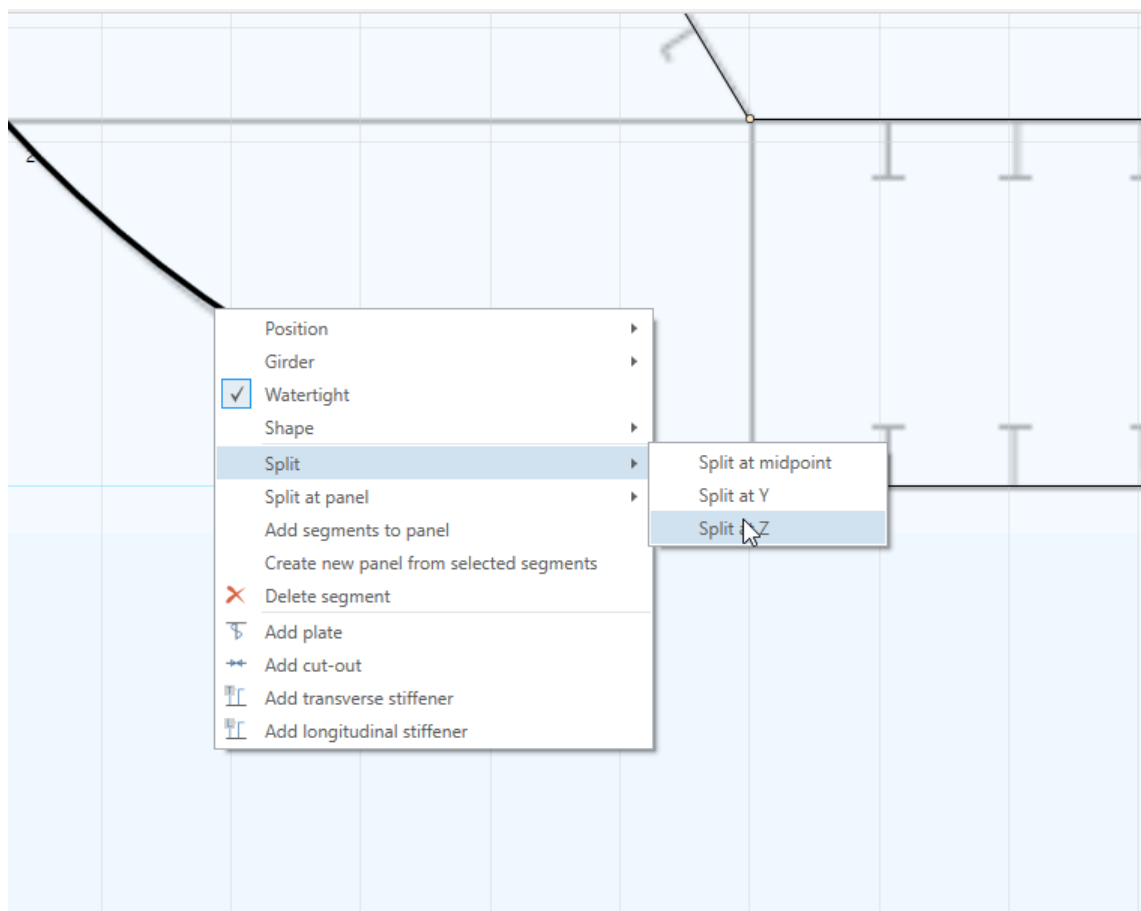
Nodes can be dragged, segments can be split and node coordinates can be inspected and modified for more accuracy.

	
Calculations	
Bending efficiency [%]	100
Shear efficiency [%]	100
Geometry	
Nodes	7 items
[0]	(0 mm, 0 mm)
[1]	(8500 mm, -27 mm)
[2]	(13600 mm, 2438 mm)
[3]	(15481 mm, 6000 mm)
[4]	(15703 mm, 10250 mm)
[5]	(15735 mm, 15350 mm)
[6]	(17761 mm, 21560 mm)
Segments	6 items

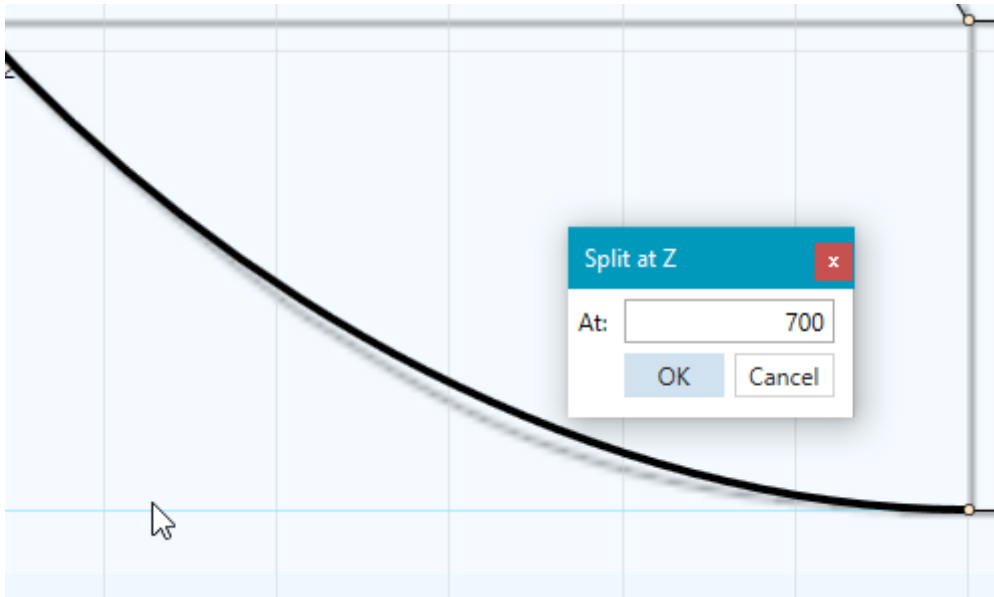
When creating panel by general tools, you will need to make sure that the position codes are correctly set. Inspect all segments and set relevant position code:



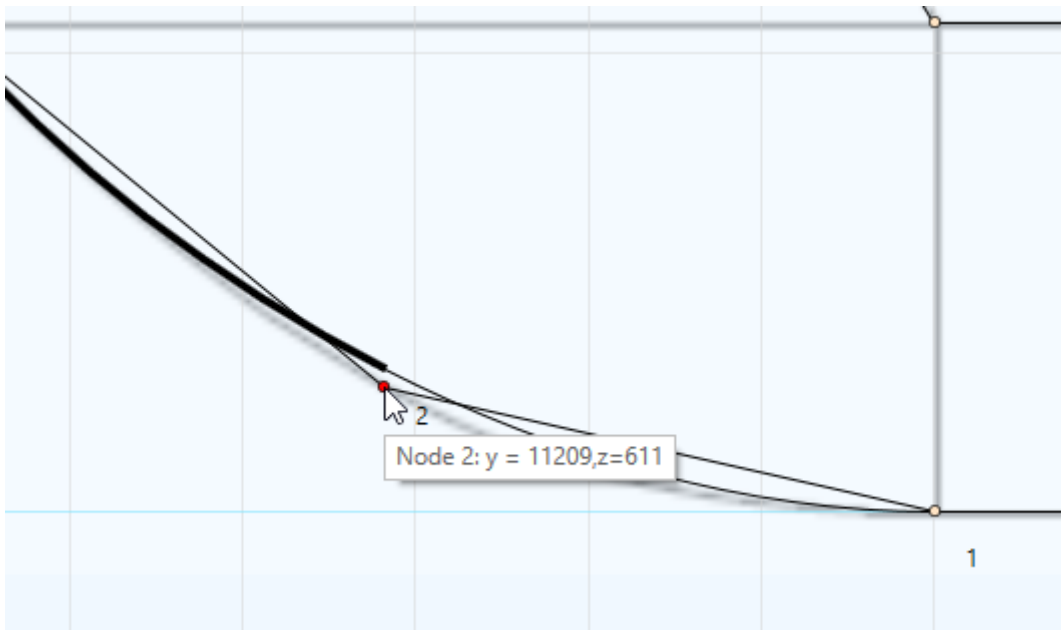
To insert nodes for more control of shapesm use **Split at Y** or **Split at Z**



Enter position:



By dragging, adjust position of new node to fit the drawing:



10.2 Use of drawings together with Rule Calculator

Nauticus Hull offers the option for prescriptive yielding and buckling check of structure not incorporated in a cross-section. This is done in the tool Rule Calculator.

The rule check is carried out on EPP level, i.e. the EPPs need to be defined in the Rule Calculator.

Elementary Plate Panel (EPP):		
Id text	LBH 19000	BHD59
X - position, EPP [Frame No.]	#61	#59
Y - position, EPP [mm]	19000	5000
Z - position, EPP [mm]	14000	4000
Length of EPP, a [mm]	2400	3000
Breadth of EPP, b [mm]	800	800
Compartments and Loads:		
Compartment 1, stiffener side	WB4	CT4P
Compartment 2, adjacent side	CT4P	CT5P
Load scenario	-All-	-All-
Panel definition:		
Structural member (level 1)	Inner side	Transverse WT bulkhe...
Sub-member (level 2)	<----->	<----->
Collision bulkhead	☐	☐
Effective hull girder structure	☒	☐
Stiffening arrangement	Longitudinal	Vertical on transverse sti
Panel angle to horizontal plane [deg]	90	90
Input Plate:		
Gross plate thk, as-built, t_{act} [mm]	10	10
Select steel type (standard, stainless)	Standard	Standard
Yield strength plate, R_{eH} [N/mm ²]	235	235
Input Stiffener:		
Select stiffener profile	WeldedAngle 450 x 120 x 1	WeldedTbar 315 x 100 x 12
Yield strength stiffener, R_{eH} [N/mm ²]	235	235
Angle between stiffener web and plate	90	90
Stiffener spacing, s [mm]	800	800
Eff. stiffener span, bend, l_{bdg} [mm]	2400	3000
Eff. stiffener span, shear, l_{shr} [mm]	2400	

Before calculating, ensure that the cross-section properties are described along the vessel in **Hull girder properties**, see further below.

Results (yield) Plate:		
Information	Longitudinal WT structure	Transverse WT structure
Design pressure for plate, P [kN/m ²]		
Design case giving max t _{req}	ExtremeSea_SD,Partial lo...	ExtremeSea_SD,Full load...
Gross req. plate thk, t _{yield_gr} [mm]	13.88	16.00
Gross required minimum thickness, t _{min_gr} [mm]	12.14	11.64
Rule status	NOT OK	NOT OK
Results (yield) Stiffener:		
Information		
Design press. for stiffener, P [kN/m ²]	165.30	249.11
Dimensioning design case, Z _{yield_net}	ExtremeSea_SD,Partial lo...	ExtremeSea_SD,Full load...
Net off. section modulus, Z _{yield_net_off} [cm ³]	1360.01	586.52
Net req. section modulus, Z _{yield_net} [cm ³]	324.44	848.04
Gross req. web thk. shear, t _{w_gr} [mm]	5.84	13.13
Dimensioning design case, t _{w_gr} [mm]	ExtremeSea_SD,Partial lo...	ExtremeSea_SD,Full load...
Gross req. min web thk, t _{min_gr} [mm]	9.98	9.48
Gross req. min flange thk, t _{min_gr} [mm]	9.98	9.48
Rule status	OK	NOT OK
Results (buckling) Plate:		
Dimensioning design case, η _{rel_plate} [-]	ExtremeSea_SD,Full load...	
Highest utilization factor, η _{rel_plate} [-]	0.77	
Gross req. plate buckling thk, t _{buckl_gr} [mm]	8.20	
Gross req. plate slend thk, t _{slend_gr} [mm]	11.00	8.90
Rule status	NOT OK	OK
Results (buckling) Stiffener:		
Dimensioning design case, η _{rel_stiffener} [-]	ExtremeSea_SD,Full load...	ExtremeSea_SD,Partial lo...
Gross web slend thk, t _{w_slend_gr} [mm]	8.71	6.53
Gross flange slend thk, t _{f_slend_gr} [mm]	12.40	6.56
Gross flange breadth, b _f [mm]	107.00	75.63
Stiffener bucl cap, η _{rel_stiffener} [-]	0.55	0.11
Rule status	OK	OK

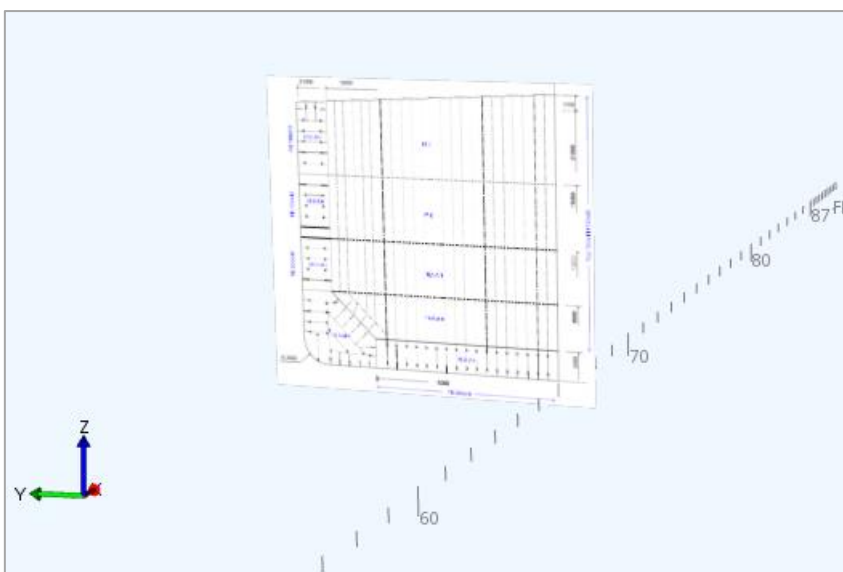
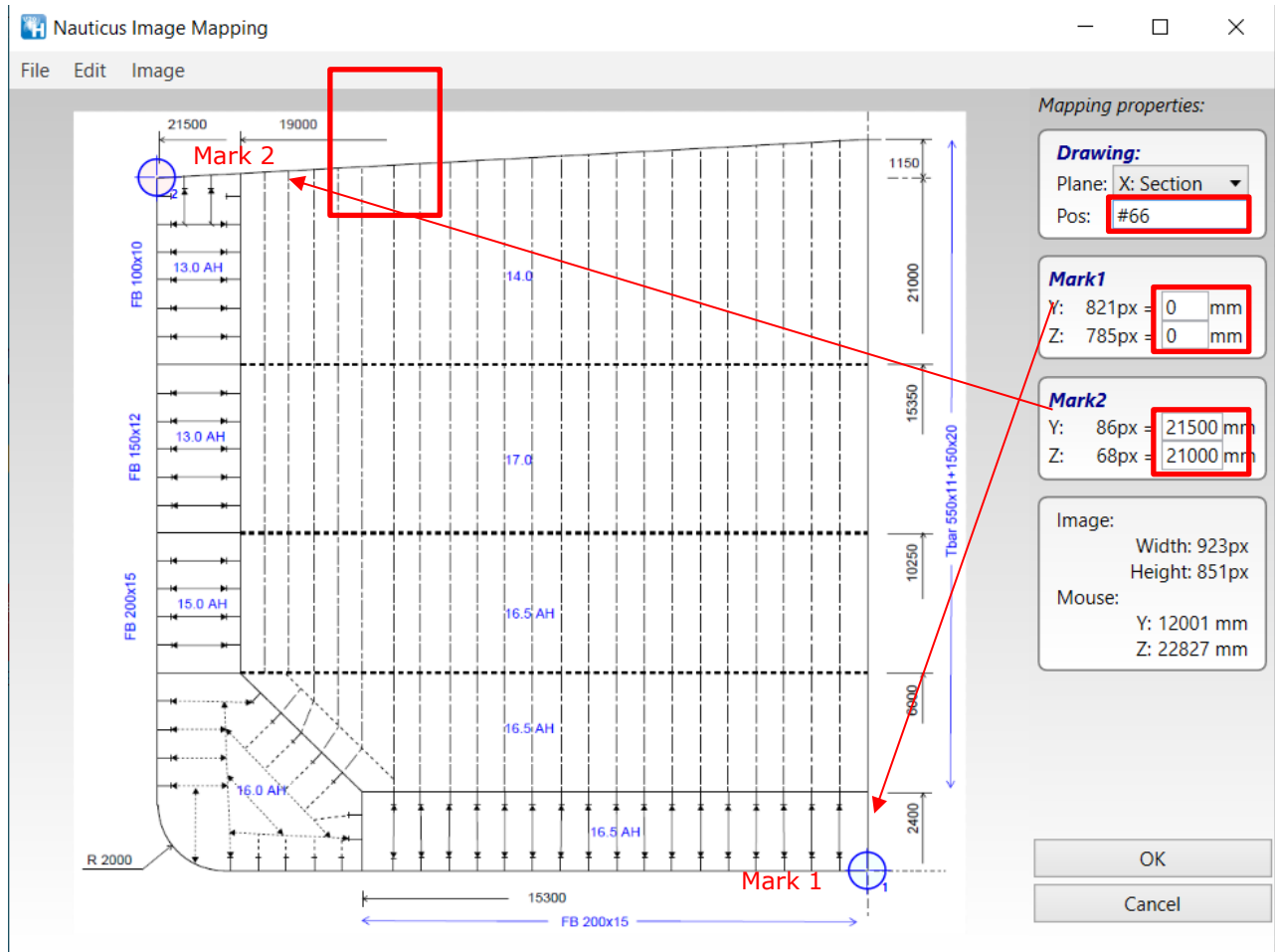
This model will not hold sufficient information (stresses) to carry out a full buckling check.

For a full buckling analysis, a FE analysis will be required and is supported in the FE part of the Nauticus Hull package.

To ease the definition of the EPPs, background drawings may be utilized for this purpose as shown below.

Open the .pdf file **Tutorial_DrawingSketch.pdf** and view the page where a transverse bulkhead is defined. Start **Screen clipping** and draw a box around the bulkhead, include the dimensions.

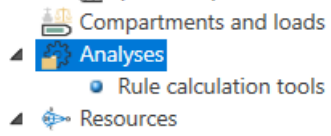
Position and calibrate the drawing in the vessel's coordinate system:



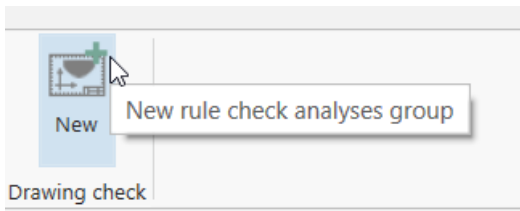


The Drawing Check plug-in need to be activated.

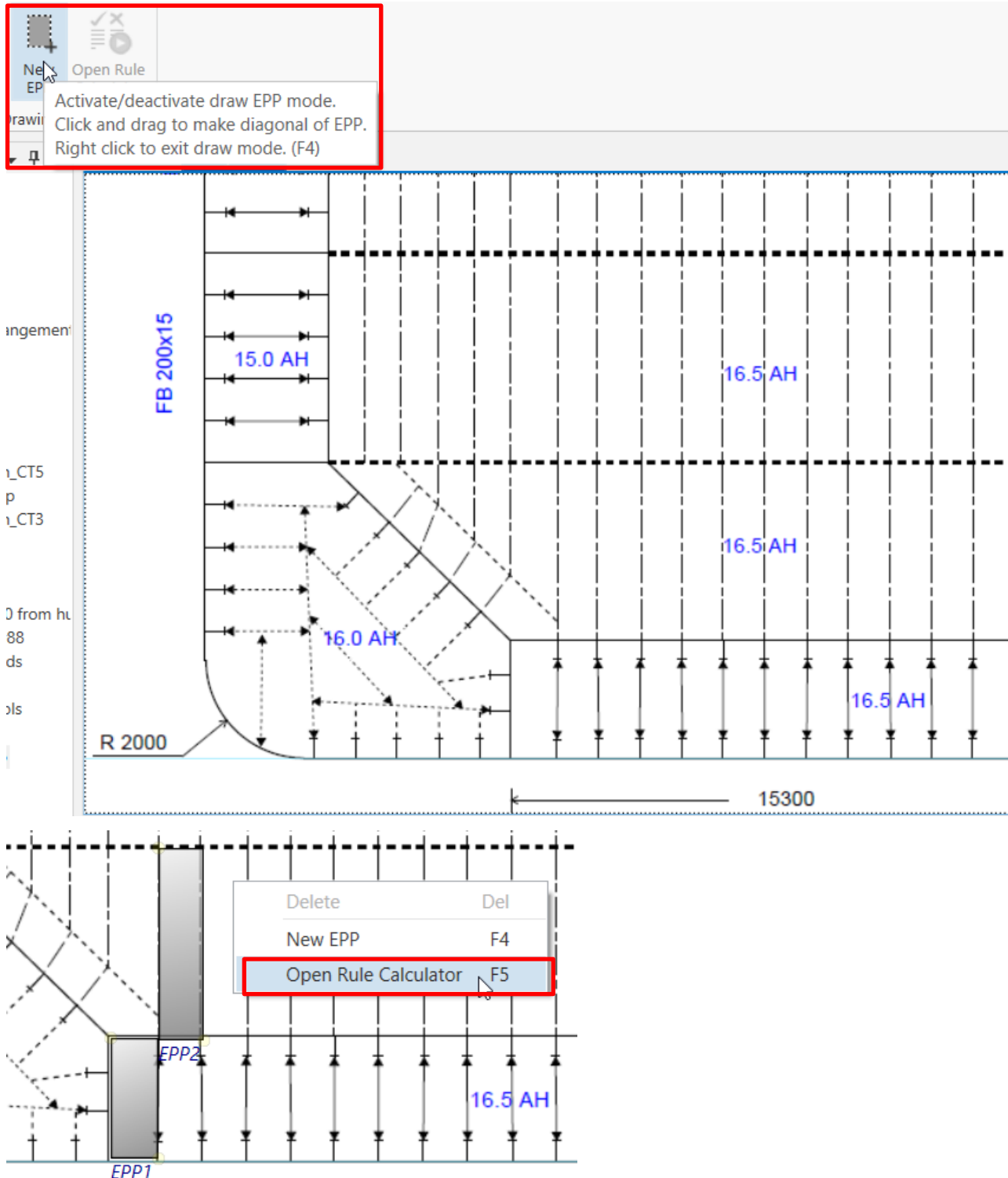
Select the **Analysis** folder in the workspace:



...and press **New**



Draw the squares representing the EPPs:



The coordinates of the corners will not be accurate at this stage. Corrections are done in Rule Calculator in the next steps.

Right-click and select **Open Rule Calculator**.

Initial dimensions and positions of the EPPs, as a result of the click-positions in the drawing. They need to be adjusted and shall be according to this:

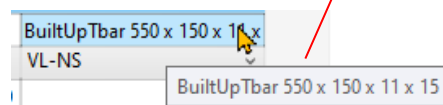
Show rows: ☒ Stiffener position

☐ tc ☐ fbdg ☐

Elementary Plate Panel (EPP):		
Id text	EPP1	EPP2
X - position, EPP [Frame No.]	#66	#66
Y - position, EPP [mm]	15300	14350
Z - position, EPP [mm]	0	2400
Y - position for stiffener [mm]	15300	14350
Z - position for stiffener [mm]	0	2400
Length of EPP, a [mm]	2400	3600
Breadth of EPP, b [mm]	930	850
Compartments and Loads:		
Compartment 1, stiffener side	WB3	CT3P
Compartment 2, adjacent side	WB4	CT4P
Load scenario	-All-	-All-

Specify the remaining properties:

Panel definition:		
Structural member (level 1)	Transverse WT bulkhead	Transverse WT bulkhead
Sub-member (level 2)	<----->	<----->
Collision bulkhead	☐	☐
Effective hull girder structure	☐	☐
Stiffening arrangement	Vertical on transverse str	Vertical on transverse str
Panel angle to horizontal plane [deg]	90	90
Input Plate:		
Gross plate thk, as-built, t_{act} [mm]	16,5	16,5
Plate material	VL-32	VL-32
Input Stiffener:		
Select stiffener profile	FlatBar 200 x 15	BuiltUpTbar 550 x 150 x 11 x
Stiffener material	VL-NS	VL-NS
Angle between stiffener web and plate	90	90
Stiffener spacing, s [mm]	930	850
Eff. stiffener span, bend, l_{bdg} [mm]	2400	3600
Eff. stiffener span, shear, l_{shr} [mm]	2400	3600



Note that the EPP and it's stiffener – if assigned - need to be fully located within a compartment.

Pressing Calculate all will perform the calculations and present the results for plate and stiffener:

Results (yield) Plate:		
Information		
Design pressure for plate, P [kN/m ²]	245.15	299.89
Design case giving max t _{req}	Harbour_S,Ballast,Static	ExtremeSea_SD,Full load...
Gross req. plate thk, t _{yield_gr} [mm]	17.49	15.60
Gross required minimum thickness, t _{min_gr} [mm]	12.14	11.64
Rule status	NOT OK	OK

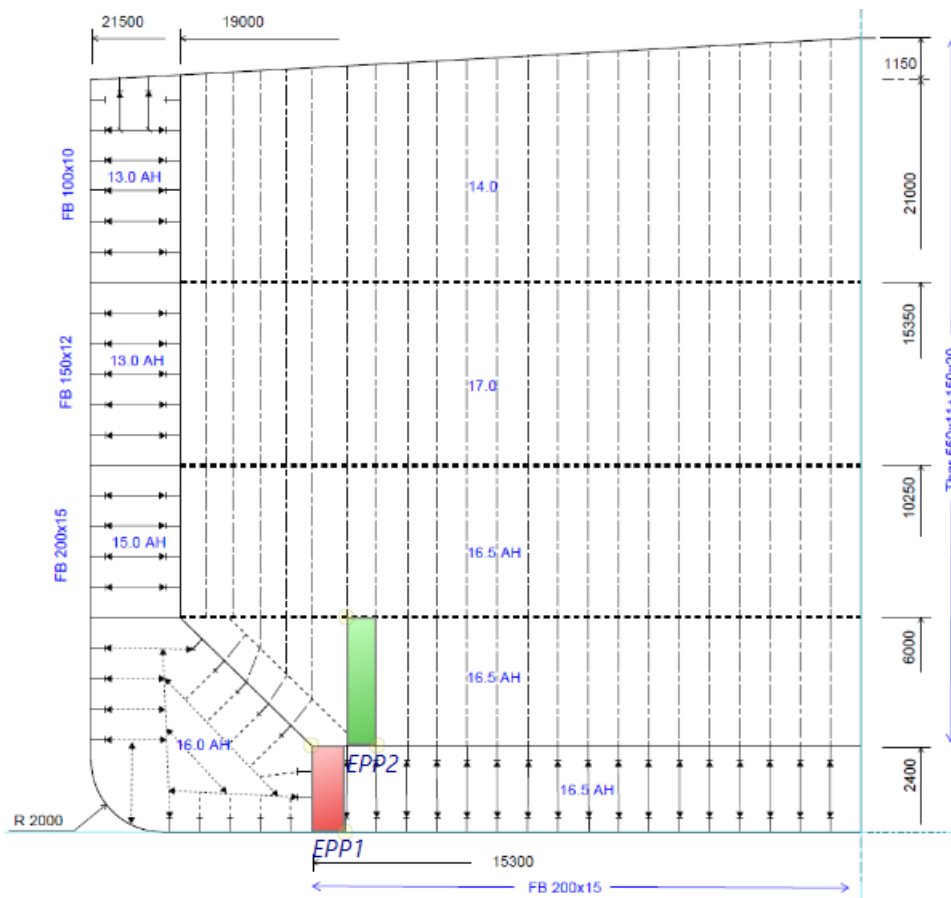
Results (yield) Stiffener:		
Information		
Design press. for stiffener, P [kN/m ²]	-233.08	276.43
Dimensioning design case, Z _{yield_net}	Harbour_S,Ballast,Static	ExtremeSea_SD,Full load...
Net off. section modulus, Z _{yield_net_off} [cm ³]	157.71	2114.35
Net req. section modulus, Z _{yield_net} [cm ³]	528.50	1074.14
Gross req. web thk. shear, t _{w_gr} [mm]	15.51	8.69
Dimensioning design case, t _{w_gr} [mm]	Harbour_S,Ballast,Static	ExtremeSea_SD,Full load...
Gross req. min web thk, t _{min_gr} [mm]	9.98	9.48
Gross req. min flange thk, t _{min_gr} [mm]		9.48
Rule status	NOT OK	OK

Results (buckling) Plate:		
Dimensioning design case, η _{rel_plate} [-]		
Highest utilization factor, η _{rel_plate} [-]		
Gross req. plate buckling thk, t _{buckl_gr} [mm]		
Gross req. plate slend thk, t _{slend_gr} [mm]	11.61	10.37
Rule status	OK	OK

Results (buckling) Stiffener:		
Dimensioning design case, η _{rel_stiffener} [-]	ExtremeSea_SD,Ballast,O...	ExtremeSea_SD,Full load...
Gross web slend thk, t _{w_slend_gr} [mm]	13.53	11.03
Gross flange slend thk, t _{f_slend_gr} [mm]		9.62
Gross flange breadth, b _f [mm]		138.13
Stiffener bucl cap, η _{rel_stiffener} [-]	93.28	0.06
Rule status	NOT OK	OK

Note that for transverse structure, the buckling results covers the slenderness requirements only.

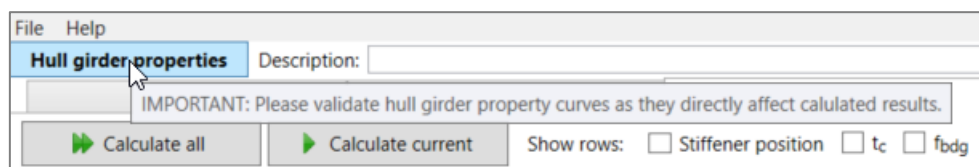
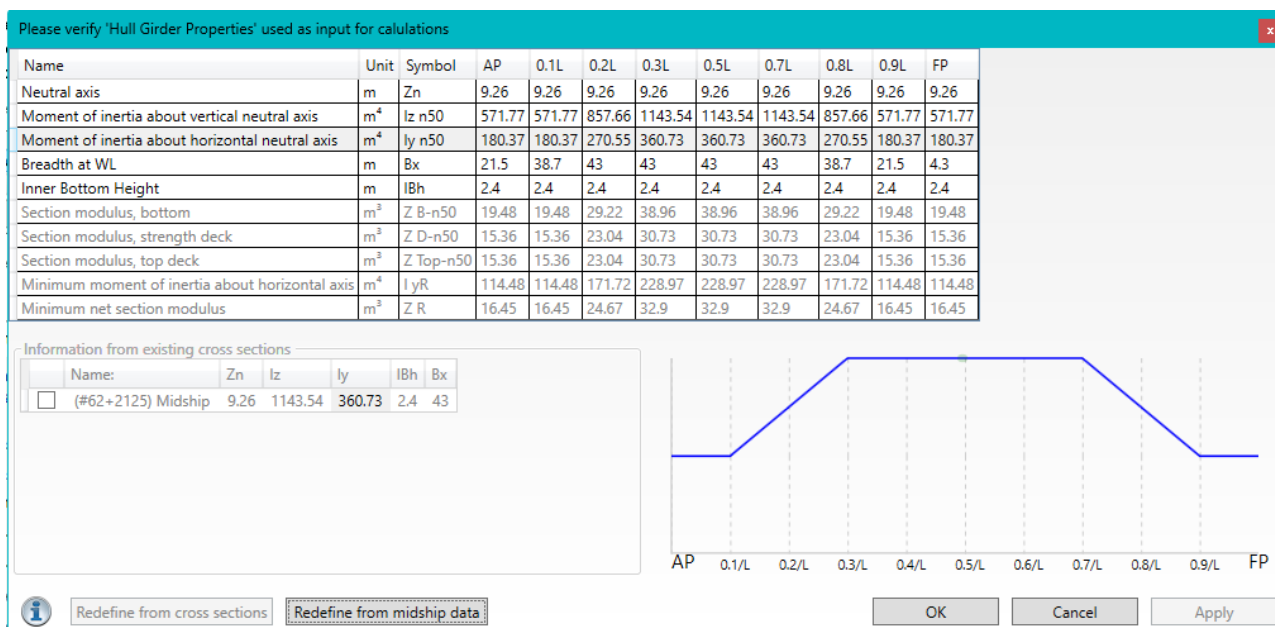
When saving and exiting the Rule Calculator, drawing is updated with indications on the status of the EPPs:



11 Rule calculator – hull girder properties

When using Rule Calculator, cross-section properties are taken from the data specified in **Hull girder properties**. This is used to estimate hull girder stresses and define other parameters not available in the Rule Calculator interface, like the breadth at waterline used to calculate dynamic sea pressure.

The Hull girder properties can be taken from the cross-section analysis results and entered manually or retrieved from already calculated cross-sections.

Name	Unit	Symbol	AP	0.1L	0.2L	0.3L	0.5L	0.7L	0.8L	0.9L	FP
Neutral axis	m	Zn	9.26	9.26	9.26	9.26	9.26	9.26	9.26	9.26	9.26
Moment of inertia about vertical neutral axis	m ⁴	Iz n50	571.77	571.77	857.66	1143.54	1143.54	1143.54	857.66	571.77	571.77
Moment of inertia about horizontal neutral axis	m ⁴	Iy n50	180.37	180.37	270.55	360.73	360.73	360.73	270.55	180.37	180.37
Breadth at WL	m	Bx	21.5	38.7	43	43	43	43	38.7	21.5	4.3
Inner Bottom Height	m	IBh	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Section modulus, bottom	m ³	Z B-n50	19.48	19.48	29.22	38.96	38.96	38.96	29.22	19.48	19.48
Section modulus, strength deck	m ³	Z D-n50	15.36	15.36	23.04	30.73	30.73	30.73	23.04	15.36	15.36
Section modulus, top deck	m ³	Z Top-n50	15.36	15.36	23.04	30.73	30.73	30.73	23.04	15.36	15.36
Minimum moment of inertia about horizontal axis	m ⁴	IyR	114.48	114.48	171.72	228.97	228.97	228.97	171.72	114.48	114.48
Minimum net section modulus	m ³	Z R	16.45	16.45	24.67	32.9	32.9	32.9	24.67	16.45	16.45

Information from existing cross sections

Name:	Zn	Iz	Iy	IBh	Bx
☐ (#62+2125) Midship	9.26	1143.54	360.73	2.4	43

Graph showing the distribution of properties along the length of the ship (AP to FP).

Buttons: Redefine from cross sections, Redefine from midship data, OK, Cancel, Apply.

The cross-section properties are derived from the minimum hull girder requirements between AP and FP.

The cross-section properties may be edited and new longitudinal positions can be inserted.

See Rule Calculator user manual for more information.

12 Hull form geometry

A surface geometry model describing the hull form can be utilised to simplify the following tasks:

Modelling outer shell geometry

Create outer shell for a cross-section by making a transverse intersection of the hull form at a given X-position.

Determination of chord length for stiffeners

During cross-section analysis, program will use the hull form to determine the actual chord length of longitudinals outside parallel area, i.e. typically in fore- and aft ship.

Bow impact rule check

Determination of flare angle and waterline angle for calculation of bow impact pressure. Angles are automatically determined during cross-section analysis.

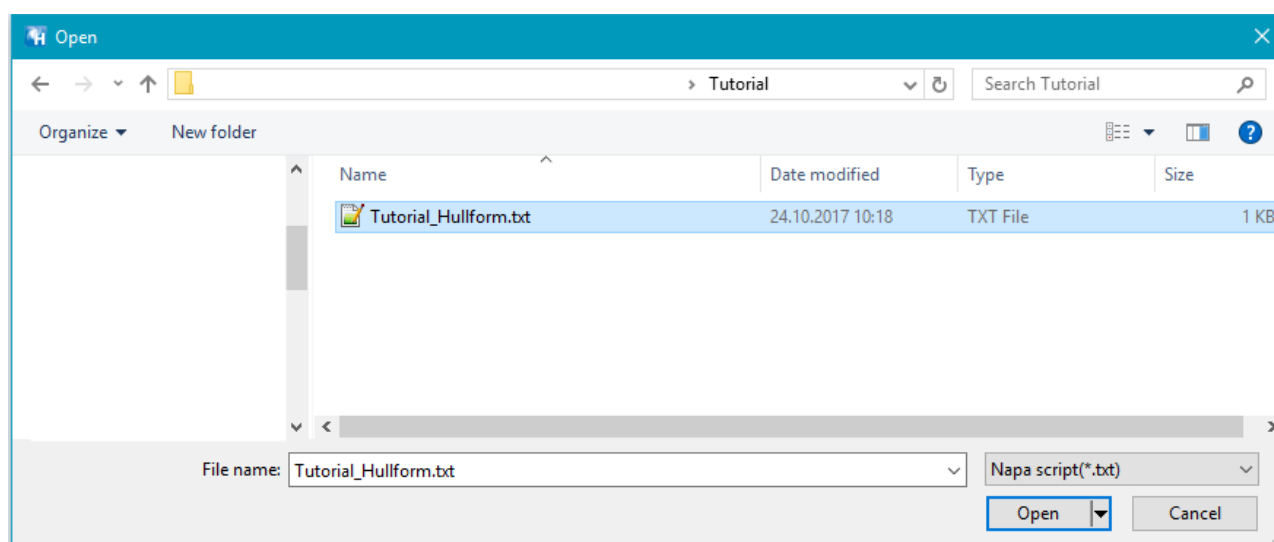
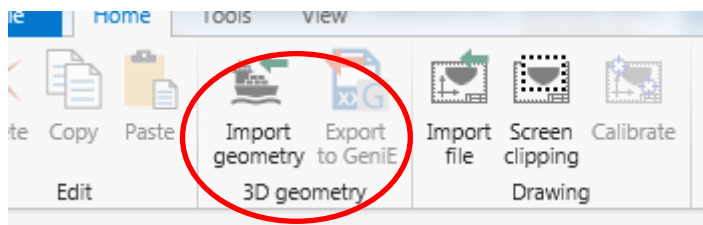
Ice, including Polar class rule check

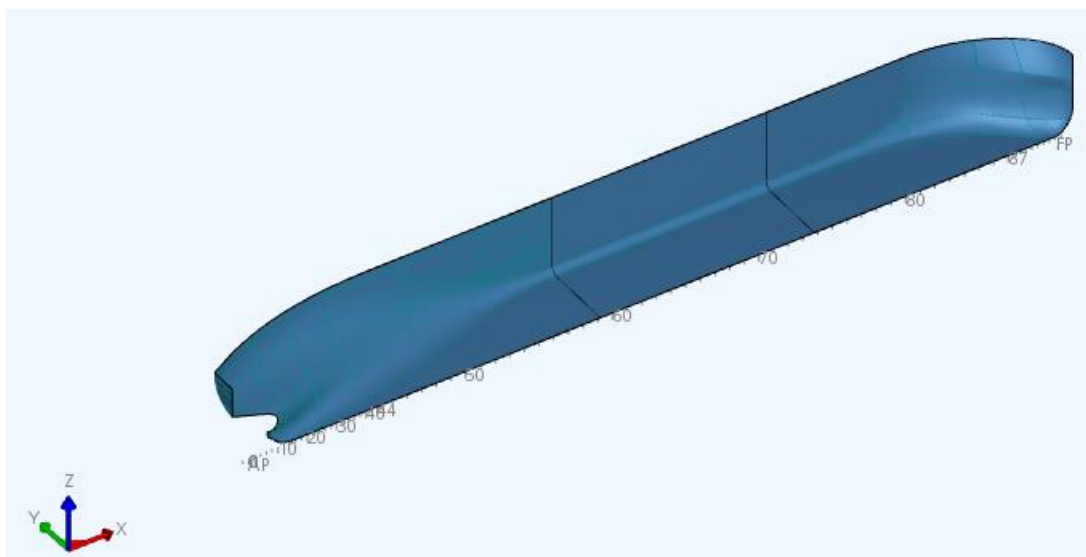
Determination of ice regions and angles for ice load calculations performed in the cross-section analysis.

12.1 Import hull form geometry

Typically a hull form definition from NAPA will be used. This file contain NAPA commands describing the curves and positions which the surfaces are based on.

Go to **Resources** | **Import geometry**, import the hull form available in the course folder:





For more information regarding use of the 3D model other than shown below, please refer to **Nauticus Hull 3D geometry modelling** document.

Create a new cross-section at position #88+400, define outer shell by intersecting the hull form:

New cross section

Name:

Frame 88+400 from hull form

Position #:

#88+400

☒ Intersect 3D model/hull definition

Adjacent main structural positions

2. aft: #86

1. aft: #87

1. fwd: #90

2. fwd: #93

Add position

Span of longitudinals:

2550.0 [mm]

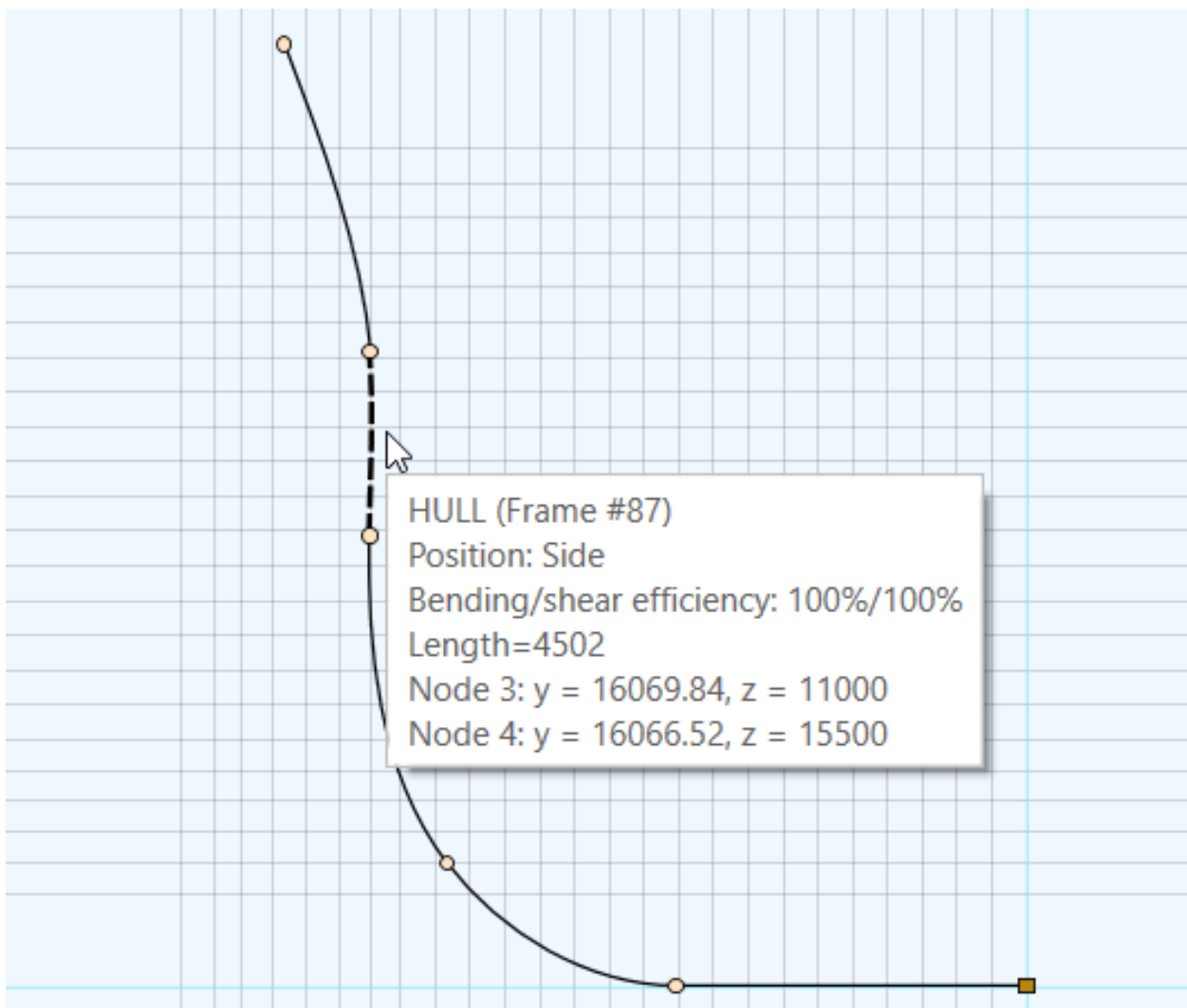
Standard spacing between trv. stiffeners:

800.0 [mm]

☐ Within cylindrical part of the ship

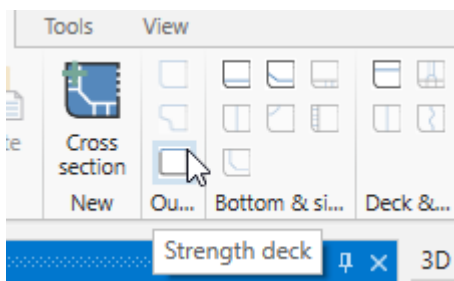
Ok

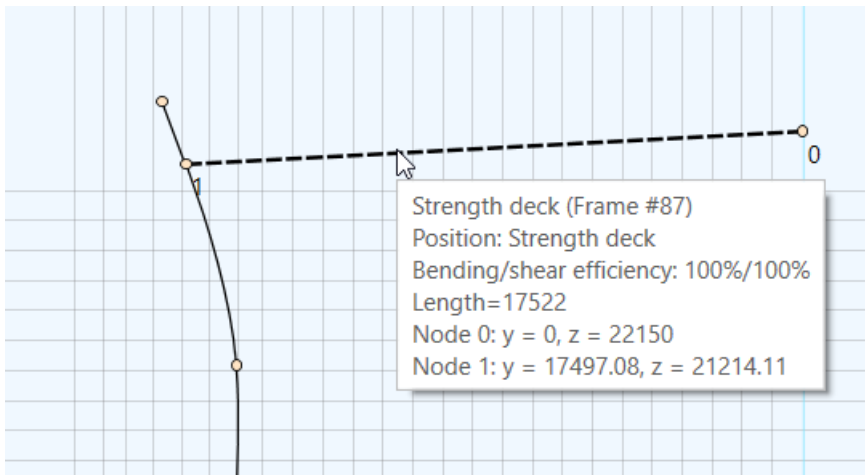
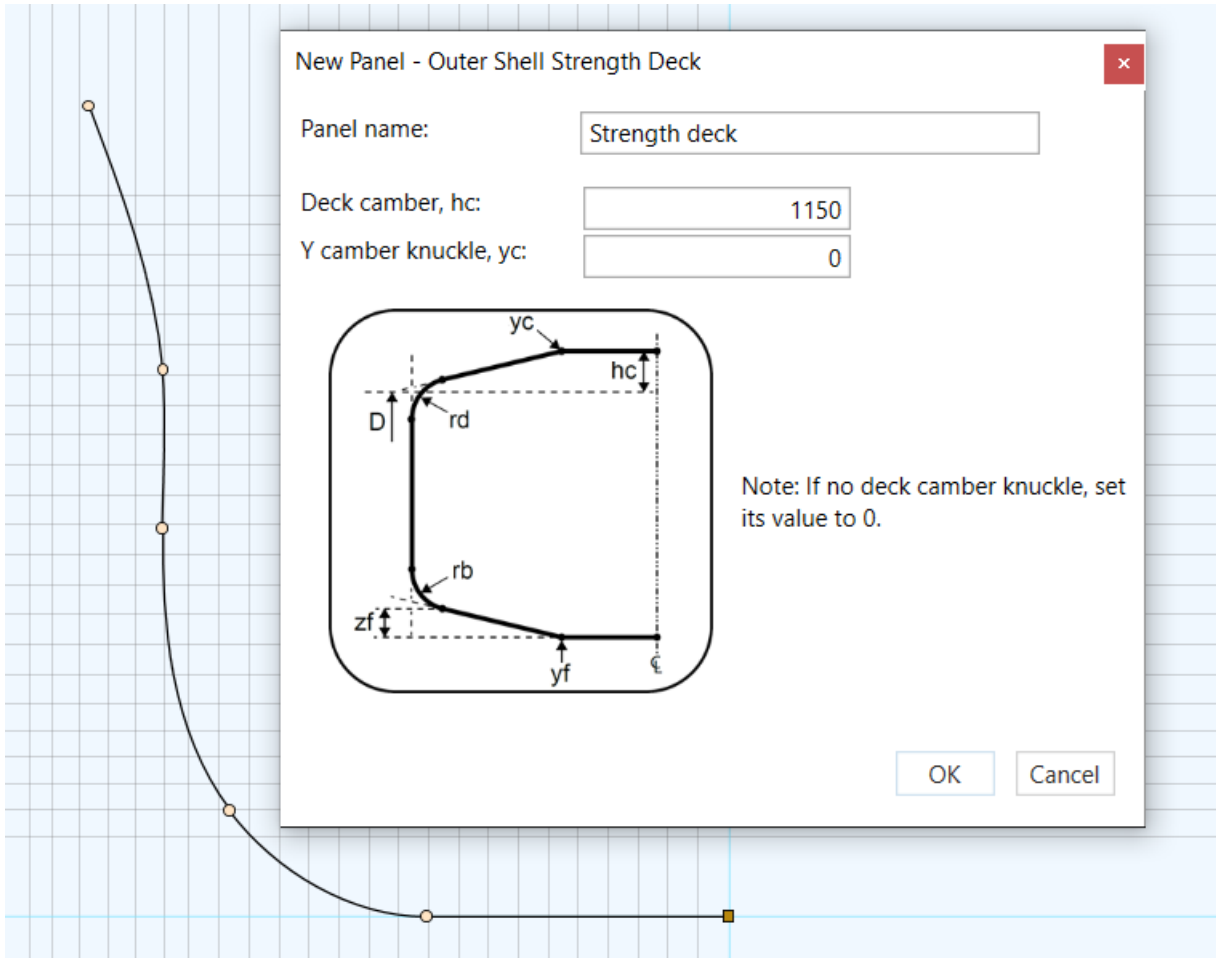
Cancel



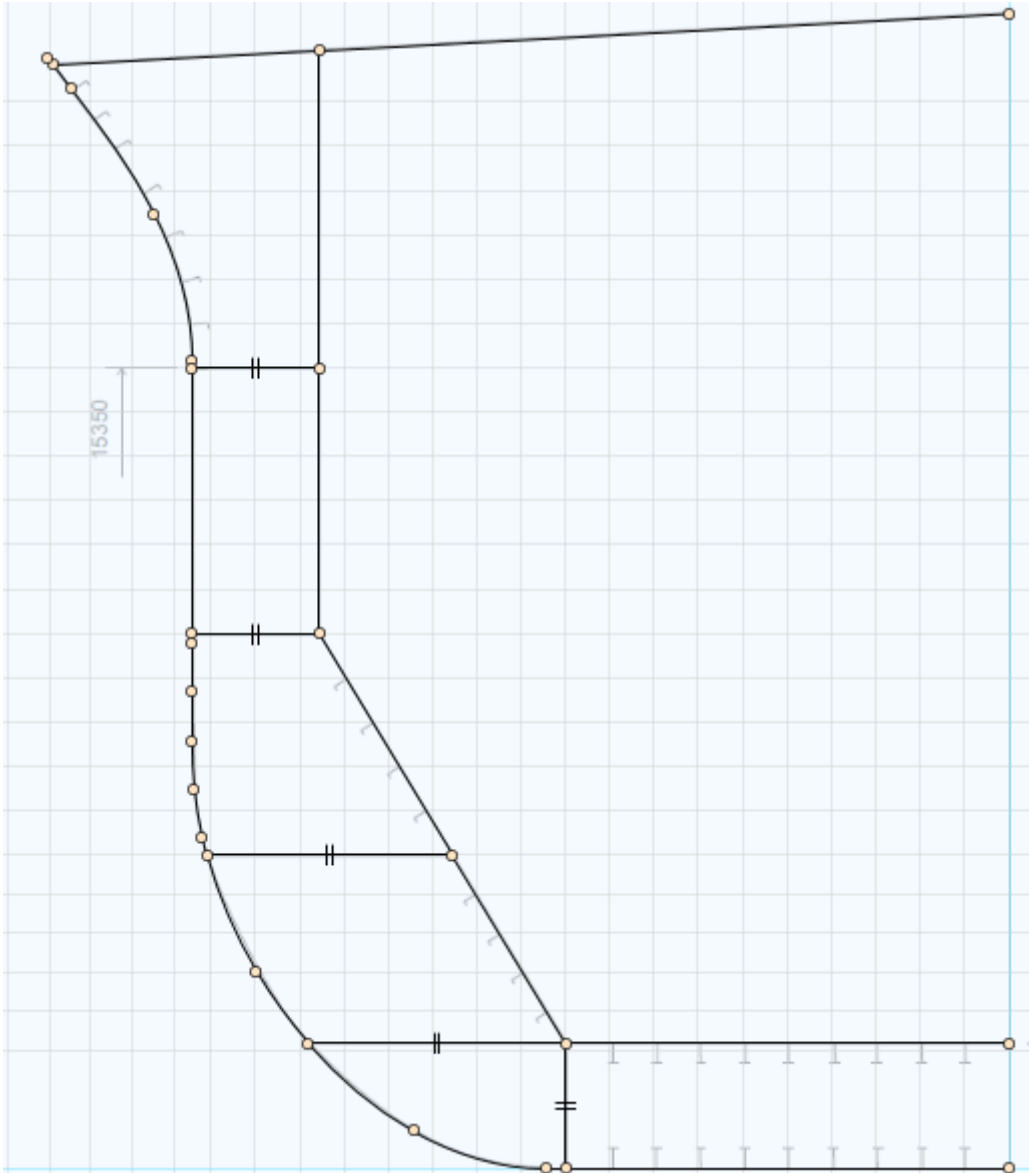
Inspect and modify the segment position codes as needed. In particular the bilge/bottom area may need adjustments due to the curvature.

Strength deck can be inserted by wizard:





Delete redundant nodes and add panels, set proper position codes:





ABOUT DNV

DNV is an independent assurance and risk management provider, operating in more than 100 countries, with the purpose of safeguarding life, property, and the environment. As a trusted voice for many of the world's most successful organizations, we help seize opportunities and tackle the risks arising from global transformations. We use our broad experience and deep expertise to advance safety and sustainable performance, set industry standards, and inspire and invent solutions.