
NAUTICUS HULL
TUTORIAL

**Containership
Cross-section
analysis**

Reference to part of this report which may lead to misinterpretation is not permissible.

No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
1.0	2019-09-10	First issue			

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CONTENTS

1	INTRODUCTION	5
1.1	User interface	6
1.2	Hotkeys and mouse	7
1.3	Concept Sketch	8
2	NEW WORKSPACE.....	11
3	SHIP DATA.....	12
3.1	Identification data	12
3.2	Applicable rules	13
3.3	General ship data	14
3.4	Frame table	16
3.5	Y/Z-grid	17
3.6	Main structural arrangement	18
3.7	Ice class	19
4	HULL GIRDER LOADS	20
4.1	Hull girder loads	20
5	LIBRARY	21
5.1	Materials	21
5.2	Profiles	22
5.3	End connections	23
6	SECTION SCANTLINGS	25
6.1	Establish the cross-section	25
6.2	Create outer shell	28
6.3	Plates	50
6.3.1	Strength deck	54
6.3.2	Deck 2	54
6.3.3	Deck 3	54
6.3.4	Deck 4	54
6.3.5	Inner bottom	55
6.3.6	Longitudinal Bulkhead 23	55
6.3.7	Longitudinal Bulkhead 26	55
6.3.8	Longitudinal Girders	55
6.3.9	Vertical Coaming	55
6.3.10	Horizontal Coaming	55
6.3.11	Plates completed	56
6.4	Longitudinal stiffeners	59
6.4.1	Outer shell	60
6.4.2	Longitudinal Bulkheads	81
6.4.3	Strength deck and Coaming	84
6.4.4	Decks	85
6.4.5	Inner bottom	87
6.4.6	Longitudinal Girders	91
6.4.7	Openings (cut-outs)	94
6.4.8	Completed longitudinal structure	96
6.4.9	Transverse stiffener in Pipe Duct	97
6.5	Apply end connection details	99
6.6	Compartments and loads	102
6.7	Re-use cross-section in other holds – copy/paste	110

7	CROSS-SECTION ANALYSIS	113
7.1	Running analysis	113
7.2	Plotting	116
7.3	Reporting	118
7.4	Saving result details to file (.h5)	119
8	USE OF DRAWINGS.....	120
8.1	Example of use of background drawing	122
9	HULL FORM GEOMETRY	124
9.1	Import hull hull form geometry	124
10	DATA PREPARED IN ADVANCE.....	127

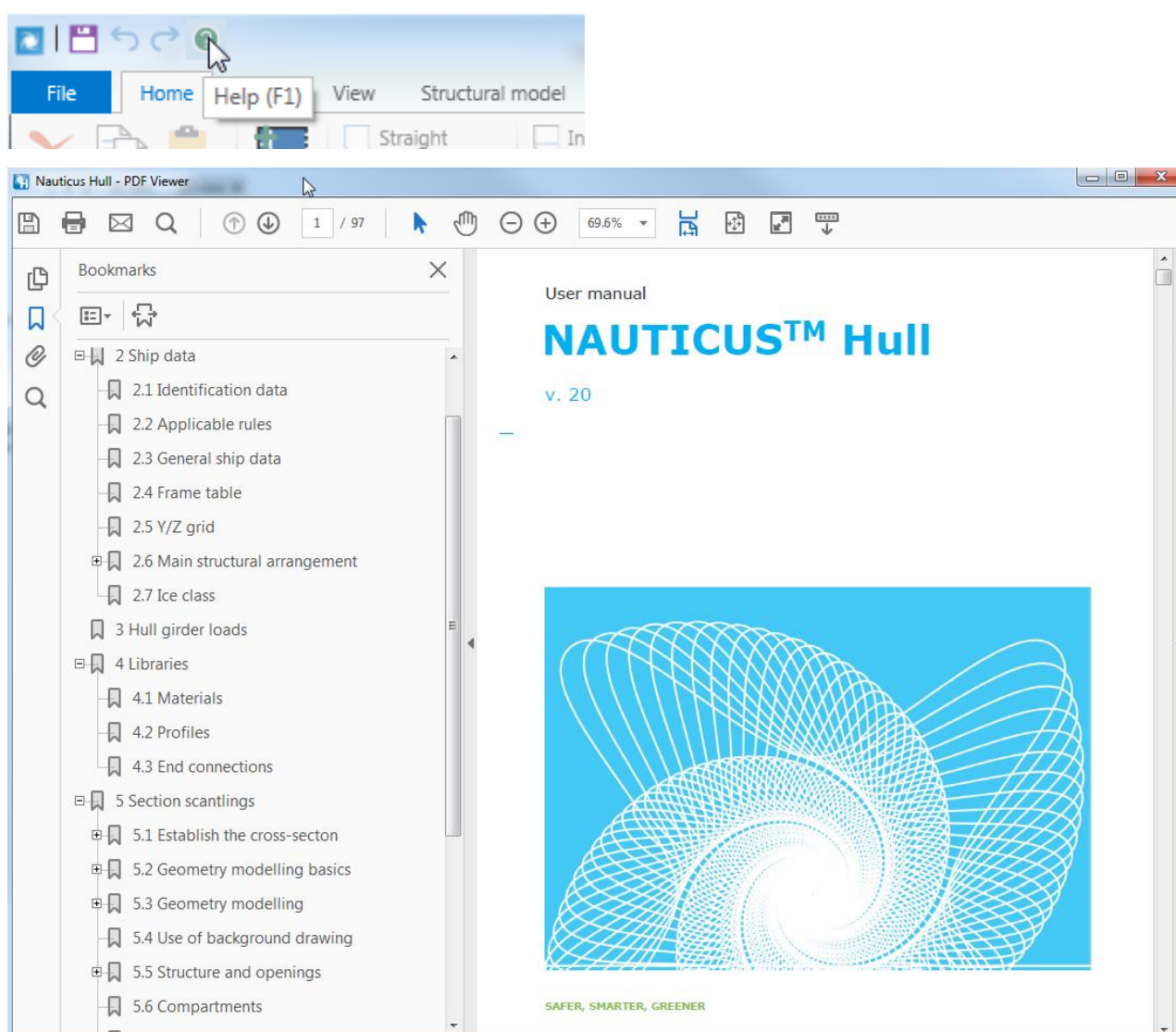
1 Introduction

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 with the background of DNV GL rules.

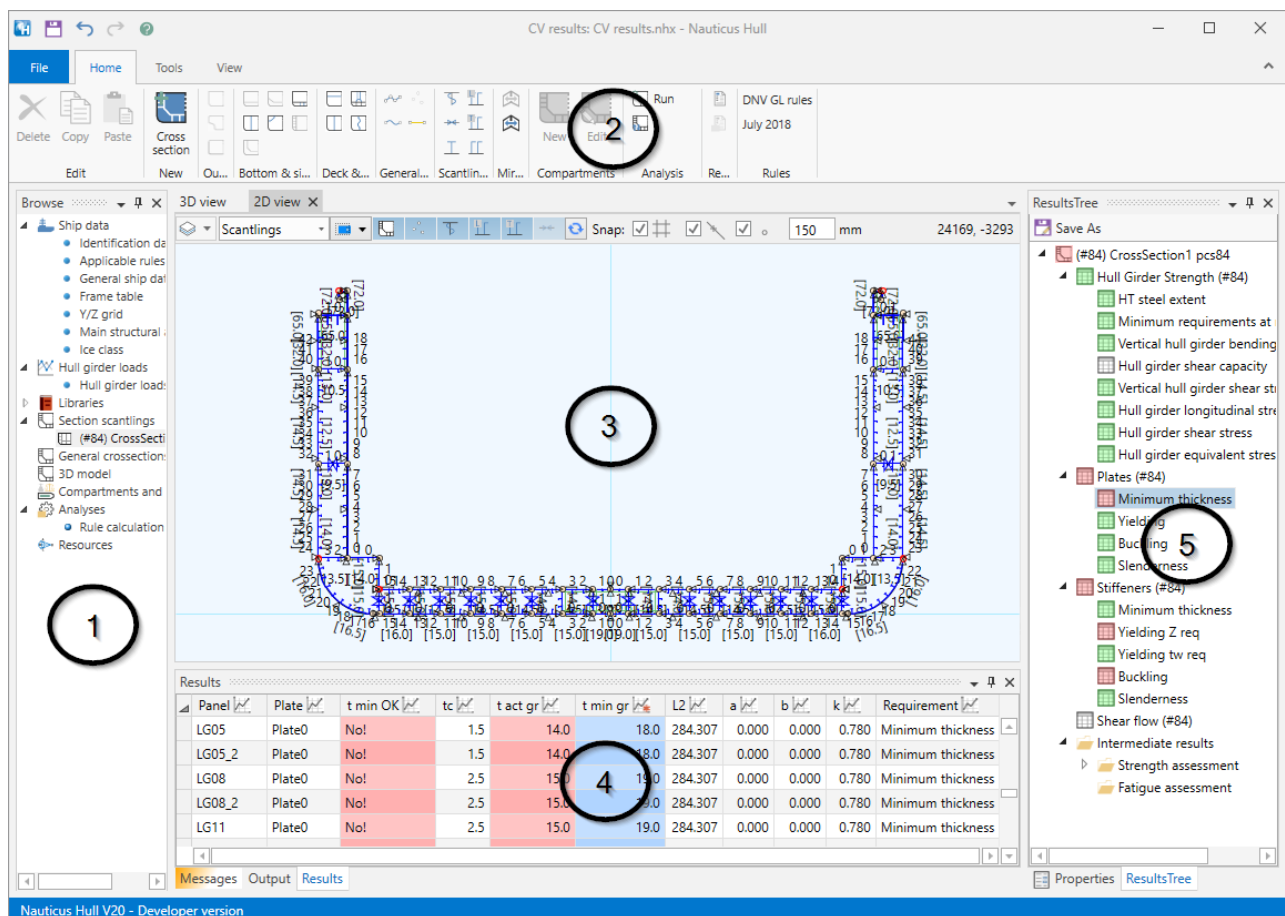
This tutorial is linked to **modularized sample files** where the user might decide to step in at later chapters or check his progress.

The intention of this tutorial is not to provide guidance on how to approach different vessel types or can be taken as design course.

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



1.1 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
Script log
Detailed results
- 5 – Properties and results
Modify and inspect properties for selected object
Selection of results to display

1.2 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:	Doubecllick
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

1.3 Concept Sketch

To Do

Collection of the characteristic ship's data which are necessary for the sizing of transverse sections.

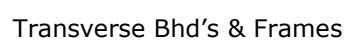
Requirements

This step does not require the prior completion of any Nauticus program section.

In this example the ship's characteristic dimensions and design parameters are as follows:

Ship Type:	Container Ship „CONTEST“
Class:	DNV GL Container Ship
Lpp:	289 m
LWL:	292 m
B:	48,2 m
H:	24,6 m
D1:	24,6 m
Deadweight dwt:	110875 t
T:	14,5 m
cB :	0,70
V0 :	22 kn
T (normal ballast):	6,6 m
T (smallest design draught at FP):	10 m
Deepest equilibrium waterline:	14,5 m
Floor spacing:	3.250 mm
Transverse frame spacing:	765 mm
XA:	Fr. 66

The abbreviations conform to the syntax in the DNV GL Rules. For more information call the Online Help for this section. For the first pictorial representation of the midship section, a concept sketch has been made up.



Location	Longl. No.	Scantlings
Upper Deck	-	800x64 FB , VL-40FA
Side Shell	33 – 35	350x11 + 150x18 T , VL-32
	36 – 40	300x11 + 140x15 T , VL-32
	42	300x90x13/17 L , VL-32
	43 – 45	300x90x11/16 L , VL-32
	46 - 49	250x90x10/15 L , VL-32
	51 - 52	320x32 FB , VL-32
	53	400x32 FB, VL-36
Bottom & Bilge	0 – 1	200x90x10/14 UA, VL-32
	3, 4 , 12-16	400x100x13/18 L , VL-32
	6 – 10	350x100x12/17 , VL-32
	18 – 19	350x11 + 150x15 T , VL-32
	21 – 22	350x11 + 150x18 T , VL-32
	24 – 31	400x12 + 150x18 T , VL-32
Longitudinal Bhd's	30 – 35	350x100x12/17 , VL-32
	36 – 40	300x90x11/16 L , VL-32
	42 – 43	250x90x10/15 L , VL-32
	44 – 49	200x90x10/14 L , VL-32
	51 – 52	320x32 FB , VL-32
	53	400x32 FB, VL-36
4 th Deck	24 – 25	300x11 + 140x15 T , VL-32
	27 – 28	300x90x13/17 L , VL-32
Inner Bottom	0 – 1	150x90x12 L , VL-32
	3 – 19	300x90x13/17 L , VL-32
	21 – 22	300x11 + 140x15 T , VL-32
NWT Girders	-	150x90x12 L , VL-32
WT Girders	-	300x90x13/17 L , VL-32

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**.

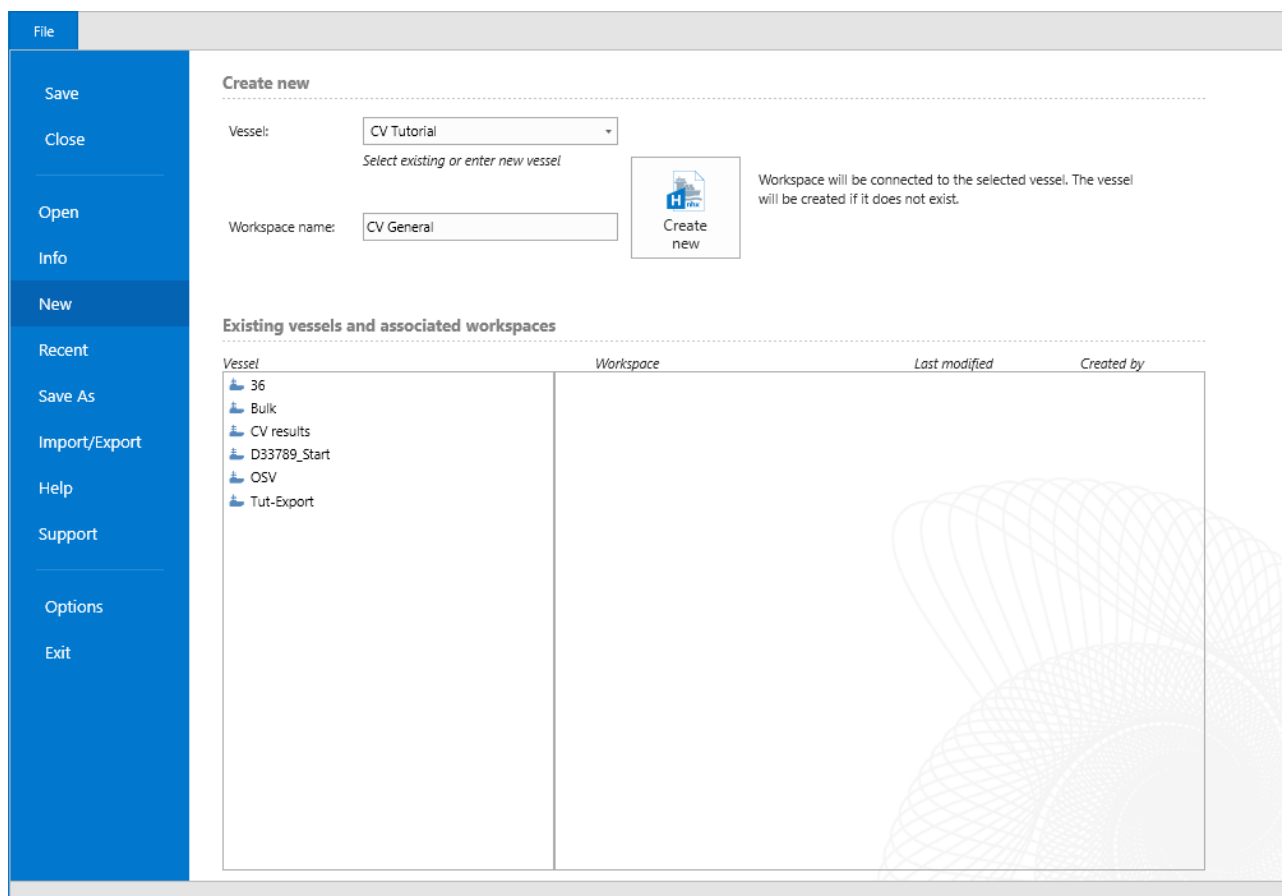
Select **File | Options** to inspect the current workspace folder, default workspace folder is:

C:\DNVGL\Workspaces\NauticusHull\Vessels

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

C:\DNVGL\Workspaces\NauticusHull\Vessels**<vessel name>**\<workspace name>

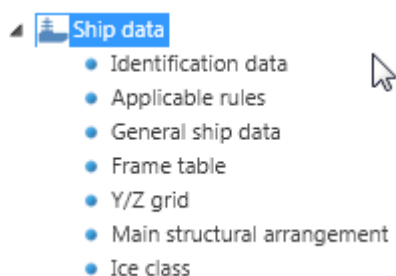
Select **File | New** and enter vessel identification, for instance "CV-Tutorial" and any workspace name, for instance "CV General" for beginning from scratch:



3 Ship data

Ship data is stored on workspace level, and not shared in 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.

3.1 Identification data

Project name	CV Training
Id number of ship	CV Tutorial
Date	3/27/2019 4:44:40 PM
Signature	Miches
Comment	This is the first module for general data

We recommend to follow up your own work with the help of the sample files.

This will give you more insight and enables you to detect any difference to your own modelling.

3.2 Applicable rules

The possibility to choose the rule version of a particular rule set enables us to calculate even older projects to their contraction date.

Applicable rules

- ☒ DNV GL rules
- ☐ DNV GL offshore rules
- ☐ IACS CSR for bulk carriers and oil tankers

Rule version:

July 2018

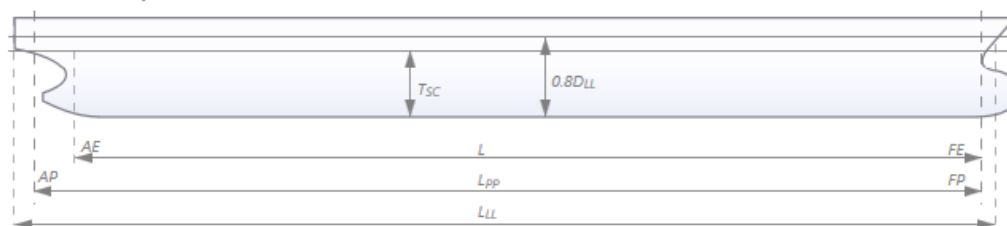
- ☐ No ship type notation
- ☐ Bulk carriers and dry cargo ships
- ☒ Container ships (under development, see info)
- ☐ RO/RO ships
- ☐ Passenger ships
- ☐ Oil tankers
- ☐ Chemical tankers
- ☐ Liquefied gas tankers
- ☐ Compressed gas tankers
- ☐ Offshore service vessels
- ☐ Vessels for special operations
- ☐ Non self-propelled units
- ☐ Fishing vessels
- ☐ Naval and naval support vessels
- ☐ Service area restrictions
- ☐ Ice strengthening
- ☐ ESP notation
- ☐ Special operations are applicable

Container ship with IACS UR S11A	
☐ Offshore service vessel	
☐ Standby vessel	
None	
None	

- ⇒ For recalculating older projects you may choose "Containerships without S11A" to meet the requirements prior IACS UR S11A.

3.3 General ship data

General ship data



Length between perpendiculars	Lpp	289.000	[m]	
Rule length	L	284.307	[m]	...
Freeboard length	LLL	292.000	[m]	
X-position for forward end of waterline for freeboard length		292.000	[m]	
Moulded breadth of ship	B	48.200	[m]	
Moulded depth of ship	D	24.600	[m]	
Moulded freeboard depth of ship	DLL	24.600	[m]	
Scantling draught	Tsc	14.500	[m]	
Design draught	TDesign	14.000	[m]	
Ballast draught (minimum midship)	TBAL	6.600	[m]	
Heavy ballast draught	TBAL-H	0.000	[m]	
Design slamming draught at FP (any ballast tanks empty)	Tf-e	6.000	[m]	
Design slamming draught at FP (all ballast tanks full)	Tf-f	6.600	[m]	
Block coefficient at scantling draught	Cb	0.700		...
Moulded displacement at scantling draught		142569	[t]	
Maximum service speed	V	22.0	[knots]	
Number of decks above 0.7 D from baseline		2		
Z coordinate of the bulkhead deck		24.600	[m]	
Deepest equilibrium waterline in damaged condition		14.500	[m]	
Ship with high speed and/or large flare		☒		
Projected area of upper deck forward 0.2 L	ADK	2399	[m ²]	
Area of waterplane forward 0.2 L at Tsc	AWP	948	[m ²]	
Vertical distance from summer load WL to deckline measured at F.E.	zf	10100	[mm]	
Area of waterplane at Tsc	AW	11764	[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		71560	[mm]	
Design still water torsion moment	Mst	342186	[kNm]	...

⇒ To insert the Design Still Water Torsional Moment please use the wizard just beside.

Torsional Moment calculator



Maximum number of 20' containers

9000

Mass of 20' container

14.000 [t]

OK

Cancel

3.4 Frame table

The frame table in x-direction shows the individual frame distances.

Frame table (X)

Position of Frame 0
 [mm] Fwd. 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>	600				
-5	800	-4.000	0.0000	-4.000	0.0000
18	2900	14.400	0.0341	14.400	0.0493
19	3250	17.300	0.0443	17.300	0.0592
21	1850	23.800	0.0672	23.800	0.0815
22	3050	25.650	0.0737	25.650	0.0878
24	3250	31.750	0.0952	31.750	0.1087
26	1850	38.250	0.1180	38.250	0.1310
27	760	40.100	0.1245	40.100	0.1373
35	815	46.180	0.1459	46.180	0.1582
43	820	52.700	0.1689	52.700	0.1805
66	2100	71.560	0.2352	71.560	0.2451
67	3050	73.660	0.2426	73.660	0.2523
69	3250	79.760	0.2640	79.760	0.2732
71	1850	86.260	0.2869	86.260	0.2954
72	3050	88.110	0.2934	88.110	0.3017
74	3250	94.210	0.3149	94.210	0.3226
76	1850	100.710	0.3377	100.710	0.3449
77	3250	102.560	0.3442	102.560	0.3512
79	3050	109.060	0.3671	109.060	0.3735
81	1850	115.160	0.3885	115.160	0.3944
82	3250	117.010	0.3951	117.010	0.4007
84	3050	123.510	0.4179	123.510	0.4230
86	1850	129.610	0.4394	129.610	0.4439
87	3250	131.460	0.4459	131.460	0.4502
89	3050	137.960	0.4687	137.960	0.4725
91	1850	144.060	0.4902	144.060	0.4934
92	3250	145.910	0.4967	145.910	0.4997
94	3050	152.410	0.5196	152.410	0.5220
96	1850	158.510	0.5410	158.510	0.5428
97	3250	160.360	0.5475	160.360	0.5492
99	3050	166.860	0.5704	166.860	0.5714
101	1850	172.960	0.5918	172.960	0.5923
102	3250	174.810	0.5984	174.810	0.5987
104	3050	181.310	0.6212	181.310	0.6209
106	1850	187.410	0.6427	187.410	0.6418
107	3250	189.260	0.6492	189.260	0.6482
109	3050	195.760	0.6720	195.760	0.6704
111	1850	201.860	0.6935	201.860	0.6913
112	3250	203.710	0.7000	203.710	0.6976
114	3050	210.210	0.7229	210.210	0.7199
116	1850	216.310	0.7443	216.310	0.7408
119	3050	221.860	0.7638	221.860	0.7598
121	1850	227.960	0.7853	227.960	0.7807
122	3250	229.810	0.7918	229.810	0.7870
124	3050	236.310	0.8147	236.310	0.8093
126	1830	242.410	0.8361	242.410	0.8302
127	3250	244.240	0.8426	244.240	0.8364
129	3050	250.740	0.8654	250.740	0.8587
131	1600	256.840	0.8869	256.840	0.8796
132	3250	258.440	0.8925	258.440	0.8851
134	3050	264.940	0.9154	264.940	0.9073
136	800	271.040	0.9368	271.040	0.9282
163	800	292.640	1.0000	292.640	1.0000

Frame converter
[mm]

X/L

X_{rules}

X_{LL}/L_{LL}

X_{LL}

[mm]

[mm]

[mm]

⇒ For time saving reasons you may copy the table from a prepared Excel table: CV Tutorial.xls

3.5 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.

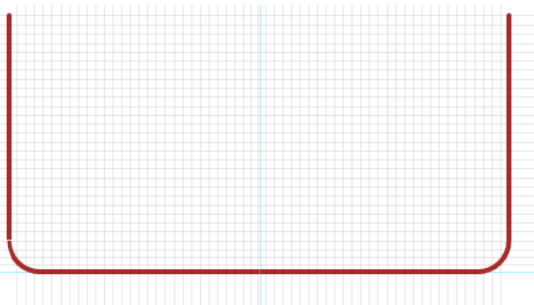
Z-grid lines are horizontal lines positioned at given Z-coordinates, typically at the positions of stringers and longitudinal stiffeners on longitudinal structure.

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
Y0	2	725	0		P+S
Y2	21	840	1450		P+S
Y23	3	870	19090		P+S
Y26	3	800	21700		P+S
Z1	2	700		550	
Z3	26	864		2000	
Z29	3	1000		24600	



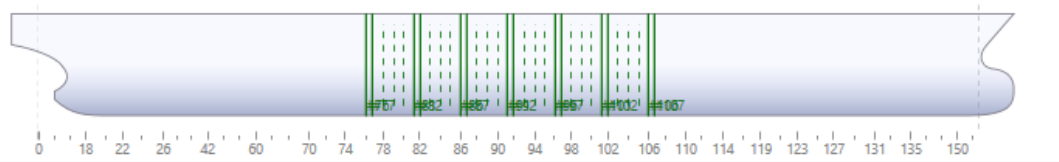
The horizontal grid lines are according to the stiffener and stringer locations on outer shell side.

3.6 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, compartment boundaries and calculation of connection strength.

Main structural arrangement



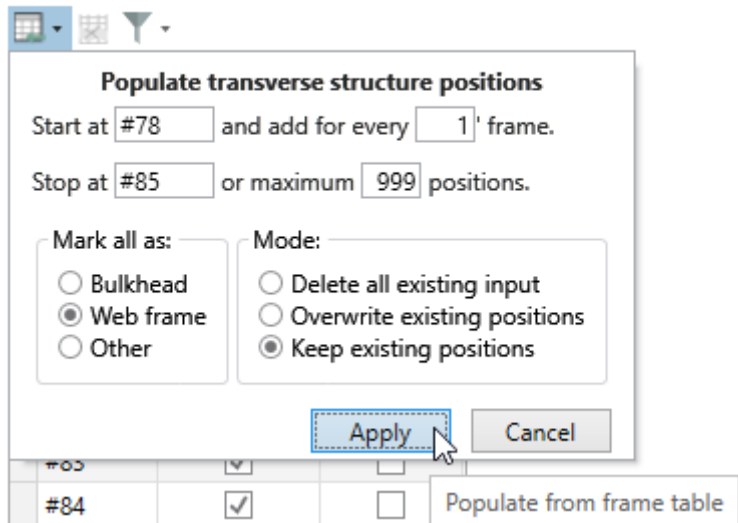
Bulkheads and web frames

Pos [#]	Web frame	Bulkhead
#76	☐	☒
#77	☐	☒
#78	☒	☐
#79	☒	☐
#80	☒	☐
#81	☐	☒
#82	☐	☒
#83	☒	☐
#84	☒	☐
#85	☒	☐
#86	☐	☒
#87	☐	☒
#88	☒	☐
#89	☒	☐
#90	☒	☐
#91	☐	☒
#92	☐	☒
#93	☒	☐
#94	☒	☐
#95	☒	☐
#96	☐	☒
#97	☐	☒
#98	☒	☐
#99	☒	☐
#100	☒	☐
#101	☐	☒
#102	☐	☒
#103	☒	☐
#104	☒	☐
#105	☒	☐
#106	☐	☒
#107	☐	☒
	☐	☐

Describe webframe and bulkhead positions in between on frames 76 and 107:

Press use the insert button 

Bulkheads and web frames



Populate transverse structure positions

Start at #78 and add for every 1' frame.

Stop at #85 or maximum 999 positions.

Mark all as:

- ☐ Bulkhead
- ☒ Web frame
- ☐ Other

Mode:

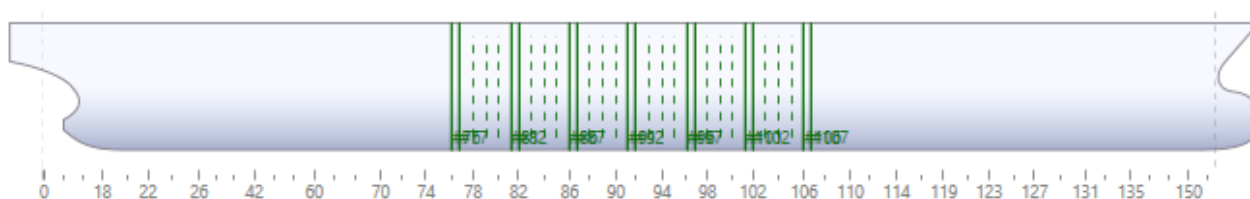
- ☐ Delete all existing input
- ☐ Overwrite existing positions
- ☒ Keep existing positions

Apply Cancel

#83	☐	☐	
#84	☒	☐	Populate from frame table

Repeat this for the next webframes and bulkheads as indicated in above table.

The result will look like below:



3.7 Ice class

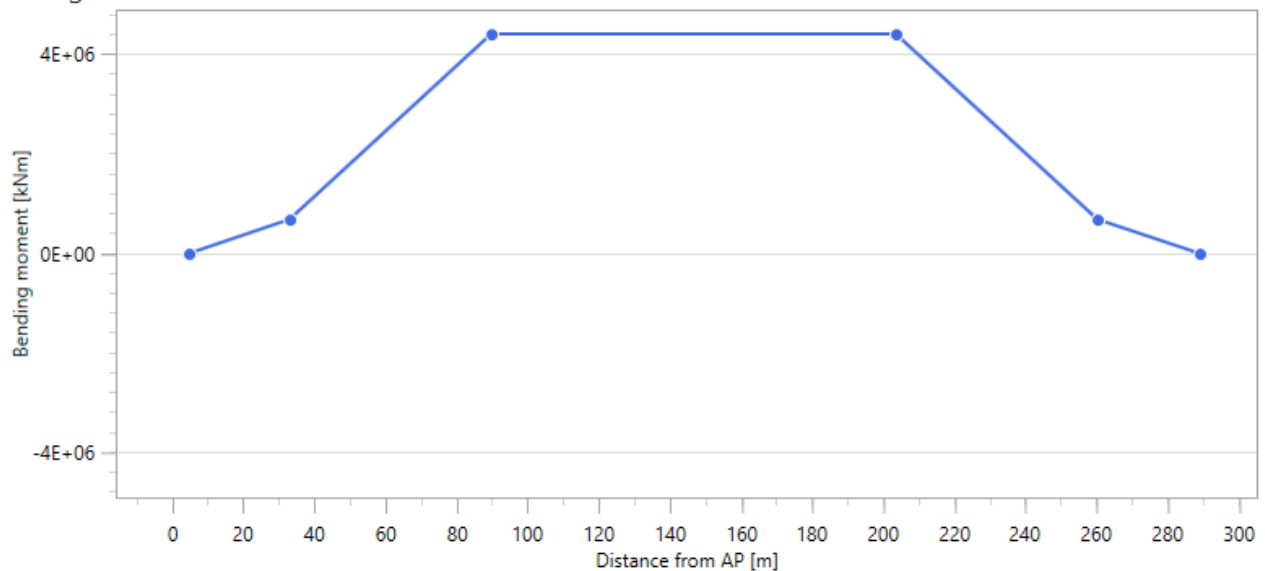
This vessel does not have any ice class notations ,leave as is.'

4 Hull girder loads

4.1 Hull girder loads

Hull girder loads are initially defined as the guidance values taken from the rules, keep as is:

Hull girder loads



Show:

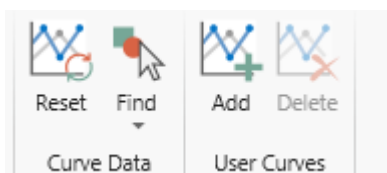
- ☒ Bending moments ☒ Stillwater
☐ Shear forces ☐ Wave
☐ BI-moments

Condition	Hog or sag	Description
Seagoing	Hogging	Maximum hogging
Seagoing	Min Hog	Minimum hogging
Seagoing	Ballast	BM in ballast condition (For FE fuel oil deep tank only)
Fatigue	Hogging	Maximum hogging
Fatigue	Min Hog	Minimum hogging
Seagoing	Torsion	User defined/Minimum
Harbour	Torsion	User defined/Minimum

Guidance values:

Pos (#)	xAP [m]	Guidance value [kNm]
#5+693	4.693	0
#24+1374	33.124	662354
#72+1875	89.985	4415697
#111+1848	203.708	4415697
#132+2129	260.569	662354
#158+360	289.000	0

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



5 Library

5.1 Materials

Any material used for plates and stiffeners shall be defined in the material library. Initially, 6 standard DNV GL materials are defined:

Name	Density (kg/m ³)	Yield stress (N/mm ²)	Material factor, k (-)	Tensile strength (N/mm ²)	Young's modulus (N/mm ²)	Shear modulus (N/mm ²)	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	0.62	570	206000	79231	Standard steel ▼
VL-40FA	7850	390	0.66	510	206000	79231	Standard steel ▼
							▼

First six standard materials can not be modified.

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.

This Containership is built of high tensile steels. Please input according materials

Selection criterias

Default material

Midship section steel material

	Material	HS-steel zone height
Above strength deck	VL-40FA ▼	
At deck	VL-36 ▼	2150 [mm]
Between	VL-32 ▼	
At bottom	VL-32 ▼	0 [mm]

Longitudinal extension of HS-steel

☒ Entire ship length
☐ From frame No to

⇒ Please note the difference in between VL-40 and VL-40FA (Fatigue Assessment)

⇒ The HS-steel zone height is measured from equivalent deck downward and from bottom upward

For special purpose you may add one another material by double click in the name field.

5.2 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									

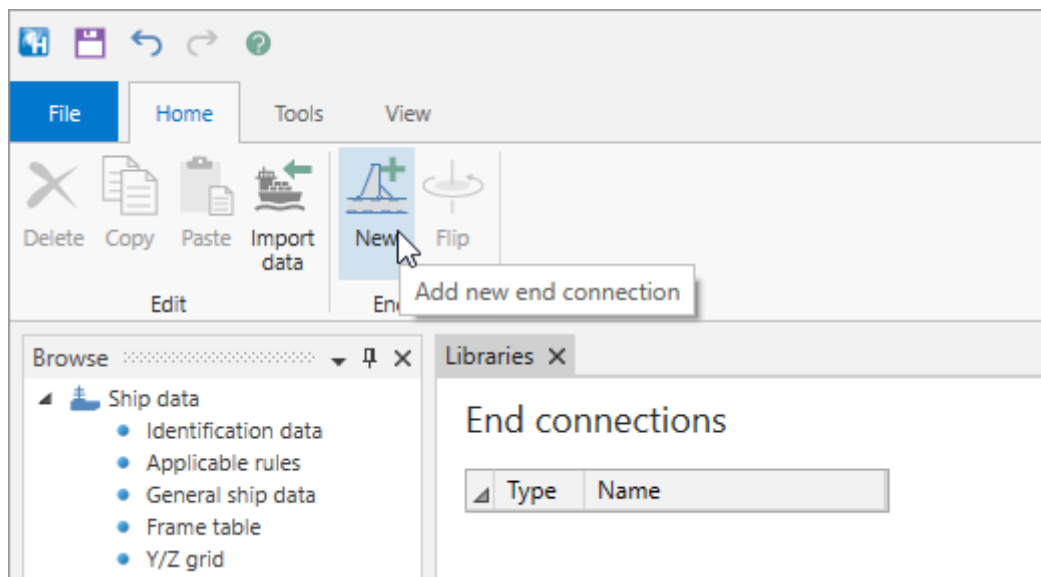
During stiffener definition, you will need to choose different profile types. To limit the list of profiles, you may tick off the **Selection** checkbox for the profiles that will be used.

Libraries X										
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]
☐	HP Bulb	120 x 7.0	120	120	7.0			10.5	21.1	149
☒	HP Bulb	120 x 8.0	120	120	8.0			11.7	23.6	165
☐	HP Bulb	140 x 6.0	140	140	6.0			11.0	25.4	216
☐	HP Bulb	140 x 7.0	140	140	7.0			12.4	29.0	241
☒	HP Bulb	140 x 8.0	140	140	8.0			13.8	32.5	266
☐	HP Bulb	140 x 9.0	140	140	9.0			15.2	36.0	291
☐	HP Bulb	140 x 10.0	140	140	10.0			16.6	39.5	315
☐	HP Bulb	160 x 7.0	160	160	7.0			14.6	38.6	373
☐	HP Bulb	160 x 8.0	160	160	8.0			16.2	43.3	411
☐	HP Bulb	160 x 9.0	160	160	9.0			17.8	47.9	449
☐	HP Bulb	160 x 11.0	160	160	11.0			21.0	57.0	522
☐	HP Bulb	160 x 11.5	160	160	11.5			21.8	59.2	540
☒	HP Bulb	180 x 8.0	180	180	8.0			18.9	55.9	609
☐	HP Bulb	180 x 9.0	180	180	9.0			20.7	61.8	663
☒	HP Bulb	180 x 10.0	180	180	10.0			22.5	67.7	717
☐	HP Bulb	180 x 11.0	180	180	11.0			24.3	73.5	770

5.3 End connections

Available end connection designs are according to DNVGL-CG-0129 Appendix A.2. Details for the end connections may be defined before you start modelling or during modelling.

End connection data will be used in fatigue calculations and determination of efficient 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 **EC1**:

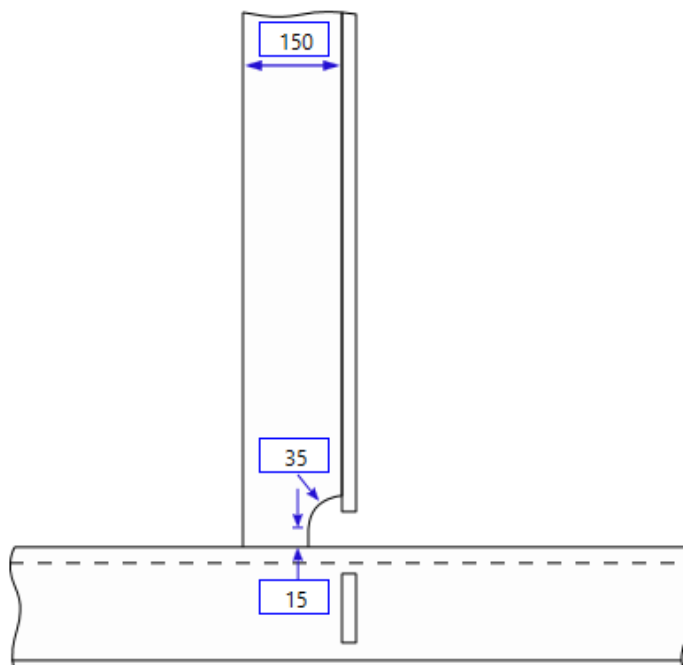


Type	Name
1	EC1

☒ Show input needed for connection area calculation

Material: VL-32

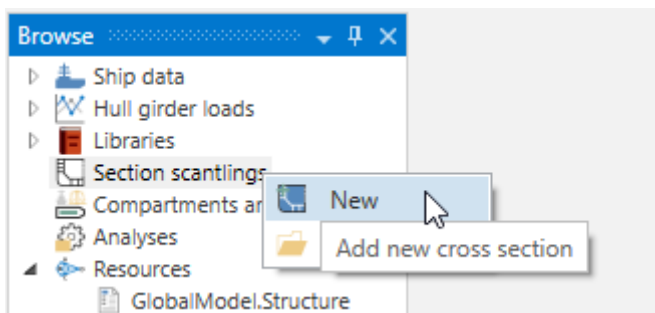
Thickness: 12



6 Section Scantlings

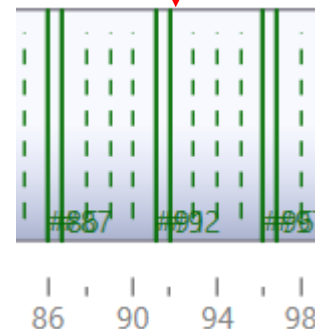
6.1 Establish the cross-section

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.

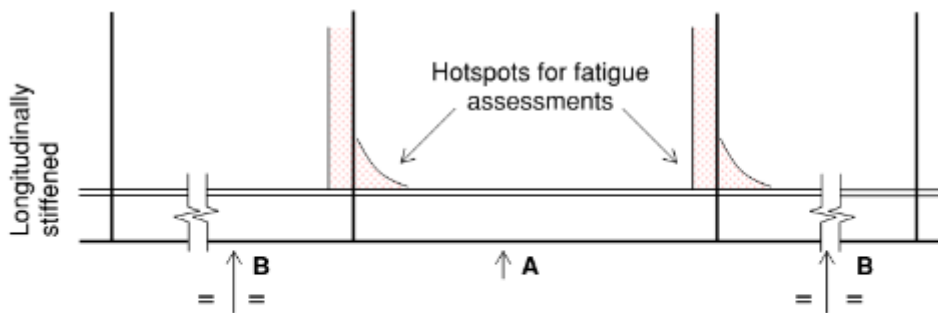


Give name **Midship** and position **#92+1625** which will use the midspan between #92 and #93.

Give **800 mm** as default spacing between transverse stiffeners.



- ⇒ Please note that the real midship position is located within the bulkhead area. As the most severe we will model a section with the largest frame distance nearby. Please see the following explanatory picture.



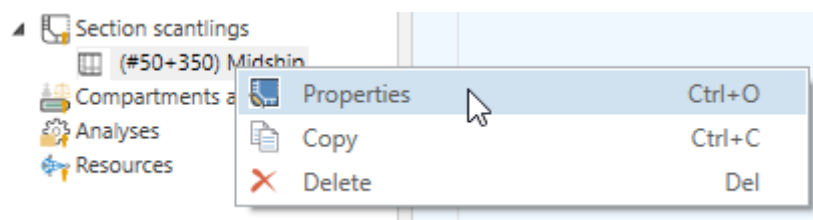
2nd aft, 1st aft, 1st fwd, 2nd fwd: Transverse bulkheads, girders or web frames defined as main structural positions.

A: Given by user. Cross-section position for calculation of local and global loads.

B: Determined by program. Positions for calculation of loads for connection strength requirements in way of 1st aft and 1st fwd.

Raw span of longitudinals will be the distance between #90 and #91.

You may modify properties from the cross-section's context menu by right mouse clicking on it:



Further the cross section properties will have to be given.

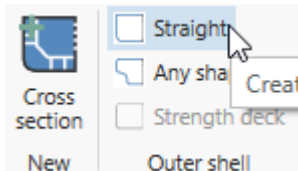
Please make reference to prior chapter 5.1 Materials.

Check the continuous strength member data and give the **width** of **21700mm** and **height** of **26600mm**.

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6.2 Create outer shell

Create outer shell and strength deck panels:



Now give the Bilge Radius with **4500mm** and the Sheer Strake overstand with **100mm**.

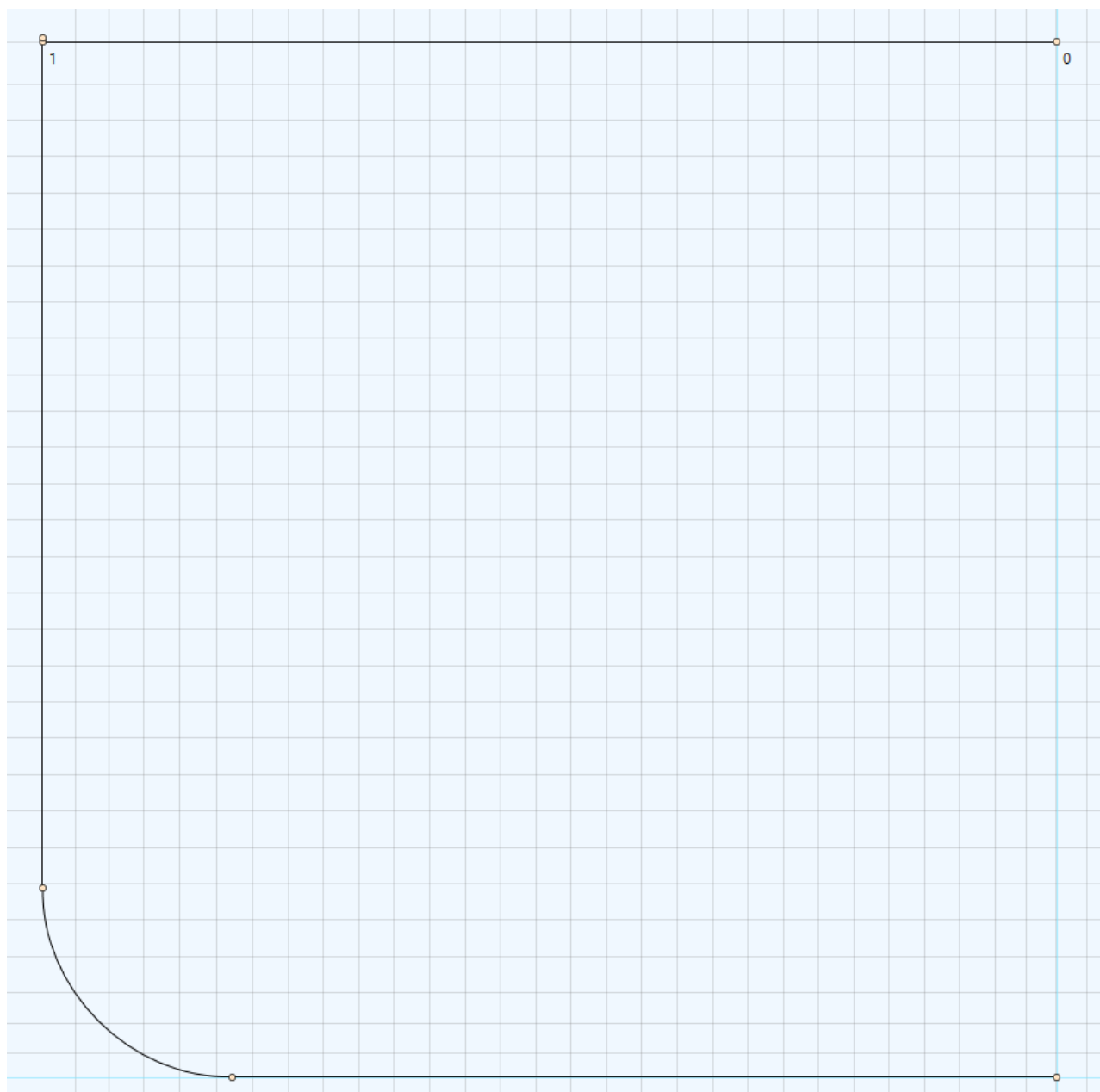
The dialog box 'New panel - outer shell' contains the following parameters:

Parameter	Symbol	Value	Unit
Panel name		Outer shell	
Deck camber	hc	0.0	[mm]
Y camber knuckle	yc	0.0	[mm]
Bilge radius	rb	4500.0	[mm]
Radius at deck corner	rd	0.0	[mm]
Sheer strake overstand	do	100	[mm]
Rise of floor	zf	0.0	[mm]
...starting at	yf	0.0	[mm]

Below the parameters is a diagram of a deck corner with labels: yc , hc , rd , rb , zf , and yf . A note states: "Note: To create a deck corner knuckle, set deck corner radius to 0 and define height of sheer strake overstand above strength deck. If no rise of floor or deck camber knuckles, set them to 0." At the bottom are 'OK' and 'Cancel' buttons.

By pressing **OK** the wizard will generate the Outer Shell and Strength Deck.

See next picture.



The centre line point (Node 0) of the strength deck shall now be edited in the Properties window to (21600;24600). Select the Strength Deck in the graphic window and open the Nodes:

Properties

Panel name
Strength Deck

Parameters

Calculations

Bending efficiency [%]	100
Shear efficiency [%]	100

Geometry

Nodes 2 items

[0]	(0 mm, 24600 mm)
-----	------------------

Coordinates

Y	Z
21600	ShipData.MainDimensions.D + 0 mm
Global	Global

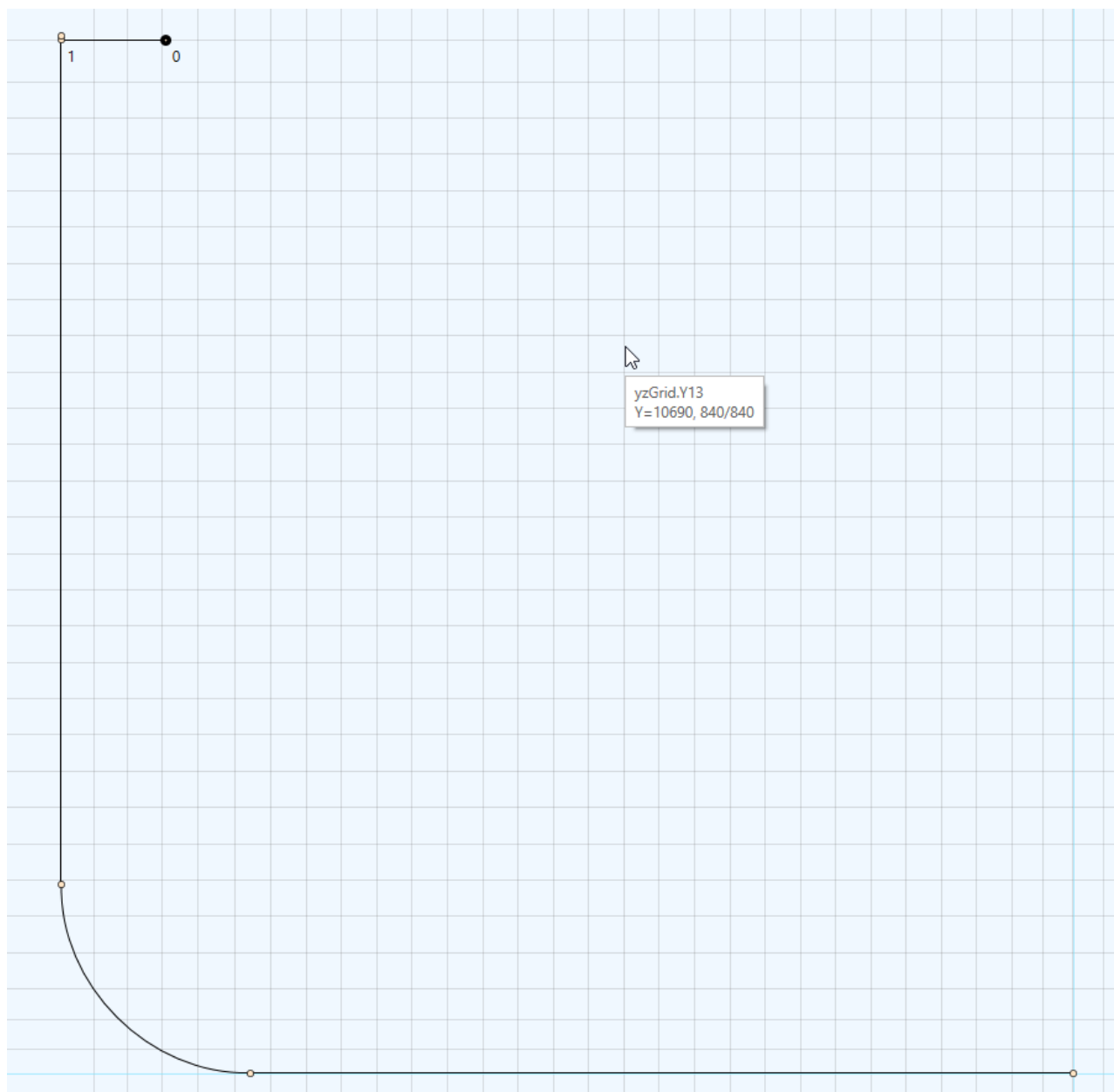
Intersect panel

<none>	<none>
--------	--------

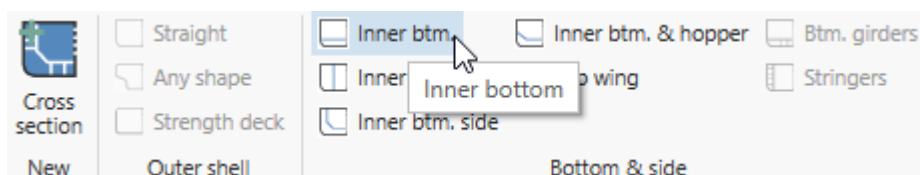
OK Cancel

Select the Node [0] and give for Y coordinate **21600mm**.

This will lead to the correct size of the Strength Deck width:



Continue with Inner bottom :



New panel - inner bottom

Panel name

Inner bottom

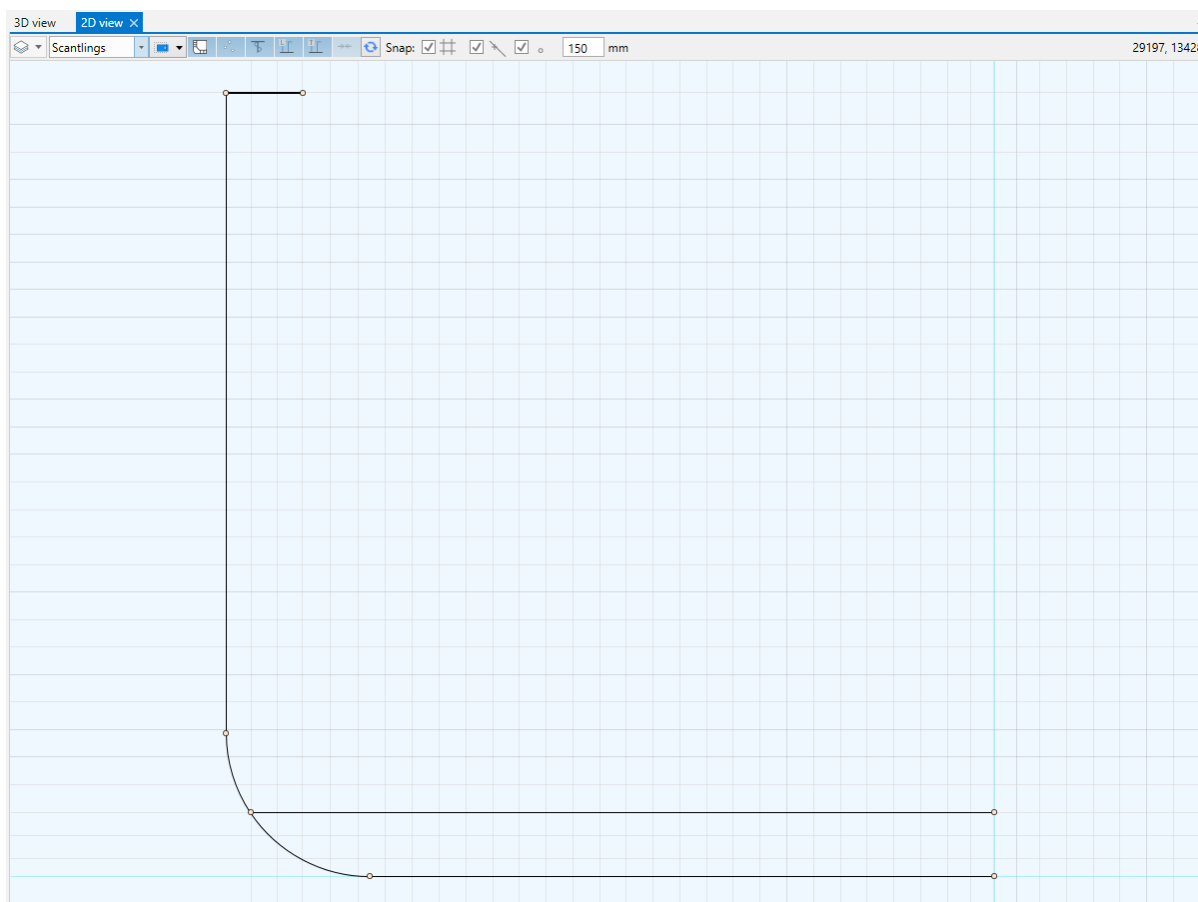
Height at centreline

2000 [mm]

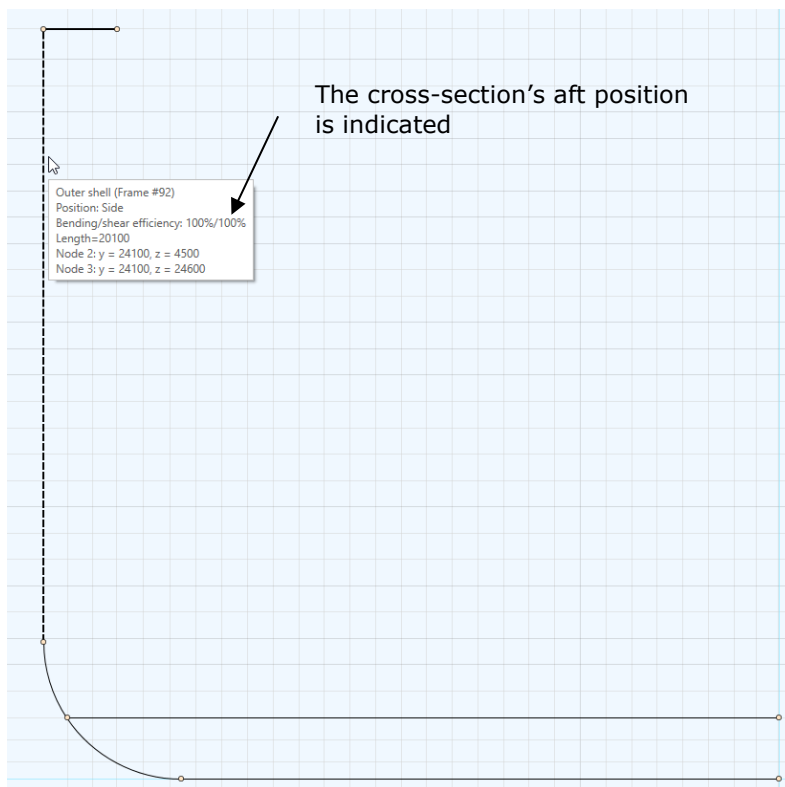
OK

Cancel

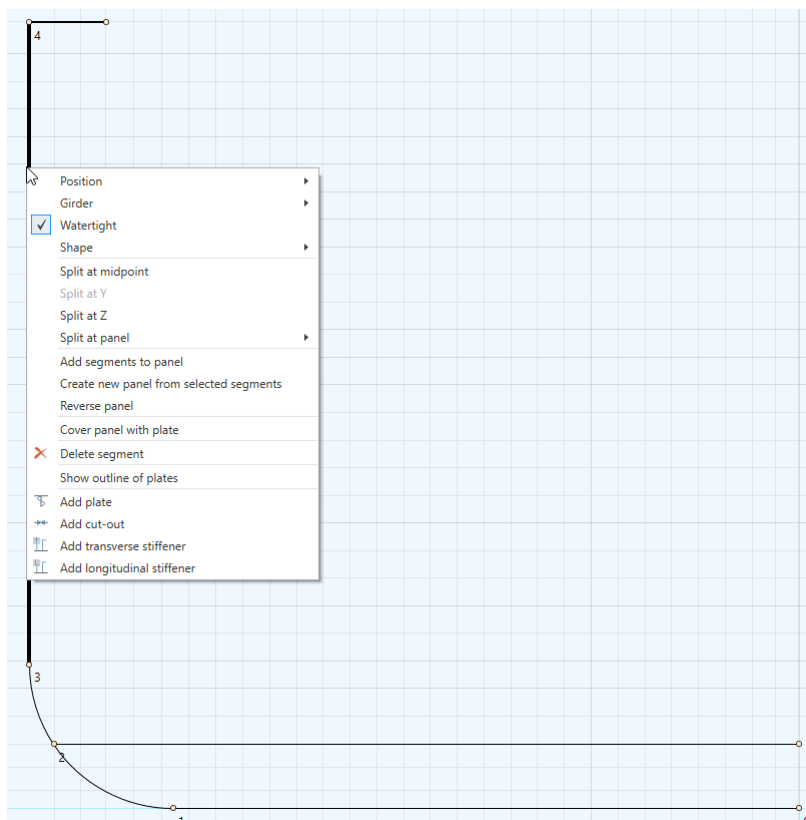
Your work will look like below picture:



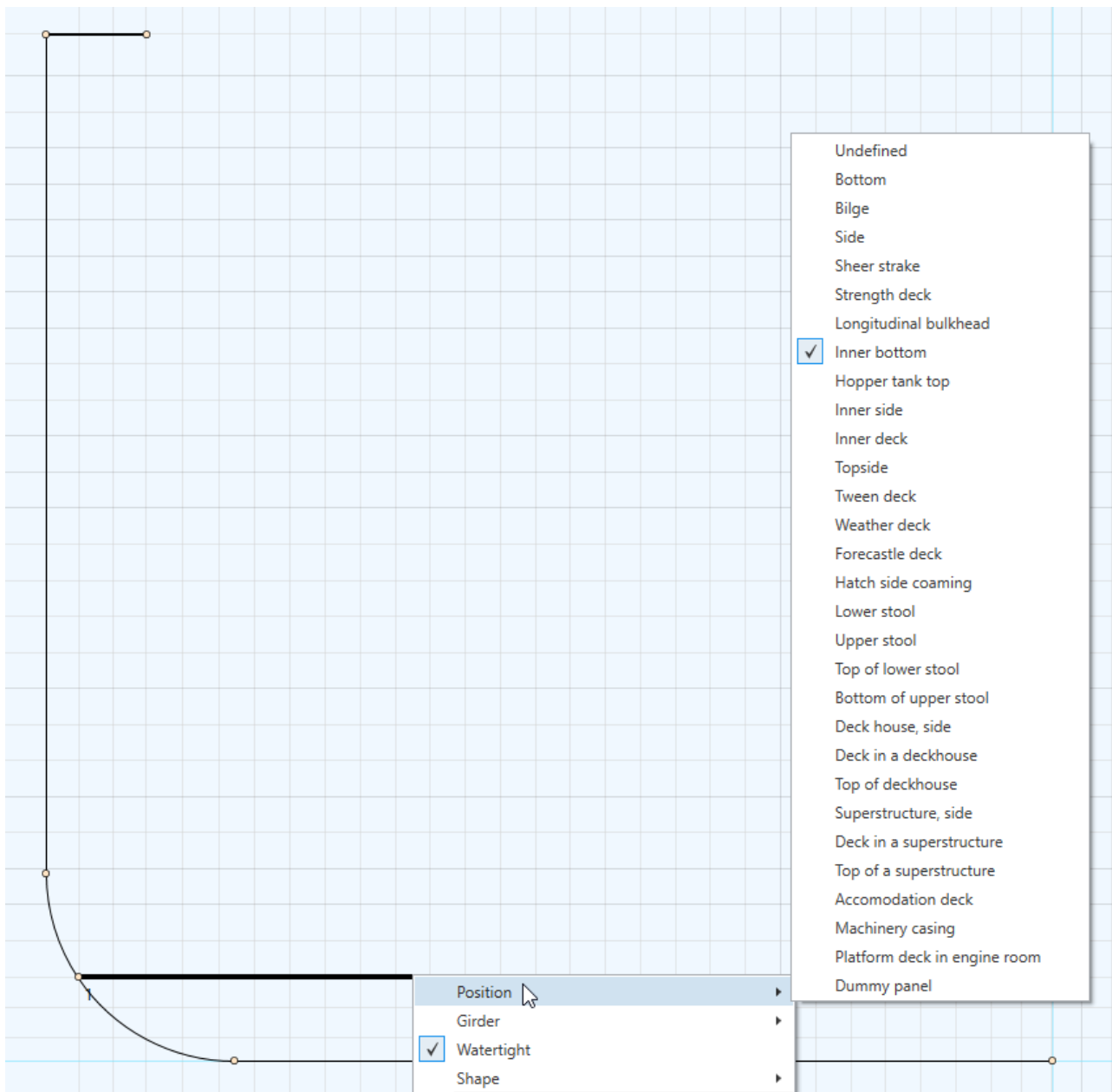
Save the workspace.



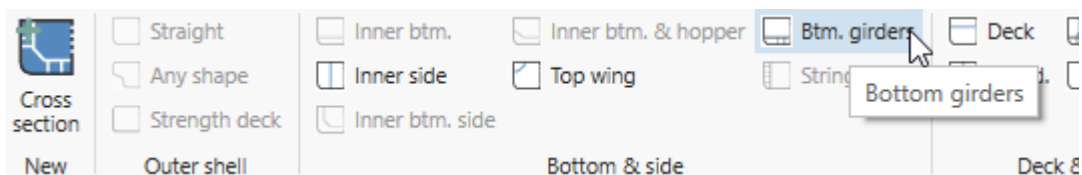
Tooltip are shown when hovering the various objects. Properties can be modified from the segment context menu by right mouse click:



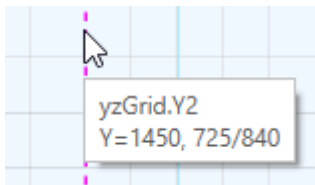
Now check the position code. Mark the segment and make a right mouse click.



Add double bottom girders:

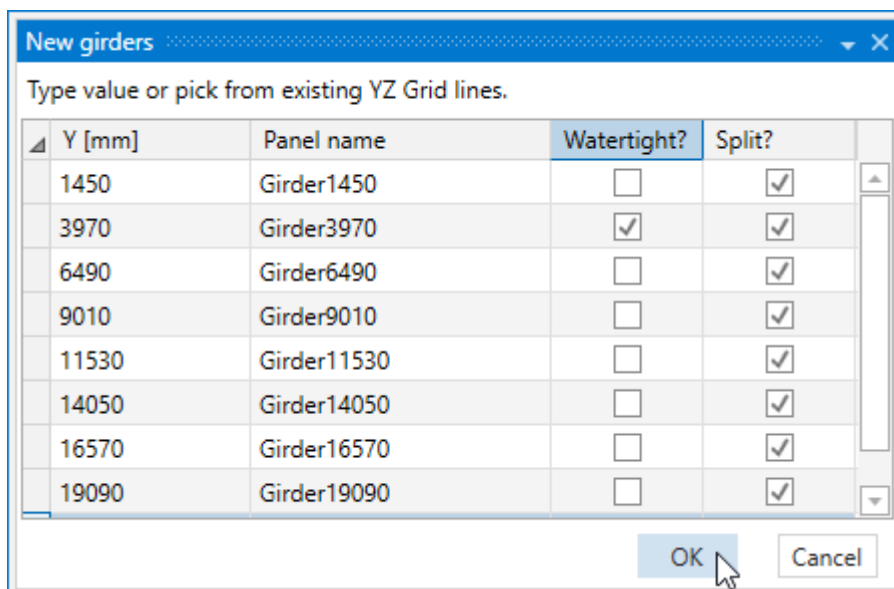


- ⇒ Please make use of the transverse frames. By clicking on them one or more girders are predefined:



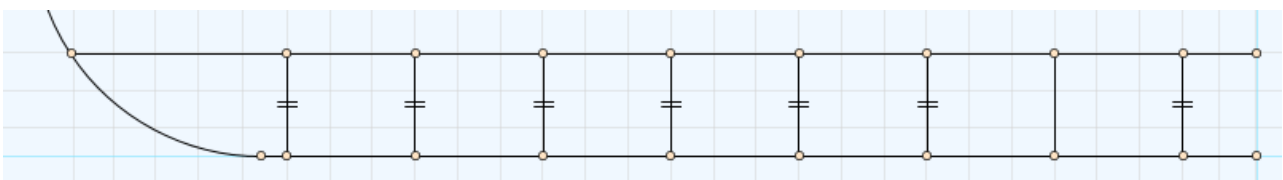
Use Y2, Y5, Y8, Y11, Y14, Y17, Y20 and Y23.

The result looks like below.

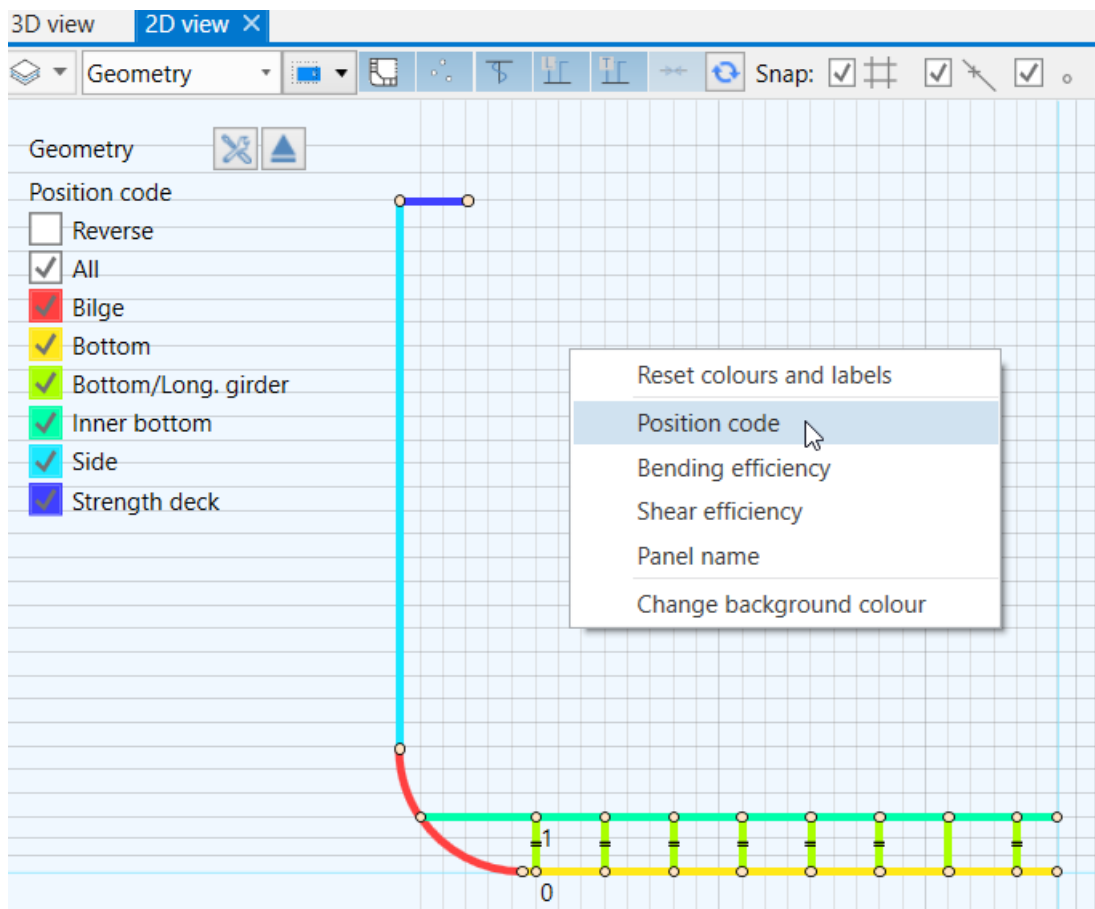


Please check the watertight checkbox of 3970.

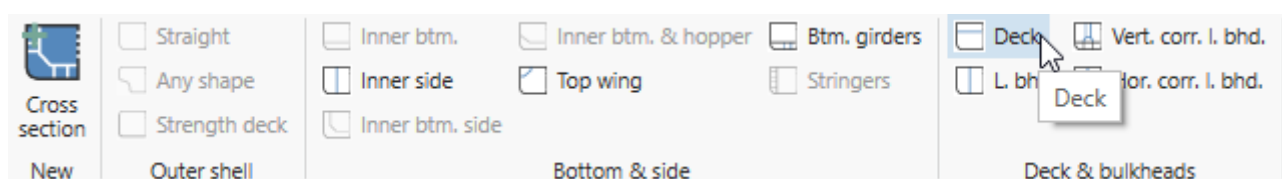
Hit the OK button and see the following result:



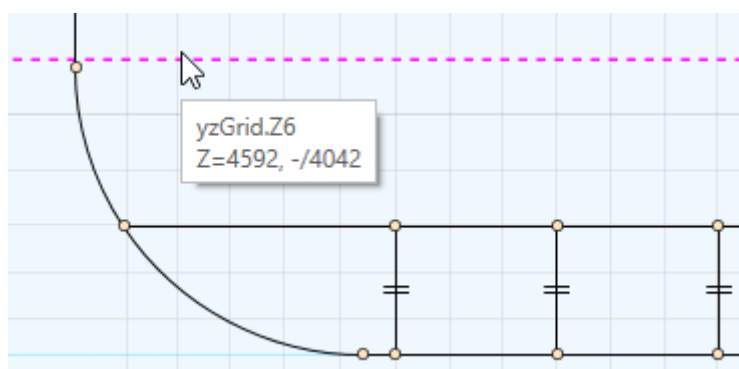
Position codes may also be inspected graphically by selecting "Position codes" from the context menu:



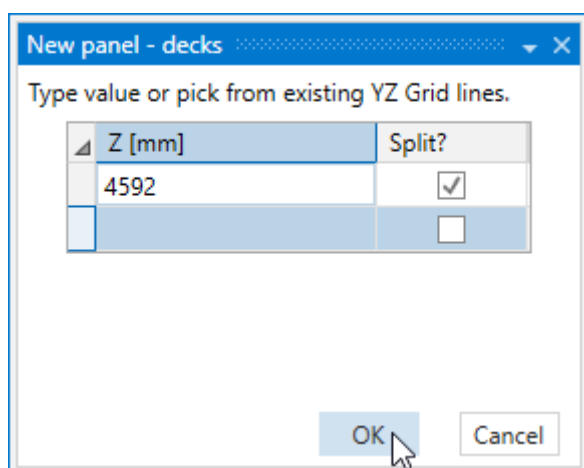
Add Deck 4:



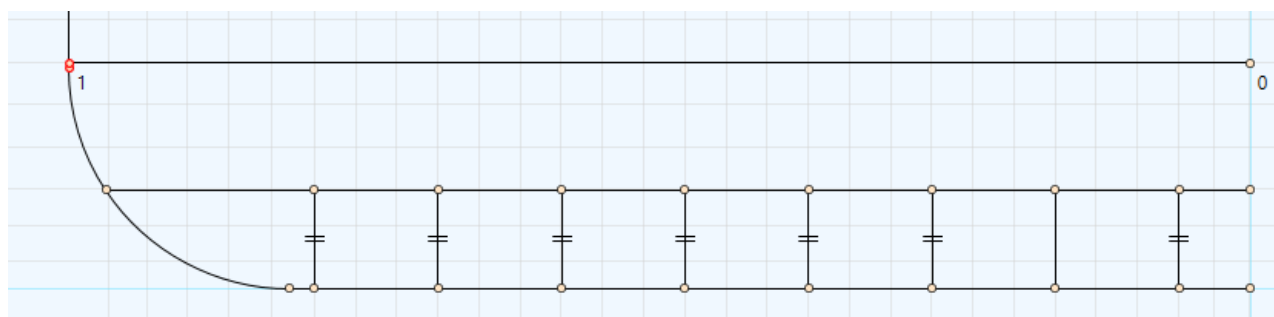
Make use of the Z6 frame:



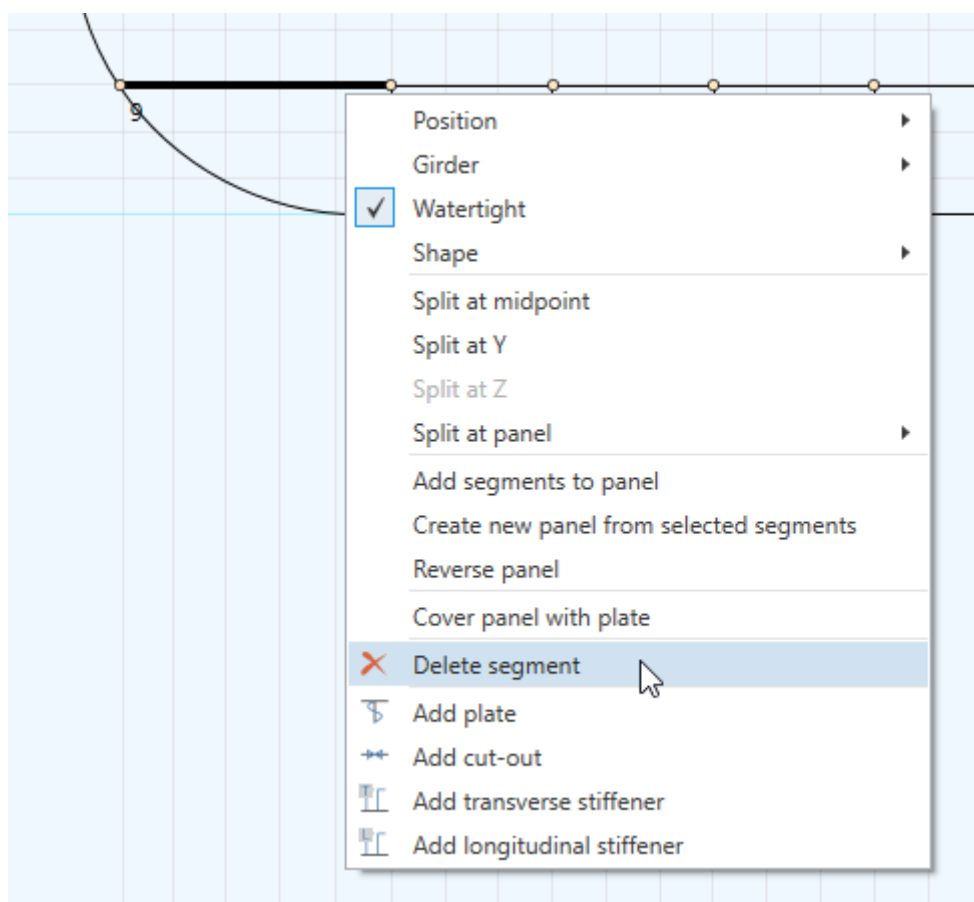
The result looks like the following:



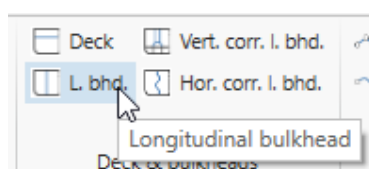
Hit the OK-button and see the updated geometry.



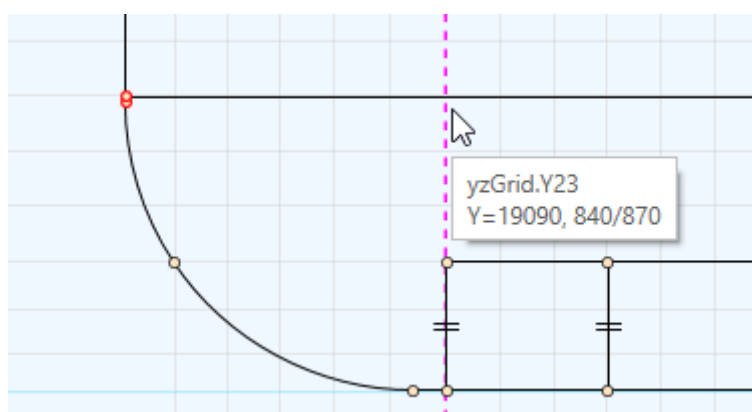
Before going further on please mark the inner bottom end segment and delete it:

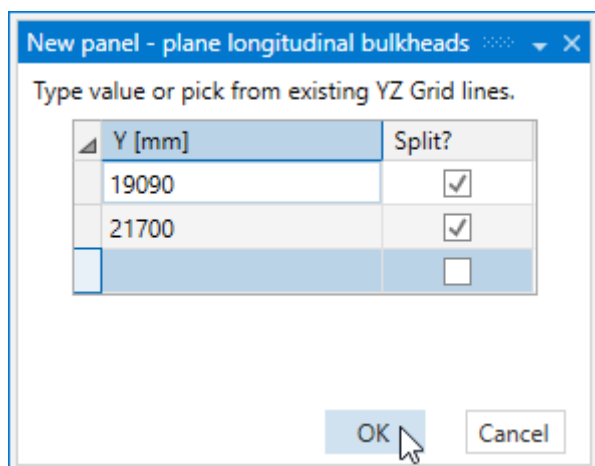


Add longitudinal bulkheads:

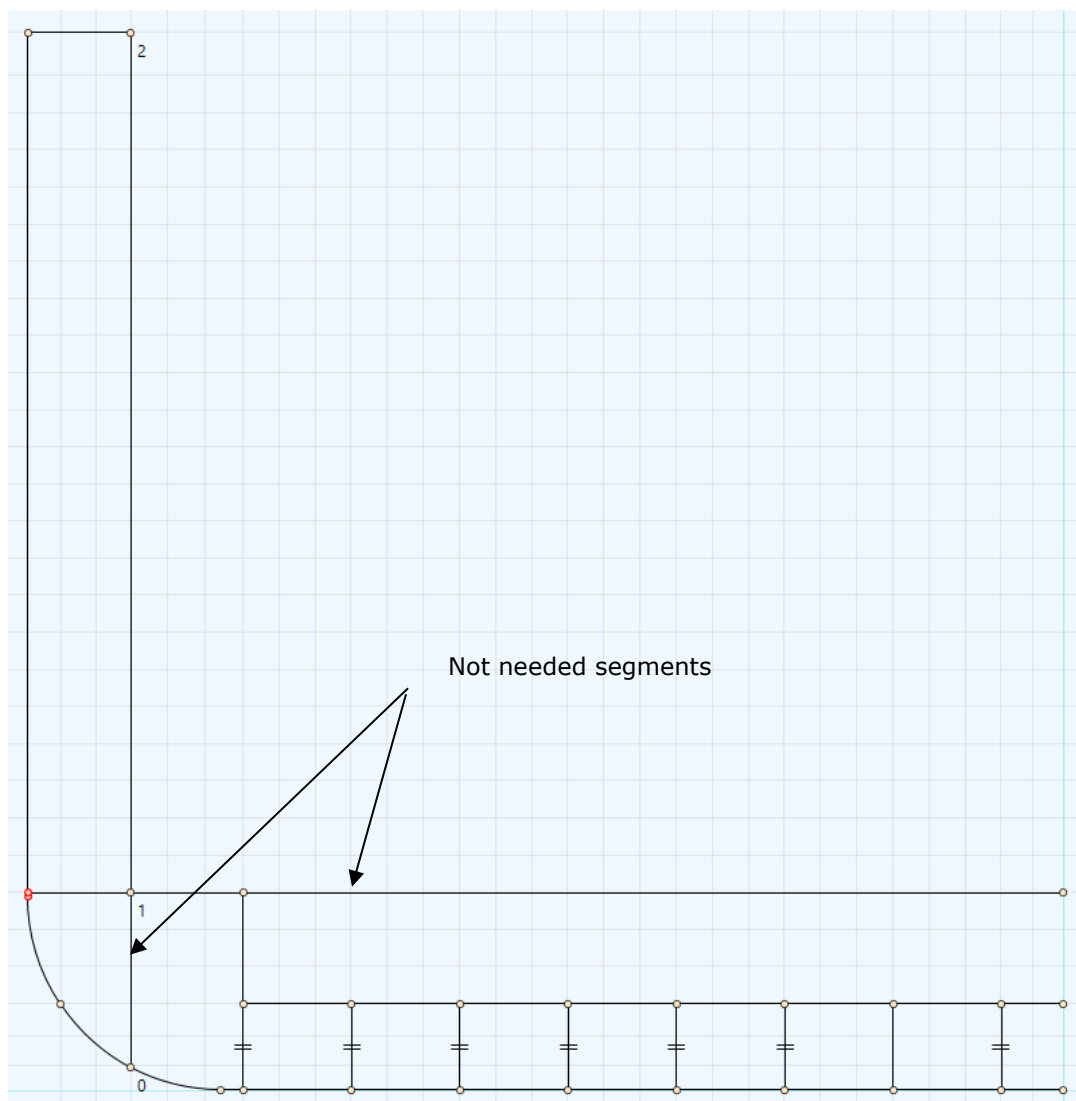


Make use of the grid **Y23** and **Y26**.

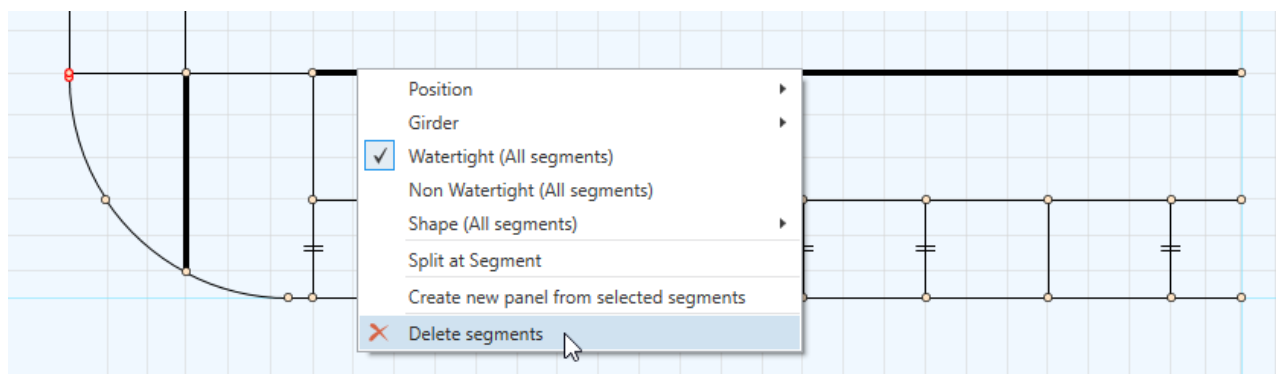




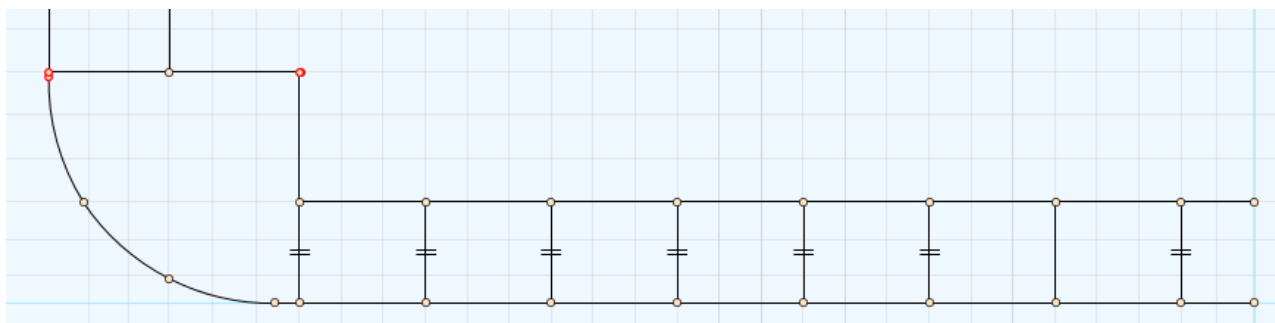
Hit the OK-button and see the following result:



Now mark the two following segments by holding CTRL on the keyboard and delete the unnecessary segments.



The result will look more feasible and saves modelling time as we make use of modelling wizards.

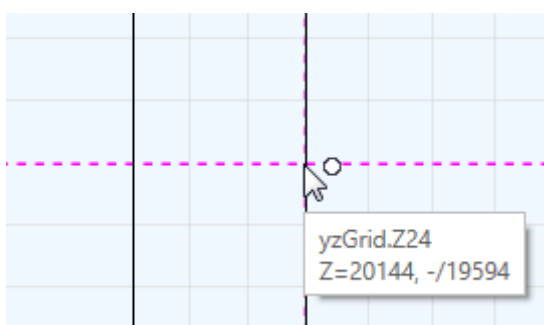


Save the workspace.

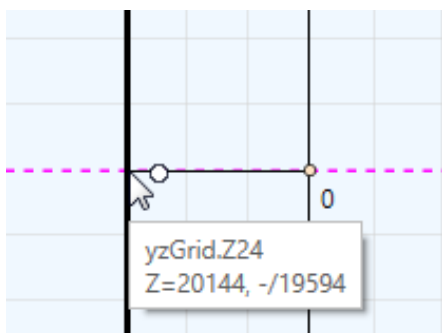
Add the two decks at Z15 and Z24 by using **Straight Panel**:



Make use of the grid again and set the starting and end point:

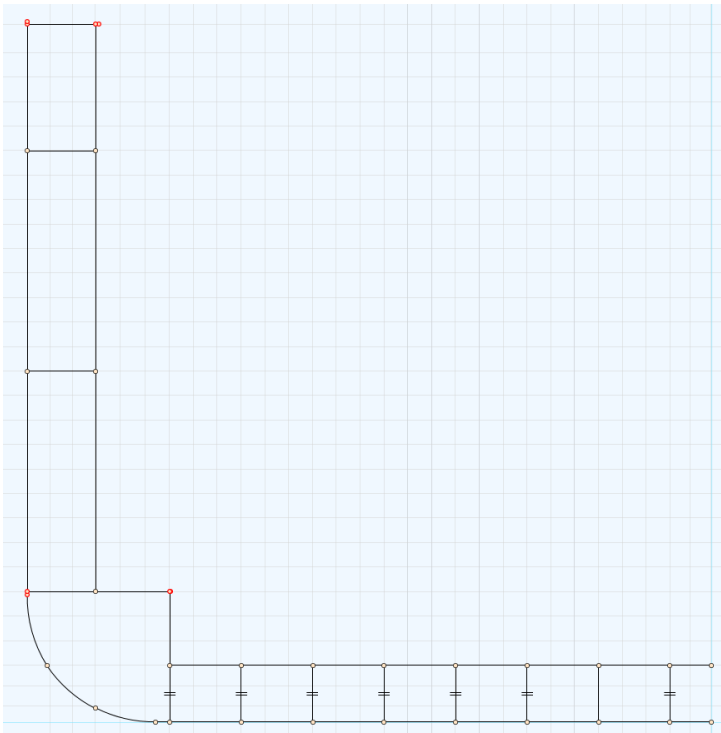


Click the starting point on the longitudinal bulkhead / Z24

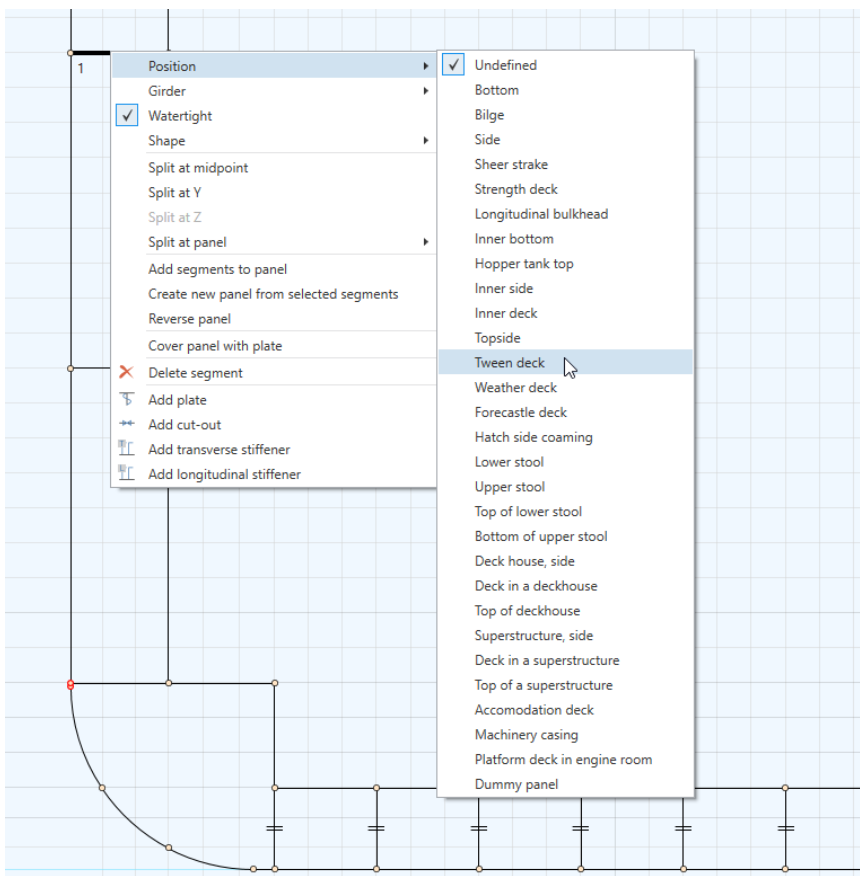


Click on the outer shell and end the input by ESC on the keyboard.

The result will look the following:

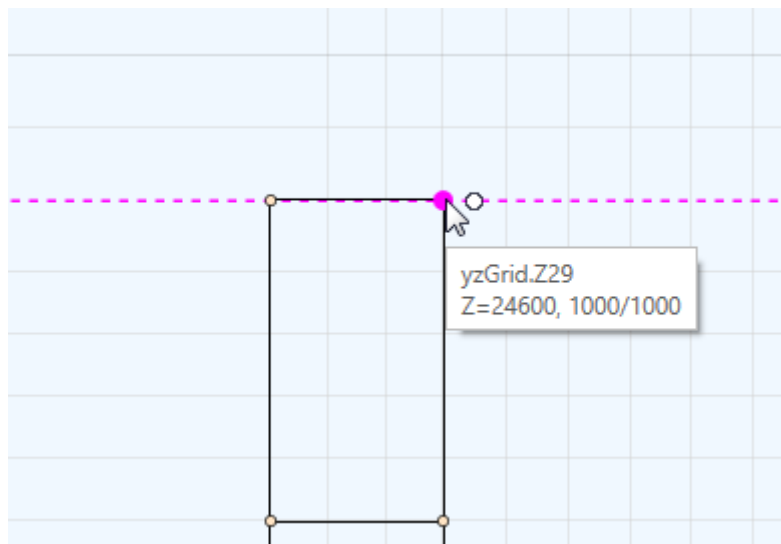


Now we will have to set the position codes for both by click each deck and make a right mouse click, choose within **Position** the **Tween Deck**:

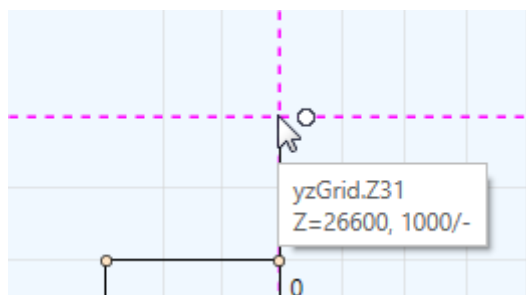


Establish the Vertical Coaming with a **Straight Panel** again:

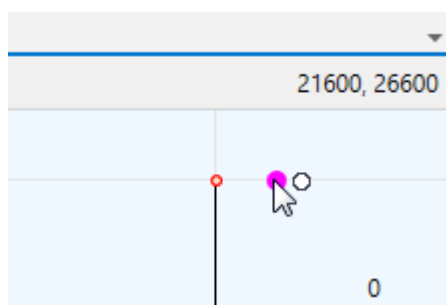
The first point is chosen **Z29**.



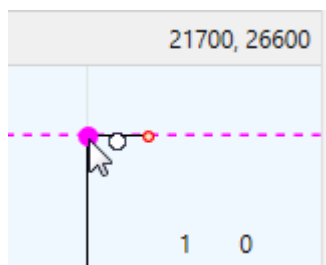
The second point is chosen **Z31** and ended by pressing **ESC-button** on the keyboard.



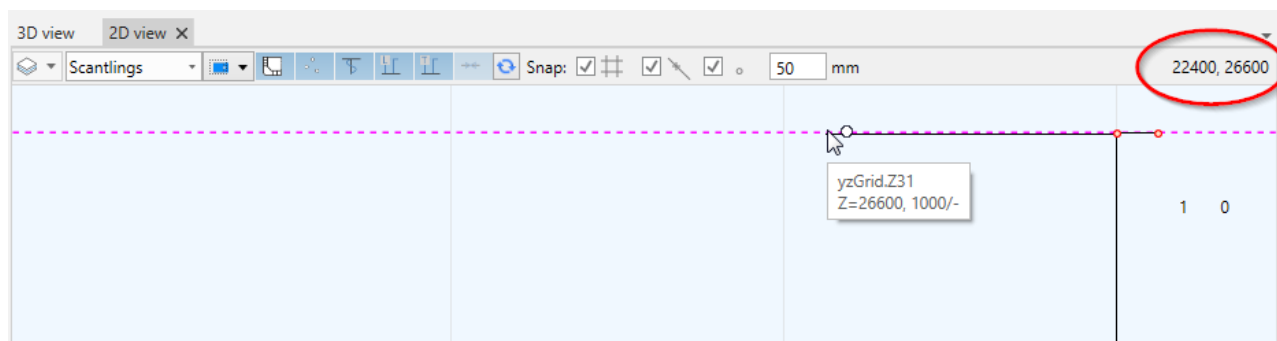
Add the Horizontal Coaming the same way:



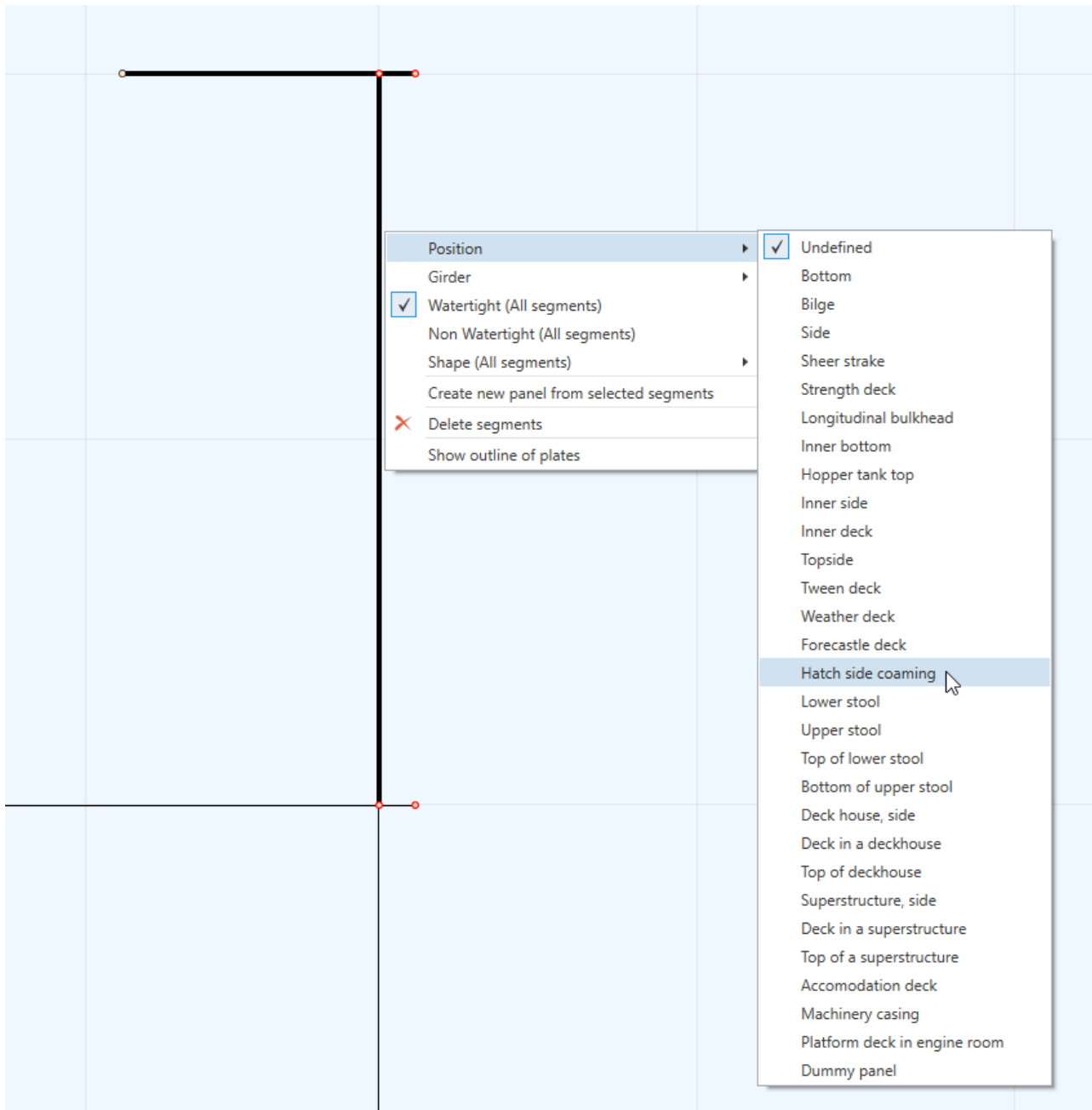
For the second point hover the vertical coaming:



For the third point use the **measure** from the right corner of window, the length shall be **800mm** and end the input by **ESC-button** on the keyboard:



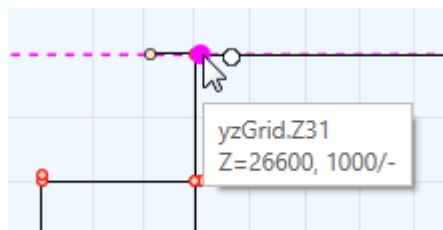
Now we have to set the position codes for both to Hatch side coaming:



For later use with the compartments we have to establish one dummy element to close the topside.

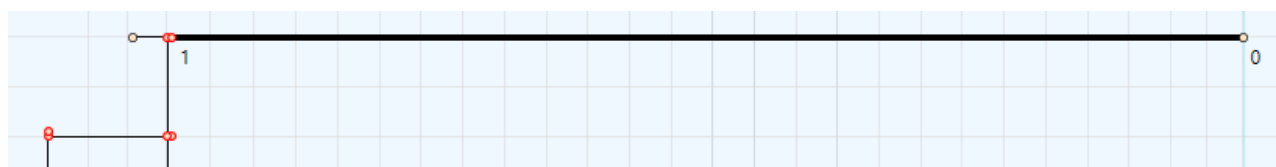
We use the Straight Panel and set the Position Code afterwards to dummy.

The second point will be the horizontal **Hatch Coaming (21600 ; 26600)**:

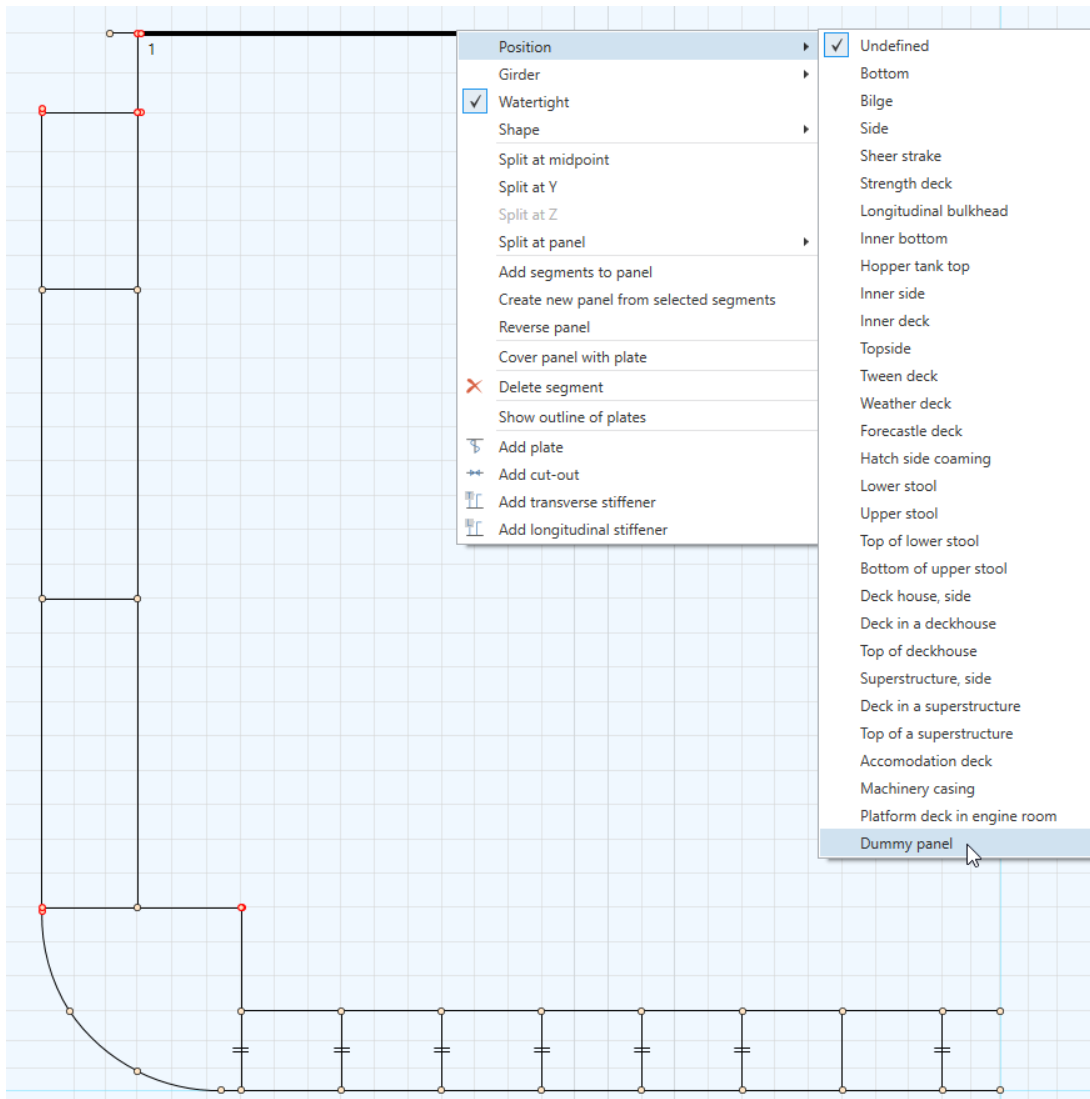


⇒ Remind to consider the overstand of the hatch coaming

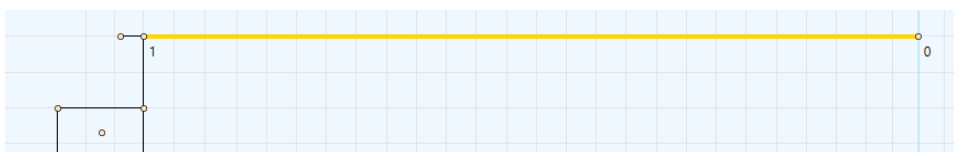
The completed panel looks the following



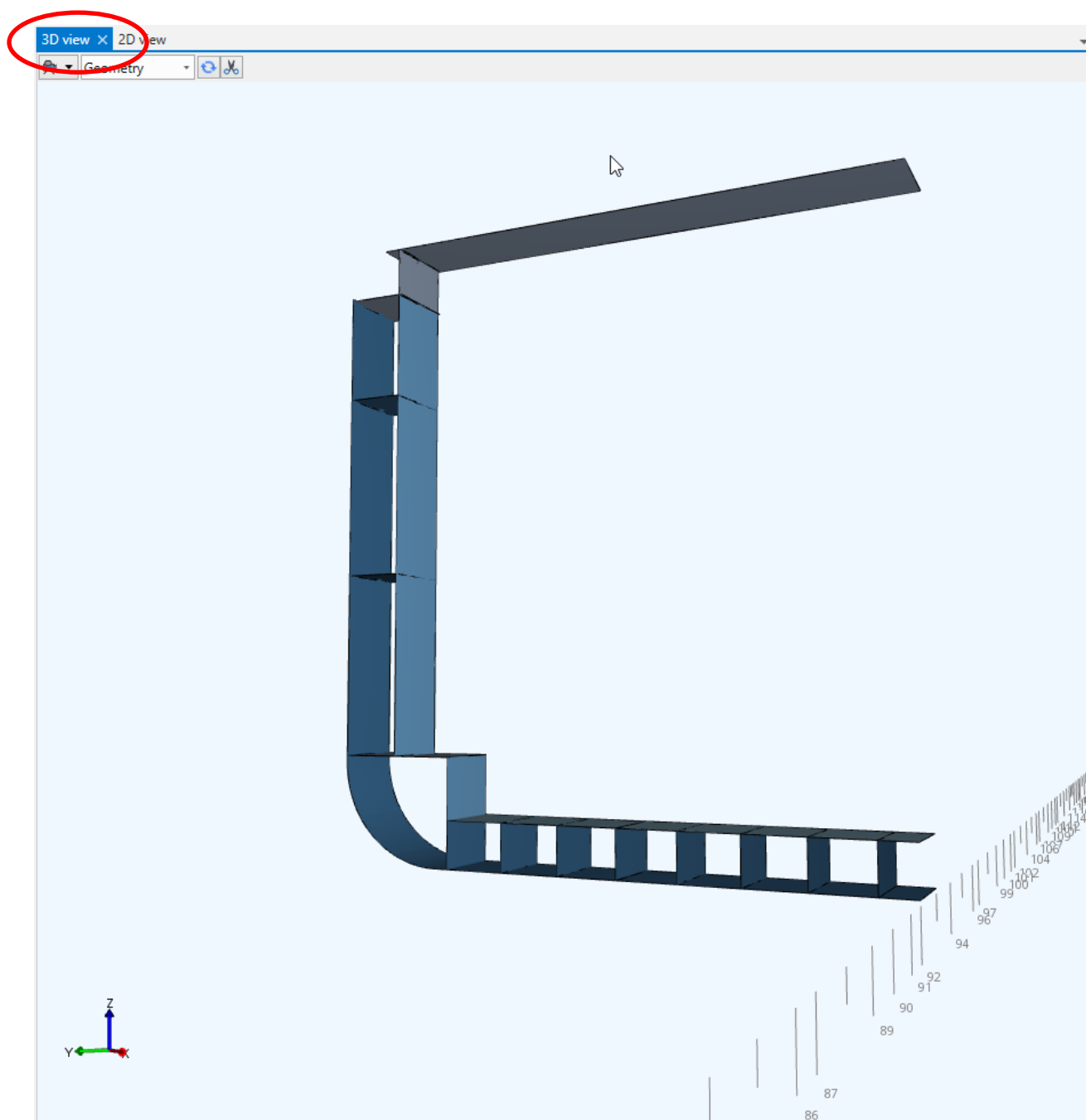
Aftwards we set the position code to **Dummy Panel**:



It will be colored yellow now:



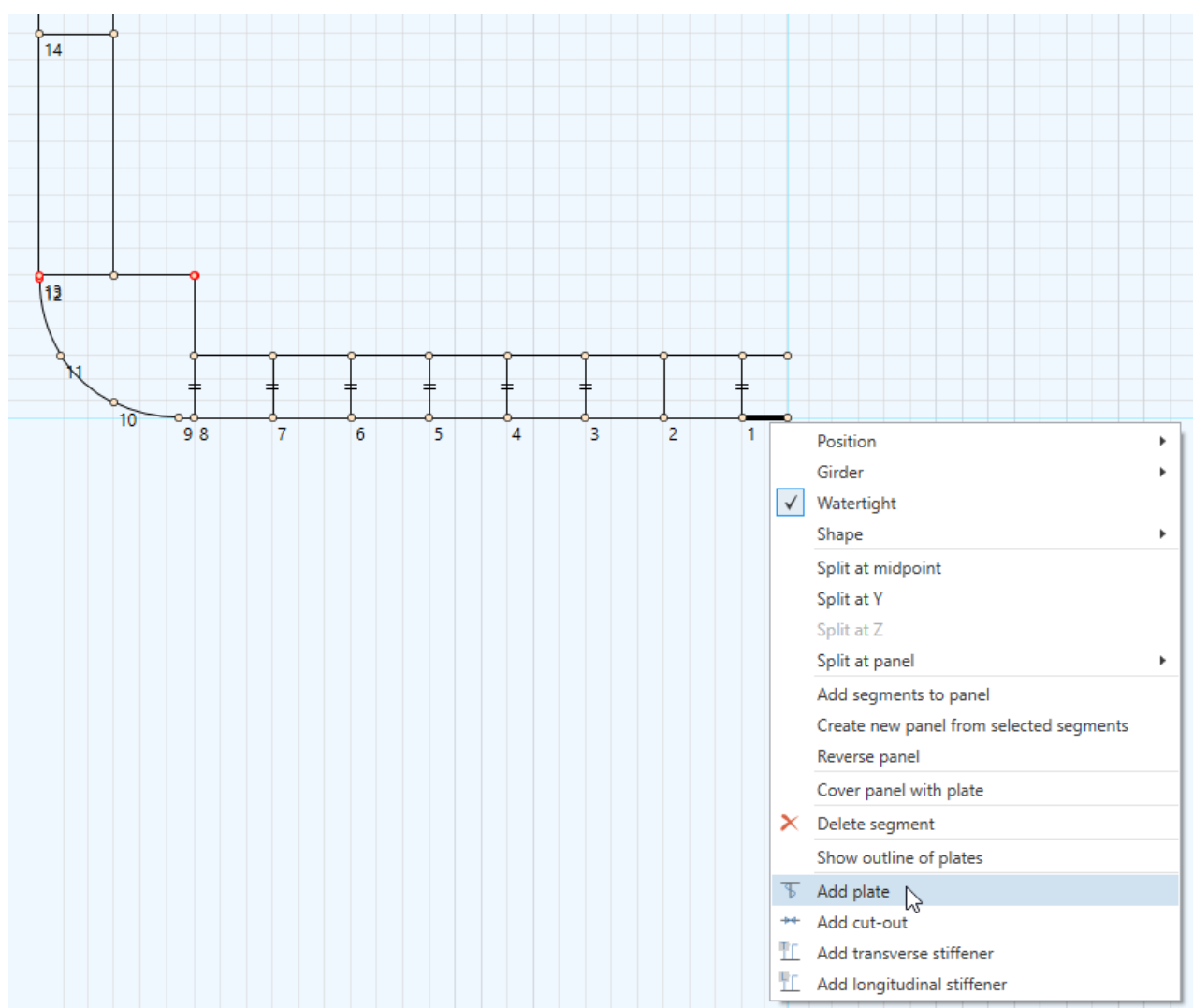
The model may be inspected in 3D view. Click in the upper left corner (red encircled):



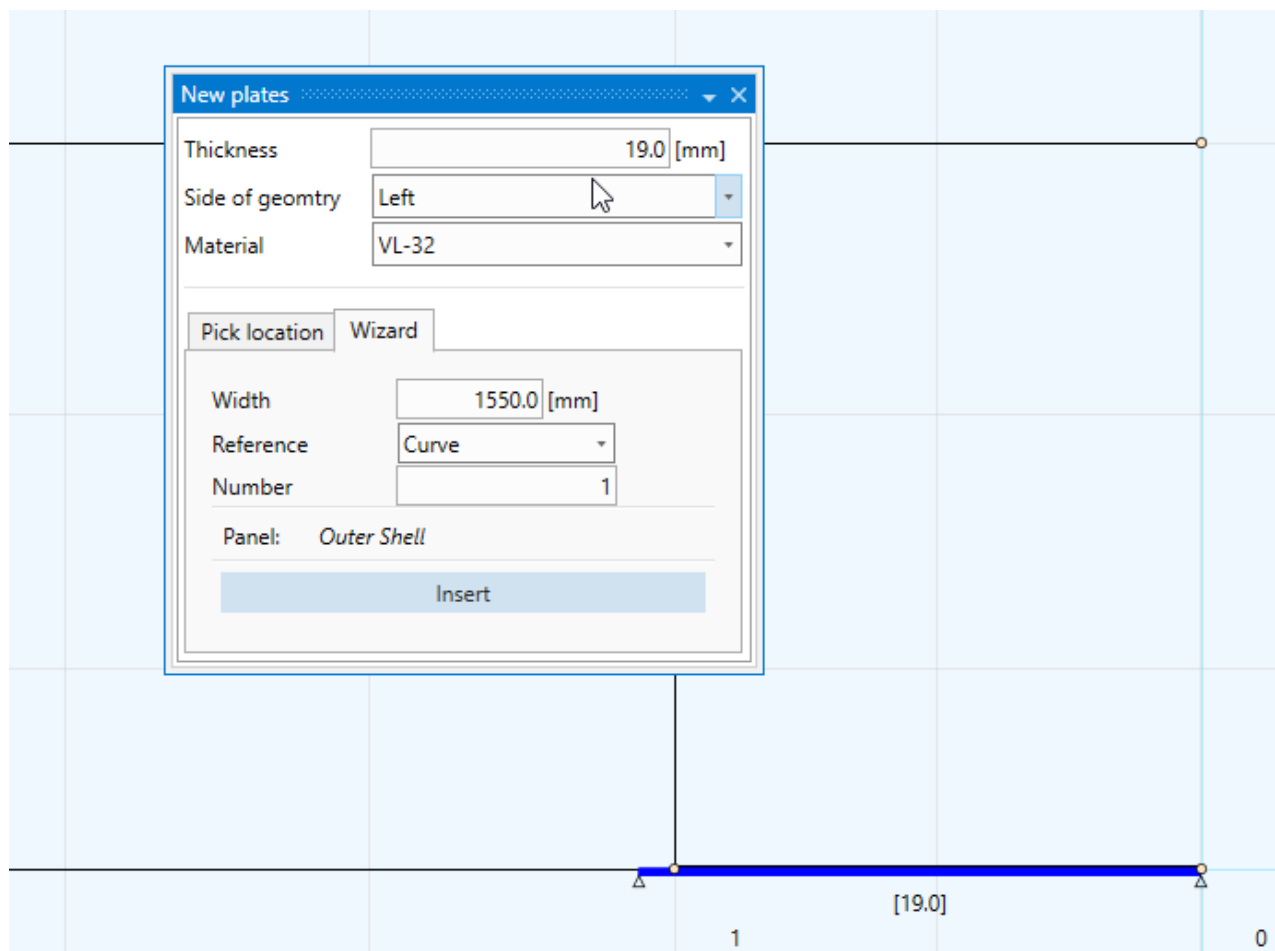
6.3 Plates

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

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



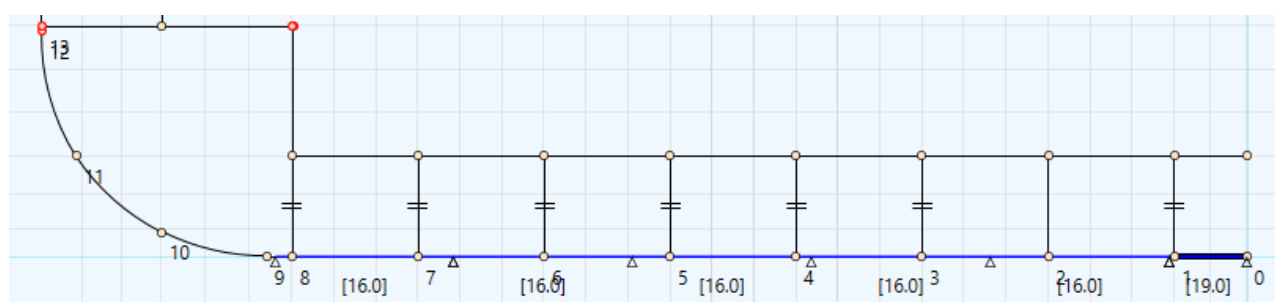
Insert the keel plate, thickness **19.0mm**, Side of Geometry **Left**, Material is **VL-32**, choose **Wizard** tab and give width **1550mm**.



⇒ Please take a closer look to the Geometry with [moulded line](#).

Insert remaining bottom plates:

Width	Along	Thickn	Material	No. of	S o Geom
3580	Curve	16.0	VL-32	4	Left
3560	Curve	16.0	VL-32	1	Left

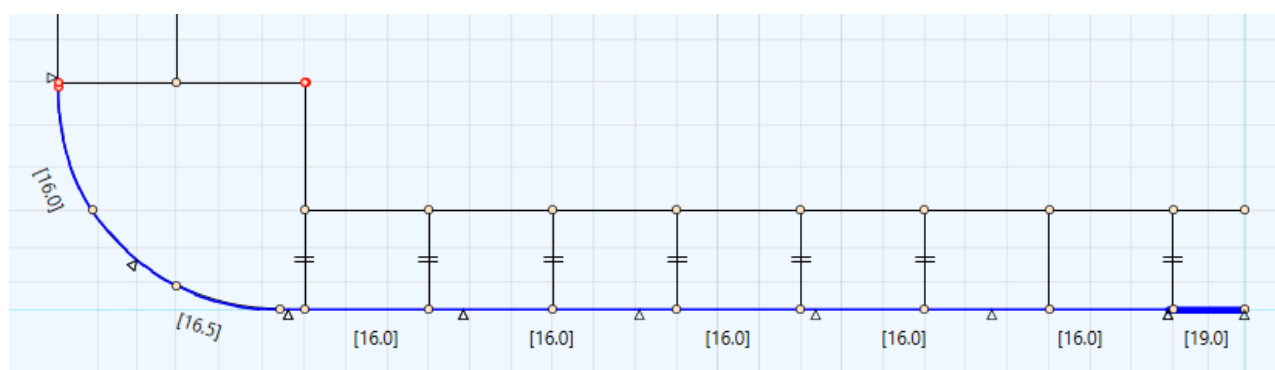


Insert the bilge plate:

Width	Along	Thickn	Material	No. of	S o Geom
1000	AlongZ	16.5	VL-32	1	Left
3700	AlongZ	16.0	VL-32	1	Left

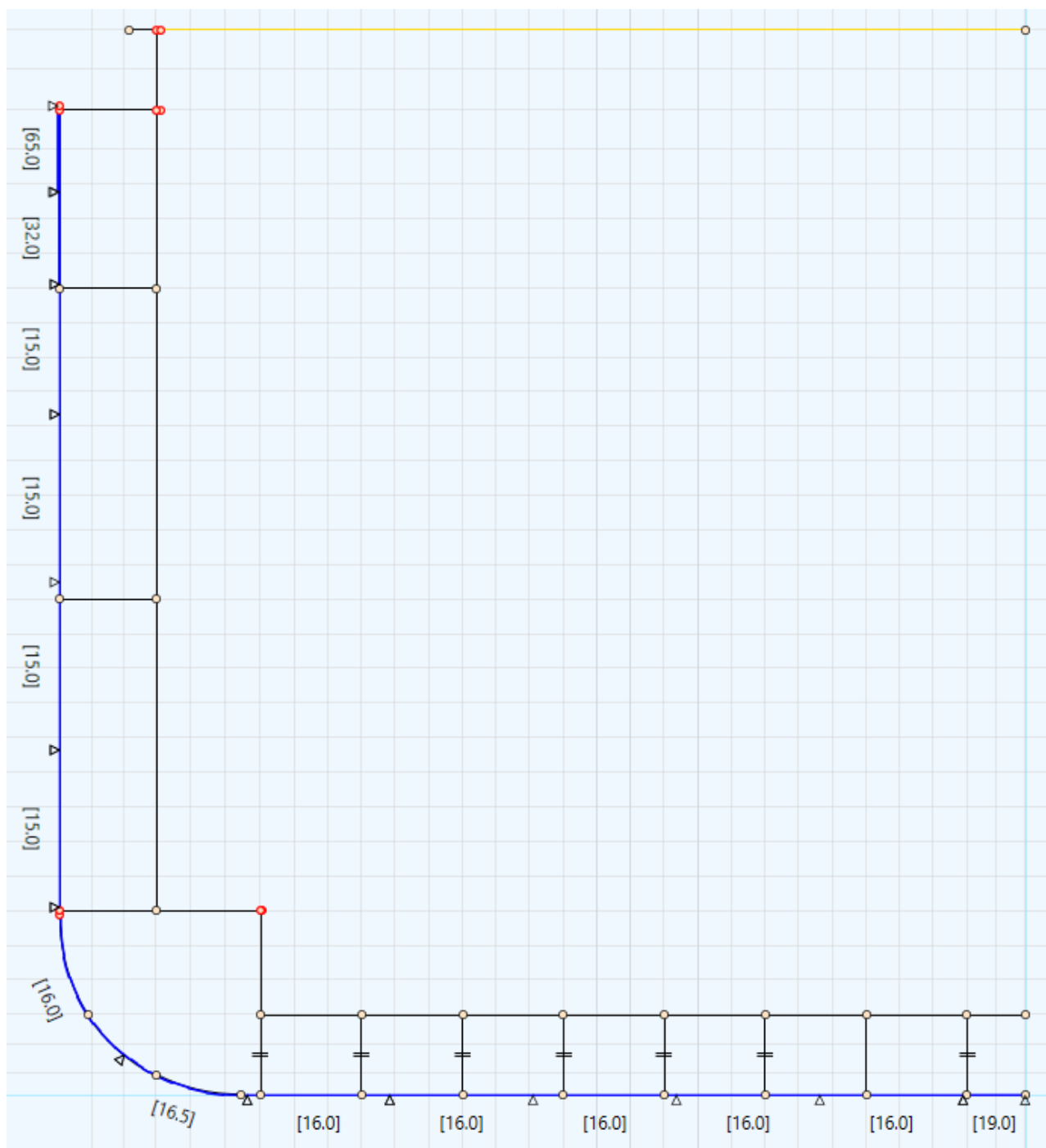
For example first bilge plate:

The result will be:



Insert the side plates:

Width	Along	Thickn	Material	No. of	S o Geom
3900	Curve	15.0	VL-32	1	Left
4200	Curve	15.0	VL-32	2	Left
20244	GlobalZ	15.0	VL-32	1	Left
2300	Curve	32.0	VL-32	1	Left
24700	GlobalZ	65.0	From def...	1	Left



Note the upper plate on side shell will get high-strength material VL-36 assigned. This is indicated by thicknesses enclosed by [], e.g. [65.0]. This is according to what is defined in HS-steel zone for the current cross-section.

6.3.1 Strength deck

Select strength deck panel and insert plate:

Width	Along	Thickn	Material	No. of	S o Geo
2500	Curve	65.0	From def...	1	Right

6.3.2 Deck 2

Select Deck 2 and insert plate:

Width	Along	Thickn	Material	No. of	S o Geo
2400	Curve	10.5	VL-32	1	Right

6.3.3 Deck 3

Select Deck 3 and insert plate:

Width	Along	Thickn	Material	No. of	S o Geo
2400	Curve	9.5	VL-32	1	Right

6.3.4 Deck 4

Select Deck 4 and insert plates:

Width	Along	Thickn	Material	No. of	S o Geo
2650	Curve	14.0	VL-32	1	Right
2360	Curve	13.5	VL-32	1	Right

6.3.5 Inner bottom

Width	Along	Thickn	Material	No. of	S o Geo
1550	Curve	13.0	VL-32	1	Right
3580	Curve	14.5	VL_32	5	Right

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

6.3.6 Longitudinal Bulkhead 23

Width	Along	Thickn	Material	No. of	S o Geom
2592	Curve	15	VL_32	1	Right

6.3.7 Longitudinal Bulkhead 26

Insert the longitudinal bulkhead plates:

Width	Along	Thickn	Material	No. of	S o Geom
4000	Curve	14.0	VL-32	1	Right
4200	Curve	13.0	VL-32	1	Right
4200	Curve	12.5	VL-32	1	Right
20244	GlobalZ	13.0	VL-32	1	Right
2300	Curve	32.0	VL-32	1	Right
24700	GlobalZ	65.0	From def...	1	Right

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

6.3.8 Longitudinal Girders

Longitudinal Girders 2- 23, select each:

Width	Along	Thickn	Material	No. of	S o Geom
2000	Curve	14	VL_32	1	Left
2000	Curve	14	VL_32	1	Left
2000	Curve	15	VL_32	1	Left
2000	Curve	15	VL_32	1	Left
2000	Curve	15	VL_32	1	Left
2000	Curve	15	VL_32	1	Left
2000	Curve	15	VL_32	1	Left
2000	Curve	15	VL_32	1	Left

6.3.9 Vertical Coaming

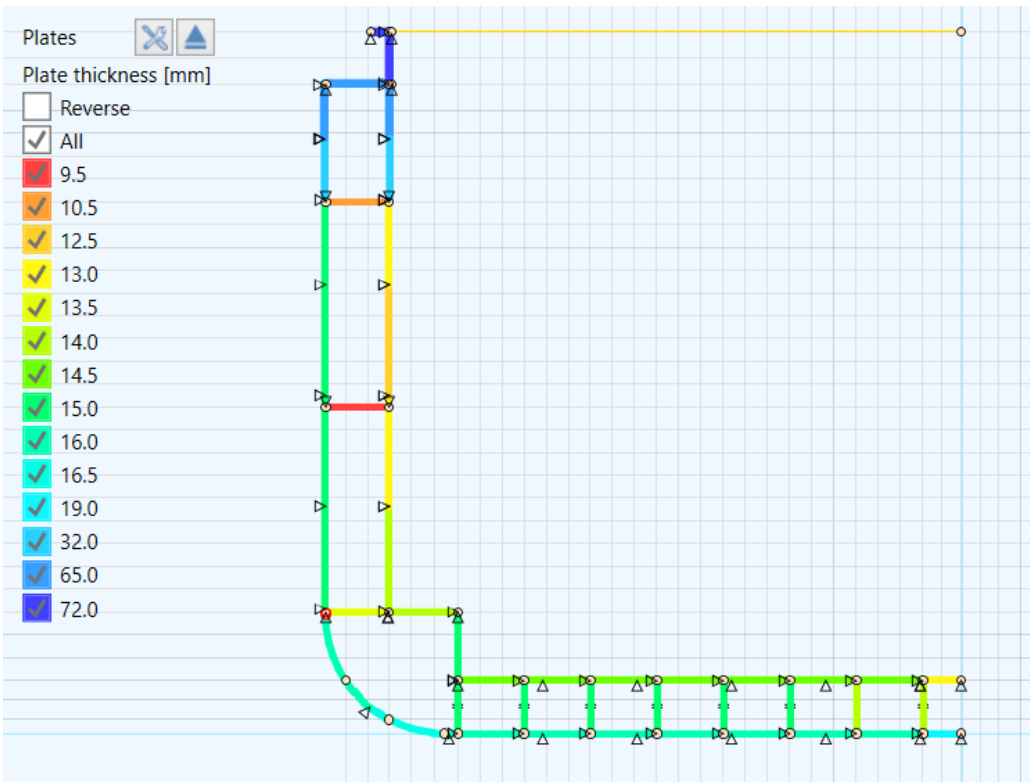
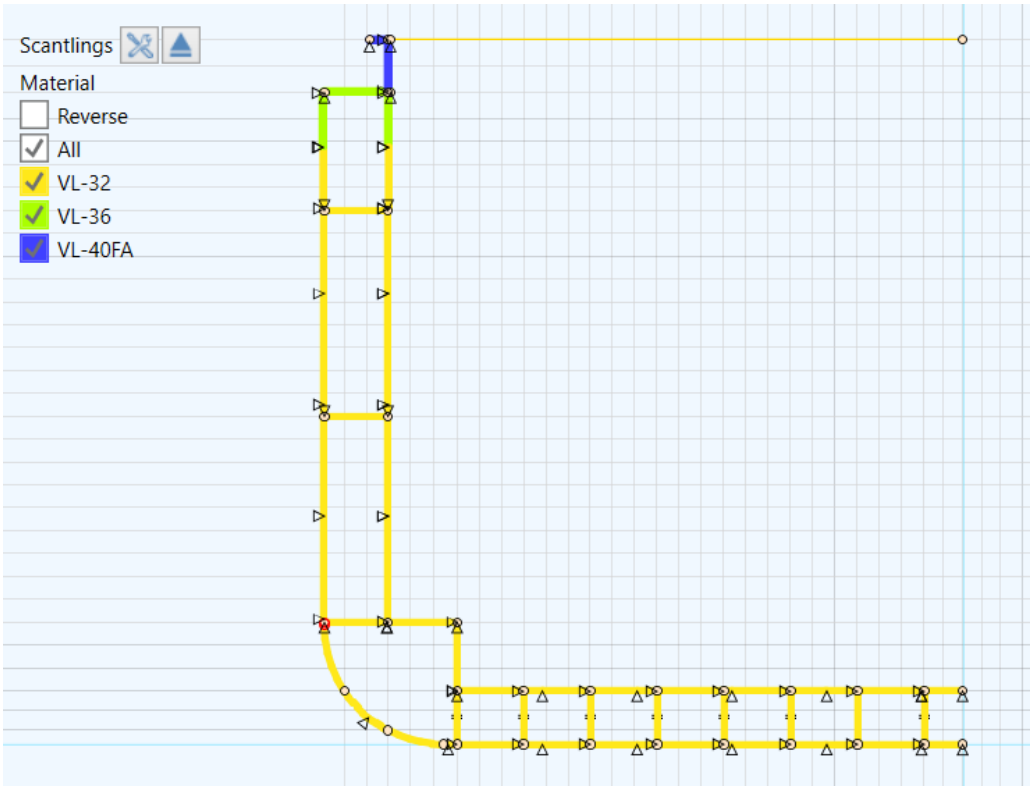
Select vertical coaming and insert plate:

Width	Along	Thickn	Material	No. of	S o Geo
2000	Curve	72	From def...	1	Right

6.3.10 Horizontal Coaming

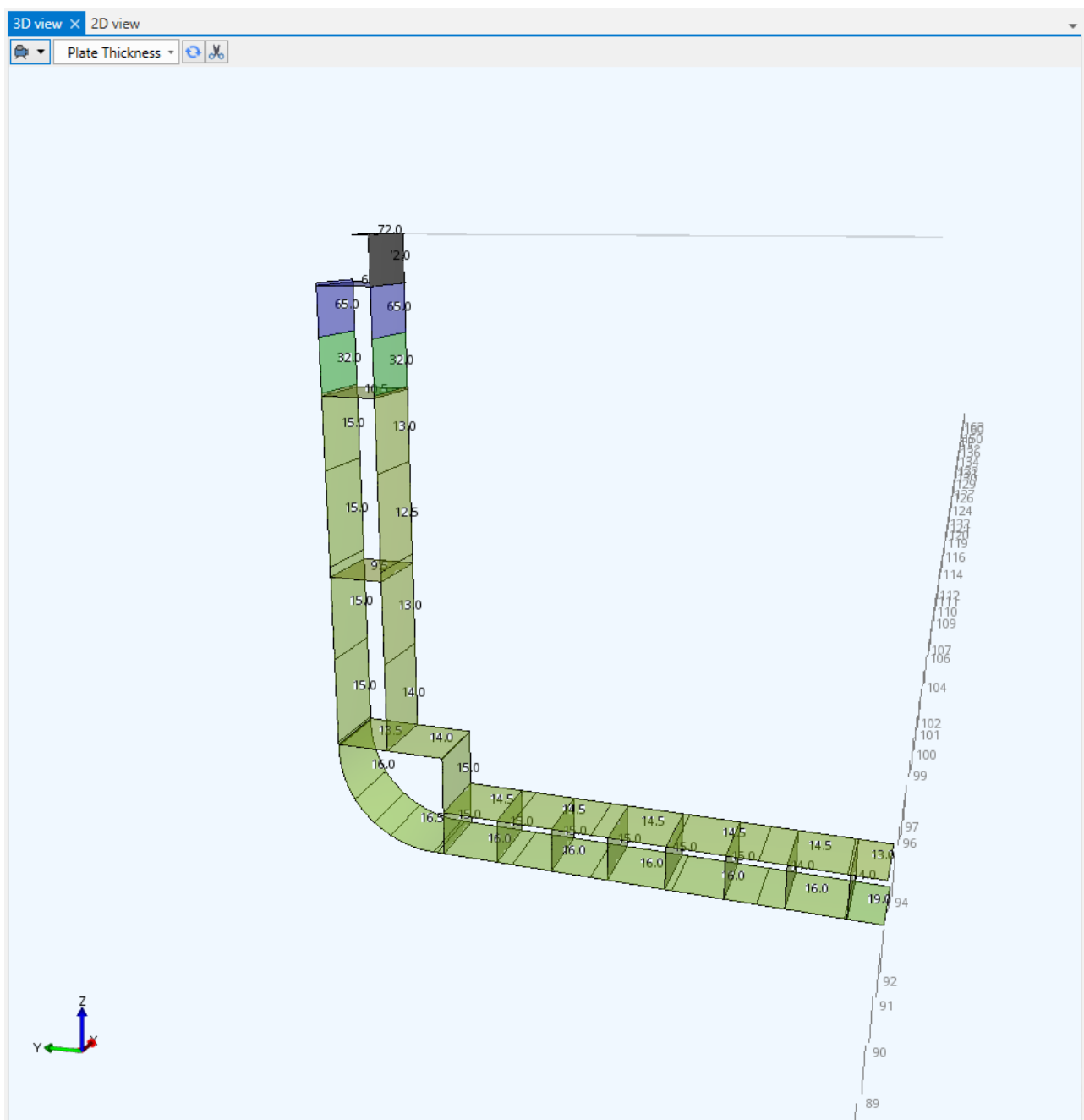
Select vertical coaming and insert plate:

Width	Along	Thickn	Material	No. of	S o Geo
800	Curve	72	From def...	1	Left



3D view, showing plates:

⇒ Please observe the red encircled selection "Plate Thickness".

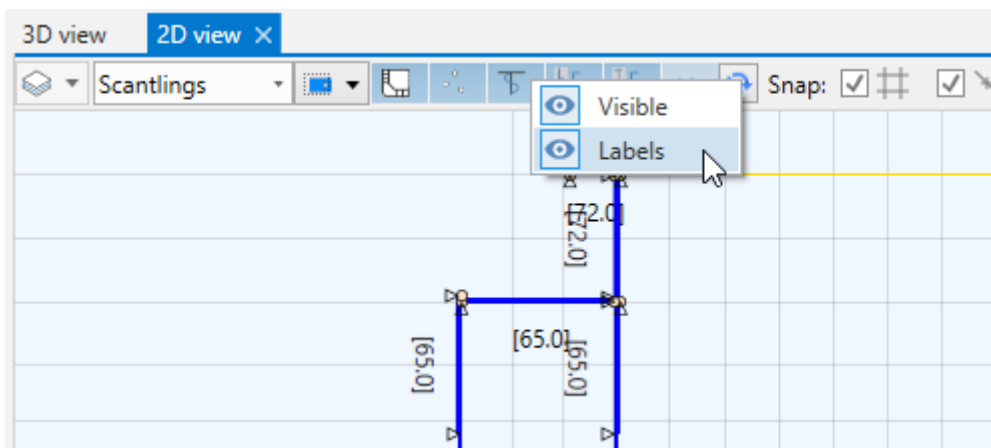


6.4 Longitudinal stiffeners

Stiffeners may be inserted by two different methods. Either by a wizard, or by clicking at the location of the insertion point. By using Snap to YZ-grid, the YZ-grid defined earlier can be utilized to define the positions.

For this tutorial, we will demonstrate both approaches.

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

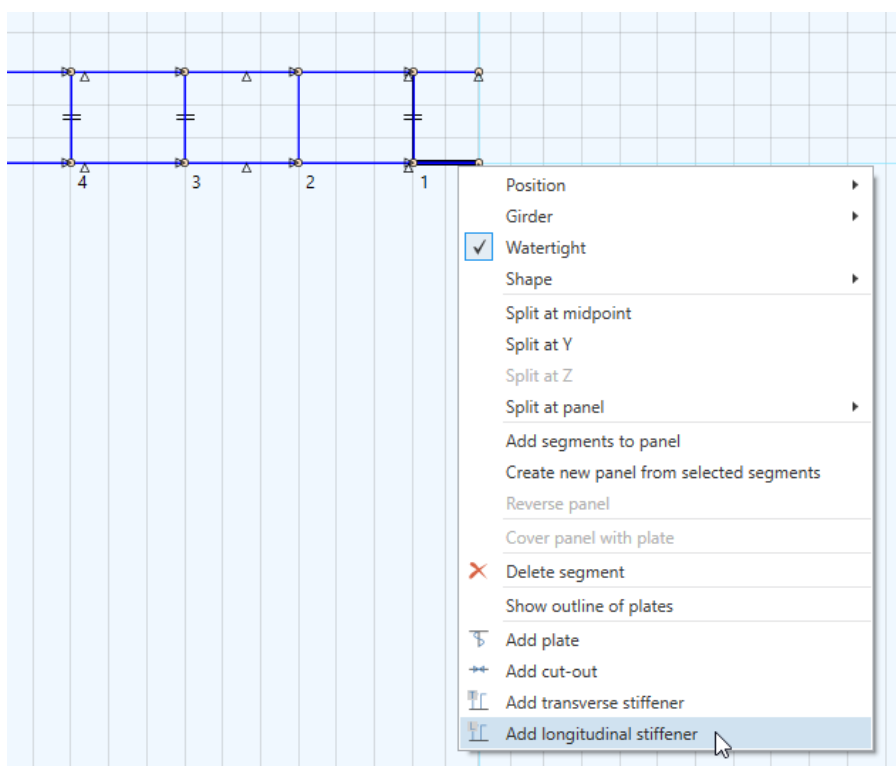


Also, turn off **Selection of plates** by clicking the plate seam icon:

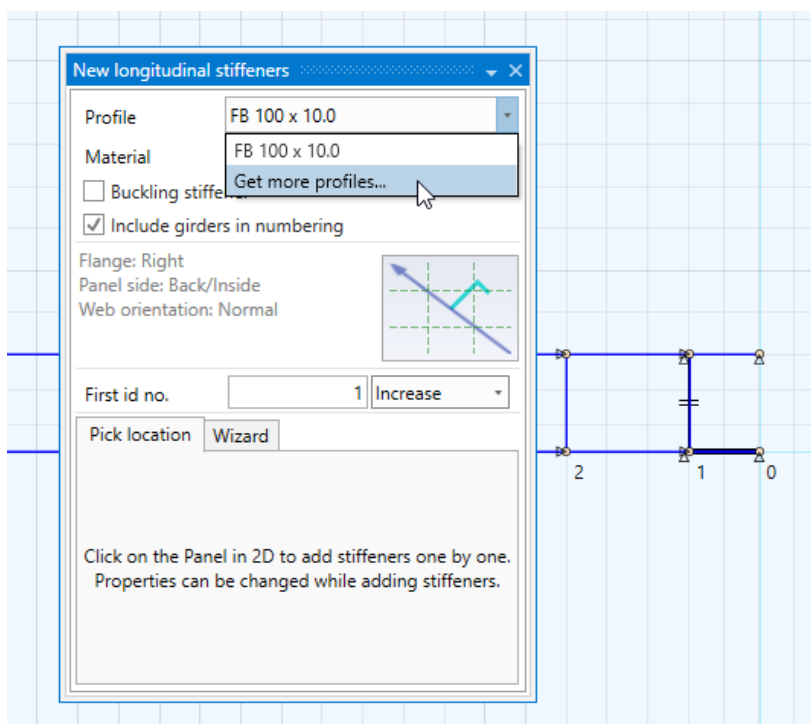


6.4.1 Outer shell

Select outer shell panel. Right-click and chose **Add longitudinal stiffener**:



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



Specify profile type **Rolled L** and give dimensions **200x90x10x14 AH**.

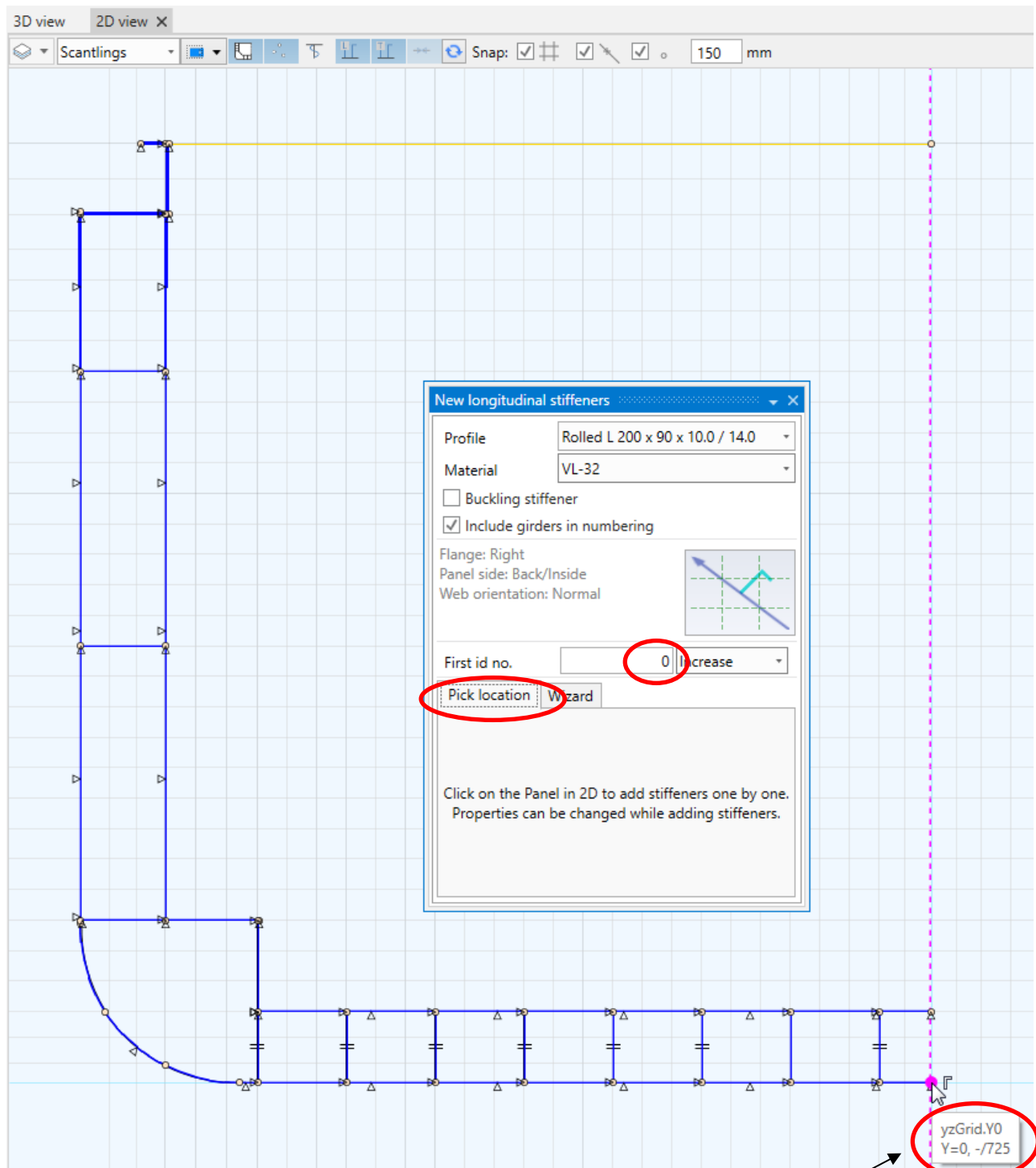
Note sequence of dimensions.

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 'Rolled Angles':

Libraries X										
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]
☐	Rolled L	450 x 120 x 11.5 / 25.0	450	425	11.5	120	25.0	79.5	564.3	16876
☐	Rolled L	450 x 120 x 12.5 / 27.0	450	423	12.5	120	27.0	85.9	609.8	18165
☐	Rolled L	475 x 120 x 11.5 / 28.0	475	447	11.5	120	28.0	85.6	632.7	20139
☐	Rolled L	475 x 120 x 12.5 / 30.0	475	445	12.5	120	30.0	92.3	683.0	21630
☐	Rolled L	500 x 120 x 11.5 / 30.0	500	470	11.5	120	30.0	90.7	702.3	23587
☐	Rolled L	500 x 120 x 13.5 / 35.0	500	465	13.5	120	35.0	105.4	815.1	27182
☒	Rolled L	200 x 90 x 10.0 / 14.0	200	186	10.0	90	14.0	31.3	96.7	1291
> LheadOnSlab										
> WeldedAngle										

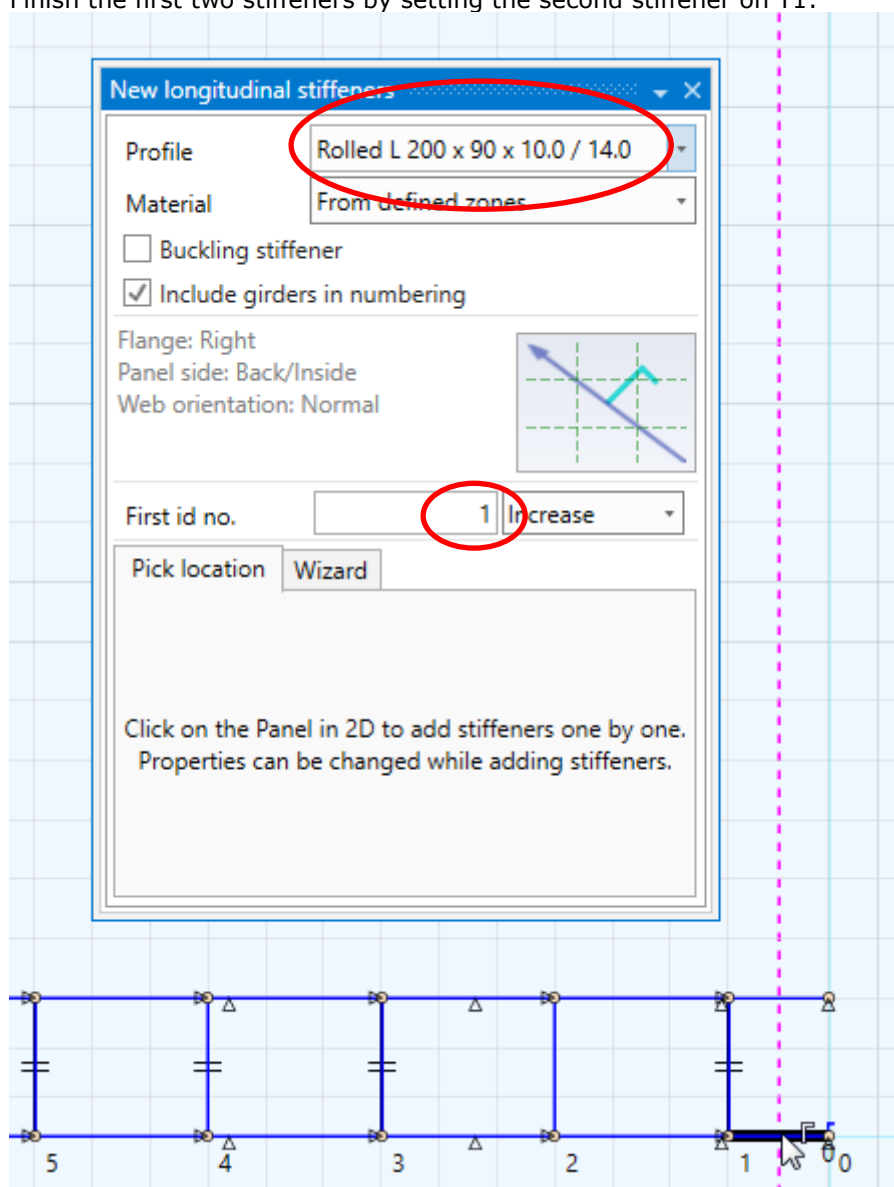
When method is set to **Pick location**, stiffener insertion point can be selected by hitting close to the intersection between an YZ-grid line and the panel.

To stay in line with the grid and concept sketch numnering please set the **First ID No.** to **0**.

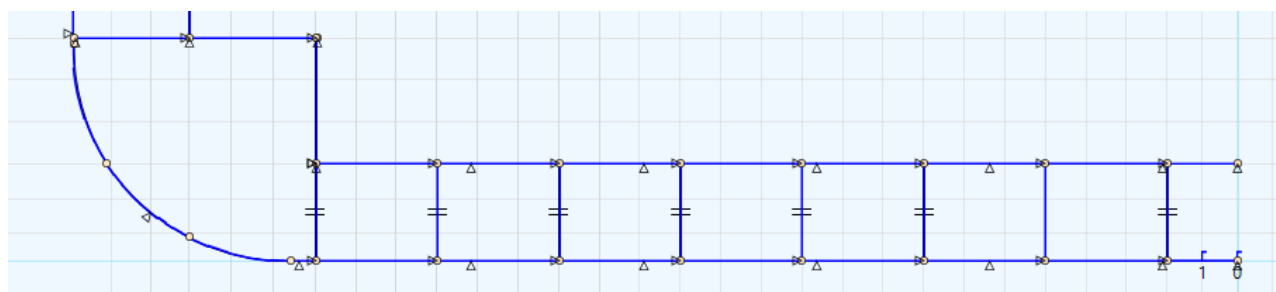


Numbers indicate distance to previous/next grid line

Finish the first two stiffeners by setting the second stiffener on Y1:



The result will look the following:



According to the concept sketch the next stiffeners for **3-4; 12-16** will be **L 400x100x13/18**. As they are not existing in the table so far we will have to establish them the same way as before:

Profile category

Profile view

Profile type

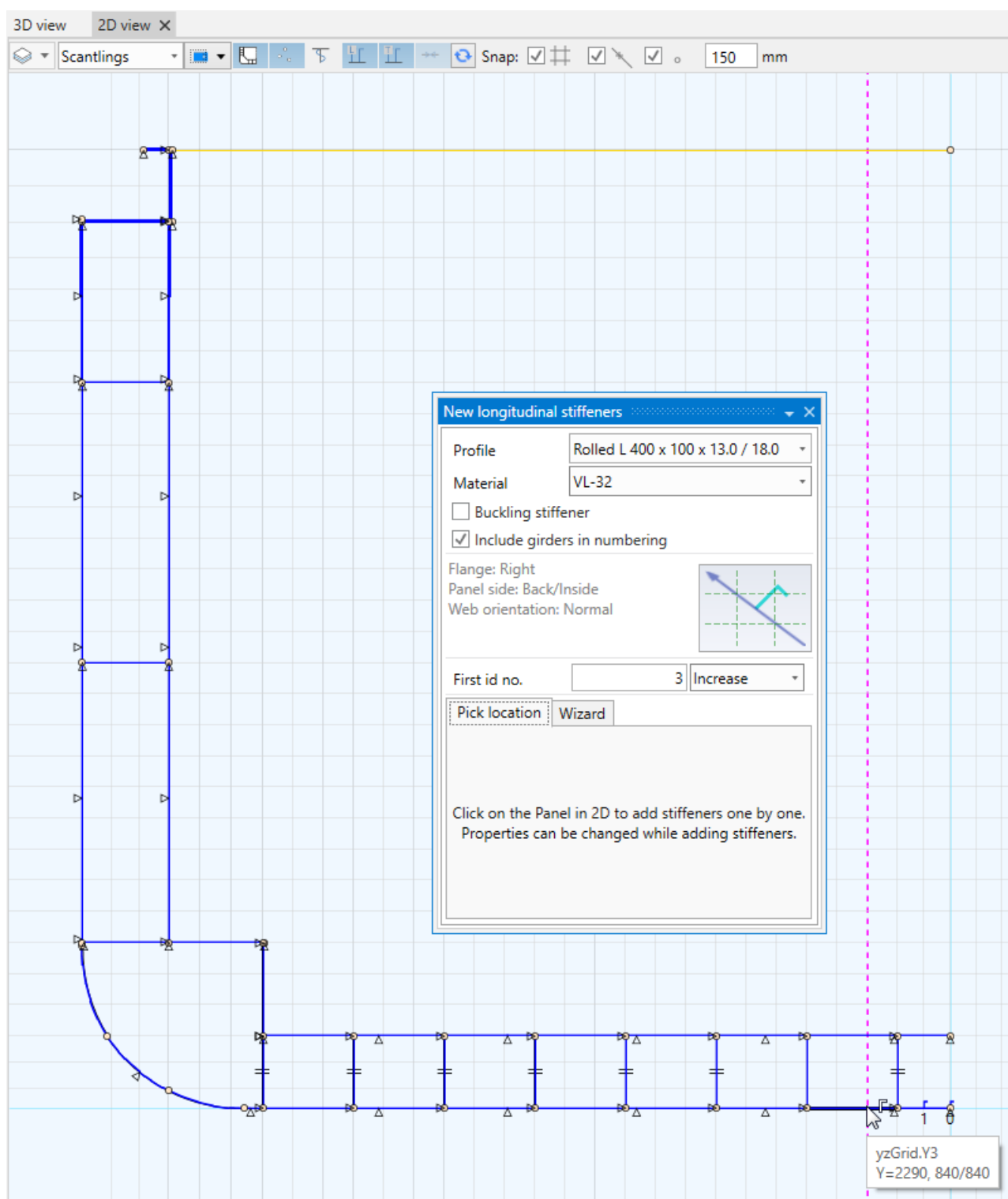
Rolled L

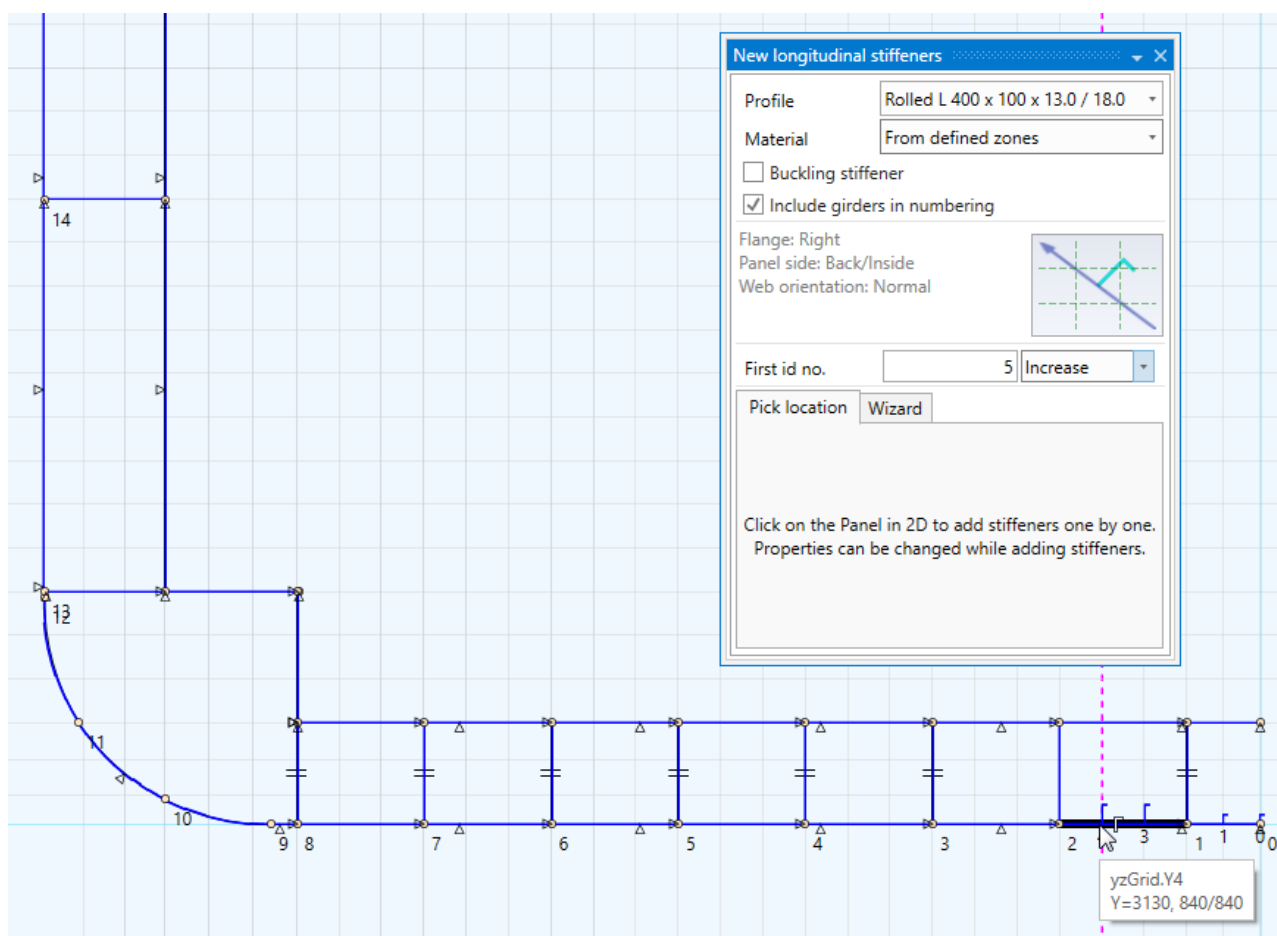
Dimensions

60 x 40 x 5.0 / 5.0

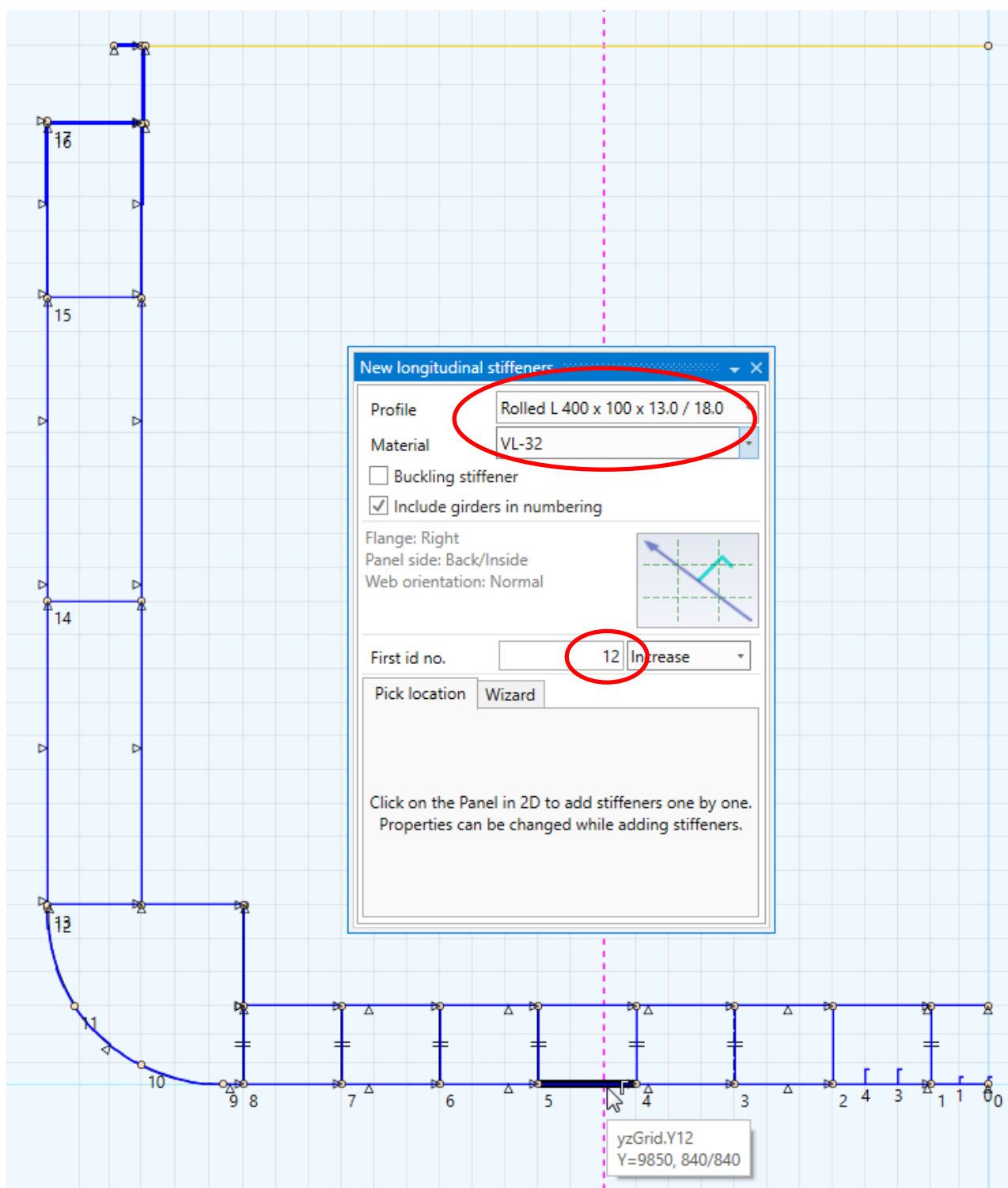
h	bf	t	tf
400	100	13	18

OK Cancel

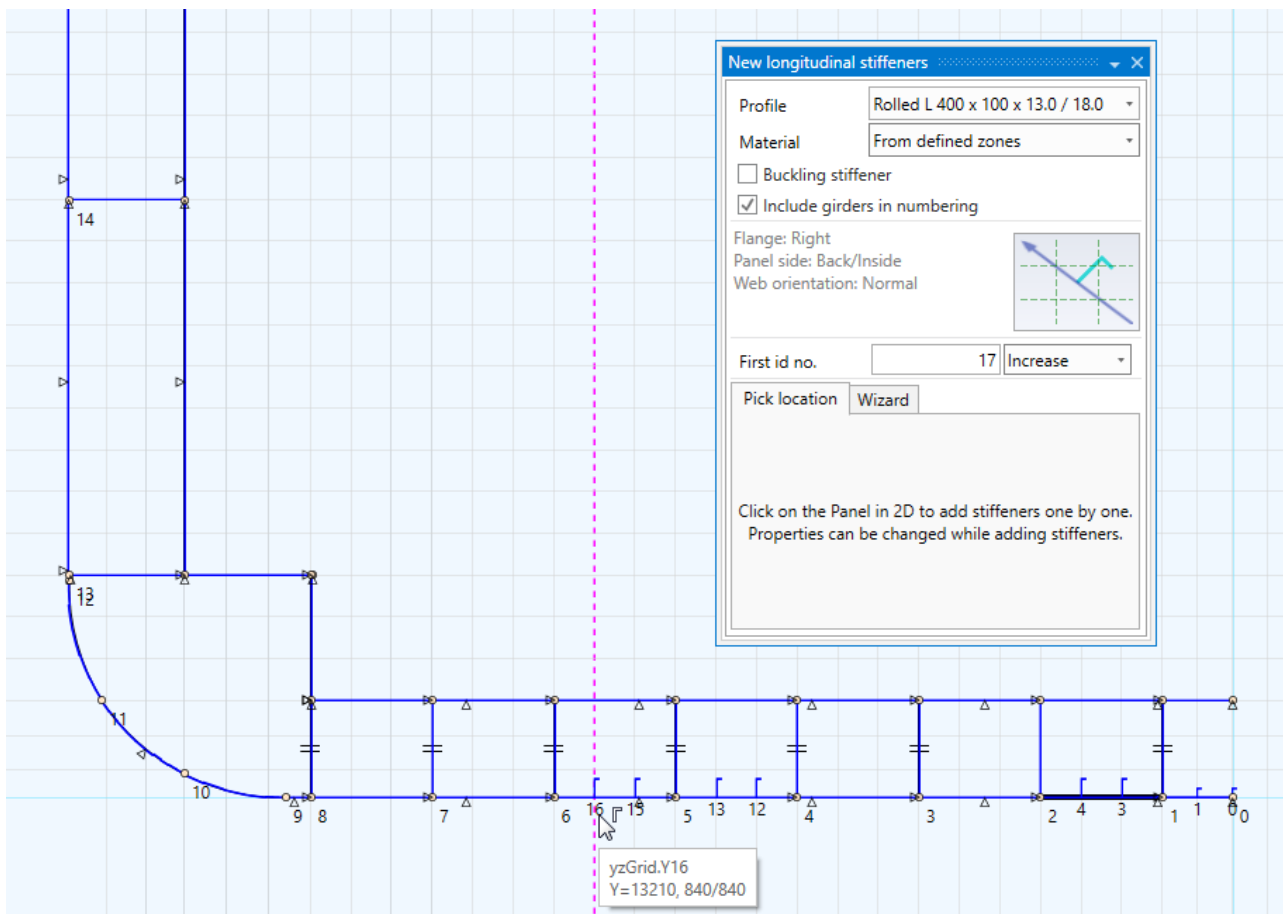




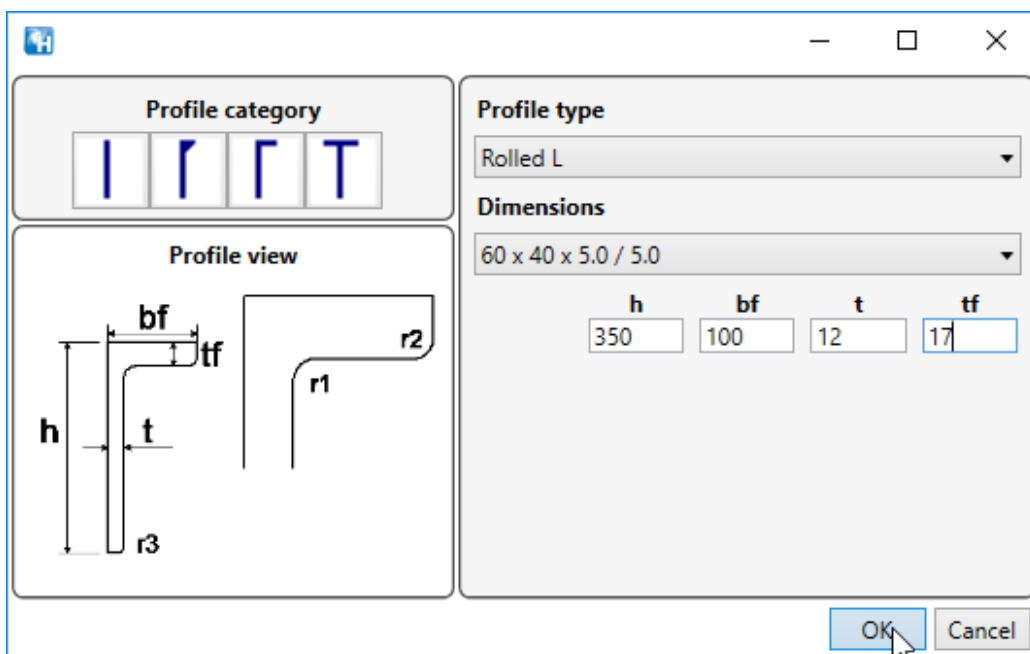
- ⇒ You may now decide to model stiffeners 12 to 16 directly or model all stiffeners in the double bottom and edit them later.

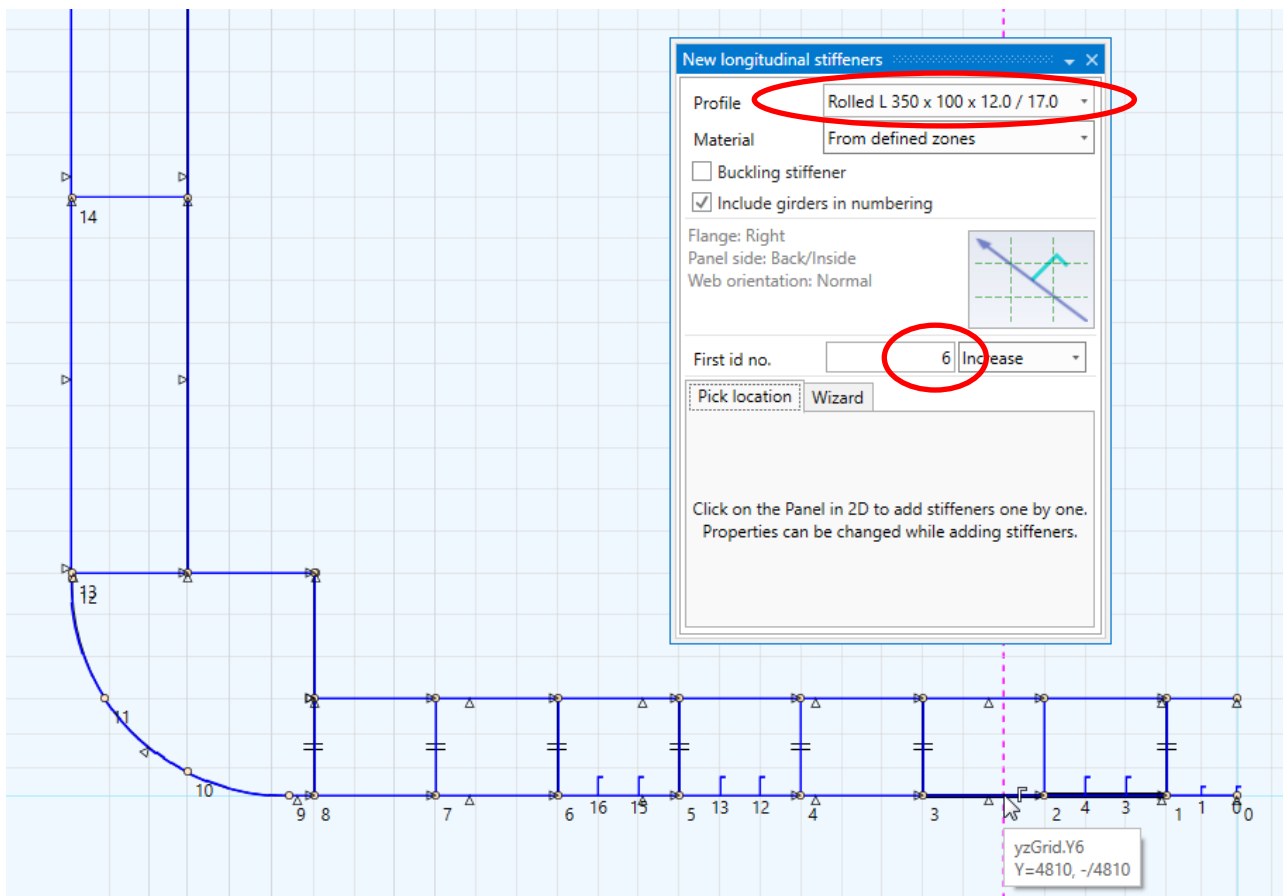


Move on to generate the stiffeners up to 16.

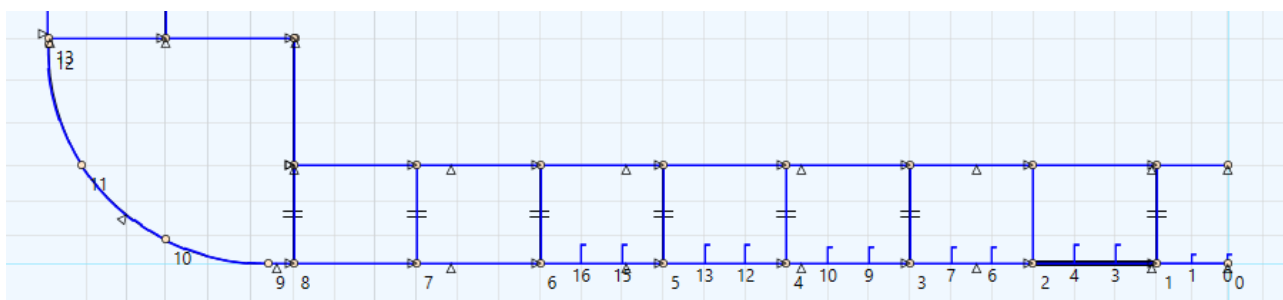


As the in between profiles have a different size we introduce now another Rolled Angle with the size **L350x100x12/17**.



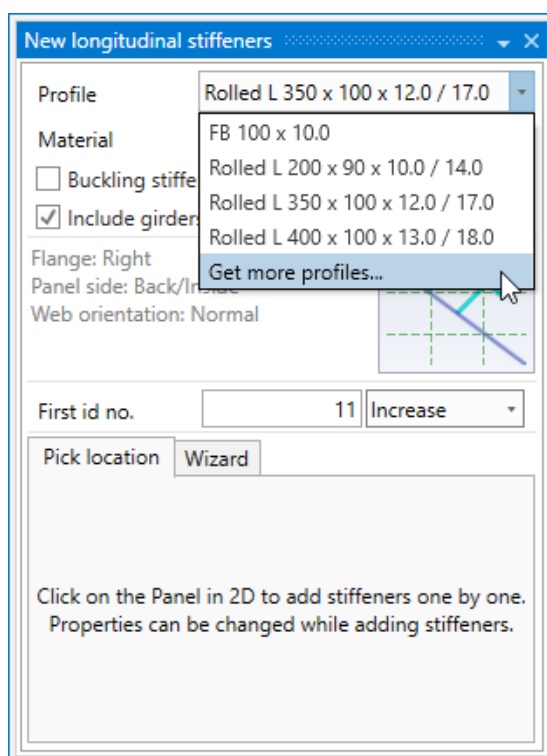


Finish the next stiffeners. The result should look like the following.

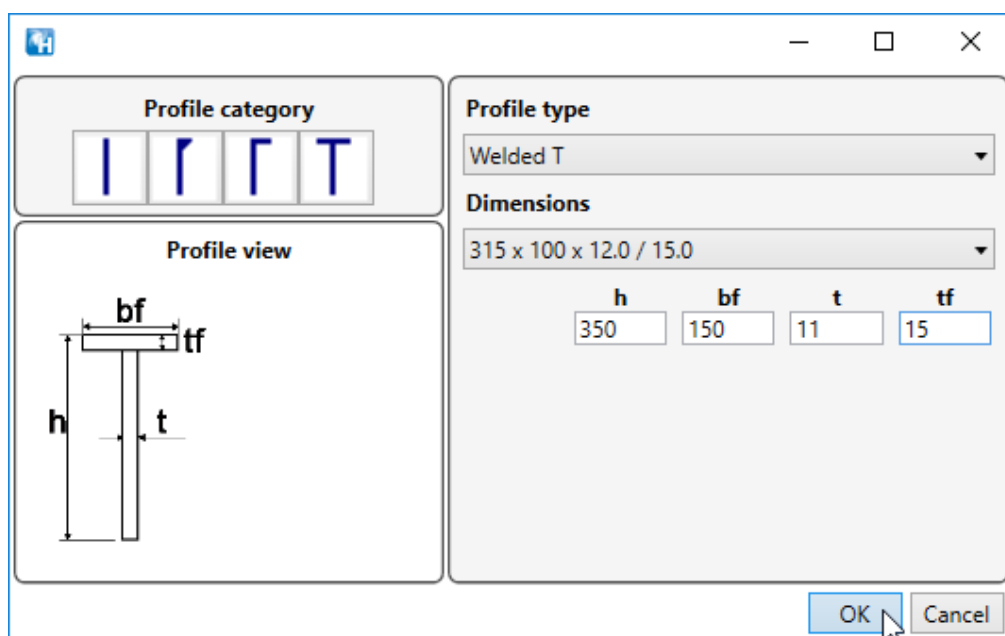


Following the concept sketch we need now T-profiles of the size **T350x11+150x15**.

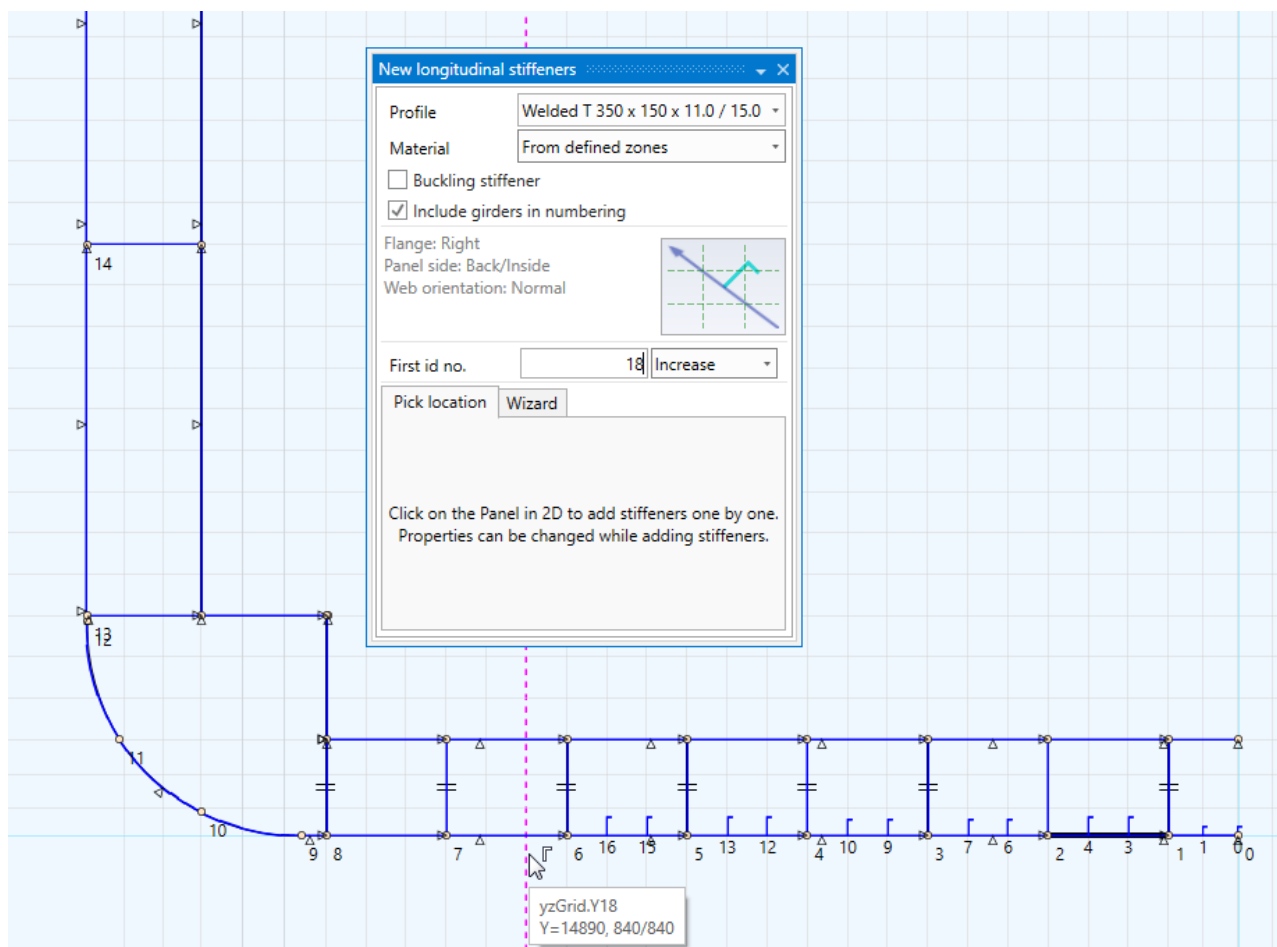
⇒ Please mind the input sequence of the fields. For explanation see the graphic beside.



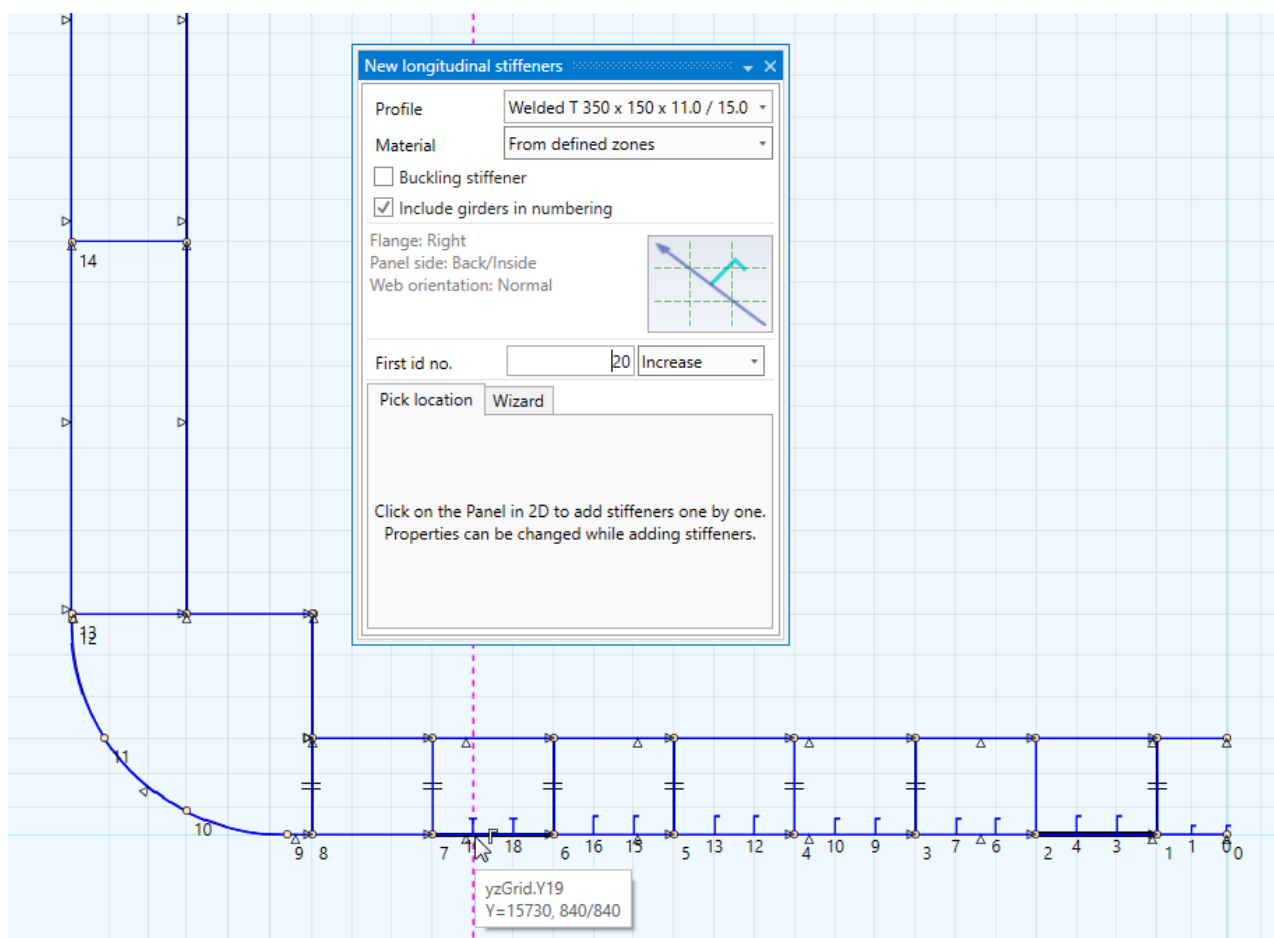
This will launch the following input window:



⇒ Built Up T might be more appropriate as h now is the full height of stiffener

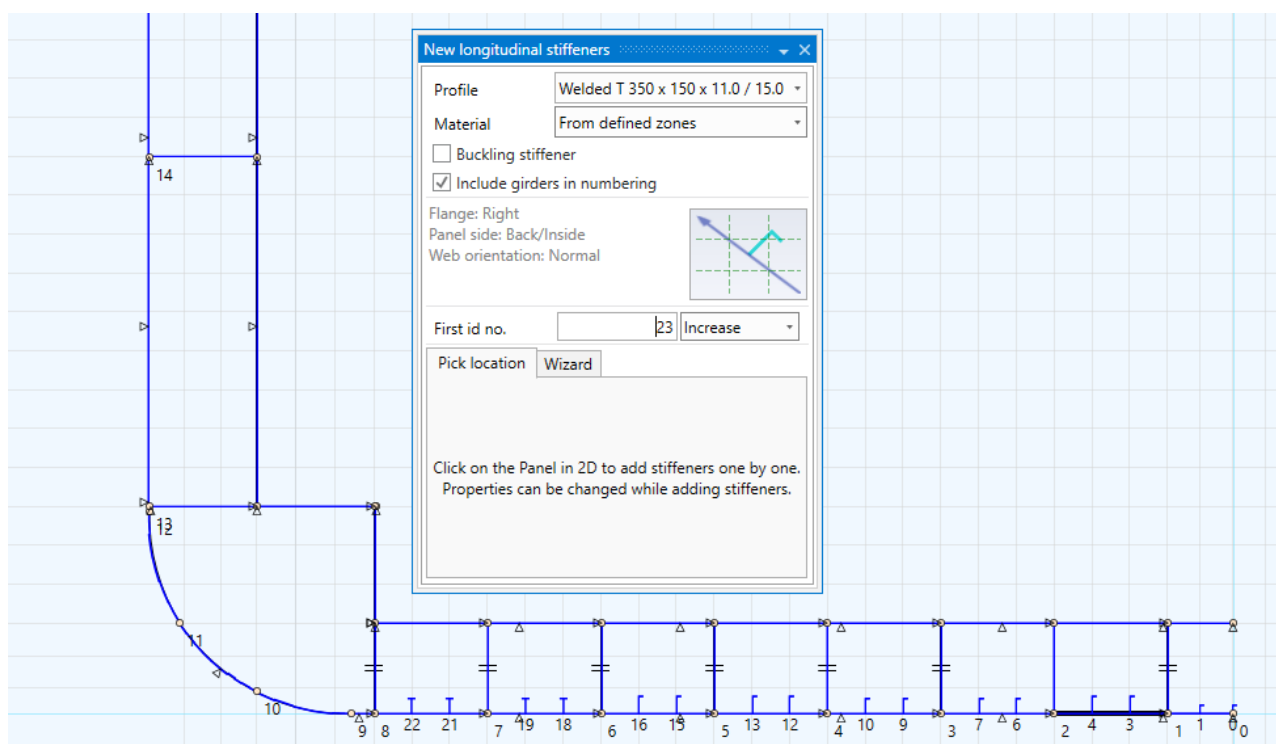


Now begin to set up the 2 T-profiles.

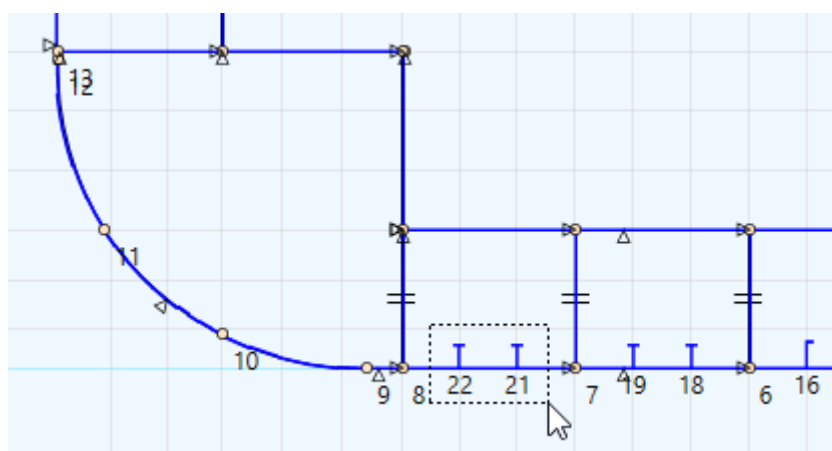


You might set another 2 T's. Although the size will be wrong this can easily adjusted later.

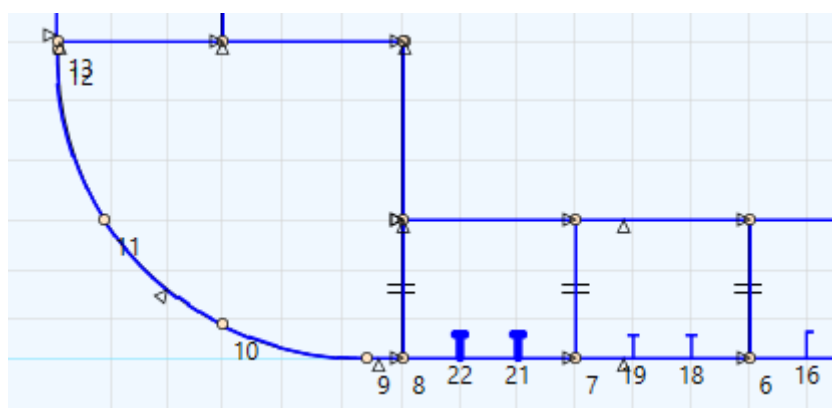
⇒ For speeding up the modelling we neglect the scantling size.



The size of the T-profiles 21 & 22 is **just not correct** and we open a rubber band box over them.



Through this both profiles are marked and will be edited in the Properties pane on the right side:



Properties
Layout

General	
Id	21 22
Name	LongStiff15 LongStiff16
Properties	
Material	VL-32
Type	Longitudinal
Profile	Welded T 350 x 150 x 11.0 / 15.0
Orientation	
Flange orientation	FB 100 x 10.0
Panel side	Rolled L 200 x 90 x 10.0 / 14.0
Web orientations	Rolled L 350 x 100 x 12.0 / 17.0
Web angle to plate	Rolled L 400 x 100 x 13.0 / 18.0
	Welded T 350 x 150 x 11.0 / 15.0
	Get more profiles...
Connection of stiffeners to PSM	
Construction type	Single skin
Welding, tgap [mm]	2.0
Aft frame	
End connection	Undefined
Shear connection	Undefined
Weld leg length, end connection [mm]	
Weld leg length, shear connection [mm]	
Fwd frame	
End connection	Undefined
Shear connection	Undefined
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	3250
Bending span	3250
Shear span	2830
Calculations	
Buckling stiffener	☐

Within the Properties pane you will find the same dialog. Change tf only to **18mm**.

Pressing the Ok-button you will find the new size activated.

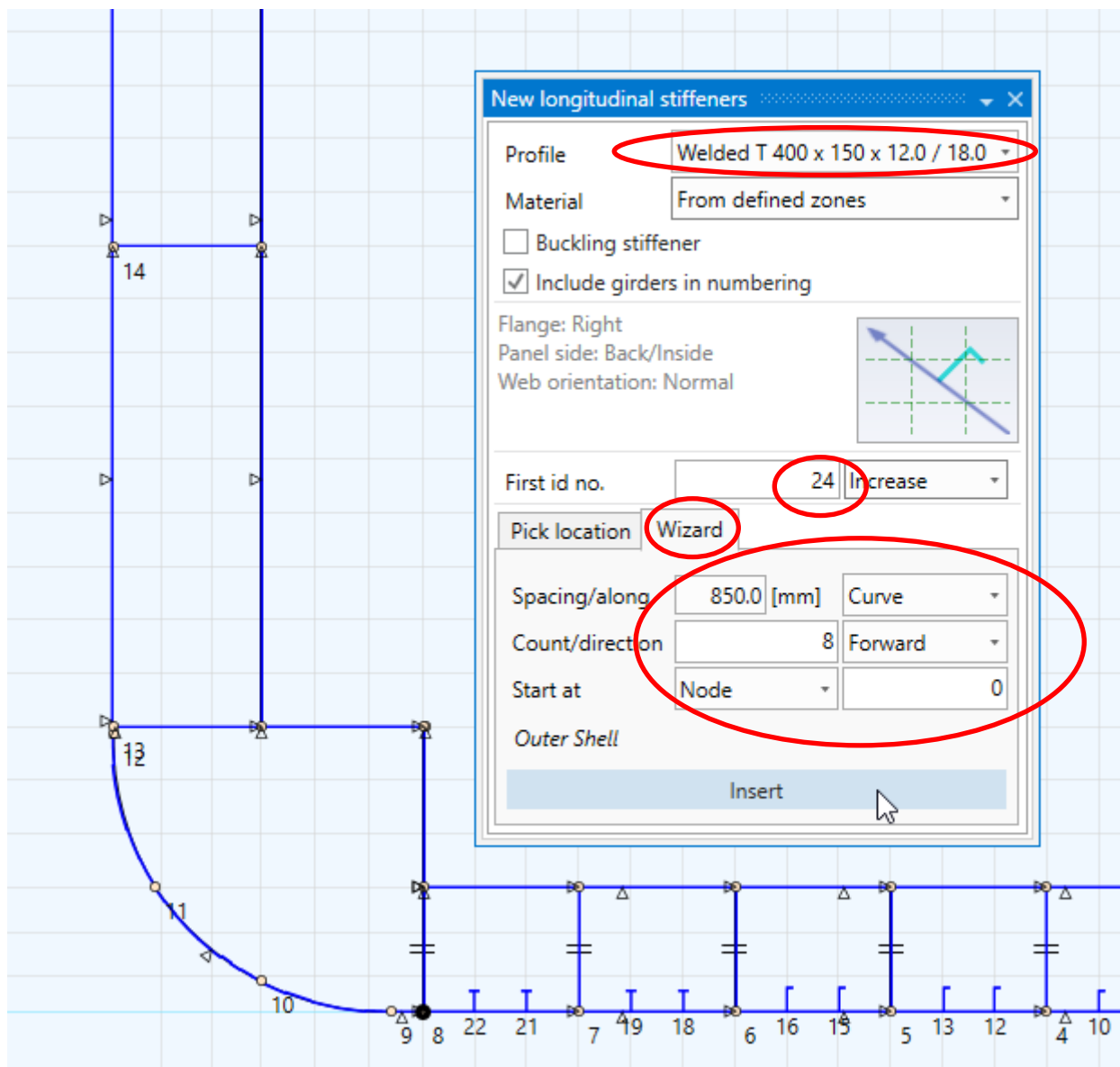
⇒ Later we will make use of it when we have to model the side longitudinals.

Now we will have to care for the Bilge stiffeners. They are **T 400x12 + 150*18**.

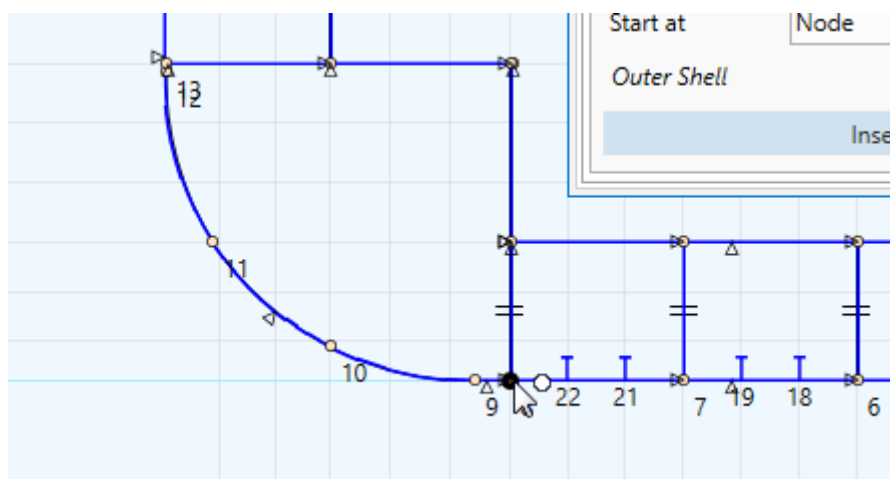
First you will have to establish the profile In a second step please choose the Wizard and give spacing to **850mm**, Count **8**.

Since the longitudinal girder we cannot use **Start at Stiffener** when defining the bilge stiffeners.

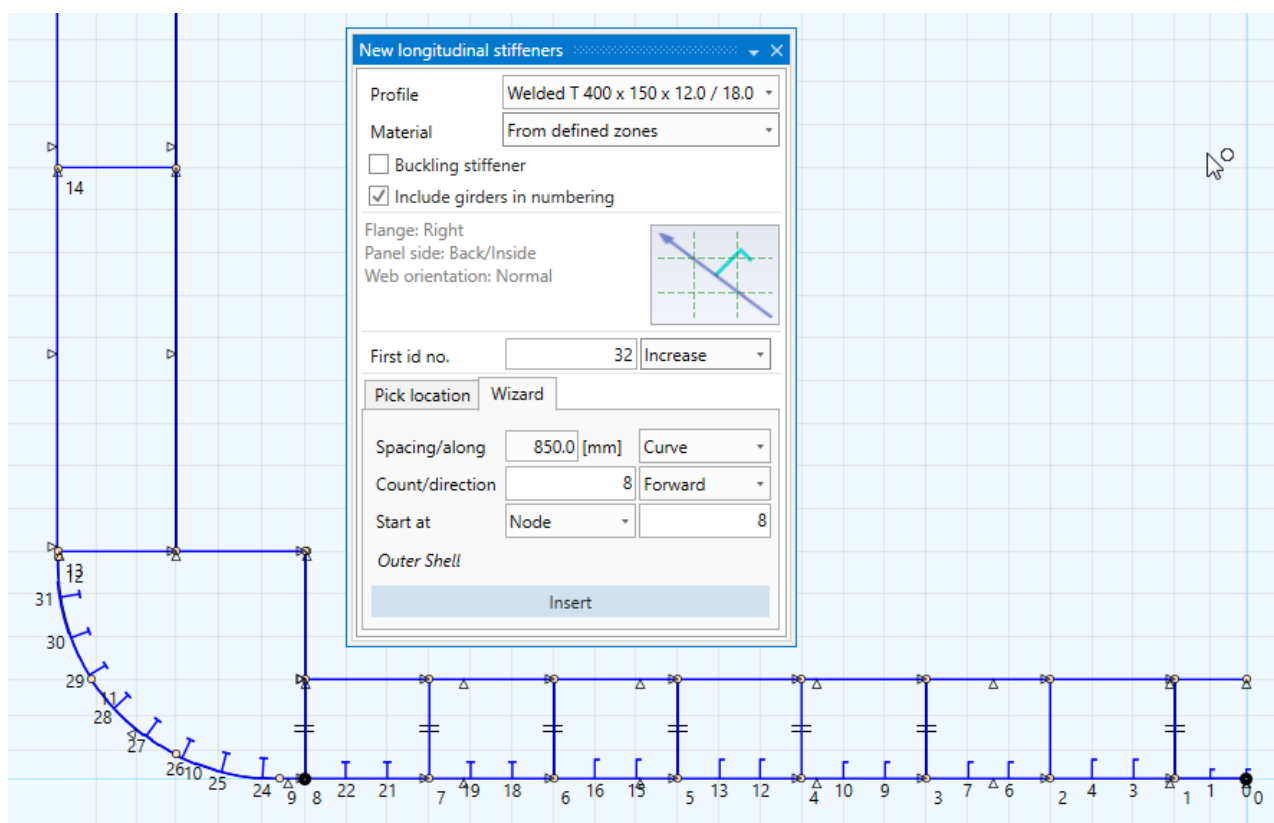
Therefore, change to **Start at Node** and make sure **node 8** is specified.



The Node is picked with the Mouse pointer when **Start at** is changed to **Node** :

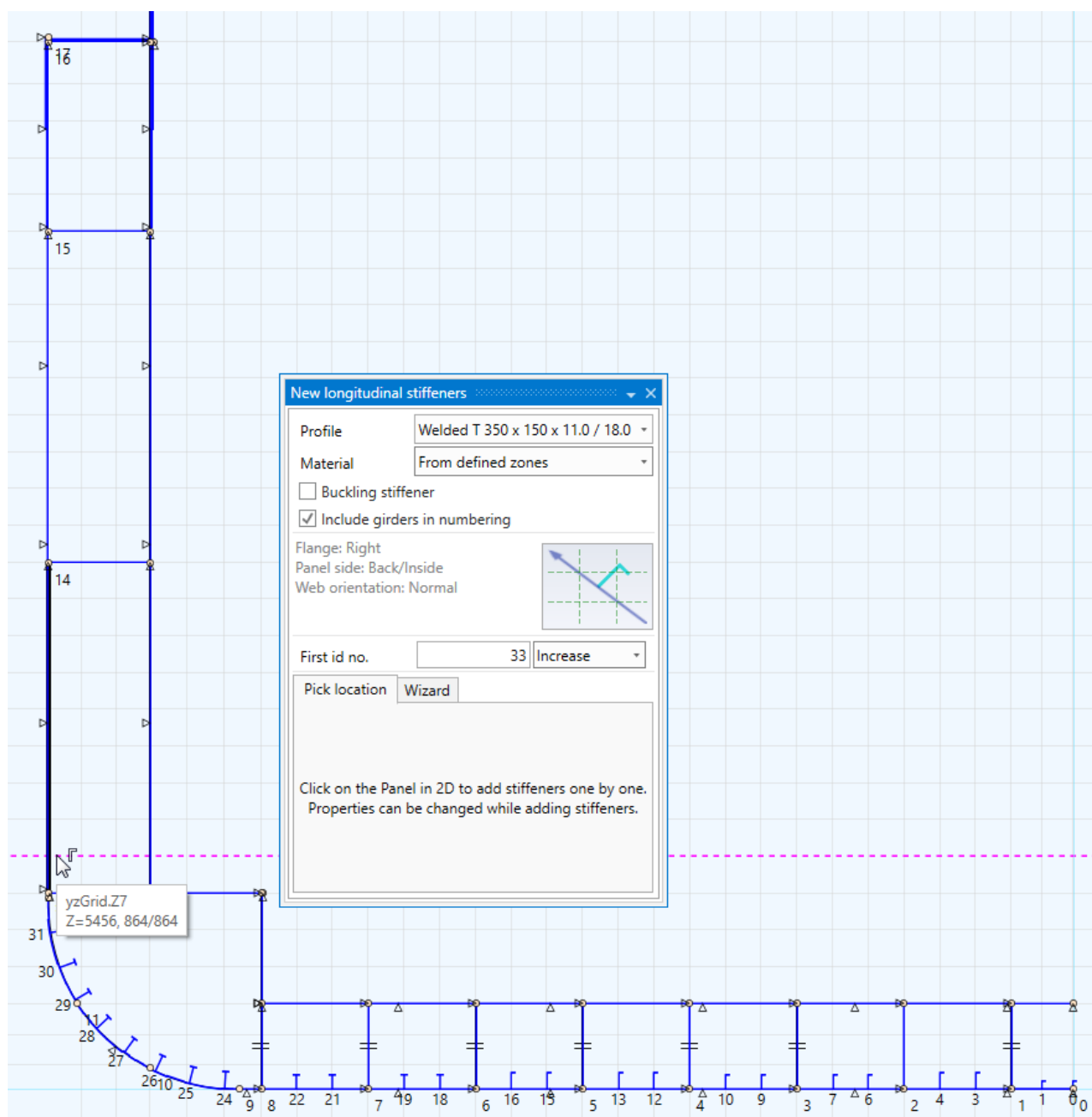


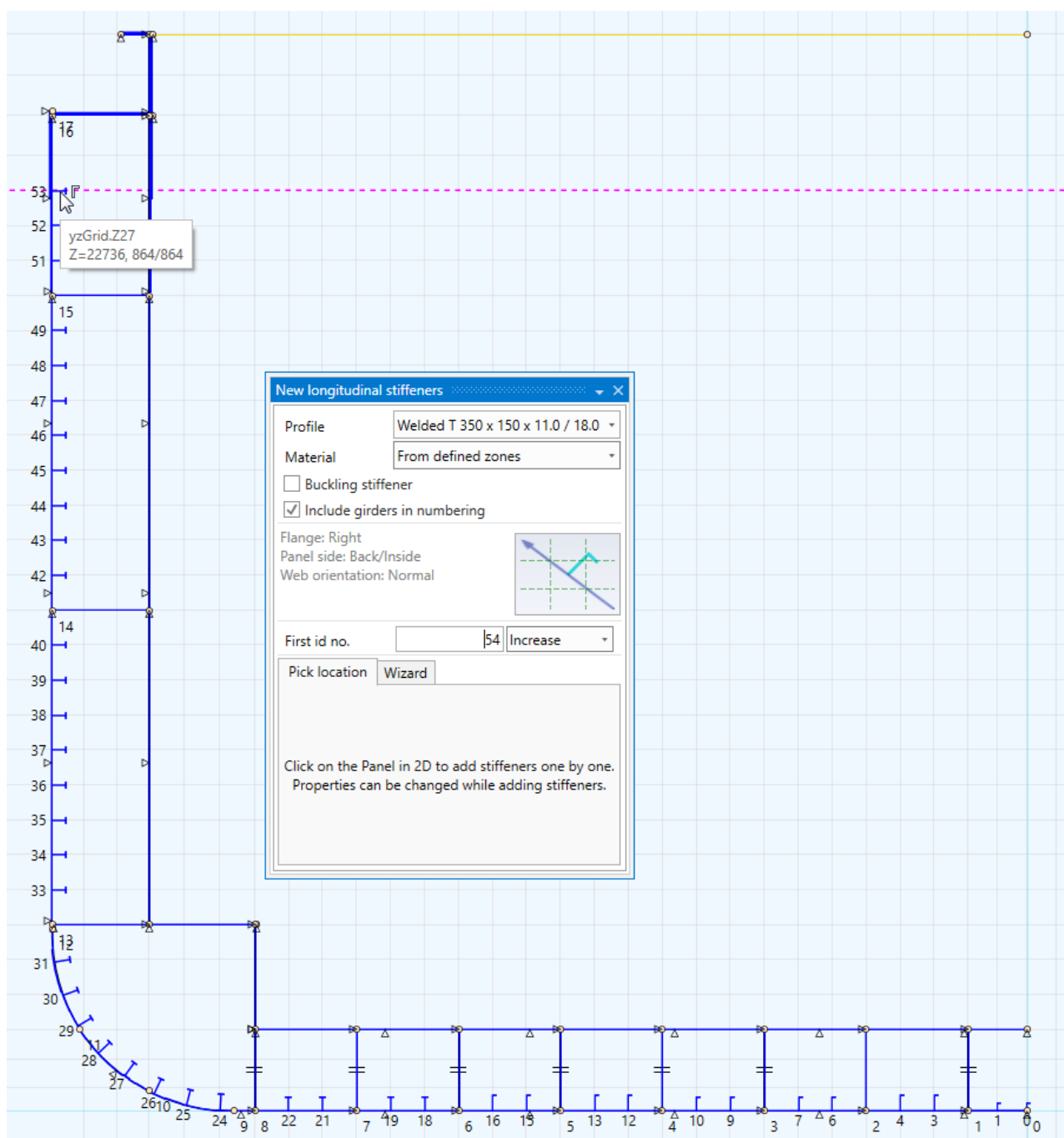
The result will look the following:



The longitudinals of the Bilge are finished.

Now we have to care for the side longitudinals on the Outer Shell.

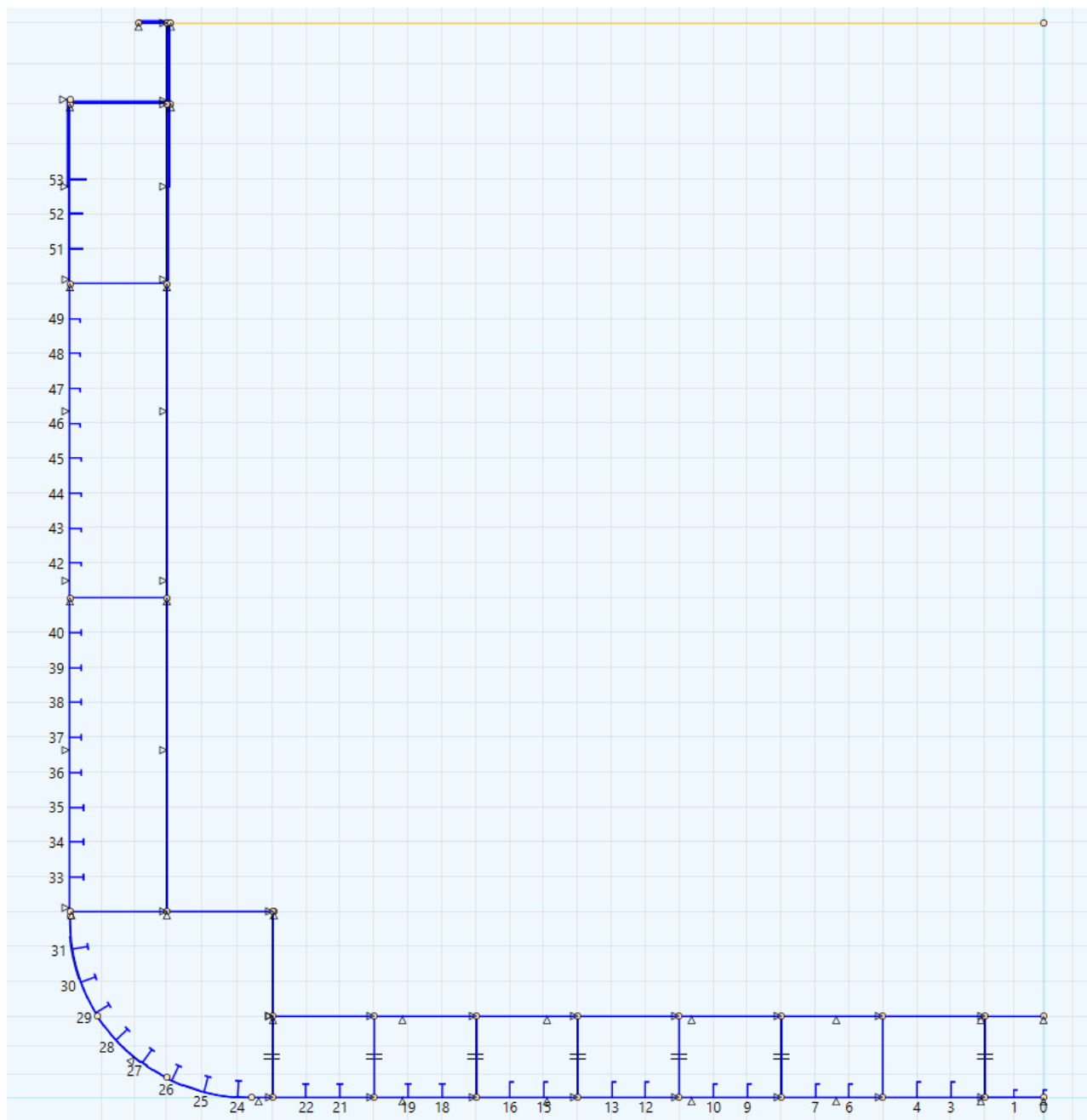




Now adjust the size of the profiles as show before with a rubber band box and the Properties pane.

Side Shell	53	FB 400x32 VL-36
	51-52	FB 320x32 VL-32
	46-49	L 250x90x10/15 VL-32
	43-45	L 300x90x11/16 VL-32
	42	L 300x90x13/17 VL-32
	36-40	T 300x11 + 140x15 VL-32
	33-35	T 350x11 + 150x18 VL-32

The result will look like the following:

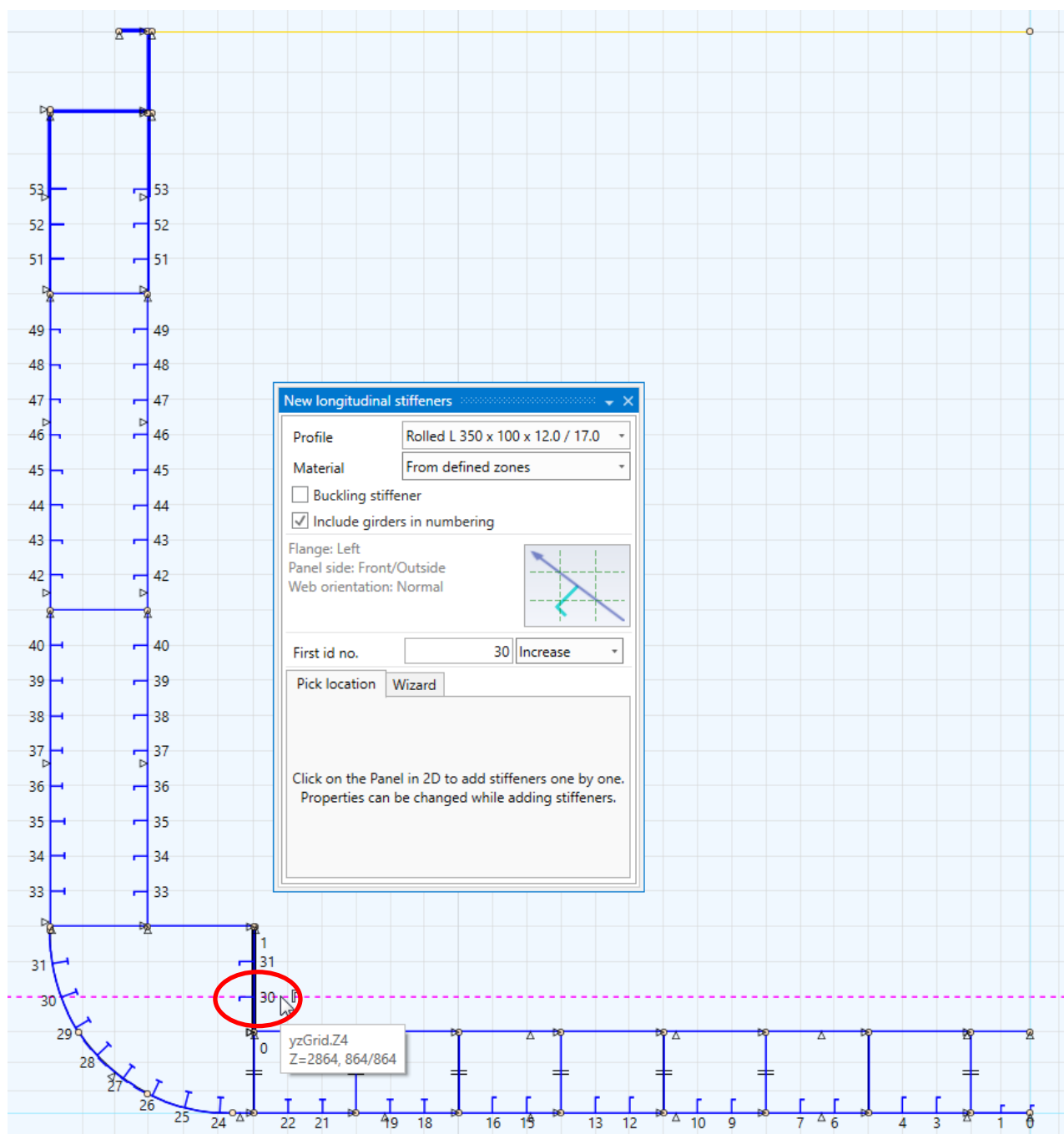


The Outer Shell stiffeners are finished.

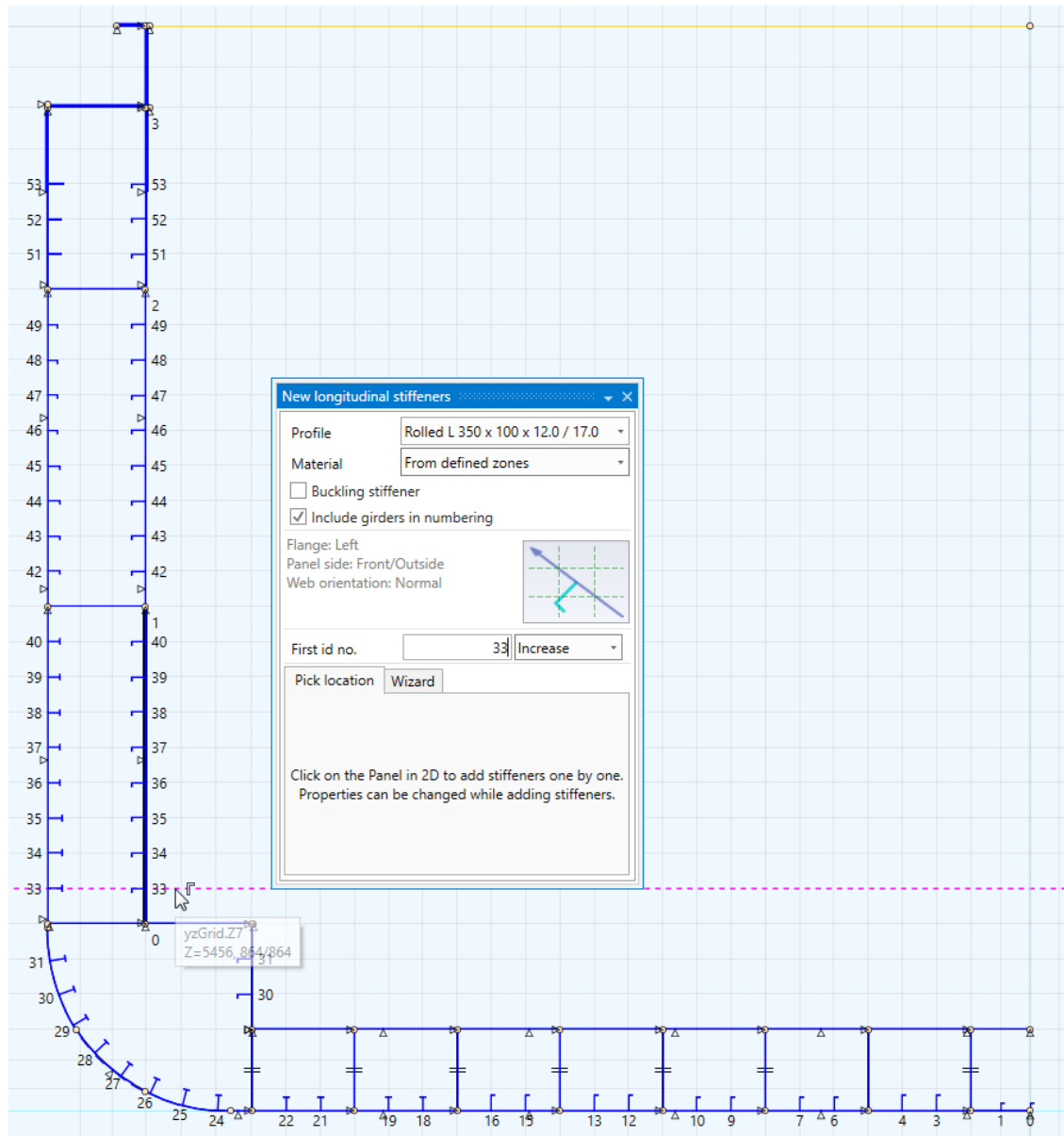
Save the Workspace.

6.4.2 Longitudinal Bulkheads

To cover Longitudinal Bulkheads in a similar way, activate **Longitudinal Bulkhead 23**, change **First id. no** to **30** and **switch web direction**:

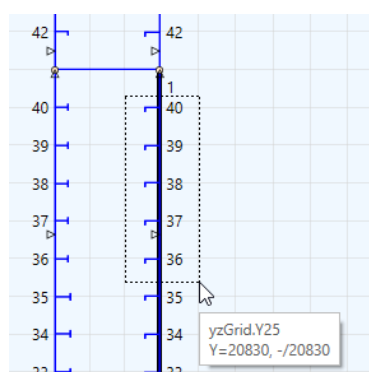


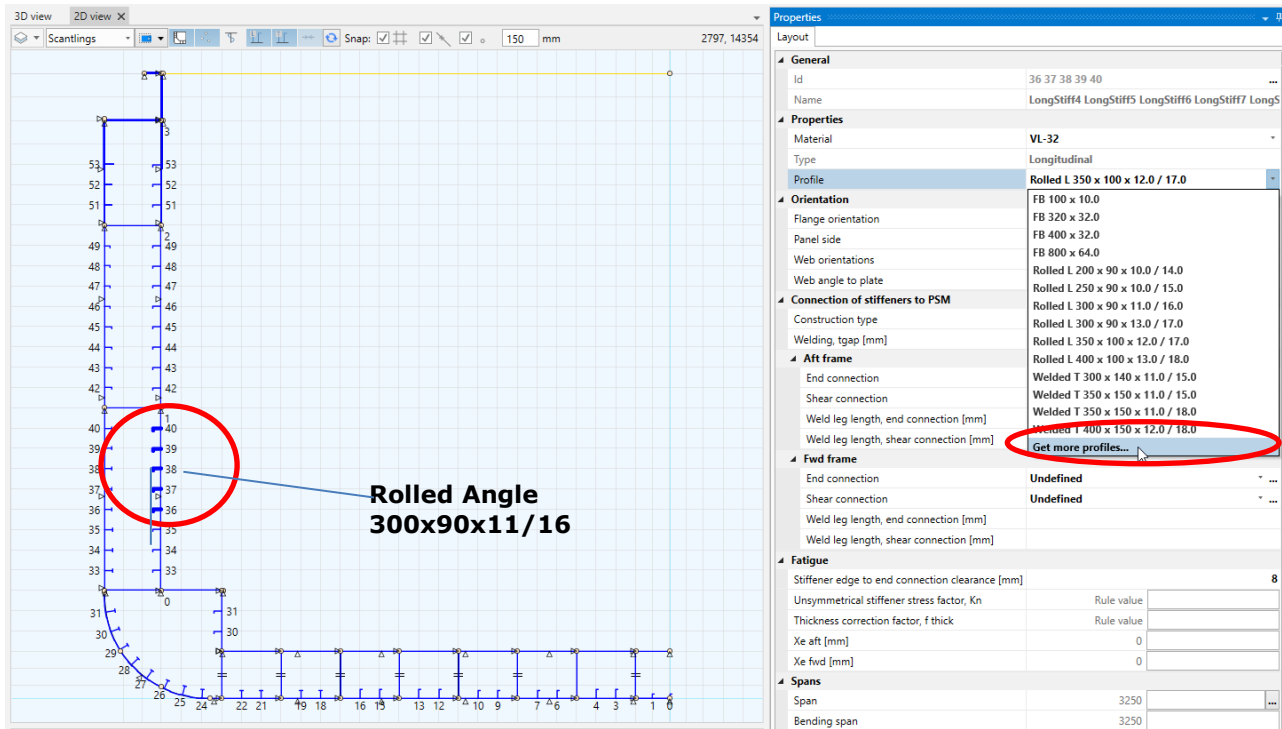
In a second step activate the **Longitudinal Bulkhead 26**, change **First id. no** to 33:



Modify stiffener profile type on Longitudinal bulkhead 26.

Select stiffeners on the longitudinal bulkhead by a rubber-band box, then modify profile:

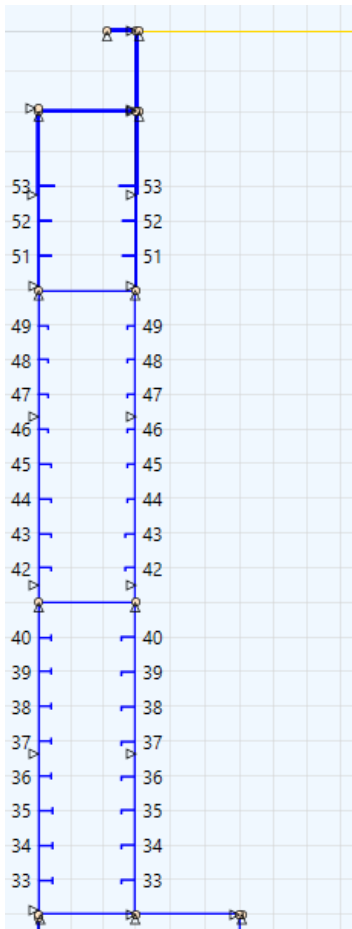




Properties

General	
Id	36 37 38 39 40
Name	LongStiff4 LongStiff5 LongStiff6 LongStiff7 LongStiff8
Properties	
Material	VL-32
Type	Longitudinal
Profile	Rolled L 350 x 100 x 12.0 / 17.0
Orientation	
Flange orientation	FB 100 x 10.0
Panel side	FB 320 x 32.0
Web orientations	FB 400 x 32.0
Web angle to plate	FB 800 x 64.0
Connection of stiffeners to PSM	
Construction type	Rolled L 200 x 90 x 10.0 / 14.0
Welding, tgap [mm]	Rolled L 250 x 90 x 10.0 / 15.0
Aft frame	
End connection	Rolled L 300 x 90 x 11.0 / 16.0
Shear connection	Rolled L 300 x 90 x 13.0 / 17.0
Weld leg length, end connection [mm]	Rolled L 400 x 100 x 12.0 / 17.0
Weld leg length, shear connection [mm]	Welded T 300 x 140 x 11.0 / 15.0
Fwd frame	
End connection	Welded T 350 x 150 x 11.0 / 15.0
Shear connection	Welded T 350 x 150 x 11.0 / 15.0
Weld leg length, end connection [mm]	Welded T 400 x 150 x 12.0 / 18.0
Weld leg length, shear connection [mm]	Get more profiles...
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	3250
Bending span	3250

Change the remaining parts of Longitudinal Bulkhead 26 according to the concept sketch:

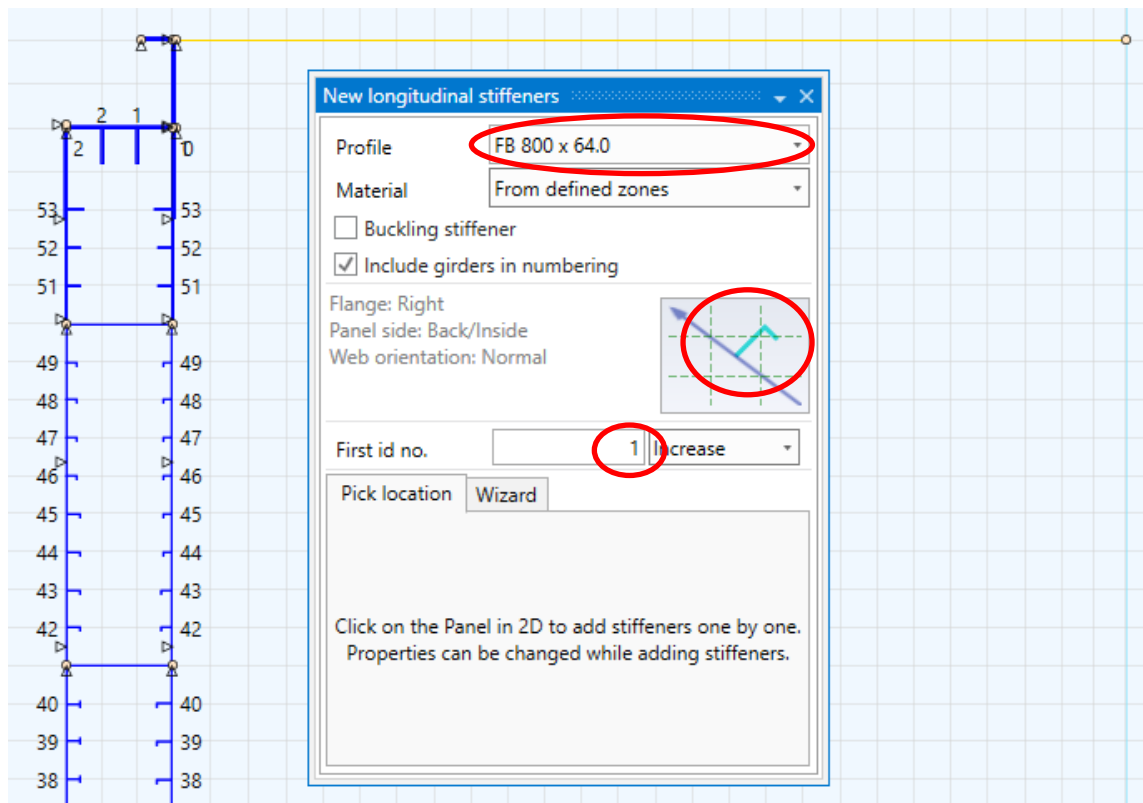


Finished change of profiles.

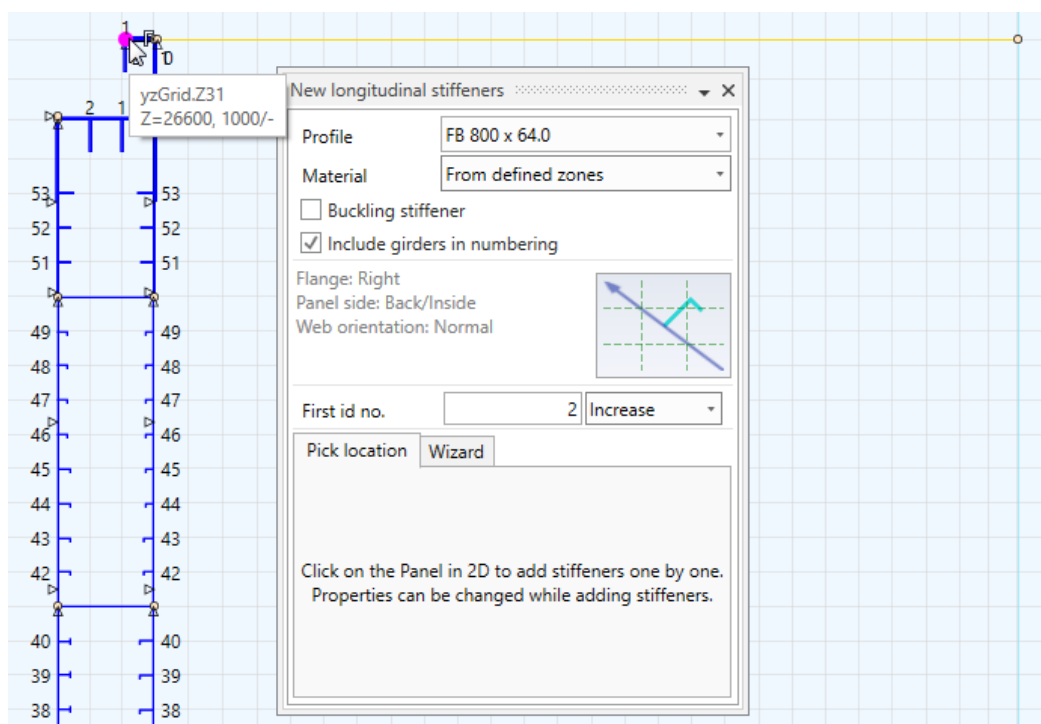
6.4.3 Strength deck and Coaming

Select strength deck segment.

Define stiffeners on strength deck by Pick location:



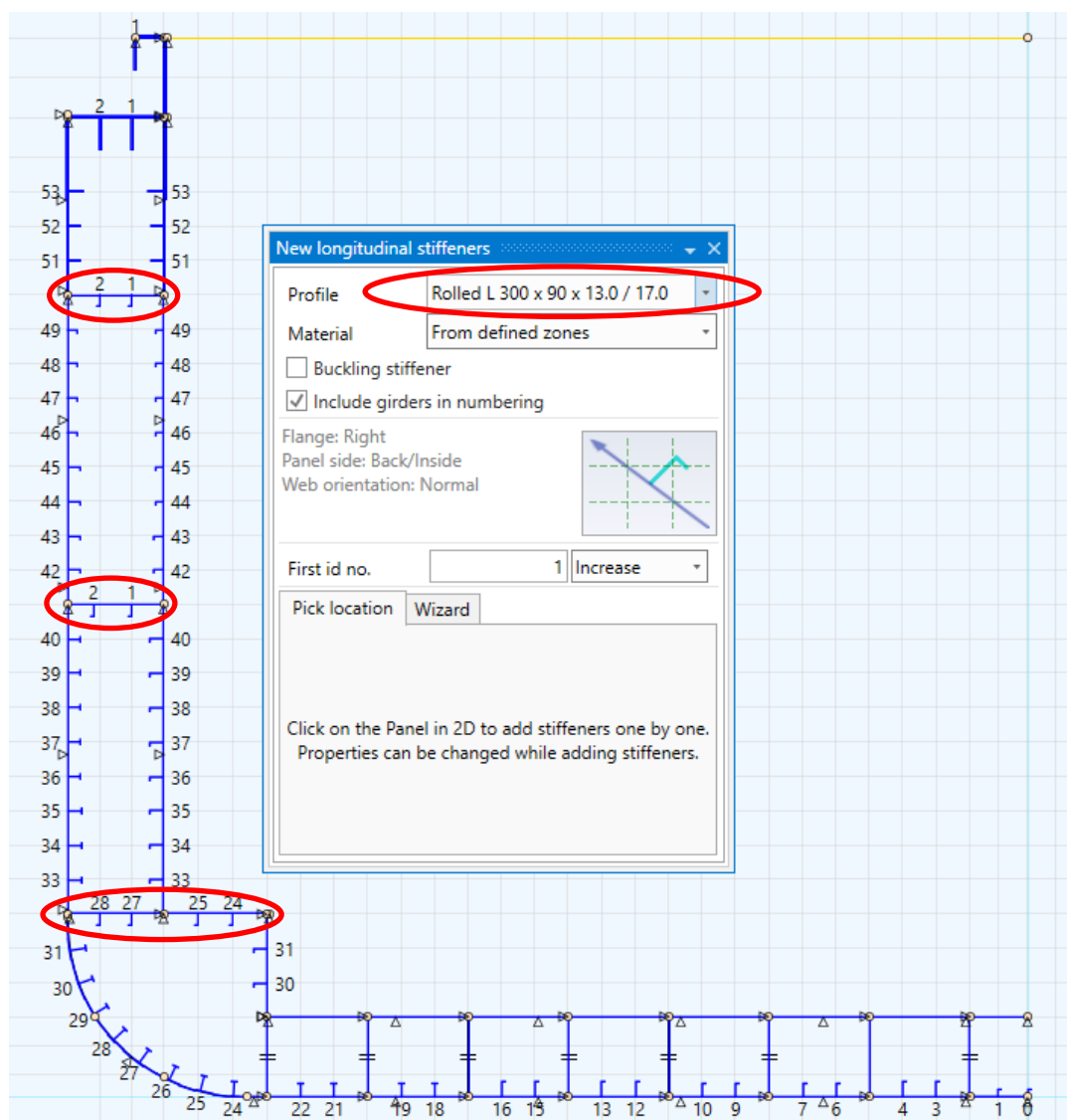
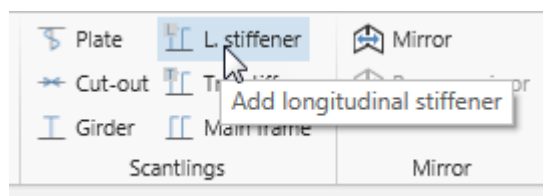
Activate the Coaming and provide the same profile to the horizontal coaming.



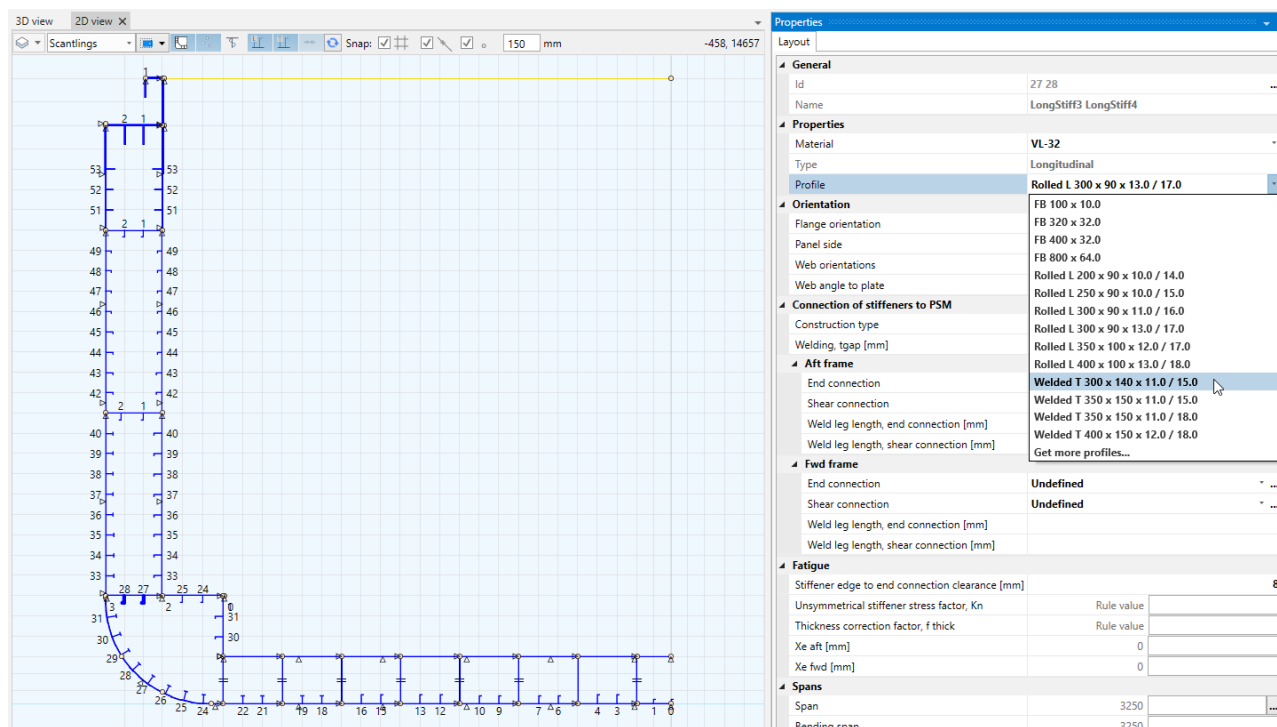
6.4.4 Decks

To define the stiffeners on the decks choose **L300x90x13/17**.

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.



Change in a second step the **stiffeners 27-28** on **Deck 4** with a rubber band box and change in the Properties pane to **T 300x11 + 140x15**:

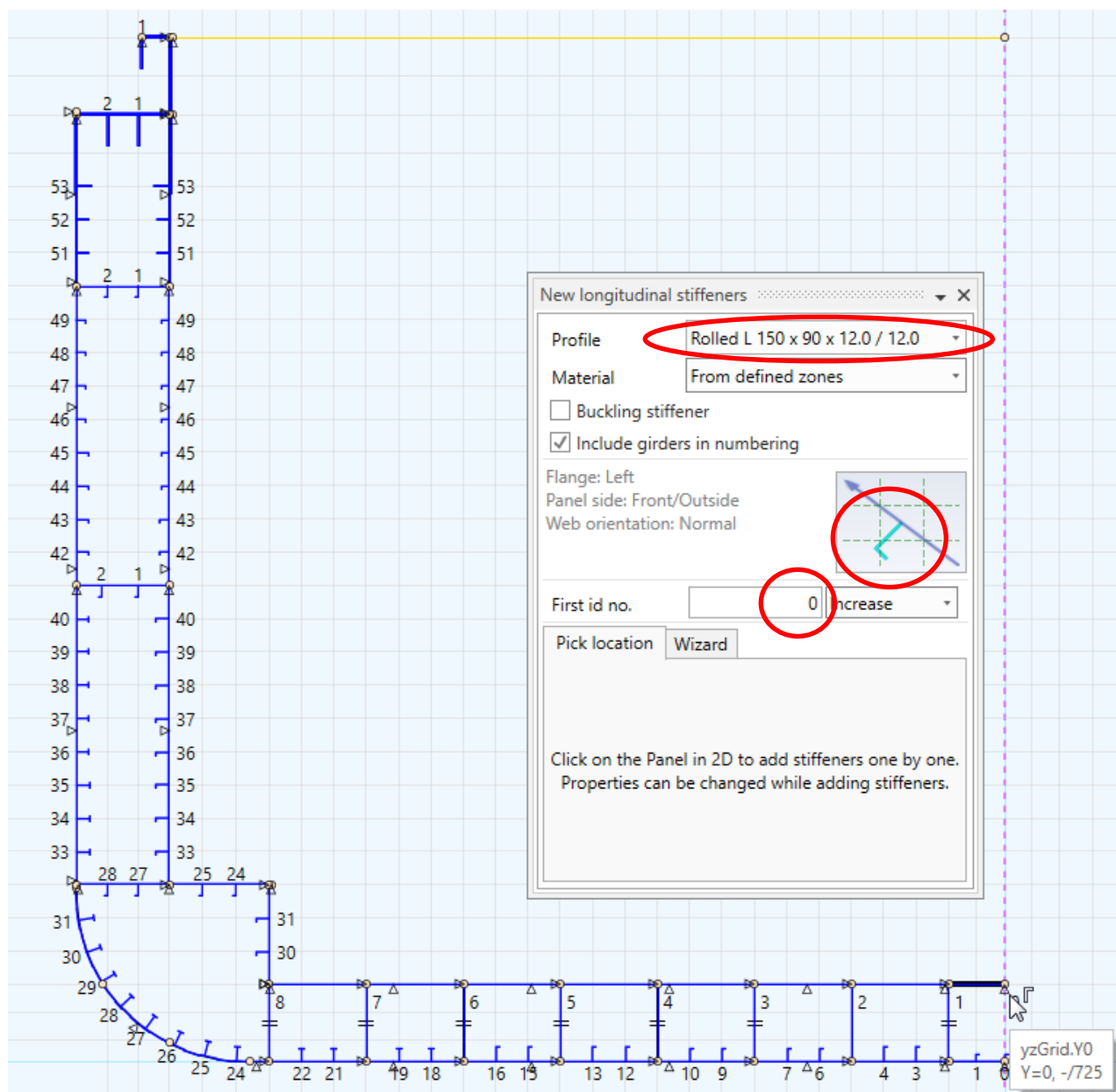


The screenshot shows the DNV GL software interface. On the left, a 2D view of a hull structure is displayed, with stiffeners numbered 1 through 31. Stiffeners 27 and 28 are highlighted. On the right, the Properties pane is open, showing the following details:

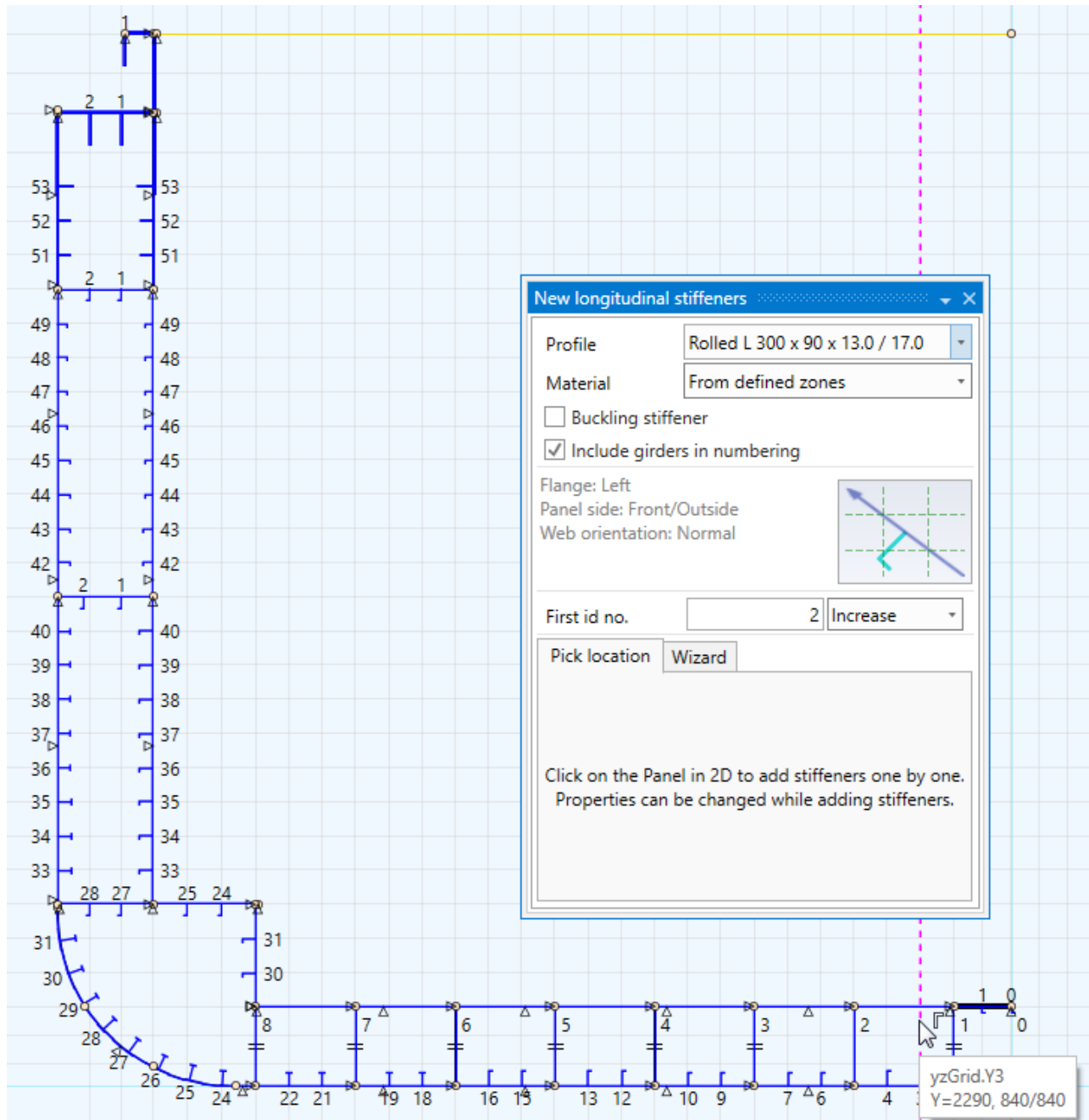
Properties	
Layout	
General Id: 27 28 Name: LongStiff3 LongStiff4	
Properties Material: VL-32 Type: Longitudinal Profile: Rolled L 300 x 90 x 13.0 / 17.0	
Orientation Flange orientation: FB 100 x 10.0 Panel side: FB 320 x 32.0 Web orientations: FB 400 x 32.0 Web angle to plate: FB 800 x 64.0 Rolled L 200 x 90 x 10.0 / 14.0 Rolled L 250 x 90 x 10.0 / 15.0 Rolled L 300 x 90 x 11.0 / 16.0 Rolled L 300 x 90 x 13.0 / 17.0 Rolled L 350 x 100 x 12.0 / 17.0 Rolled L 400 x 100 x 13.0 / 18.0	
Connection of stiffeners to PSM Construction type: Rolled L 300 x 90 x 11.0 / 16.0 Welding, tgap [mm]: Rolled L 350 x 100 x 12.0 / 17.0 Rolled L 400 x 100 x 13.0 / 18.0	
Aft frame End connection: Welded T 300 x 140 x 11.0 / 15.0 Shear connection: Welded T 350 x 150 x 11.0 / 15.0 Weld leg length, end connection [mm]: Welded T 350 x 150 x 11.0 / 18.0 Weld leg length, shear connection [mm]: Welded T 400 x 150 x 12.0 / 18.0 Get more profiles...	
Fwd frame End connection: Undefined Shear connection: Undefined 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: 3250 Bending span: 3250	

6.4.5 Inner bottom

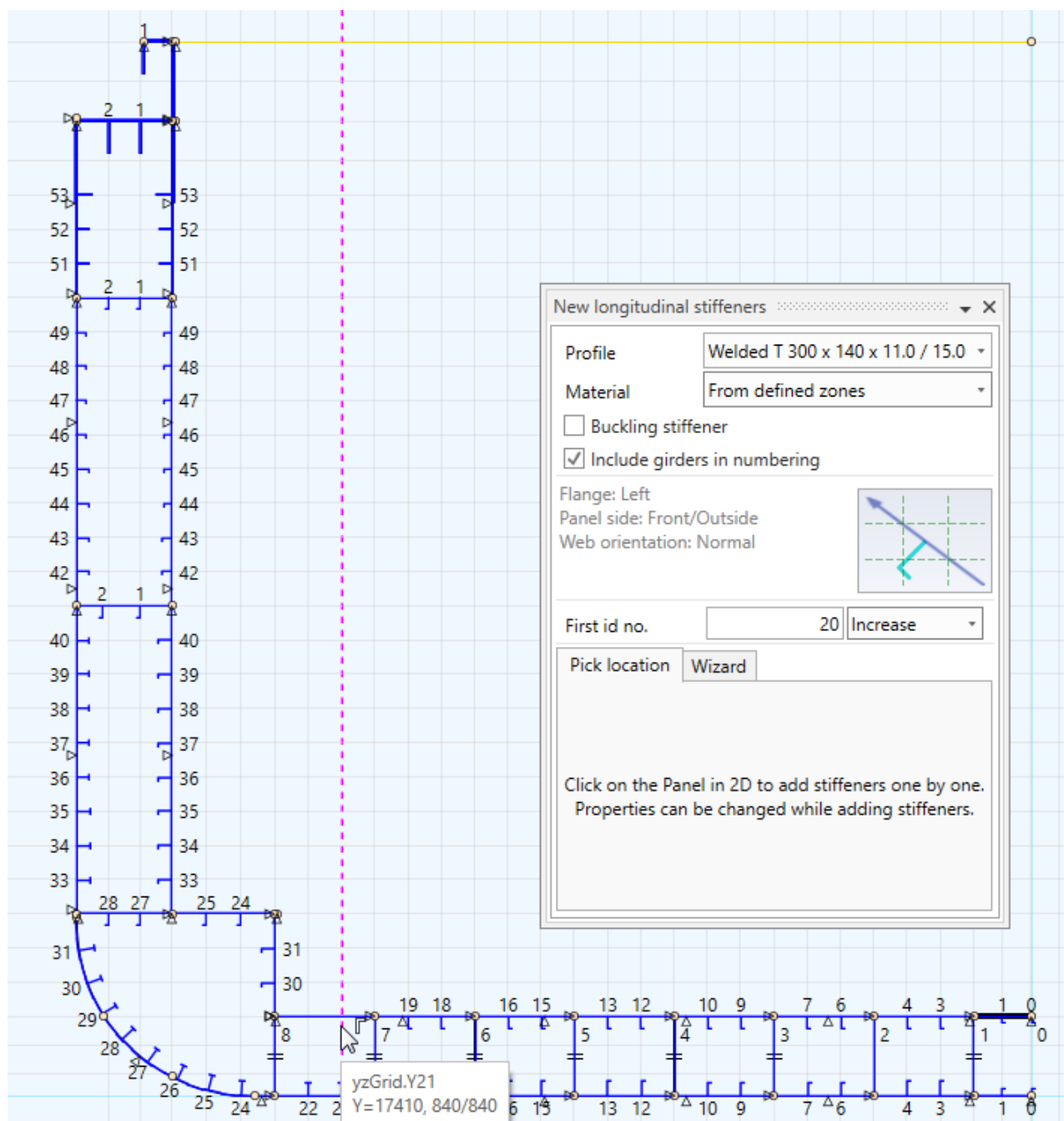
Begin with the 2 center L-profiles, switch **Web direction** and choose **L 150x90x12**



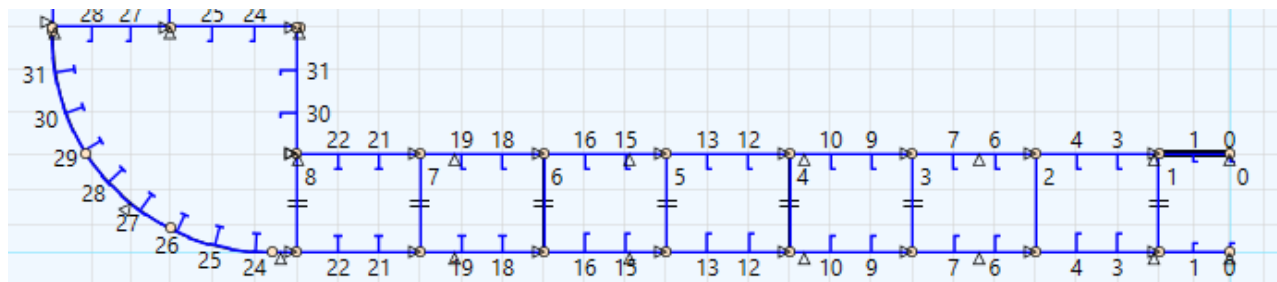
Proceed with stiffeners 3 – 19 as **L 300x90x13/17**:



Finnish the Inner Bottom with stiffeners 21-22 as **T 300x11 + 140x15**:



The result looks the following:

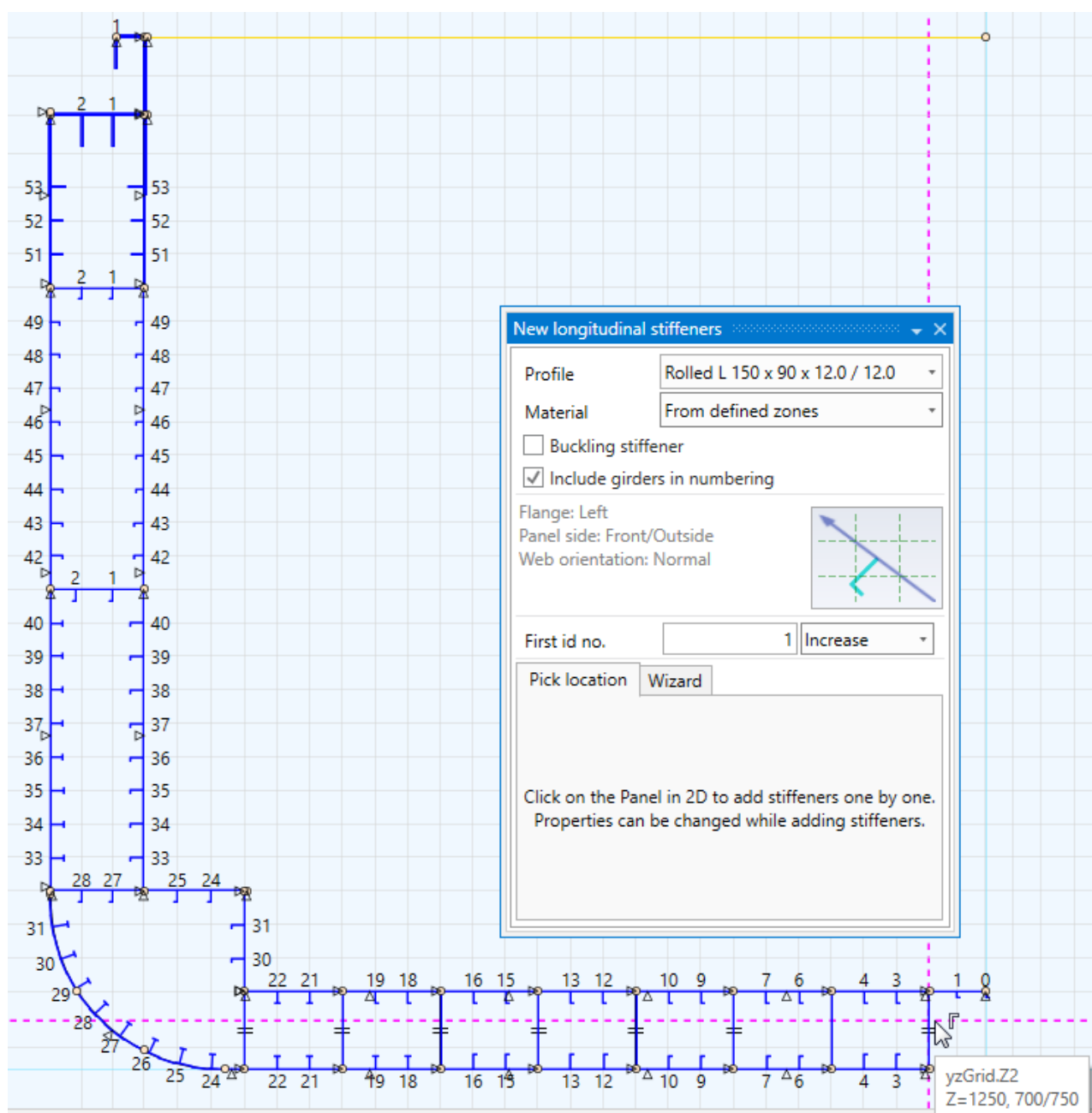


⇒ It is up to you if you work exactly or on a temporary base with editing later

6.4.6 Longitudinal Girders

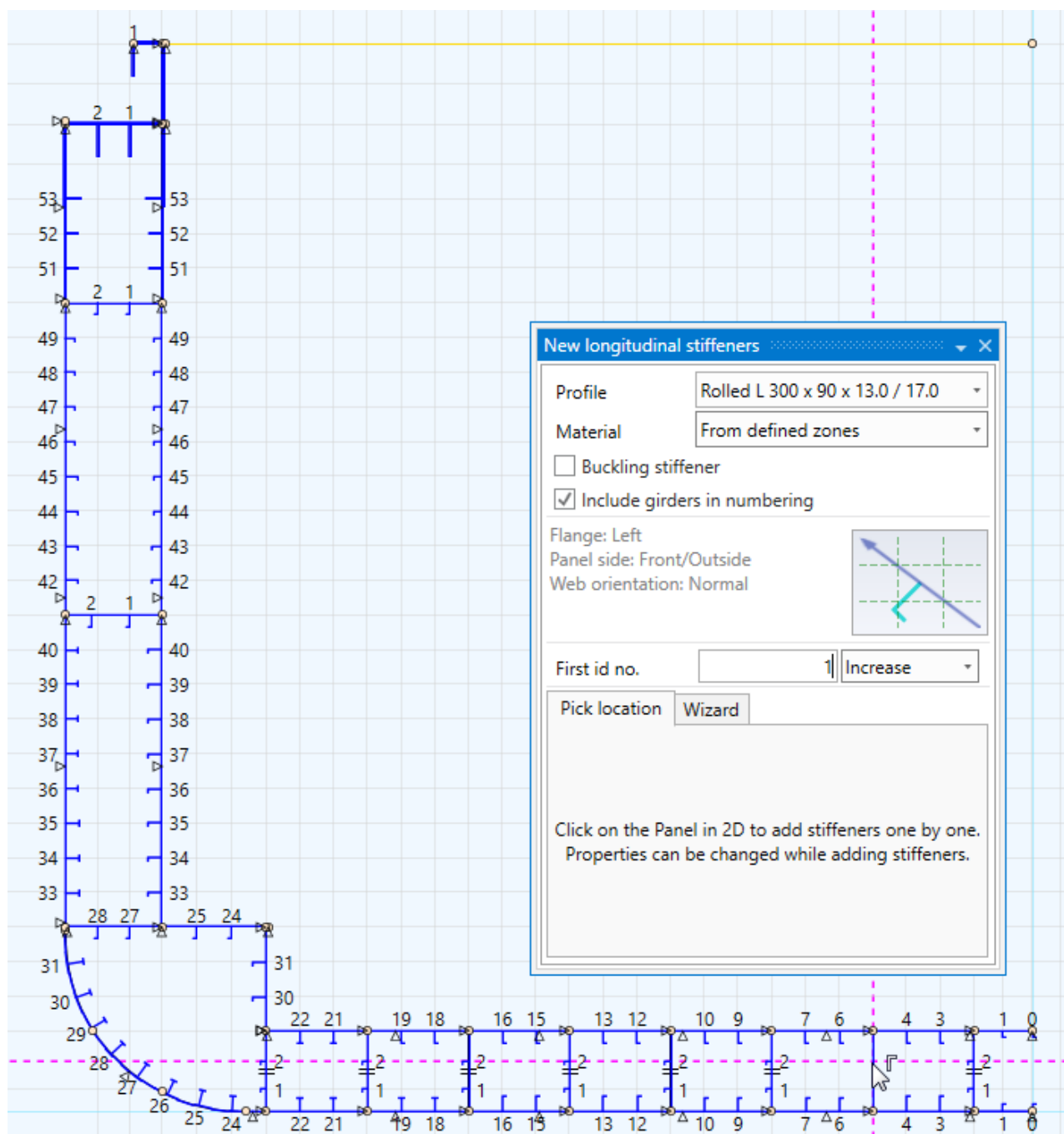
We proceed with the NWT double bottom girders and model for each individual girder 2 stiffeners **L 150x90x12**

- ⇒ It is up to you if you It is not necessary to pick always new segments but consider the ID changing before you start another

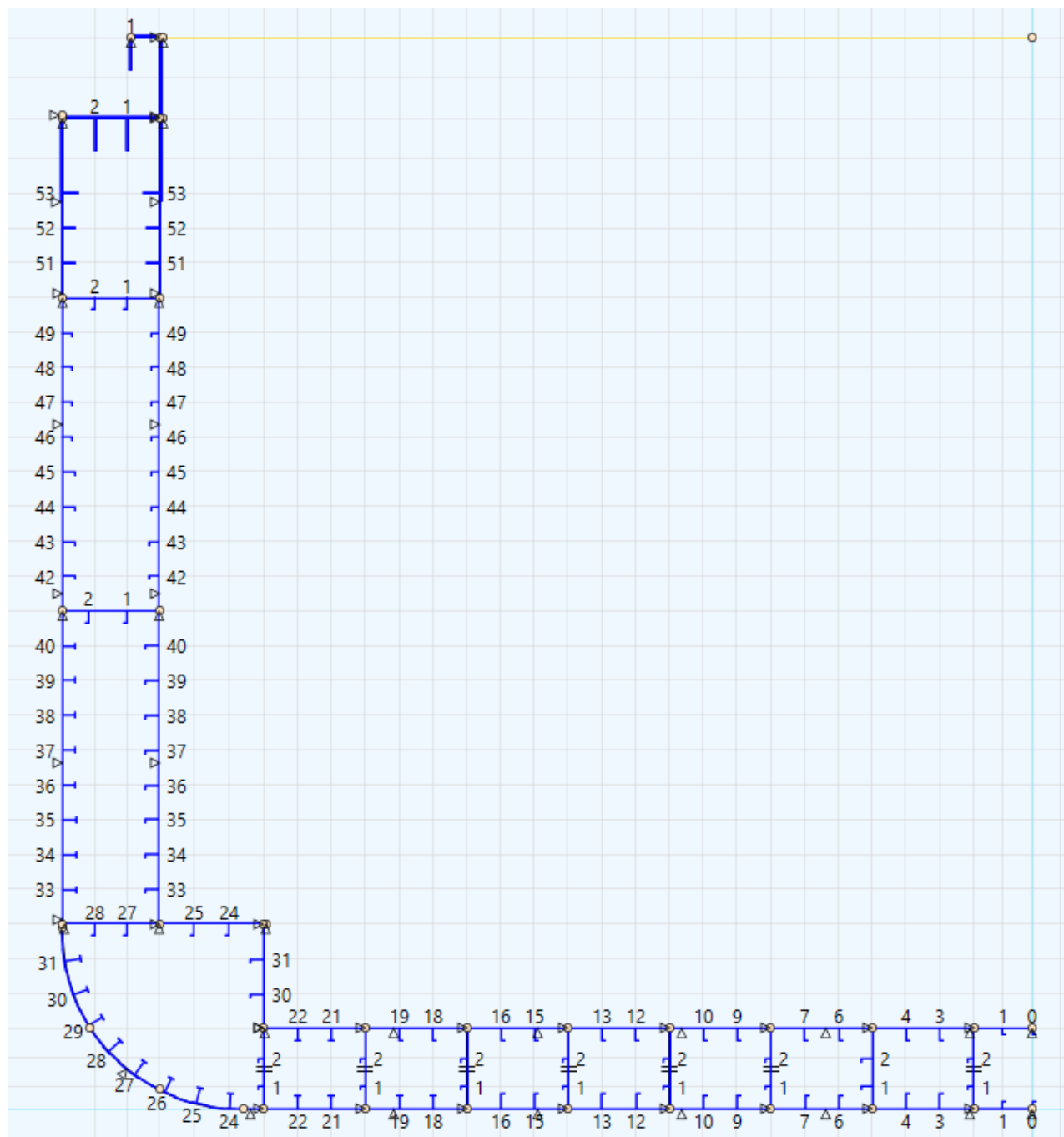


Finish your work with the last two stiffeners on the watertight Longitudinal Girder 5.

The profile is **L 300x90x13/17**.



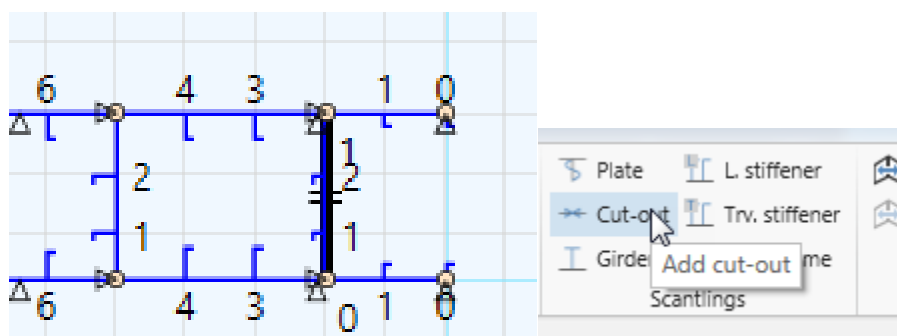
Layout of longitudinals completed:



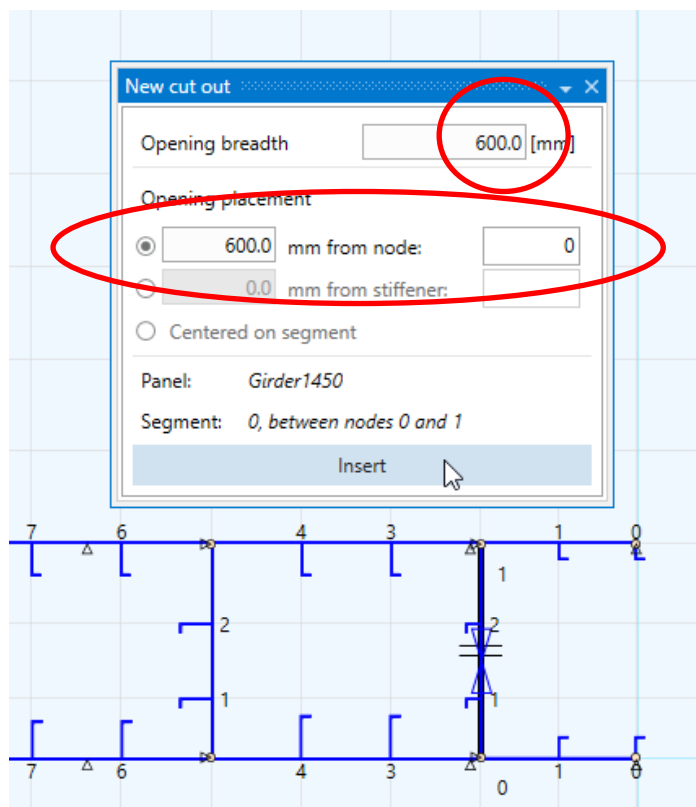
6.4.7 Openings (cut-outs)

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

⇒ Note that Nauticus calculates longitudinal strength data with and without openings.



The opening has a width of 600mm and as the the longitudinal stiffeners are not centered we will have to select **600mm** from **node 0**.

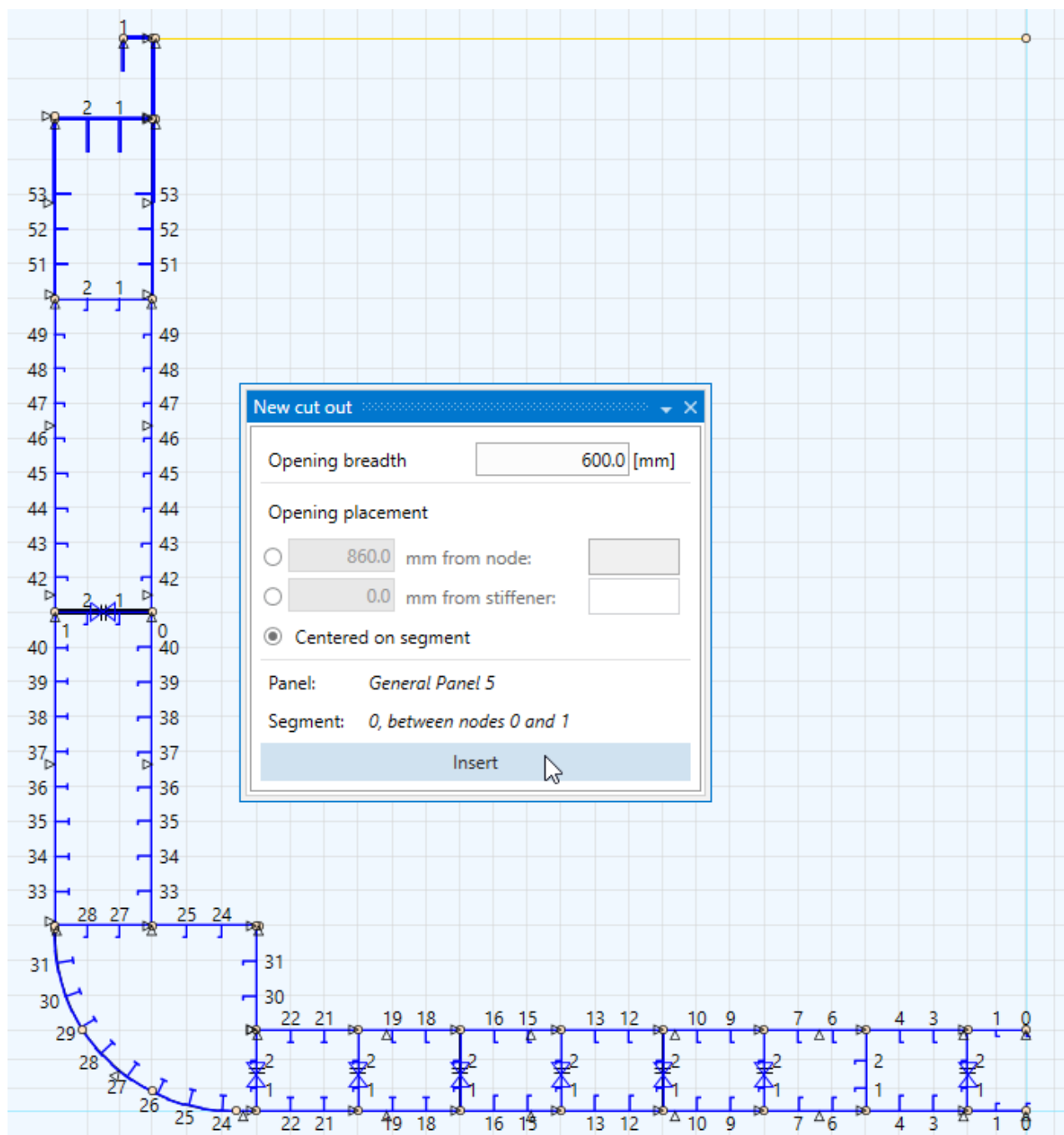


Please repeat for the other longitudinal girders in the double bottom except on Girder 5.

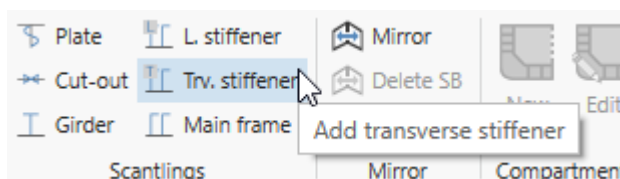
The openings (cut-outs) are finished now.

Nauticus Hull, CV-Tutorial

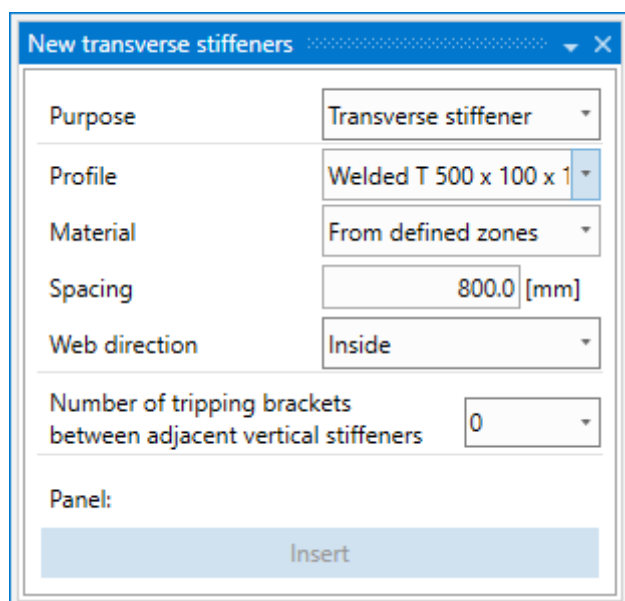
www.dnvgl.com/digital



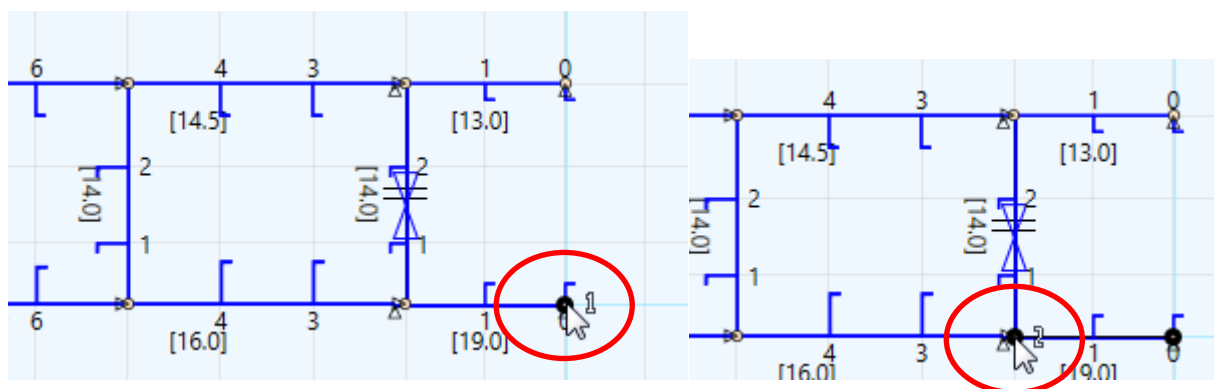
6.4.9 Transverse stiffener in Pipe Duct



Specify **T 500x13 + 100x20** and **Spacing 800**, pick the nodes before hitting the **OK-button**:

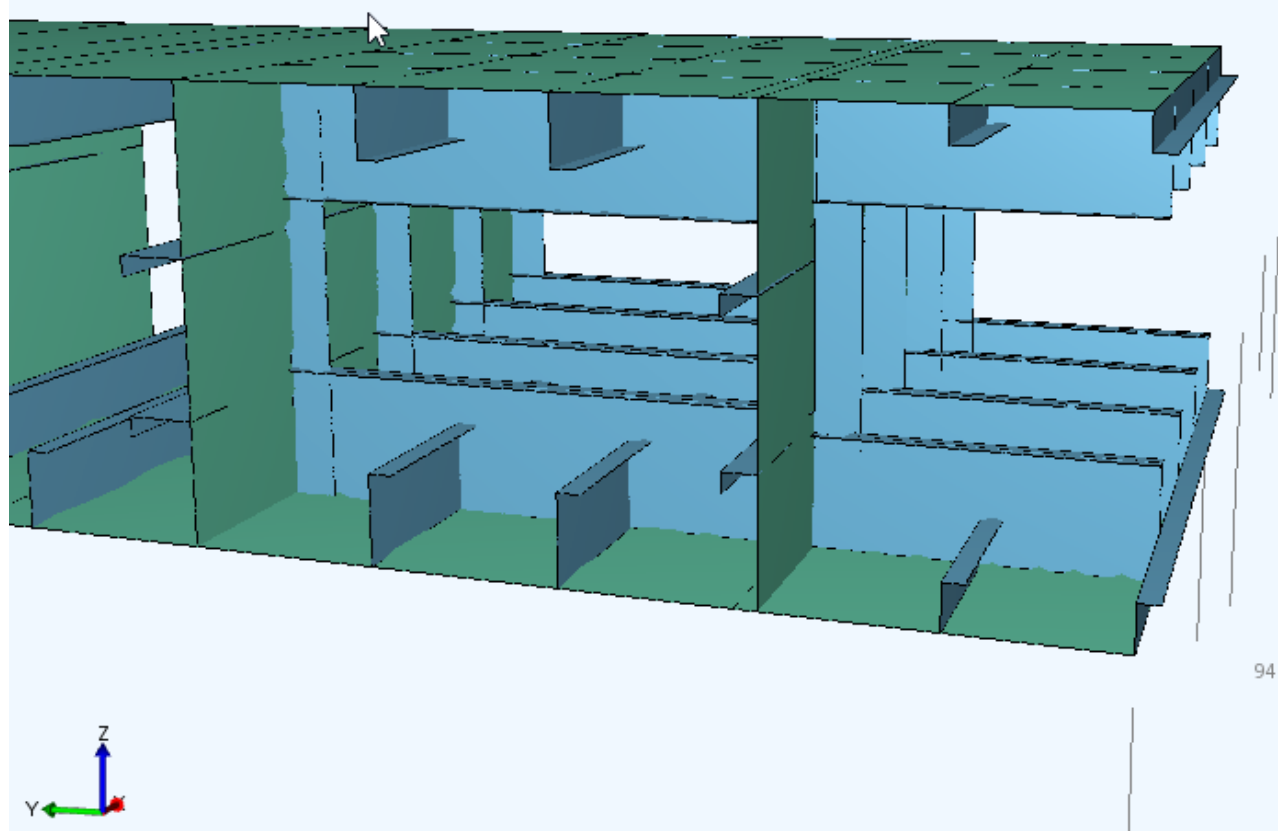
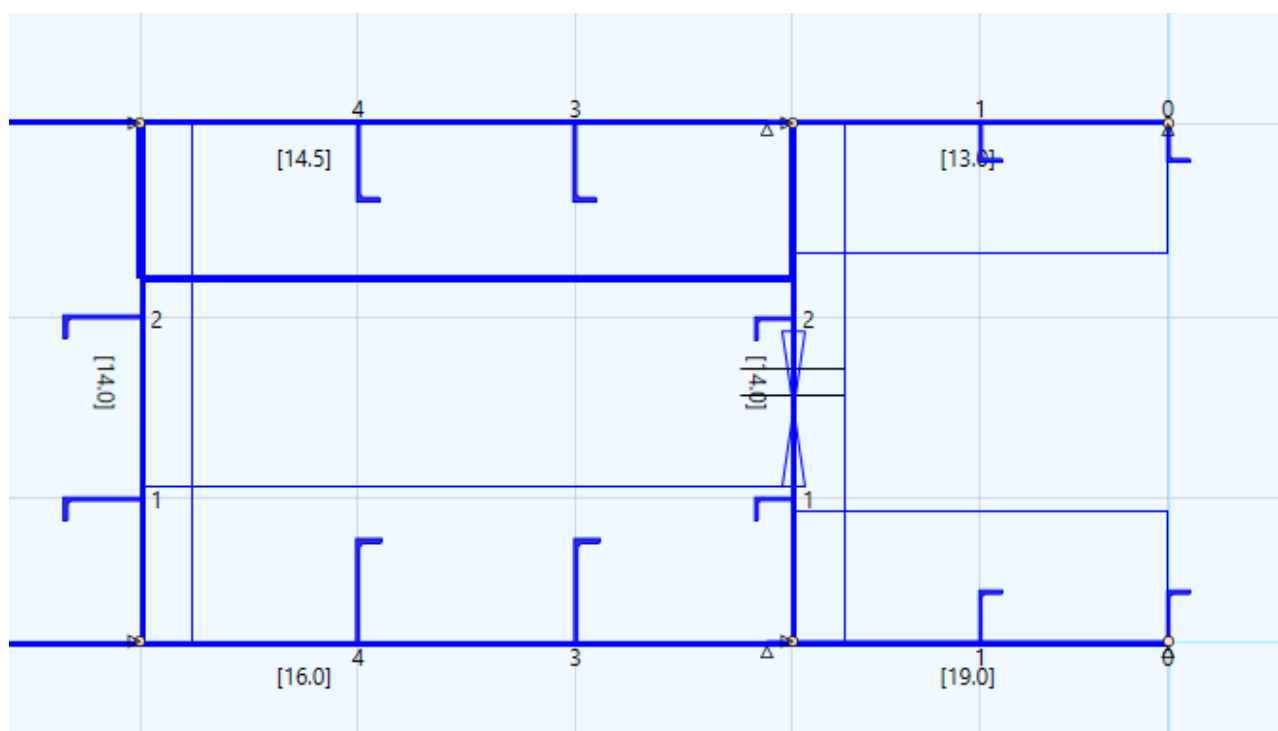


Ignore the Insert button, click 1st and 2nd point to establish start- and end of transverse frame. Pay attention to the indication at the cursor.



Specify more Transverse Frames as shown by the next picture.

For the upper ones take **Outside**.



94

6.5 Apply end connection details

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



Longitudinals in double bottom are connected to the floors with a top stiffener.

Select stiffeners and specify end connection details where it intersects adjacent webframes.

The diagram shows a cross-section of a ship's hull. It features a double bottom structure with several longitudinal stiffeners (labeled 1, 2, 3, 4, 5, 6, 7, 8, 9, 24) and transverse webframes (labeled 5, 6, 7, 8, 9, 15, 16, 18, 19, 21, 22). The stiffeners are connected to the webframes at various points, with some connections highlighted in blue.

Flange orientation		▼
Panel side		▼
Web orientations	Normal	▼
Web angle to plate	90.0	
▲ Connection of stiffeners to PSM		
Construction type	Single skin	▼
Welding, tgap [mm]	2.0	
▲ Aft frame		
End connection	Undefined	▼ ...
Shear connection	Undefined	▼ ...
Weld leg length, end connection [mm]		
Weld leg length, shear connection [mm]		
▲ Fwd frame		
End connection	Undefined	▼ ...
Shear connection	Undefined	▼ ...
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		

For both ends, chose the end connection defined earlier and specify **Double skin**:

Connection of stiffeners to PSM	
Construction type	Double skin
Welding, tgap [mm]	2.0
Aft frame	
End connection	(1) EC1
Shear connection	Undefined
Weld leg length, end connection [mm]	(1) EC1
Weld leg length, shear connection [mm]	
Fwd frame	
End connection	(1) EC1
Shear connection	Undefined
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

Inspect, edit or define new end-connection.

The ID number refers to the fatigue detail number according to the rules.

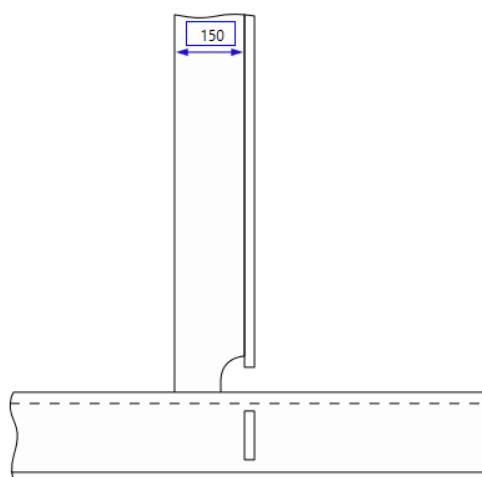
You may inspect the definition of the end-connection by clicking the '...' button.

End connections

Add new

☐ Show input needed for connection area calculation

Type	Name
1	EC1



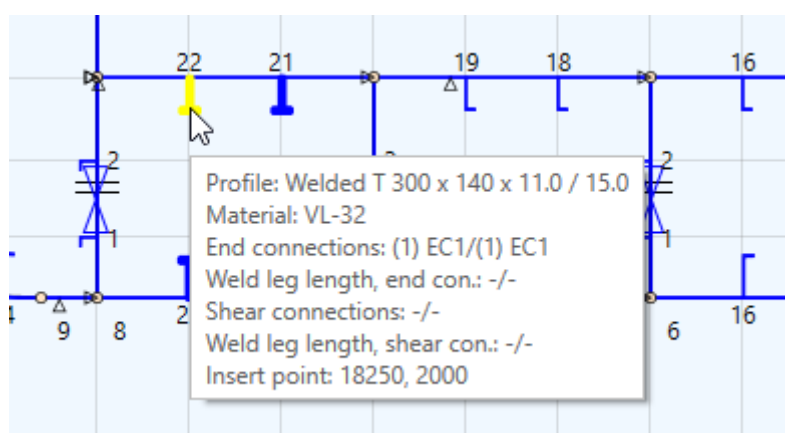
OK

Cancel

The spans are recalculated according the rules.

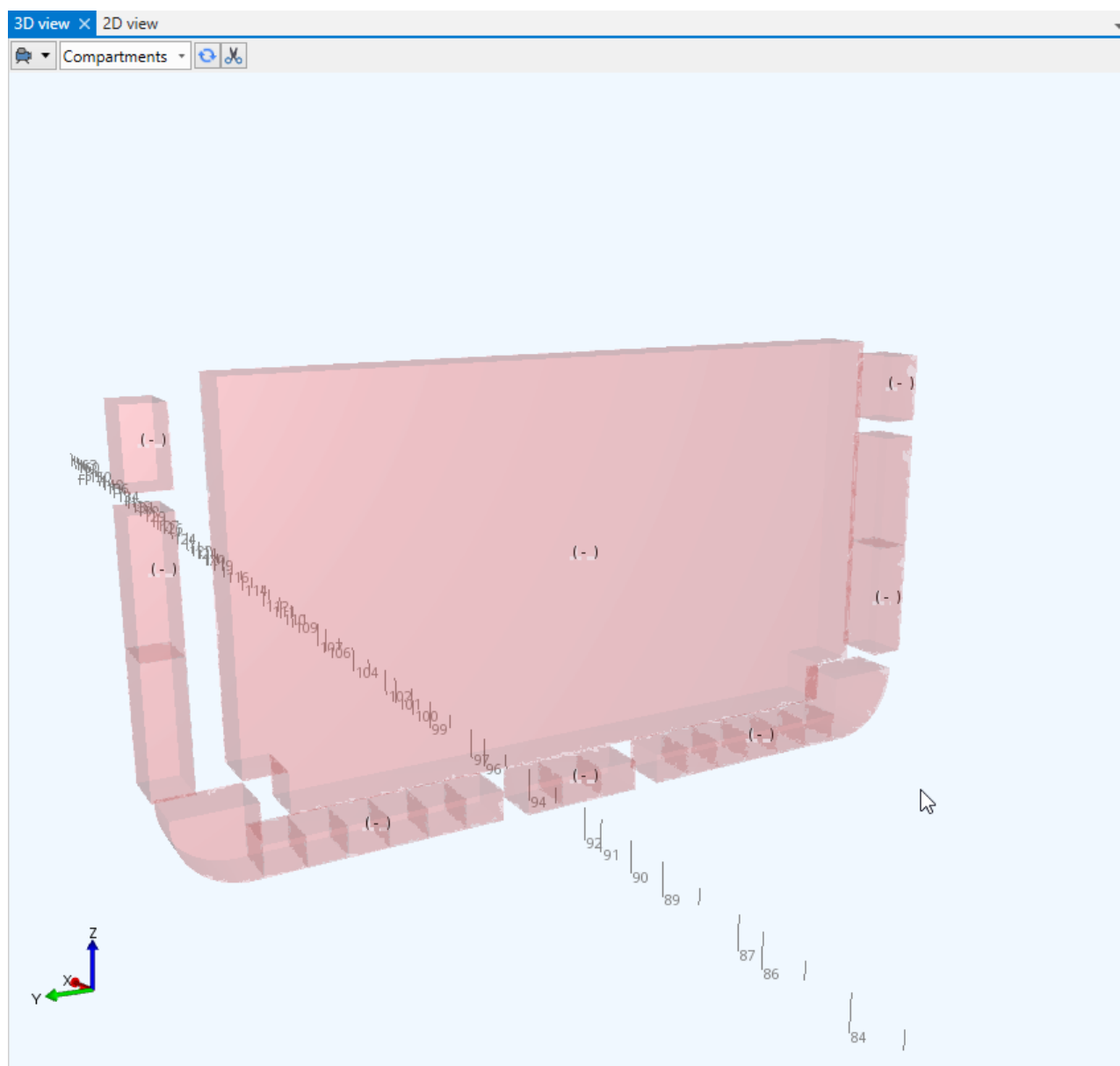
Spans			
Span	3250		...
Bending span	3100		
Shear span	2830		

The details are also available in tooltip for each stiffener:

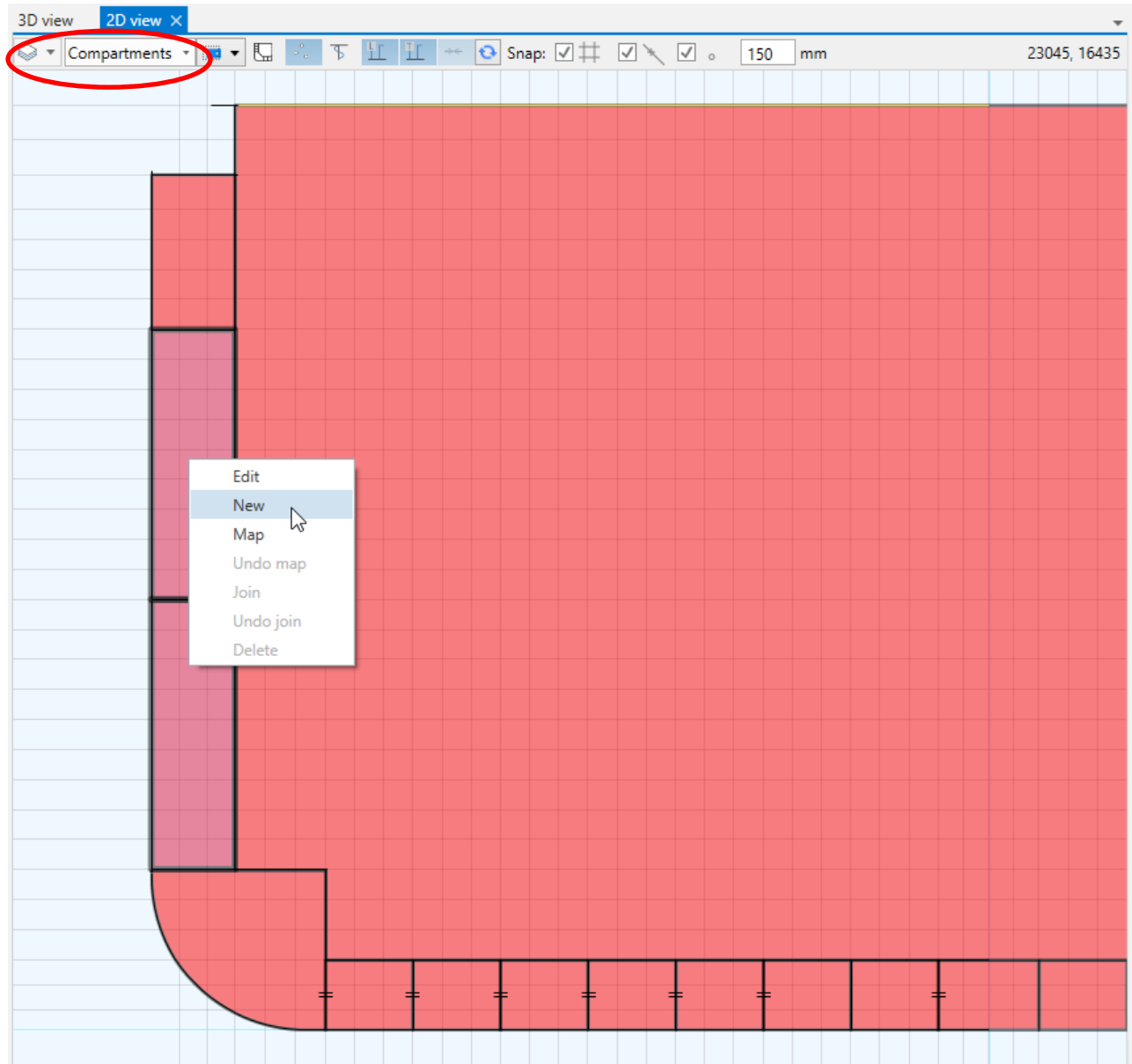


6.6 Compartments and loads

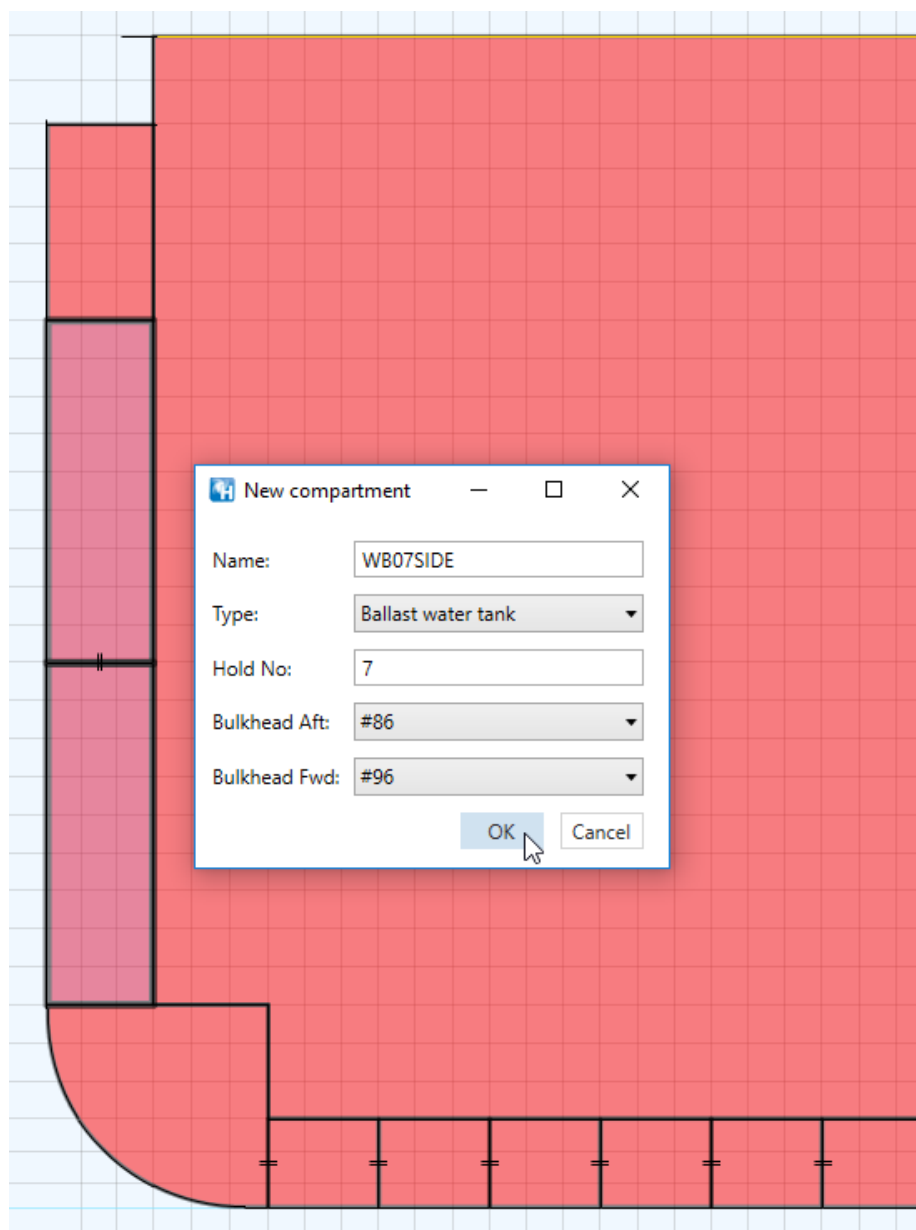
Compartment topology (cells) is defined on-the-fly in a background process as you approach with the panel definition. You may view the current cell topology in 3D view at any time:



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 **WB07SIDE**, hold no **7**.



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

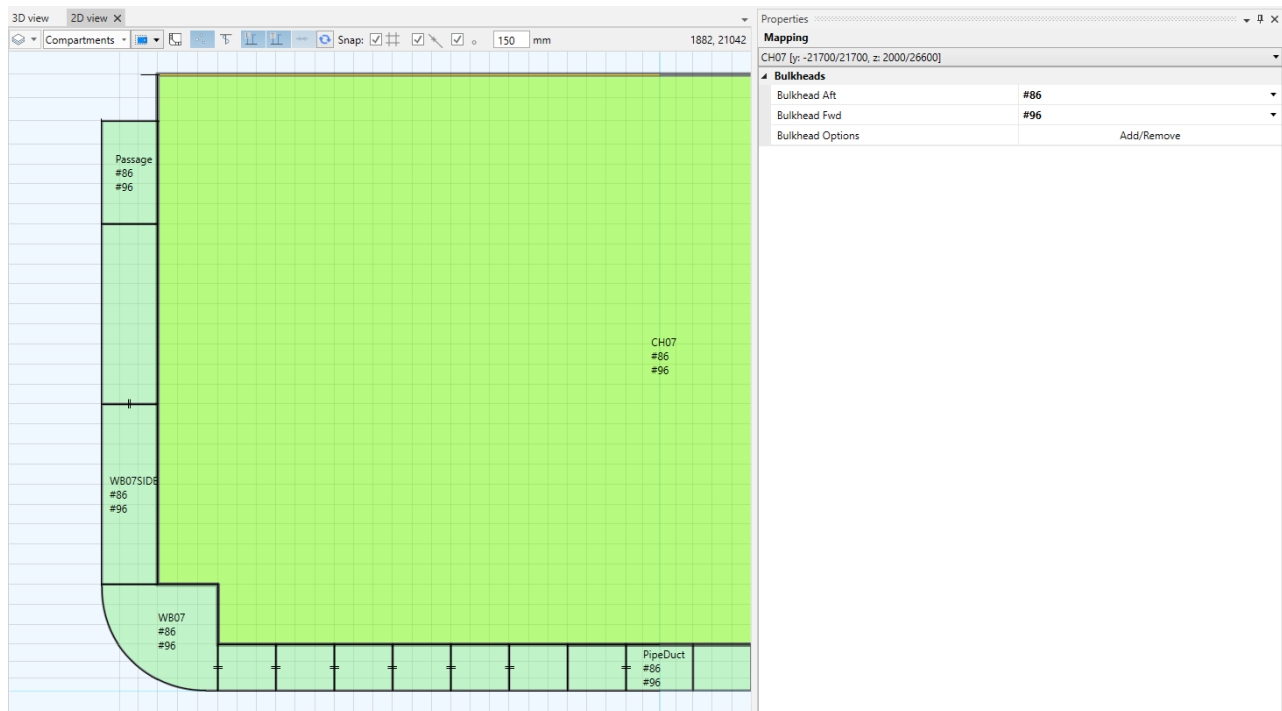
CH7, hold no **7** from **#86** to **#96**, **Cellular Container Hold**

Passage, hold no **7** from **#86** to **#96**, **Dry Space**

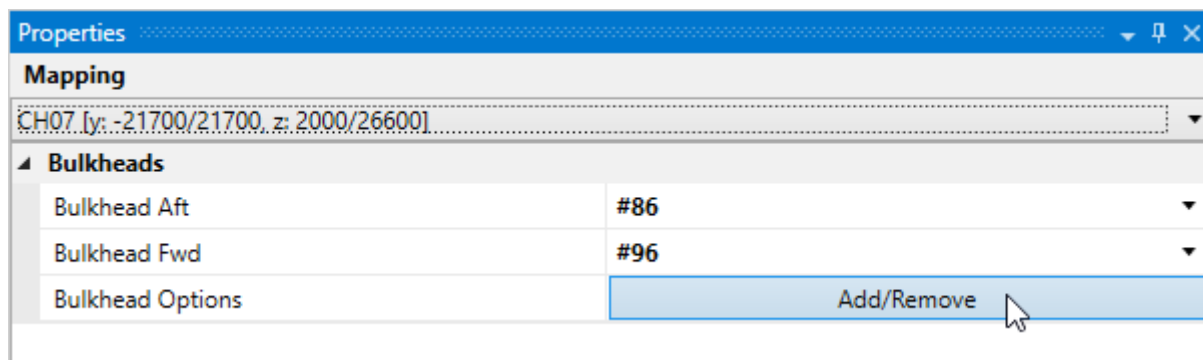
WB07, hold no **7** from **#86** to **#96**, **Ballast water tank**

PipeDuct, hold no **7** from **#86** to **#96**, **Pipe Tunnel**

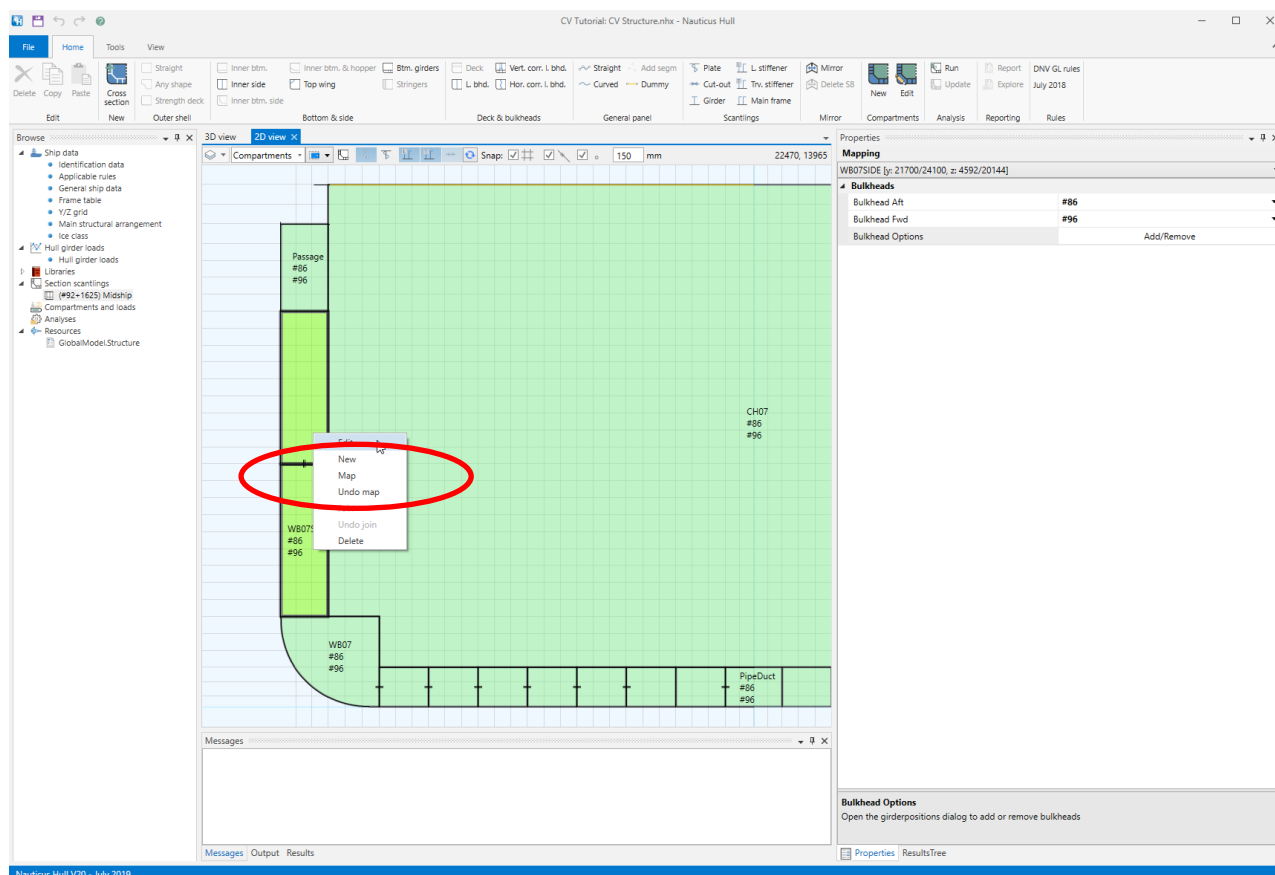
Positions for aft and forward compartment boundaries can modified from compartment property window:



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 **WB07Side** 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-2 (kN/m2)** has to be changed for this design to **0** for both water ballast tanks. See below picture.

Edit Compartments and Loads

100% (#92+1625) Midship

100%

Comp. category

- Undefined
- Cargo
- Ballast
- Other
- Void

Compartment data | Loads

General data | Tank data | Sloshing data | Hatch data | Geometry data | Container bays data | All

Edit
New
Delete
Join
Undo join
Export
Import

Compartment name	Top of air pipe/chain pipe (mm)	Ballast water exchange by flow-through operations	Maximum overflow height from BL (mm)	Overpressure during flow through BWE, Pdrop-1 (kN/m ²)	Overpressure due to liquid flow, Pdrop-2 (kN/m ²)	Pressure valve fitted	Emptying with air overpressure	Air overpressure, P0 (kN/m ²)
WB07SIDE	20904	☐		0	0	☒	☐	
WB07	5352	☐		0	0	☒	☐	
PipeDuct		☒				☒	☒	
Passage		☒				☒	☒	
CH07		☒				☒	☒	

OK Cancel Apply

As it might be necessary to adjust the densities or settings of pressure valves during design process we switch now to the **Loads**.

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. See red circle in below picture.

Prescriptive loading conditions

Name	Condition	Draught (m)	Kr (m)	GM (m)
Full load	Full load	14.5	18.798	5.302
Ballast	Ballast	6.6	18.798	5.302

Compartment loads Loading condition: **Ballast**

Compartment name	Load type	Density (t/m3)	Filling height from BL (mm)	Design vapour pressure, Ppv (kN/m2)
WB07SIDE	Water ballast	1.025	20144	
WB07P	Water ballast	1.025	4592	

The activated loading condition shows the linked compartment. Note the pressure valve setting for the ballast water tank **WB07P & WB07SideP** in the next picture.

Fatigue loading conditions Fatigue design life: 25 (years) Fraction time at sea, f0 0.85 Trading World Wide

Name	Condition	fe	Draught (m)	Kr (m)	GM (m)	Life time fraction	Fraction of max permissible SWBM	Wave BM curve
Maximum - Filled	Maximum - Filled	0.8	14	18.798	4.338	0.7	0.9	Fatigue-Full load (Rule value at t)
Maximum - Empty	Maximum - Empty	0.8	14	18.798	4.338	0.3	0.9	Fatigue-Full load (Rule value at t)
Minimum - Filled	Minimum - Filled	0.8	14	18.798	4.338	0.7	0.1	Fatigue-Full load (Rule value at t)
Minimum - Empty	Minimum - Empty	0.8	14	18.798	4.338	0.3	0.1	Fatigue-Full load (Rule value at t)

Compartment loads Loading condition: **Maximum - Filled**

Compartment name	Load type	Density (t/m3)	Filling height from BL (mm)
WB07SIDE	Water ballast	1.025	20144
WB07P	Water ballast	1.025	4592

Generating the Fatigue loads there are messages occurring:

Messages		
	Compartments and Loads	Sum of "Life time fraction" for future trade loading conditions = 2
	Compartments and Loads	No compartment loads are specified for the loading condition "Maximum - Empty"
	Compartments and Loads	No compartment loads are specified for the loading condition "Minimum - Empty"

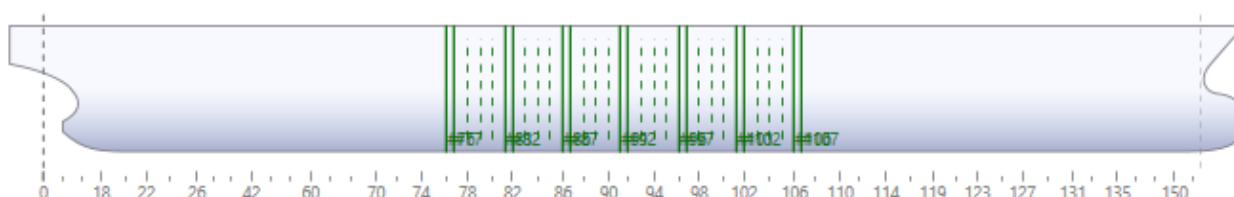
For Containerships the messages are ignored as two individual loadcases are analysed and the worst lifetime is taken. The sum must be 2. **Empty** loadcases do not need a compartment.

6.7 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.

Within our sample we provided already more main structure.

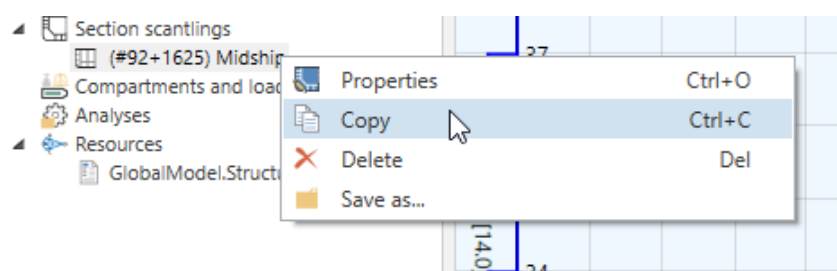
Main structural arrangement



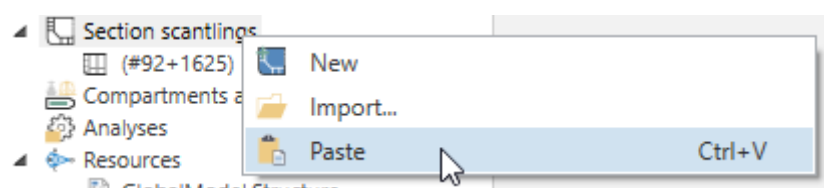
If necessary you may provide easily more structure as seen below:

Bulkheads and web frames

When finished 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 **Frame 84** and position to **#84**.

Cross section properties

Name: **Frame 84** Position #: **#84**

☐ Intersect imported hull definition

Adjacent main structural positions

- 2. aft: #83
- 1. aft: #84
- 1. fwd: #85
- 2. fwd: #86

Add position

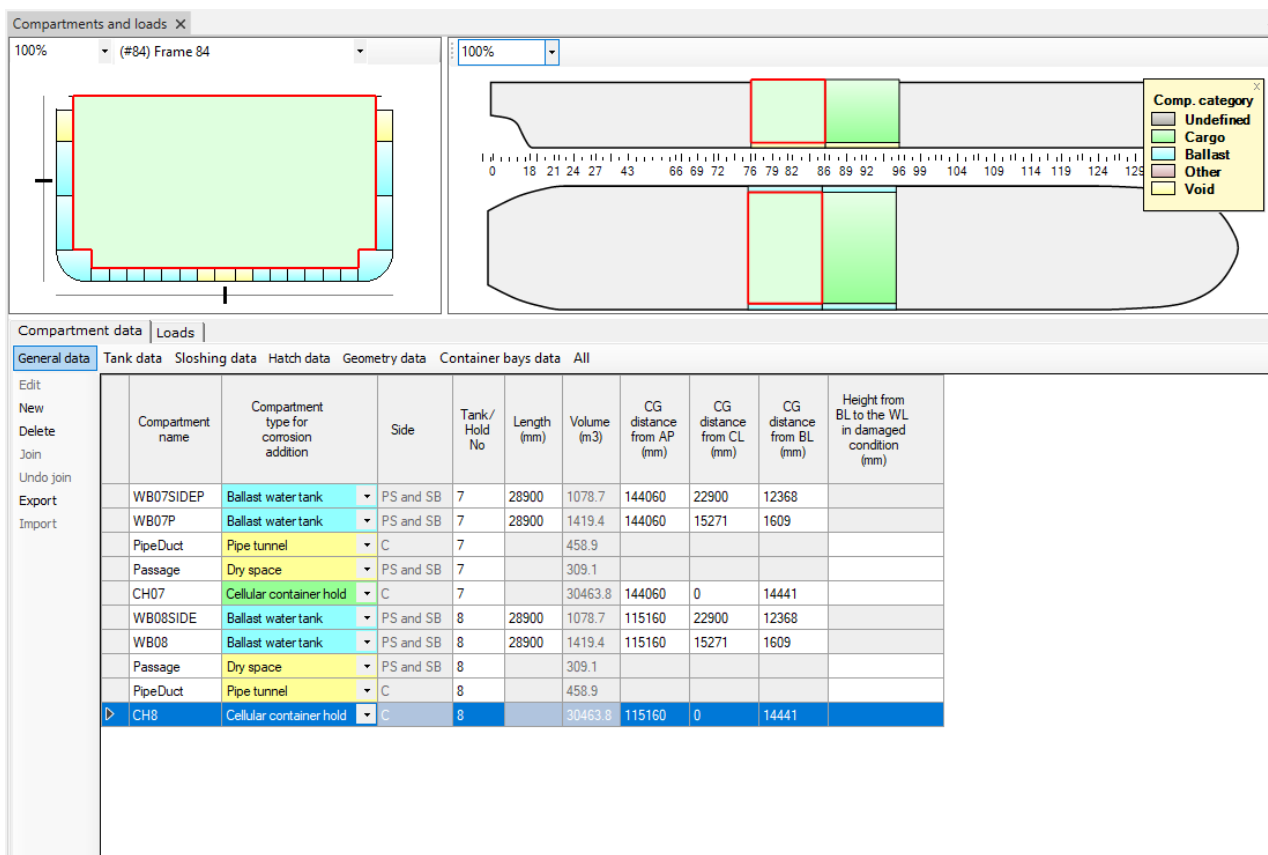
Span of longitudinals: 3050.0 [mm]

Standard spacing between trv. stiffeners: 800.0 [mm]

Ok Cancel

The positions are selected based on the available main structural positions

When the cross-section is 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 pictures.



General data | Tank data | Sloshing data | Hatch data | Geometry data | Container bays data | All

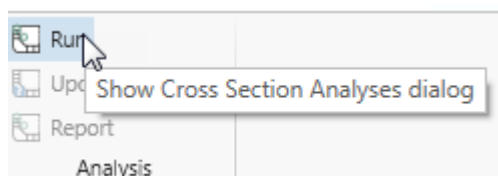
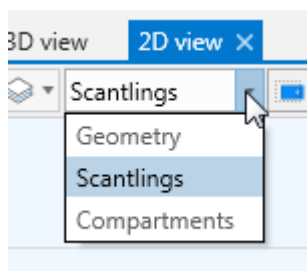
	Compartment name	Top of air pipe/ chain pipe (mm)	Ballast water exchange by flow-through operations	Maximum overflow height from BL (mm)	Overpressure during flow through BWE, Pdrop-1 (kN/m2)	Overpressure due to liquid flow, Pdrop-2 (kN/m2)	Pressure valve fitted	Emptying with air overpressure	Air overpressure, P0 (kN/m2)
	CH7		☐				☐	☐	
	WB07P	5352	☐			0	☐	☐	
	PipeDuct		☐				☐	☐	
	WB07SIDE	20904	☐			0	☐	☐	
	Passage		☐				☐	☐	
	Passage		☐				☐	☐	
	WB08SIDE	20904	☐			0	☐	☐	
	CH8		☐				☐	☐	
	WB08P	5352	☐			0	☐	☐	
	PipeDuct		☐				☐	☐	

7 Cross-section analysis

7.1 Running analysis

Cross-section analysis is carried out for the currently selected cross-section. Running analysis for multiple sections in one operation is supported.

Check that you are currently in scantlings view mode:



You may make choice in between the different analyses by checking **Prescriptive** / **ULS** / **Fatigue**:

Positions	Prescriptive	ULS	Fatigue
#92+1625	☒	☐	☐
	☐	☐	☐

▲ **Prescriptive**

▲ **Vertical wave bending moments M_{wv} scaling factors**

Sagging	1
Hogging	1

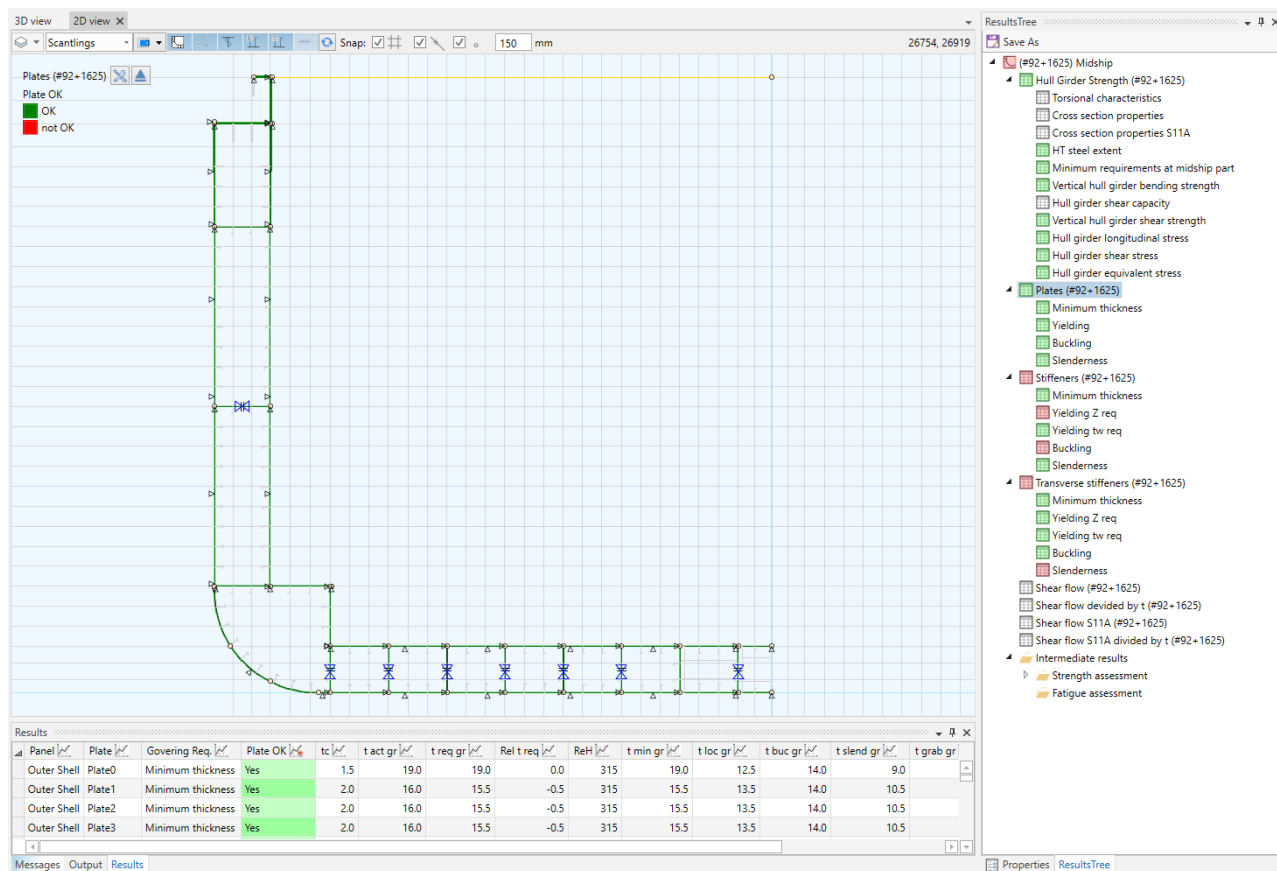
▲ **Buckling stress combination factors**

Combination 1 (τ):	0.7
Combination 2 (σ):	0.7

Calculate

Keep the remaining parameters as they are.

Results for plates are shown after analysis according to DNV GL Rules.



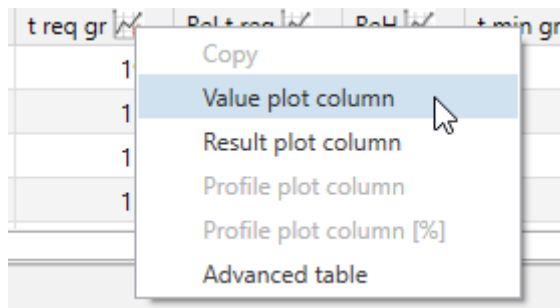
For detailed result information of plates you may access the particular results:

- Plates (#92+1625)
 - Minimum thickness
 - Yielding
 - Buckling
 - Slenderness

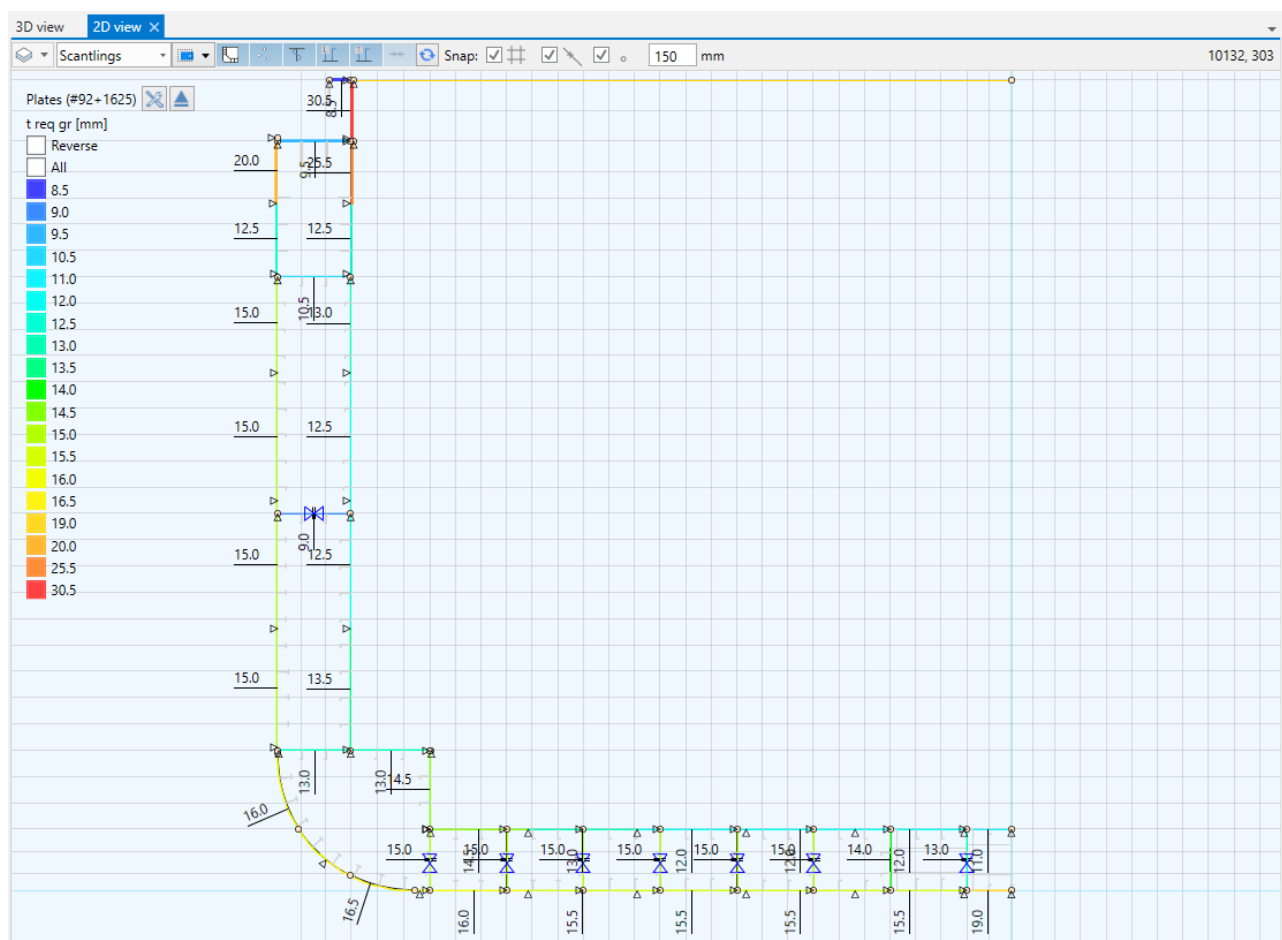
One click on the triangle in front of the row opens the EPP's:

Panel	Plate	t loc OK	tc	t act gr	t loc gr	a p	b	P	Ca	ReH	Load case	Design load set	a	P s	P d
Outer Shell	Plate0	Yes	1.5	19.0	12.5	0.746	800	172.7	0.409	315	FSM_2	SEA-1	0.840	145.8	26.9
Outer Shell	Plate1	Yes	2.0	16.0	13.5	1.000	840	174.2	0.728	315	FSM_2	SEA-1	3.250	145.8	28.4
	EPP4	Yes	1.5	16.0	12.5	0.746	800	172.7	0.409	315	FSM_2	SEA-1	0.840	145.8	26.9
	EPP5	Yes	1.5	16.0	12.5	0.746	800	173.1	0.408	315	FSM_2	SEA-1	0.840	145.8	27.3
	EPP6	Yes	1.5	16.0	12.5	0.746	800	173.5	0.407	315	FSM_2	SEA-1	0.840	145.8	27.7
	EPP7	Yes	2.0	16.0	13.5	1.000	840	173.8	0.728	315	FSM_2	SEA-1	3.250	145.8	28.0
	EPP8	Yes	2.0	16.0	13.5	1.000	840	174.2	0.728	315	FSM_2	SEA-1	3.250	145.8	28.4
Outer Shell	Plate2	Yes	2.0	16.0	13.5	1.000	840	175.7	0.726	315	FSM_2	SEA-1	3.250	145.8	29.9

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



As an example see below the result for **t req gr**:



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

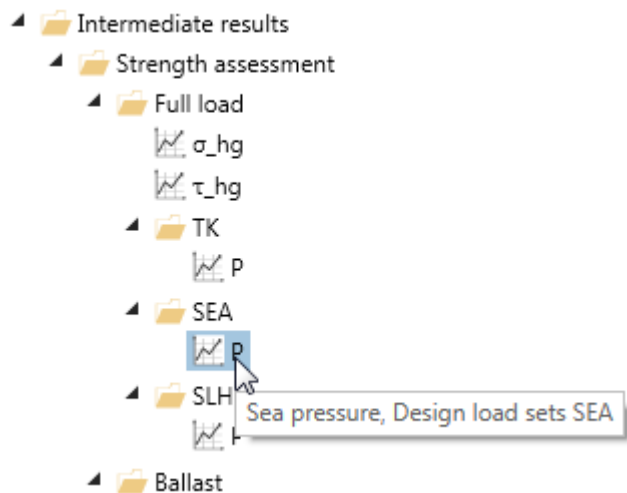
- Hull girder strength requirements
- Local requirements
- Intermediate results

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

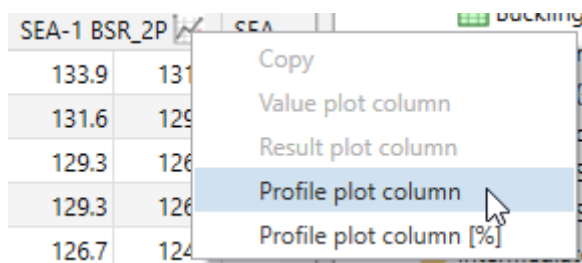
7.2 Plotting

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

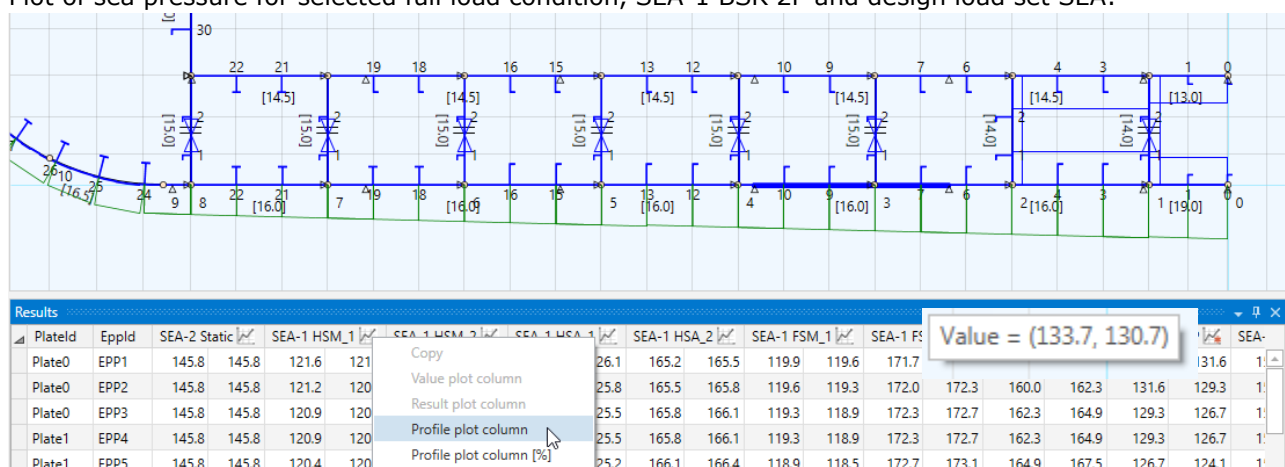
Example – inspect sea pressure for an EDW:



Make choice within the result table:



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

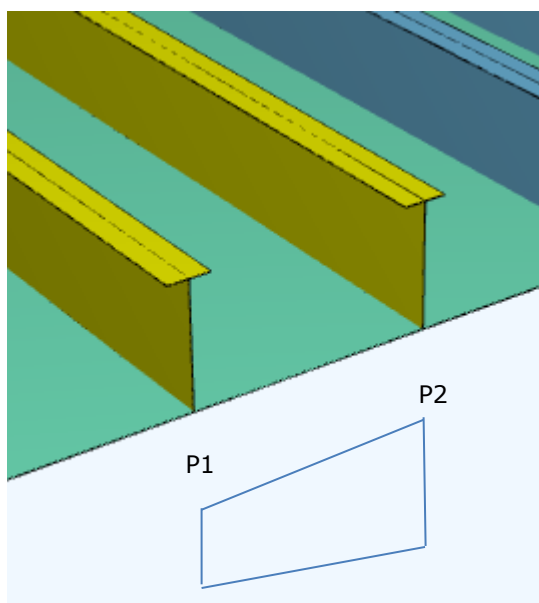


Right-click the EDW column and select **Profile plot column** to see the graphical presentation of the intermediate result.

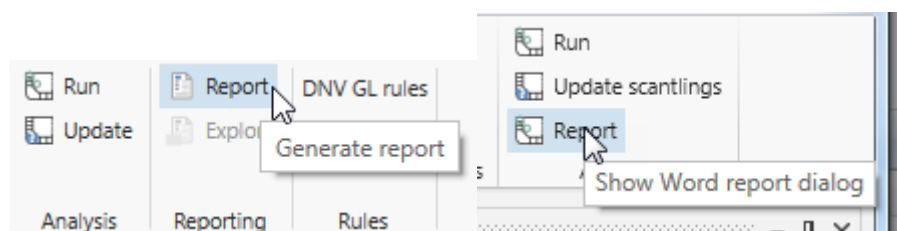
Each EDW has two result columns, showing value at start and end of EPP. These values are used to for plotting purpose to present the variation over each EPP.

The EPP itself is not selectable.

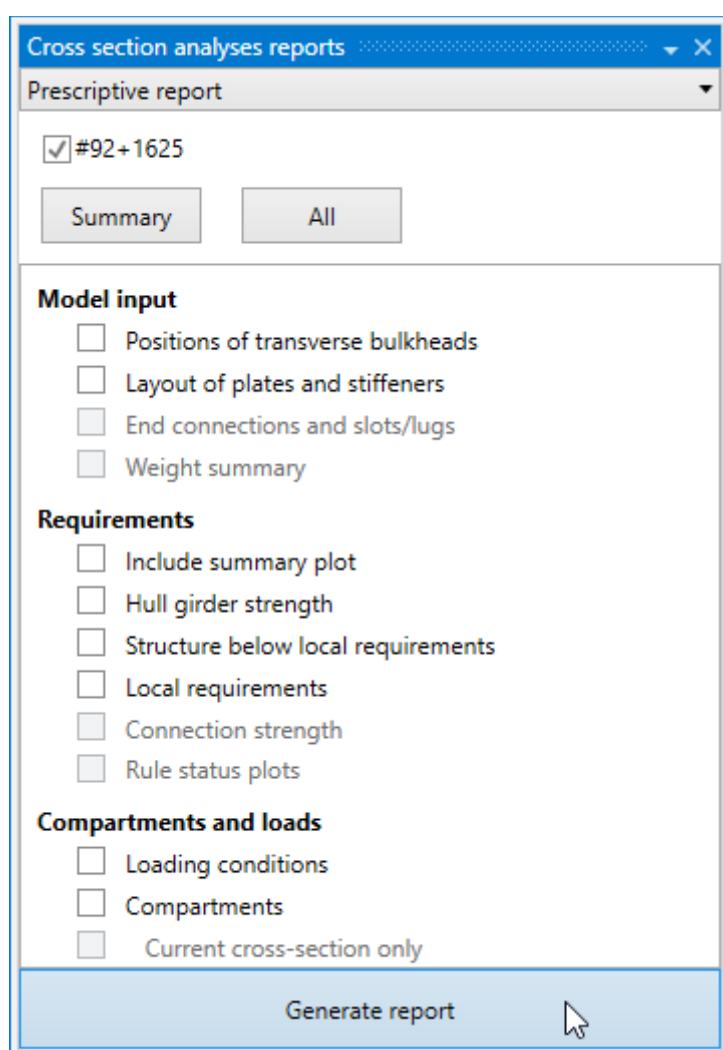
SEA-1 BSR_2P 	
139.7	136.7
136.7	133.7
133.7	130.7
133.7	130.7
130.7	127.7



7.3 Reporting

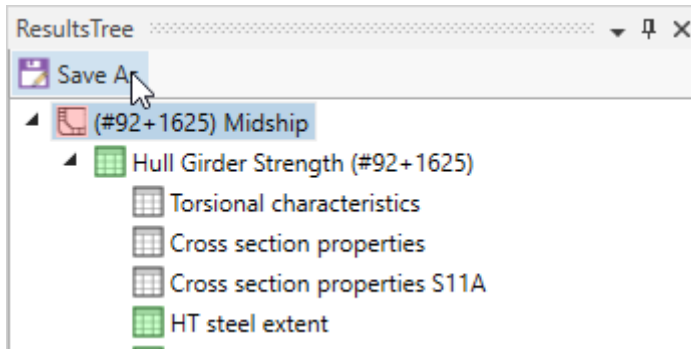


Make choice of the different topics that should be included:



7.4 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:



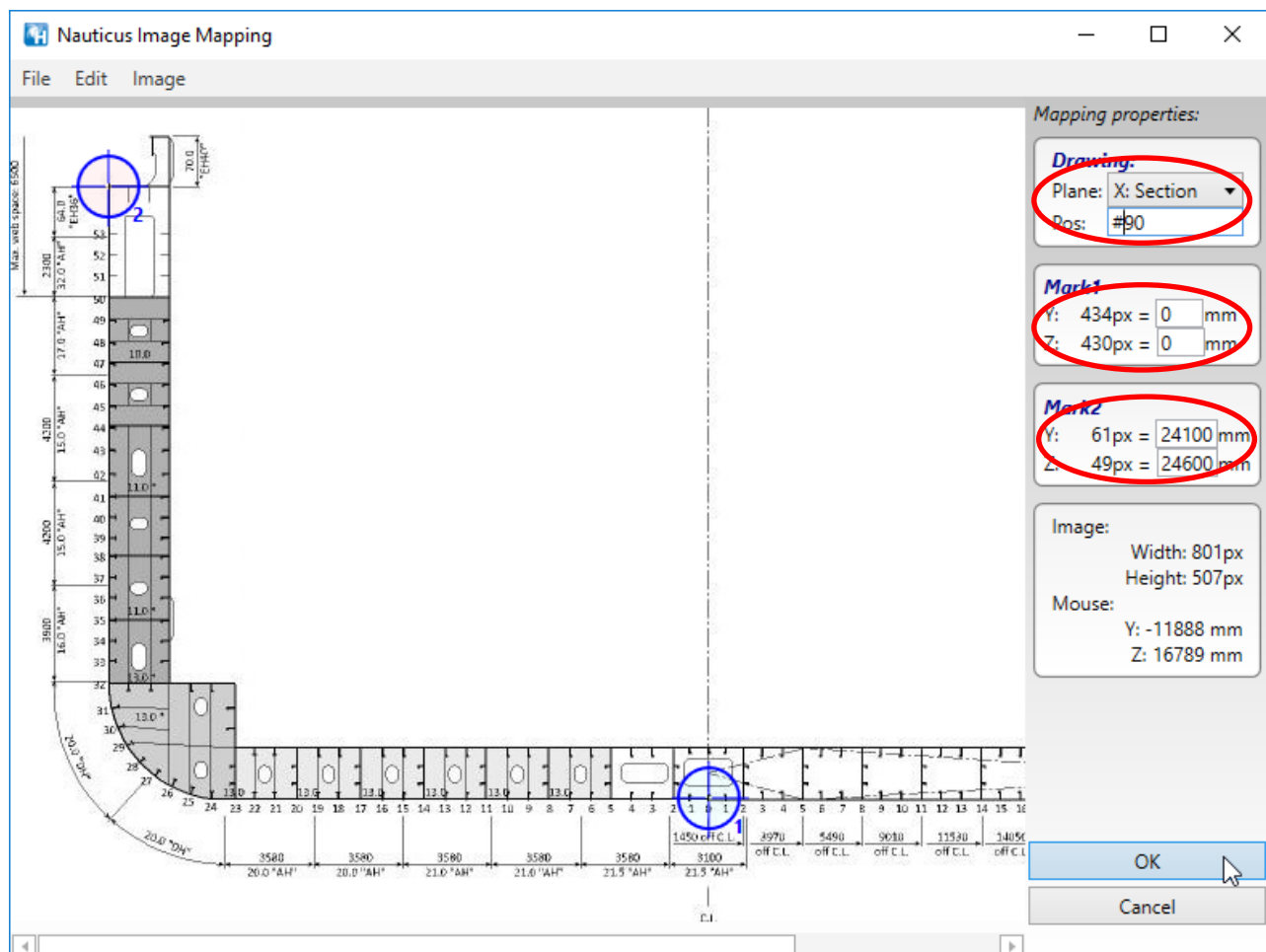
⇒ Note that a HDF5 Viewer for viewing is necessary

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 Sheer and Main Deck.

Specify coordinates as shown, X-position **#90** (note the **#** which is necessary):



Press OK, to store the drawing and the calibration.

8.1 Example of use of background drawing

As an example of how to use, create a new cross-section at #90:

New cross section

Name:

Frame 90

Position #:

#90

Intersect imported hull definition

Adjacent main structural positions

2. aft: #89

1. aft: #90

1. fwd: #91

2. fwd: #92

Add position

Span of longitudinals:

3050.0 [mm]

Standard spacing between trv. stiffeners:

800.0 [mm]

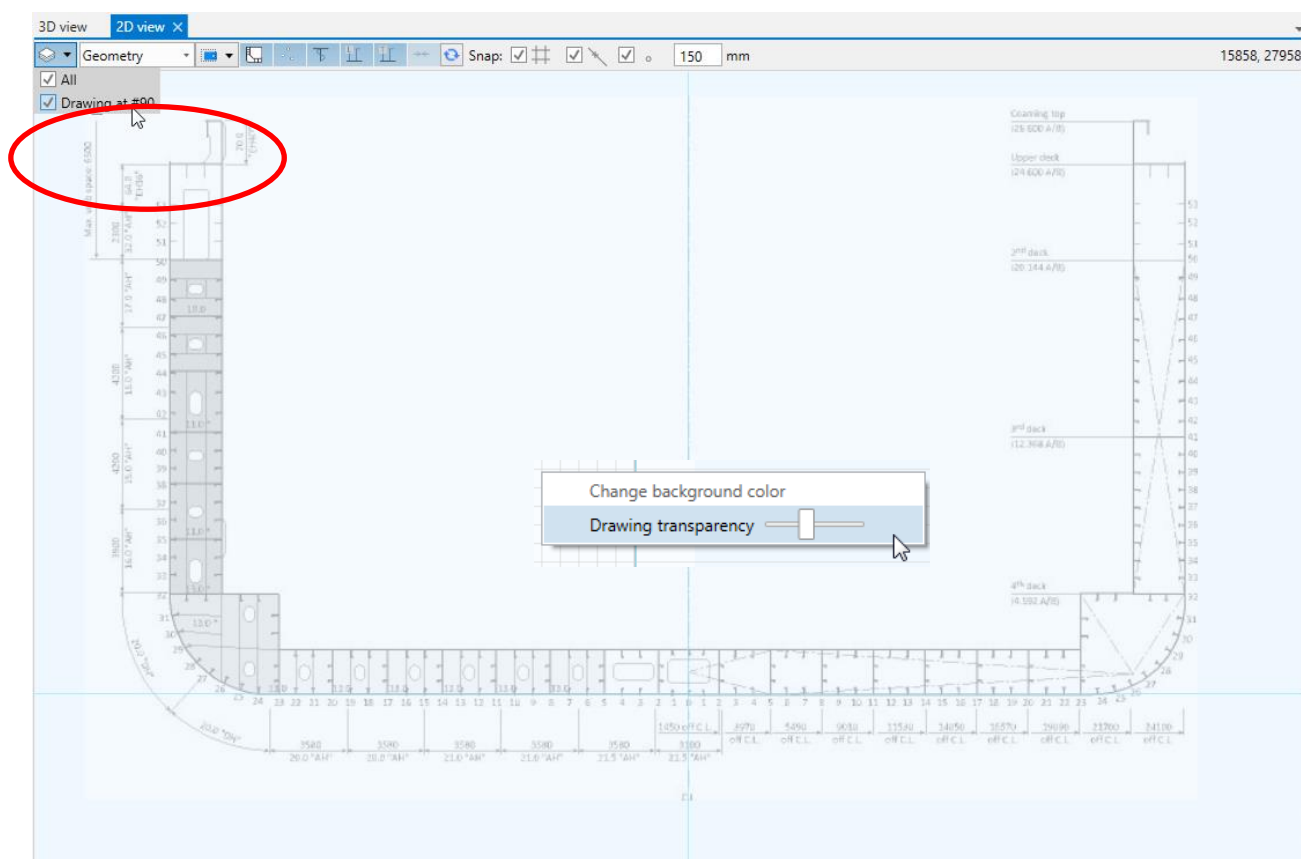
Ok

Cancel

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.

9 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 longitudinals

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.

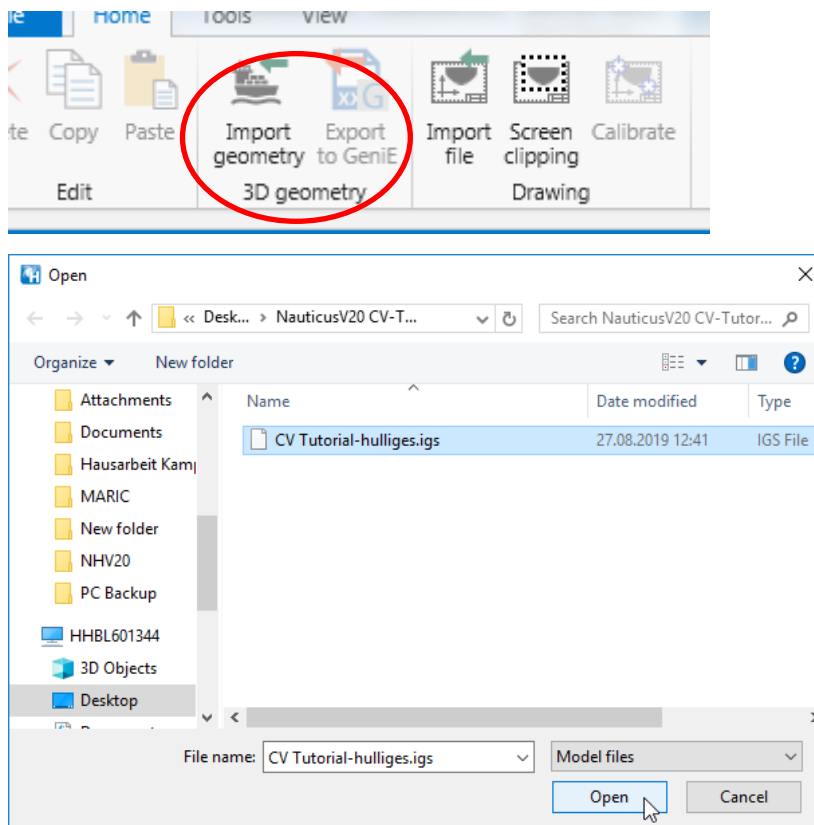
Ice, including Polar class rule check

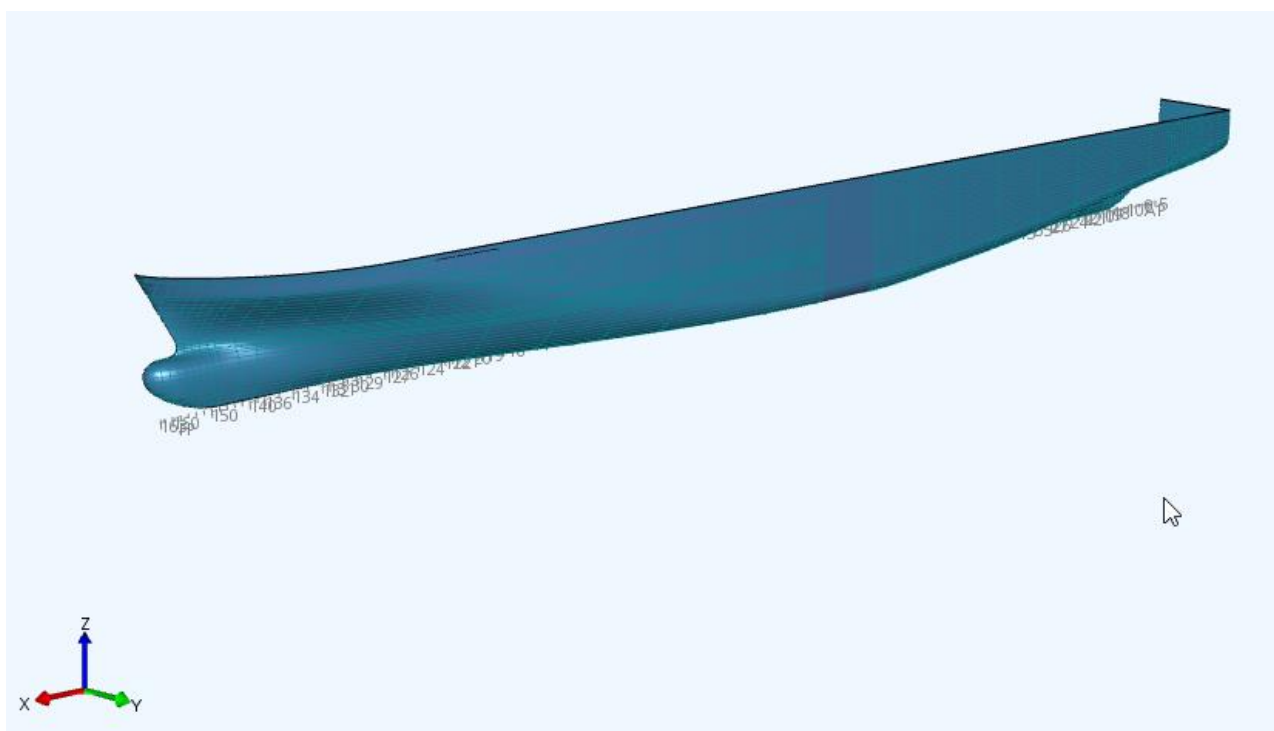
Determination of ice regions and angles for ice load calculations performed in the cross-section analysis.

9.1 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:





Create a new cross-section at position #105, this time by intersecting the hull form:

New cross section

Name:

Frame105

Position #:

#105

☒ Intersect imported hull definition

Adjacent main structural positions

2. aft: #104

1. aft: #105

1. fwd: #106

2. fwd: #107

Add position

Span of longitudinals:

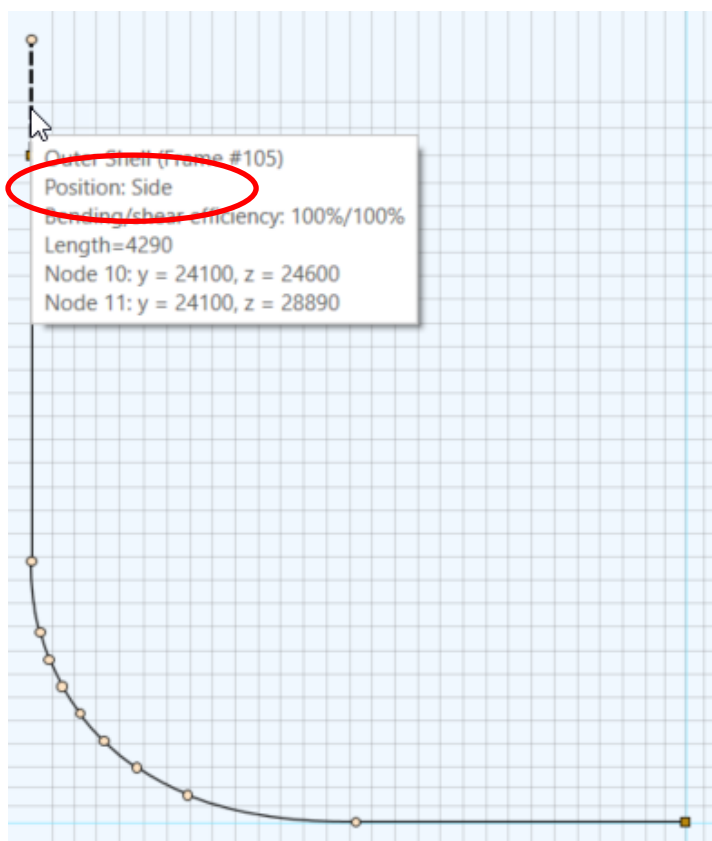
3050.0 [mm]

Standard spacing between trv. stiffeners:

800.0 [mm]

Ok

Cancel



Inspect the segment position codes, they are normally applied according to the location of the segment.

10 Data prepared in advance

Workspaces are created at several stages of this tutorial:

- CV Tutorial.CV General.zip
- CV Tutorial.CV Loads.zip
- CV Tutorial.CV Geometry.zip
- CV Tutorial.CV Structure.zip
- CV Tutorial.CV Comp+Loads
- CV Tutorial.CV Completed.zip

Frame Table in Excel:

- CV Tutorial_Frame Table

Drawing sample for use as background drawing or drawing check:

- CV Example 9000 TEU.jpg

IGES file containing description of the hull (NAPA):

- CV Tutorial-hulliges.iges

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Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.

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