




Tutorial

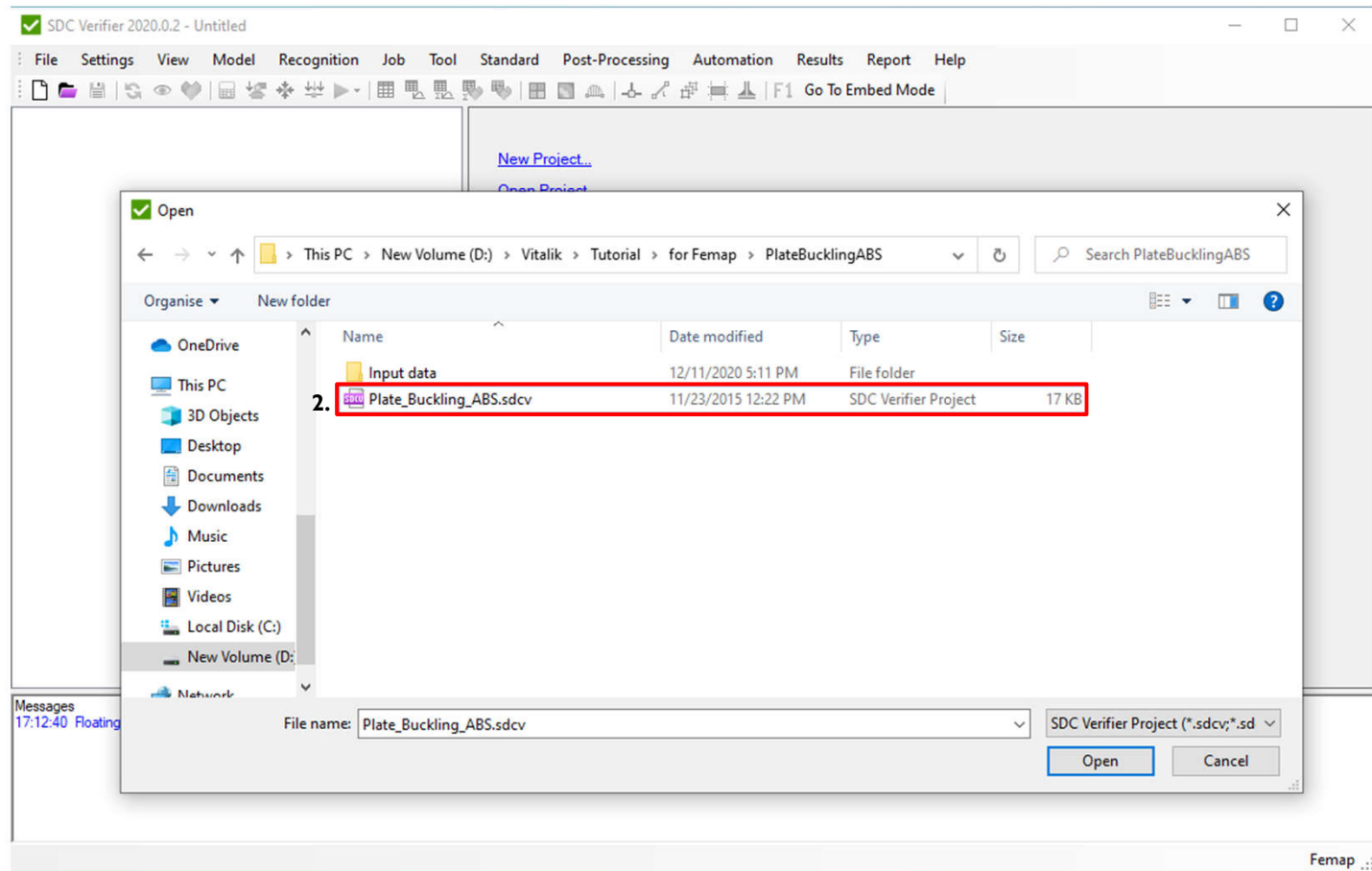
Plate Buckling ABS 2014

11 Dec 2020
version 2020.0.2

- ▶ In this tutorial an ABS 2014 Plate Buckling Check is reviewed in details.
- ▶ A part of plate model of the ship has been used as a start FEM model.
- ▶ Individual Loads, Load Sets and Load Group (Envelope) are created.
- ▶ Recognition of plates using Panel Finder.
- ▶ Plate Buckling tables and plots.
- ▶ Reporting: preparing and generating final report.

Open the starter model

- 1 Launch **SDC Verifier** 
- 2 Open project *Plate_Buckling_ABS*



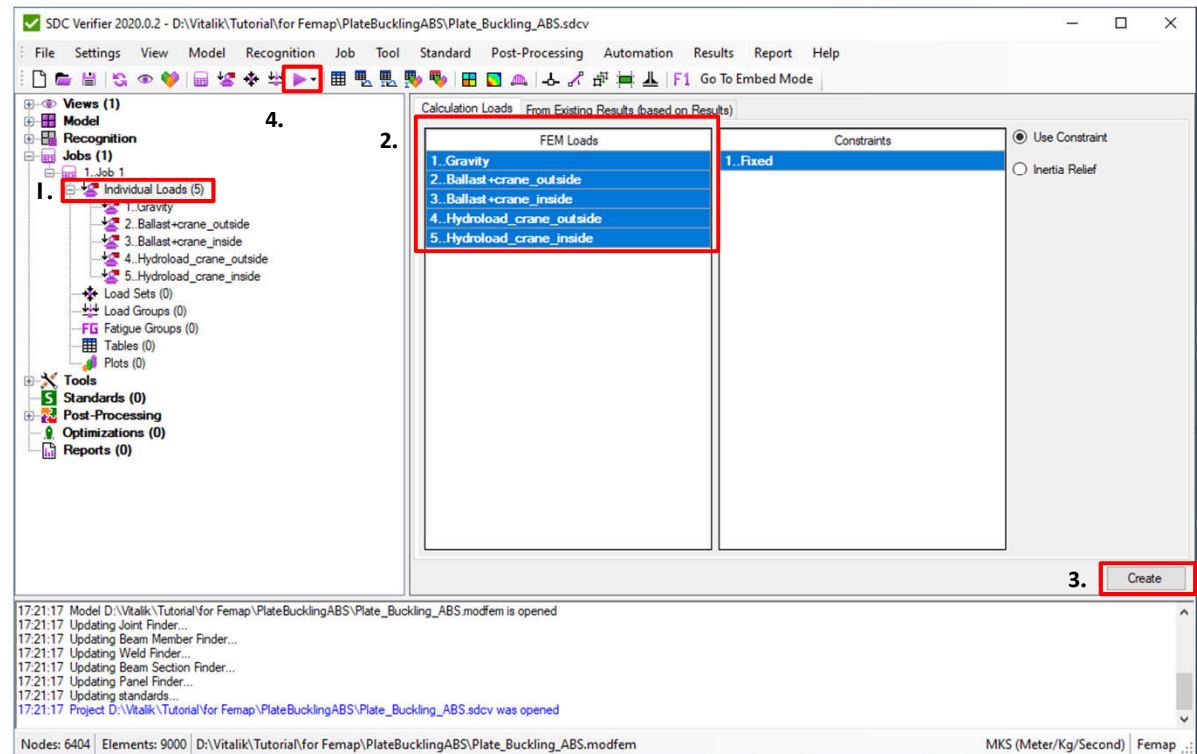
Individual Loads

1 Click on **Individual Loads**

2 Choose 5 *FEM Loads*:

3 Press *Create*

4 Press  on toolbar to analyze job




Load Sets

1

Right click on *Load Sets* => **Create/Edit multiple**

2

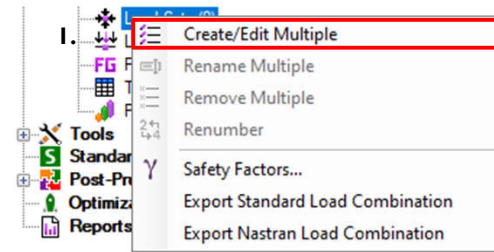
Fill in "4" into *Count* and press  to add four Load Sets.

3

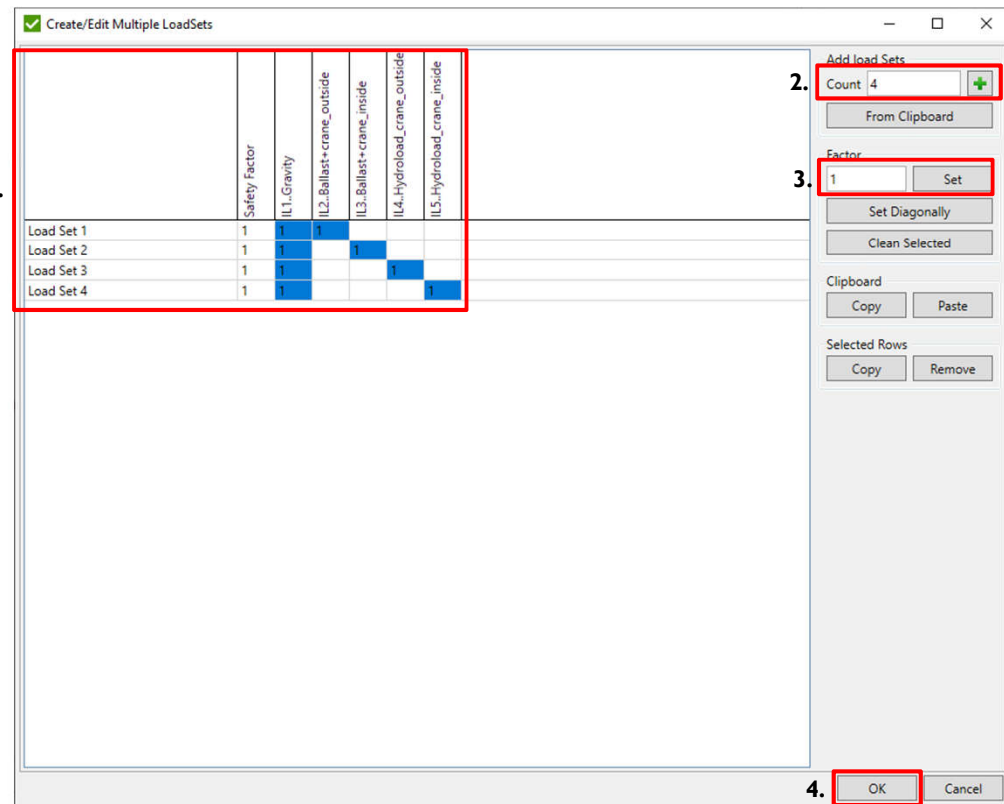
Select highlighted cells in table like shown on the picture and press *Set* to define Factors of Load Sets.

4

Press *OK*.




3.



Note: Load Sets are created with default titles "Load Set #". It is possible to rename them.
Alternatively titles and factors can be pasted from Clipboard using *Paste* button.

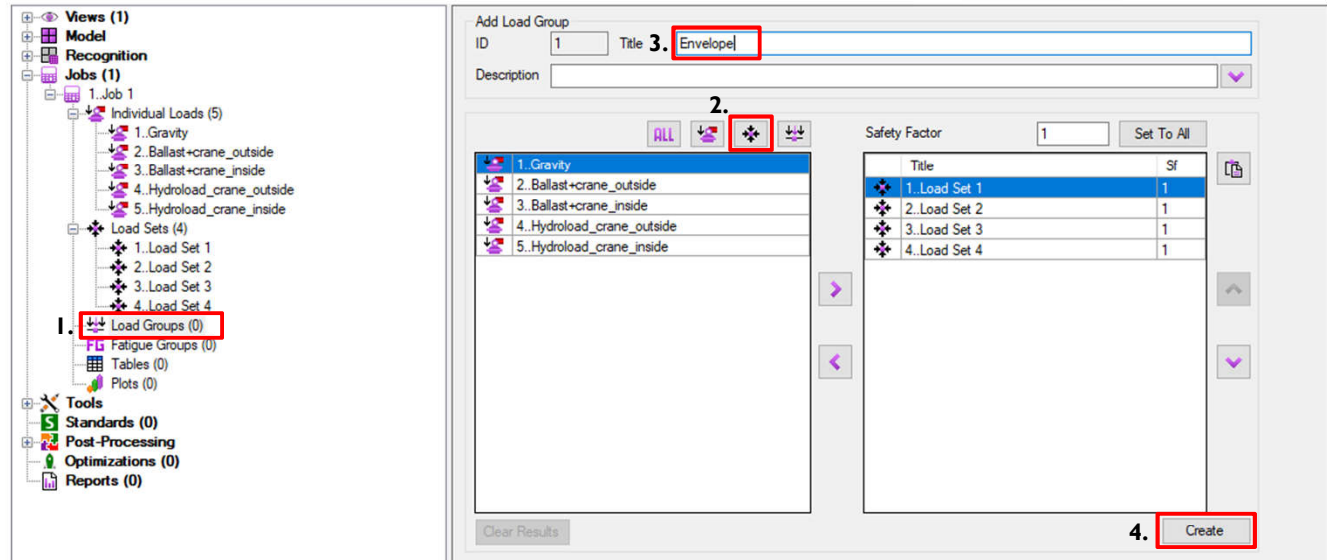
Load Groups

1 Click on **Load Groups**

2 Press  to select all Load Sets

3 **Title: Envelope;**

4 Press **Create**



The screenshot shows the SDC Verifier interface. On the left, the 'Views (1)' tree view is expanded to 'Load Groups (0)', which is highlighted with a red box and labeled '1.'. On the right, the 'Add Load Group' dialog is open. The 'Title' field is set to 'Envelope' and is highlighted with a red box and labeled '3.'. The 'Safety Factor' is set to '1'. The 'Load Sets' table is visible, and the 'Select All' icon (a square with a cross) is highlighted with a red box and labeled '2.'. The 'Create' button at the bottom right is highlighted with a red box and labeled '4.'. The 'Load Sets' table contains the following data:

Title	Sf
1..Load Set 1	1
2..Load Set 2	1
3..Load Set 3	1
4..Load Set 4	1

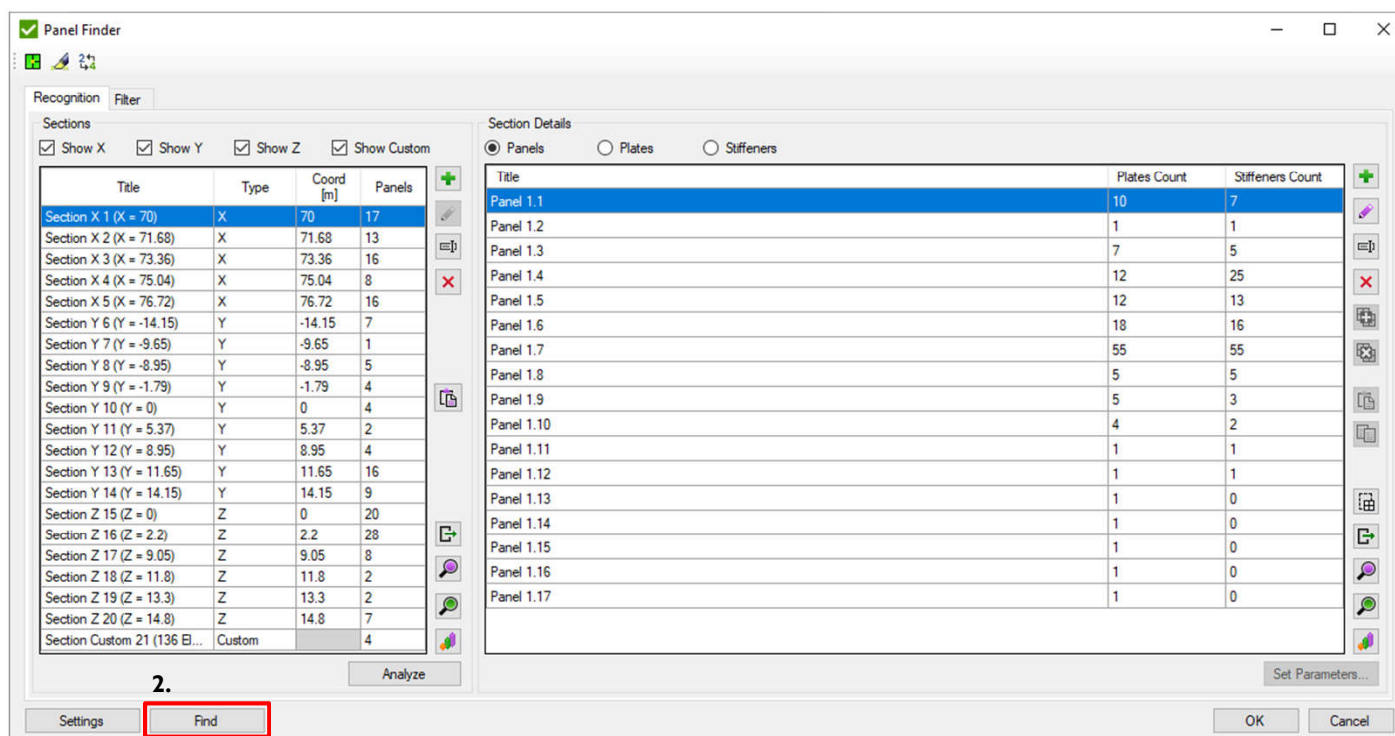
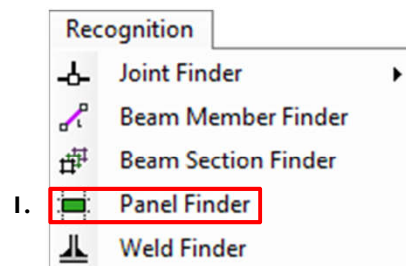
Note: Load Sets and Load Groups are analyzed by SDC Verifier.

Panel Finder. Recognize Sections.

1 Execute *Recognition - Panel Finder* from main menu

2 Click on *Find*


All Frames, Longitudinals and Desks were automatically.



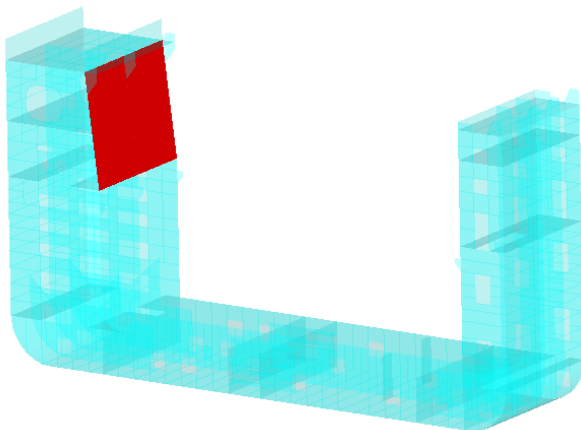
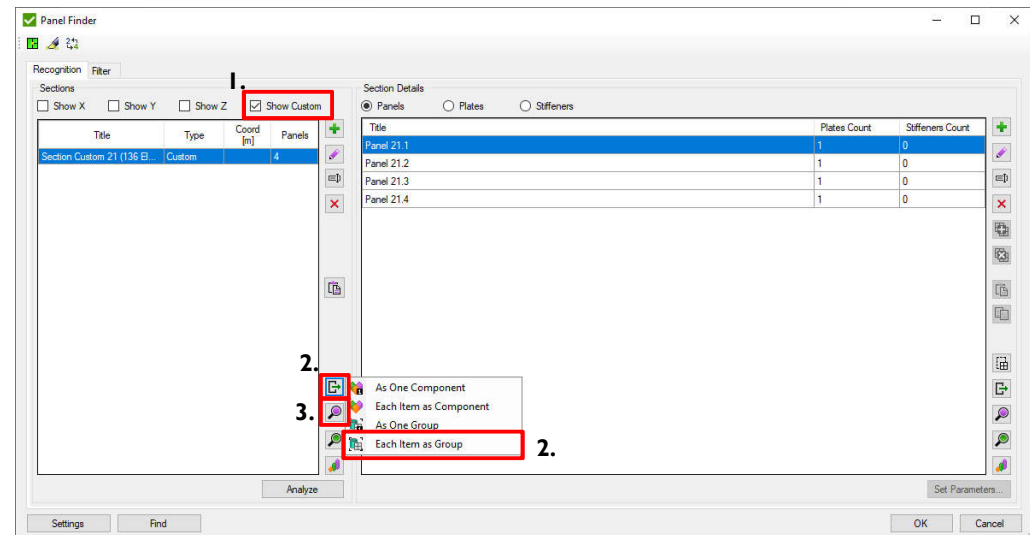
Panel Finder. Custom Section

1 Show Custom: **ON** (rest OFF)

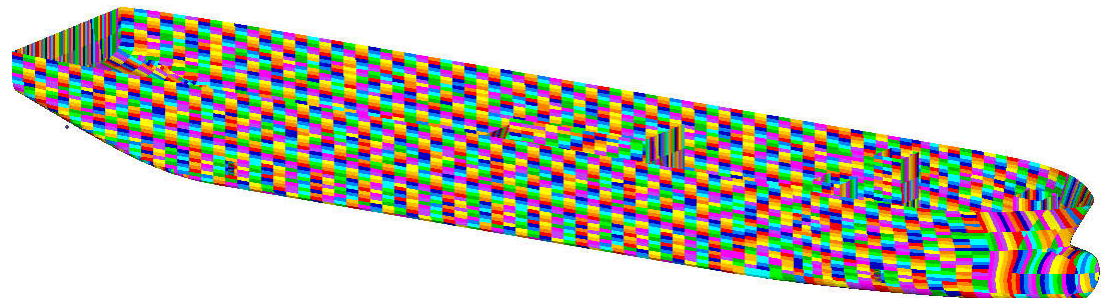
2 Press  and  to export selected sections to groups

3 Press 

Custom Section should be used for inclined/curved sections and selections like hull.



Example: It is possible to create custom section based on hull selection:




Panel Finder. Find Free Edges

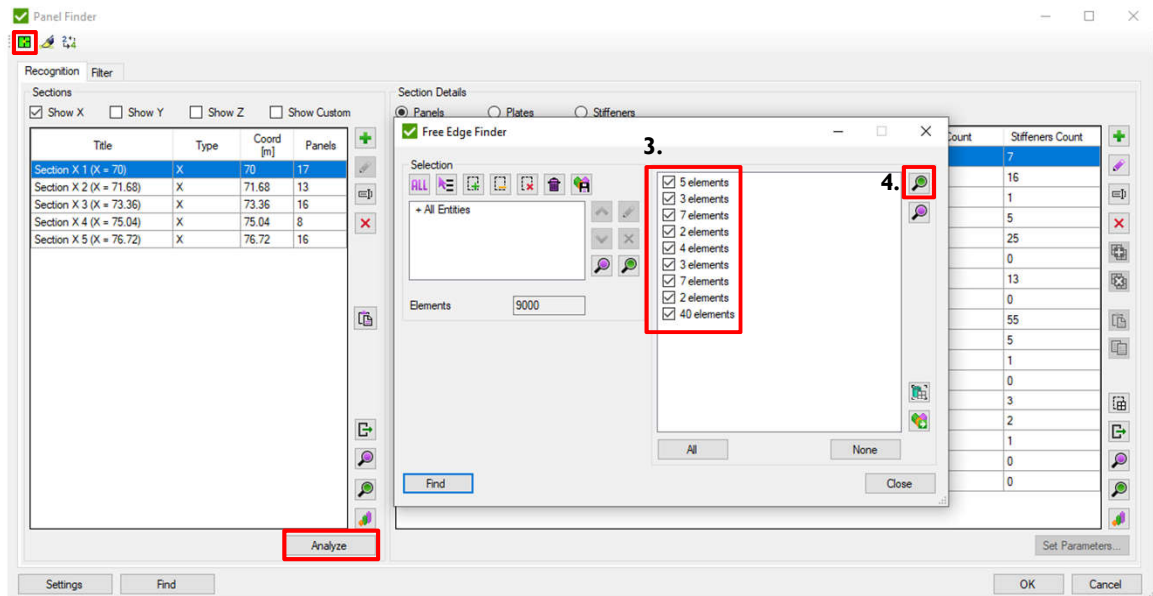
Note: Before plates recognition, the model should be checked on free edges. Not correct plate dimensions/direction, plates with undefined dimensions and as result wrong buckling factor – possible consequences of free edges.

1 Click  to Find Free edges

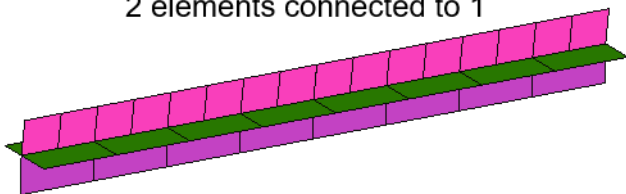
2 Press **Find**

3 Select all free edges

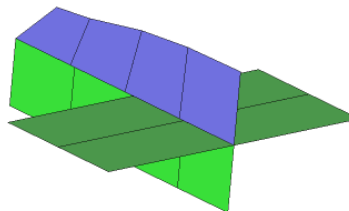
4 Press  to preview elements with free edges



2 elements connected to 1



Mesh does not coincide



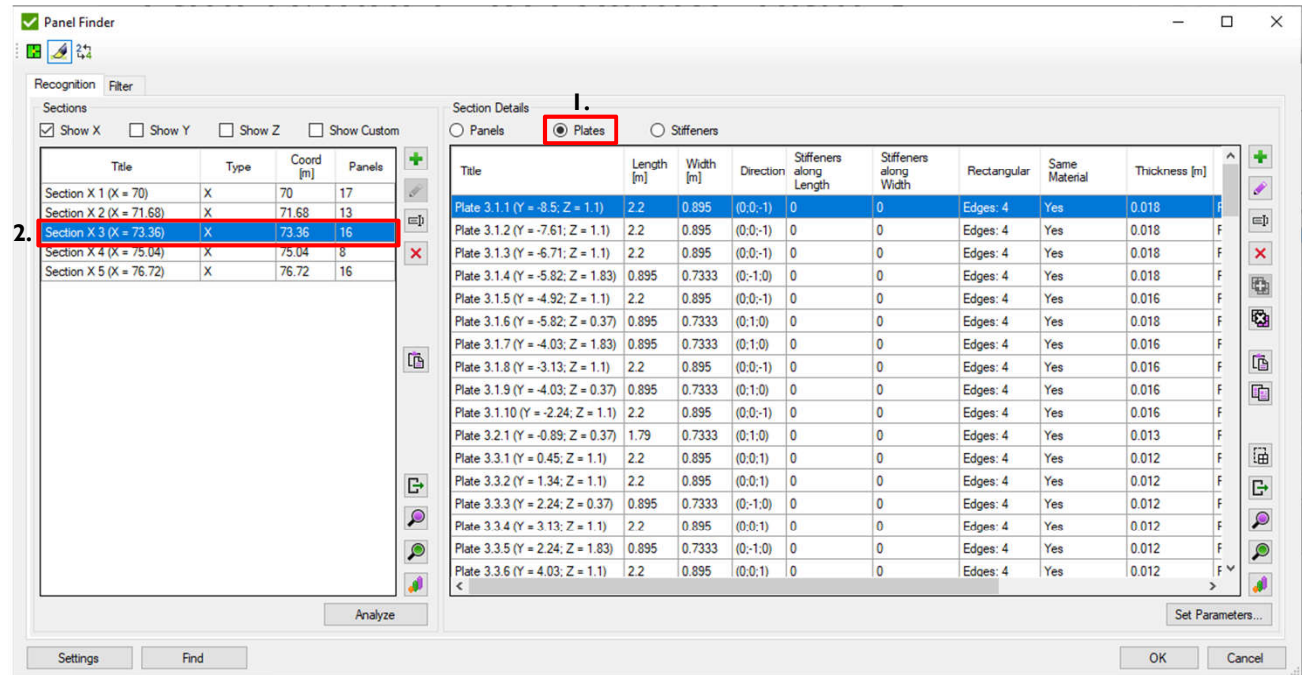
Note: Free edges should be fixed by remeshing the model and run recognition of plates. (In tutorial we skipped step with remeshing but for commercial project it is crucial step to do).

Panel Finder. Recognize plates

1 In Selection details Press **Plates**

2 Select **Section X3**.

Tip: If it is necessary to recognize plates only for one section press *Analyze*



Title	Length [m]	Width [m]	Direction	Stiffeners along Length	Stiffeners along Width	Rectangular	Same Material	Thickness [m]
Plate 3.5.15 (Y = 13.73; Z = 1...	0.8333	0.75	(0;1;0)	0	0	Edges: 4	Yes	0.012
Plate 3.6.1 (Y = 12.9; Z = 2.39)	2.5	1.5333	(0;1;0)	0	0	Edges: 8	Yes	Min = 0.016

Section ID. Panel ID. Plate ID

Plate is rectangle with all corners = 90 degrees

Plate has elements more than from one property

Plate Dimensions and Thicknesses

Dimensions: Results depend on plate dimensions and direction and it is important to understand how Panel Finder performs recognition. Length is considered the longest edge of plate and width the longest perpendicular to the longest edge:

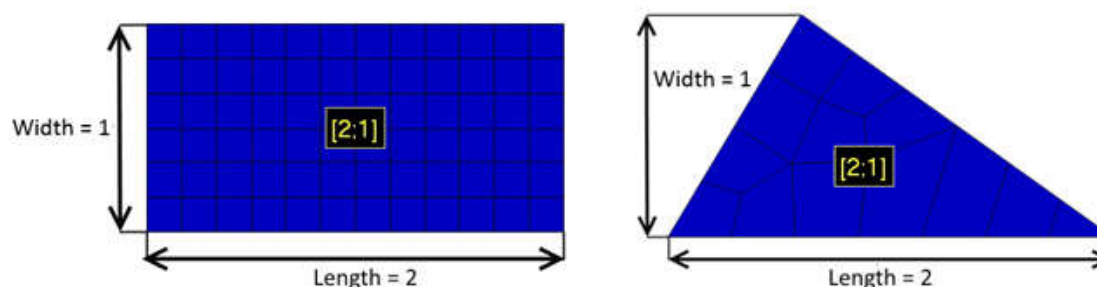


Plate Thickness: Calculations are performed on every element and thickness is taken directly from each element. It is possible to set thickness manually for plate, in this case element thickness will be ignored and user defined thickness will be used. Example: Plate with 2 properties 0.01 and 0.02 thicknesses. Left picture displays property labels with property thicknesses and right presents plate buckling plot of thickness parameter:

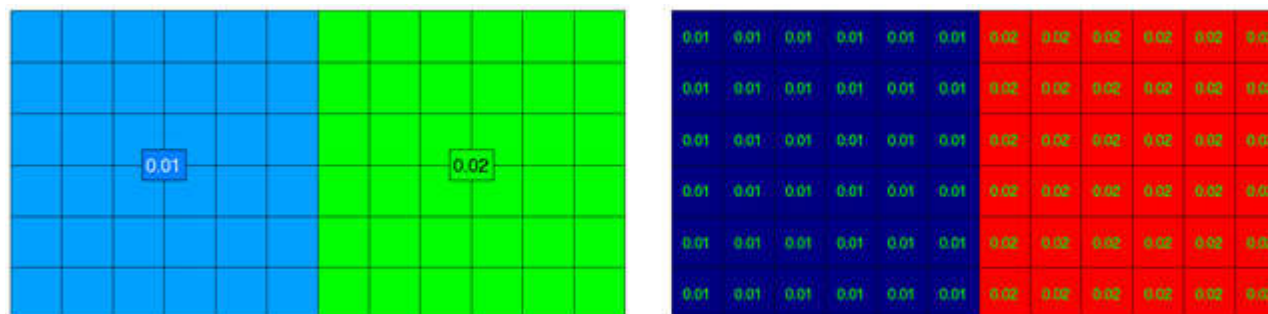
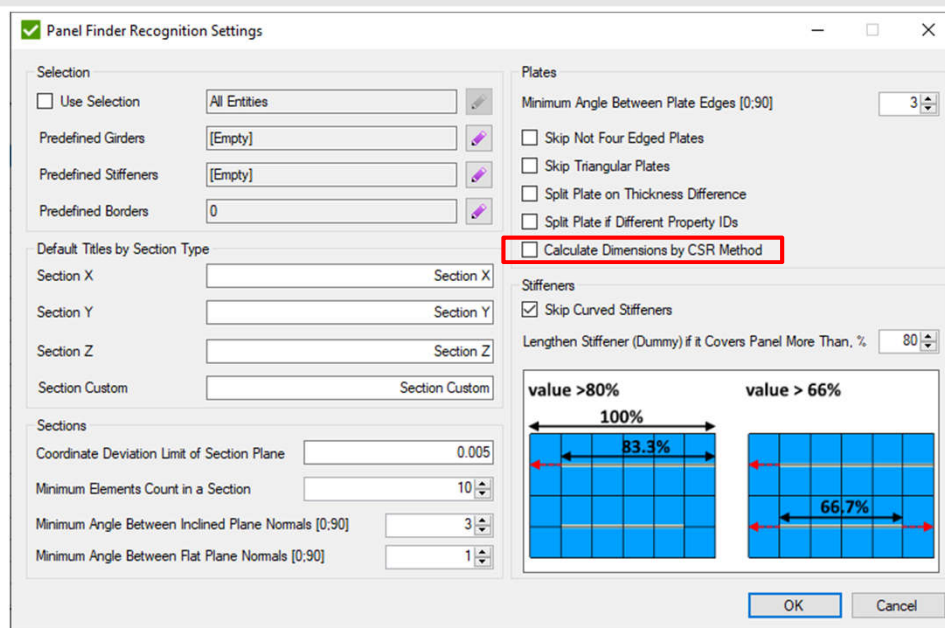


Plate Buckling Dimensions by CSR



2.3.2 Modelling of an unstiffened panel with irregular geometry

Unstiffened panels with irregular geometry are to be idealised to equivalent panels for plate buckling assessment according to the following procedure:

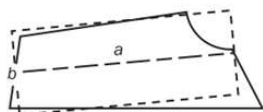
- e) The length of shorter side, b in mm, is to be taken as:

$$b = A/a$$

where:

A : Area of the plate, in mm^2

a : length defined in (d), in mm

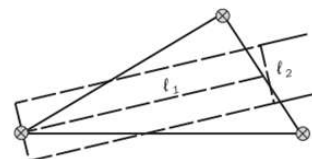


- c) The width of the model, ℓ_2 , in mm, is to be taken as:

$$\ell_2 = A/\ell_1$$

where:

A : Area of the plate, in mm^2



Editing plates manually

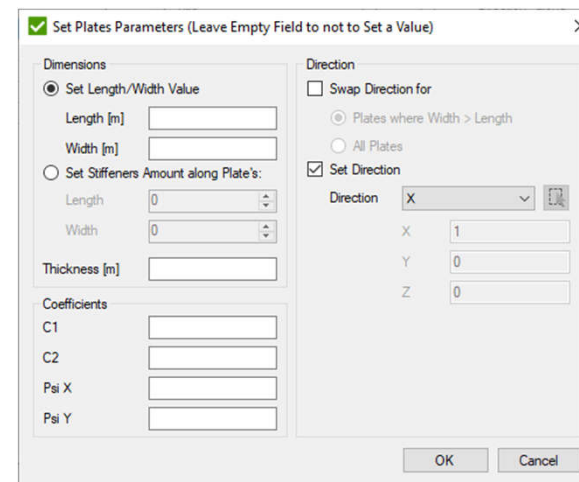
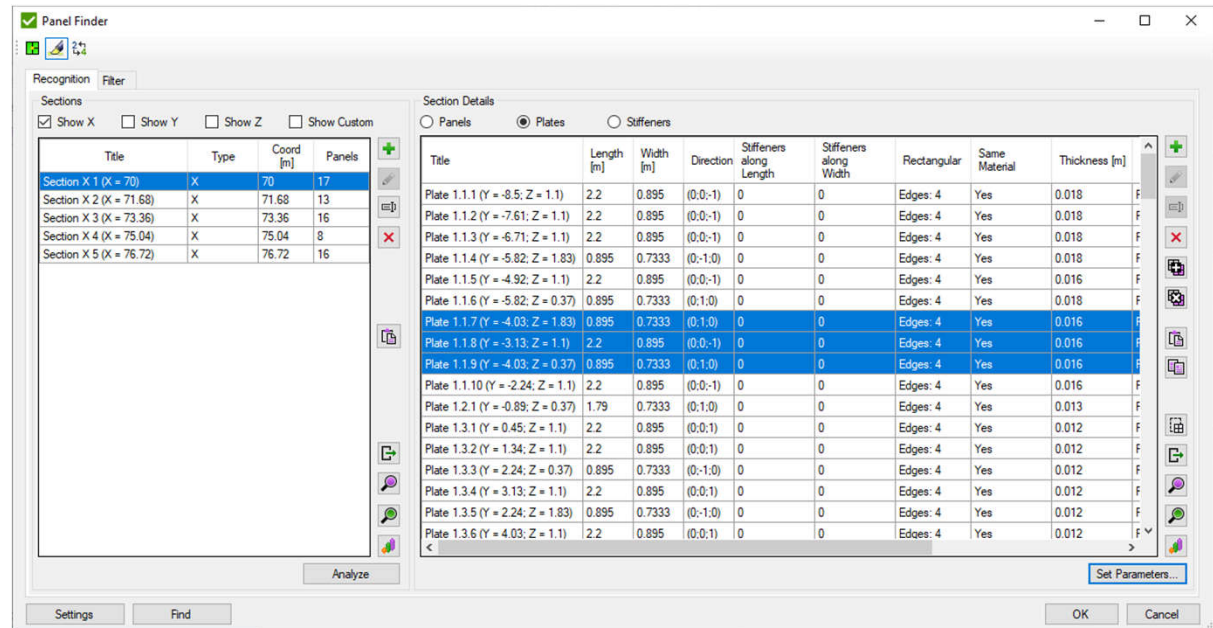
To modify plates select them from the list and press *Set Parameters*. It is possible to edit (Length / Width / Thickness / Coefficients / Direction).

It is possible to define parametric stiffeners along the Length and Width.

If thickness is changed you can see in table what was the original thickness recognized from model:

Thickness
0.016 (Original: 0.012)
0.016 (Original: 0.012)
0.016 (Original: 0.012)

If the direction of plate should be modified, define global axis or custom vector and press *Set Direction*.



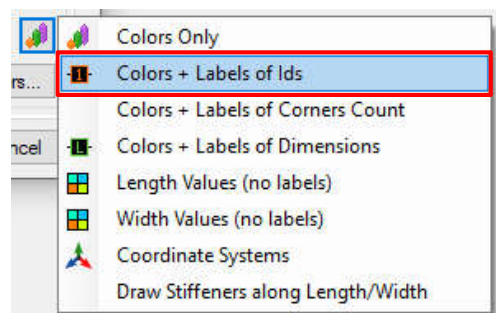
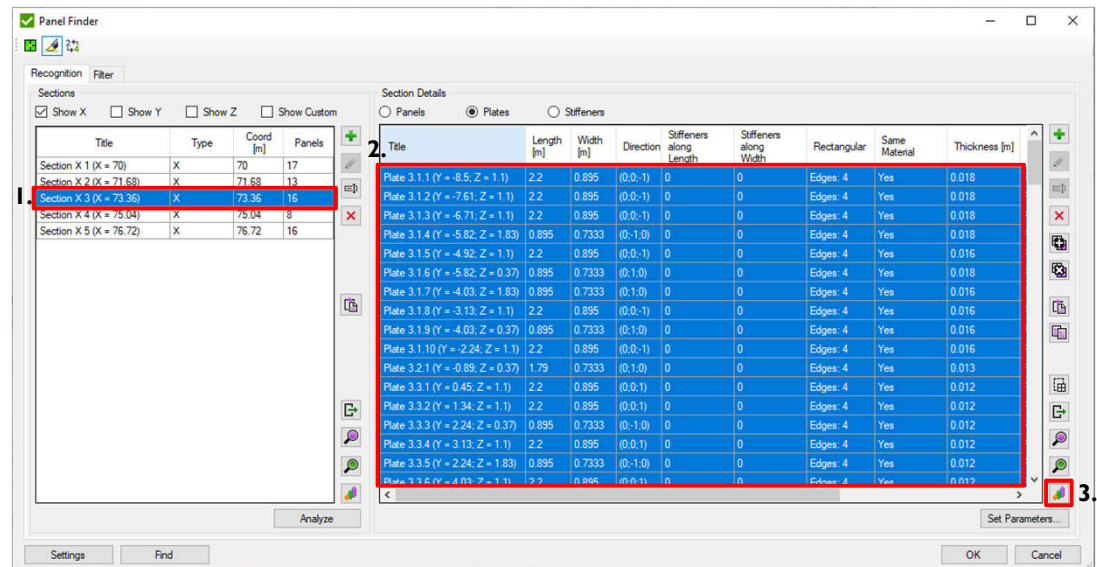
Panel Finder. Plates Plot

1 Select **Section X3**

2 Select All *Plates*

3 Press 

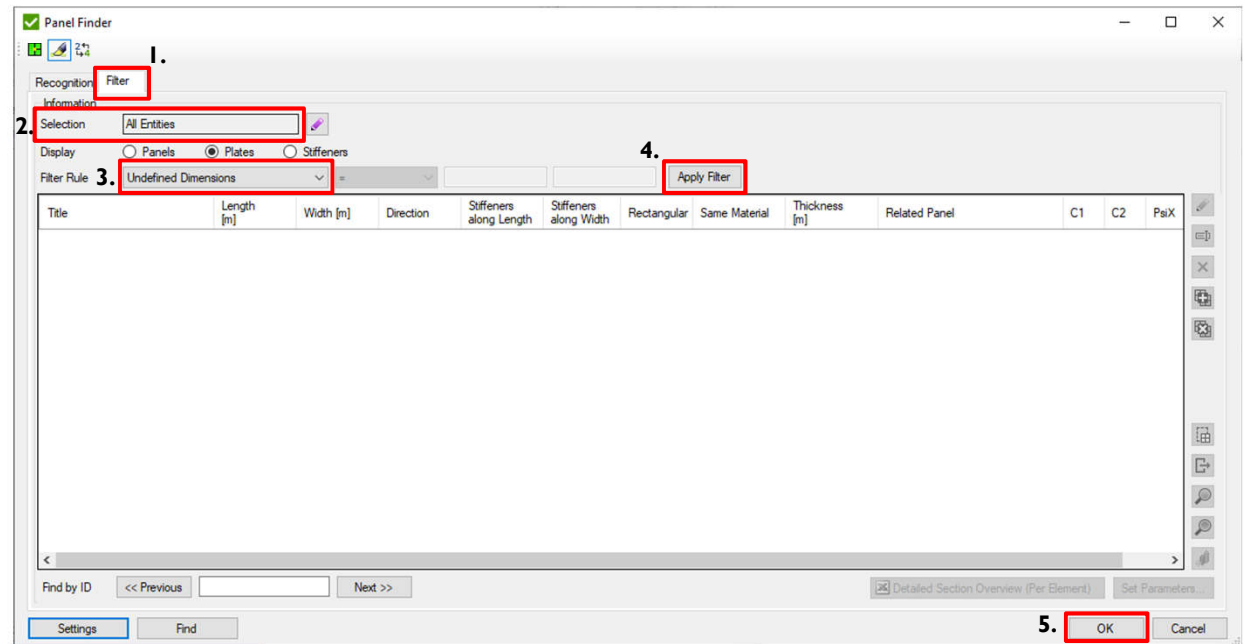
4 Click on *Colors + Labels of Ids*.



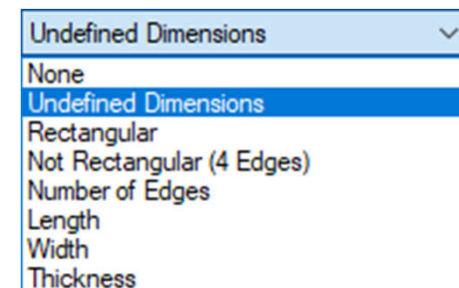
Panel Finder. Filter

Note: It is very important to check that all plates dimensions were recognized. If in the model, there are coincident nodes, coincident elements or free edges Panel Finder cannot recognize plate dimensions.

- 1 Click on *Filter* tab
- 2 Selection: **All Entities**
- 3 Filter: **Undefined dimensions**
- 4 Press *Apply Filter*
- 5 Table with plates is empty means that there is no plates with undefined dimensions. Press *OK*

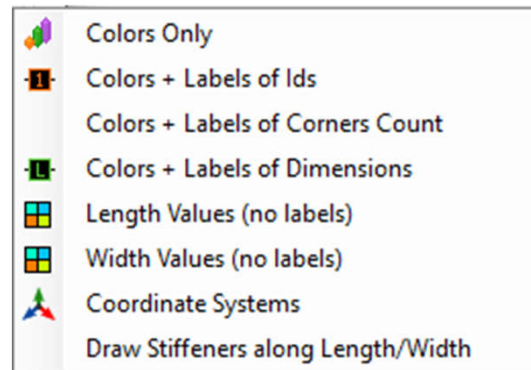


Tip: It is also possible to filter plates by shape (triangle, rectangular) or number of edges parameters.
E.g. Plates with numbers of edges > 4 can be displayed.
Control using Selection plates from which Sections should be filtered.

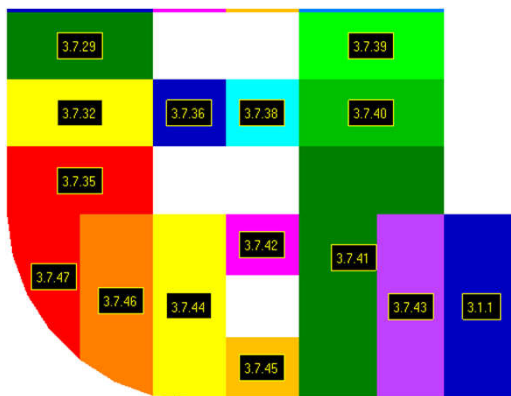


Panel Finder. Plot Options

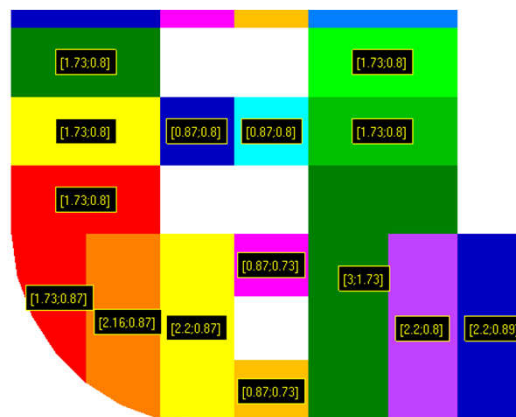
Note: Plate Plot can be displayed with different colors labels (labels of ids, labels of corners count or labels of dimensions). Also it is possible to show plates in length and width, coordinate systems etc.



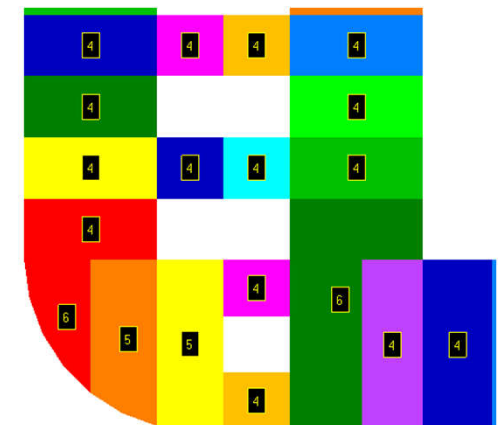
Labels of Ids



Labels of dimensions

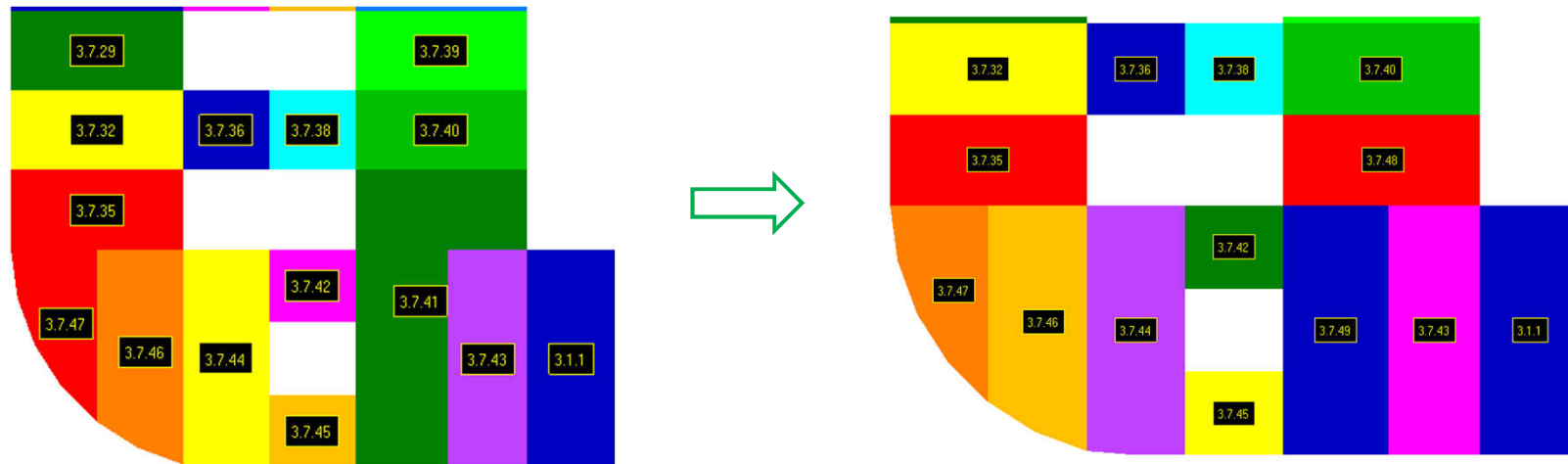


Labels of Corners Count



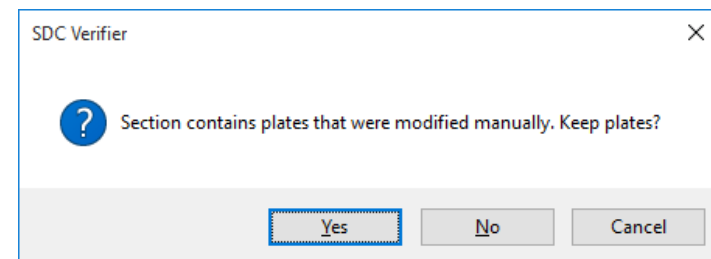
Panel Finder. Update Plates

In some cases (e.g. stiffener is not modeled) plate is recognized not correctly, dimensions are bigger than in reality which leads to wrong results. Plate has to be updated manually. In Section X3 plate with Id = 3.7.41 should be split on 2 plates



Note: if plates were modified manually and later user decided to run recognition of plates - Panel Finder will ask what to do with modified plates:

- Keep plates that was modified;
- Clear everything and recognition from scratch;



Panel Finder. Split Plate

1 Select **Section X1 (X = 70)**.

2 Select **Plate 1.9.48**.

3 Press **Split by elements**

4 Selected plate is displayed in Femap. Select elements for one plate. And press **OK**

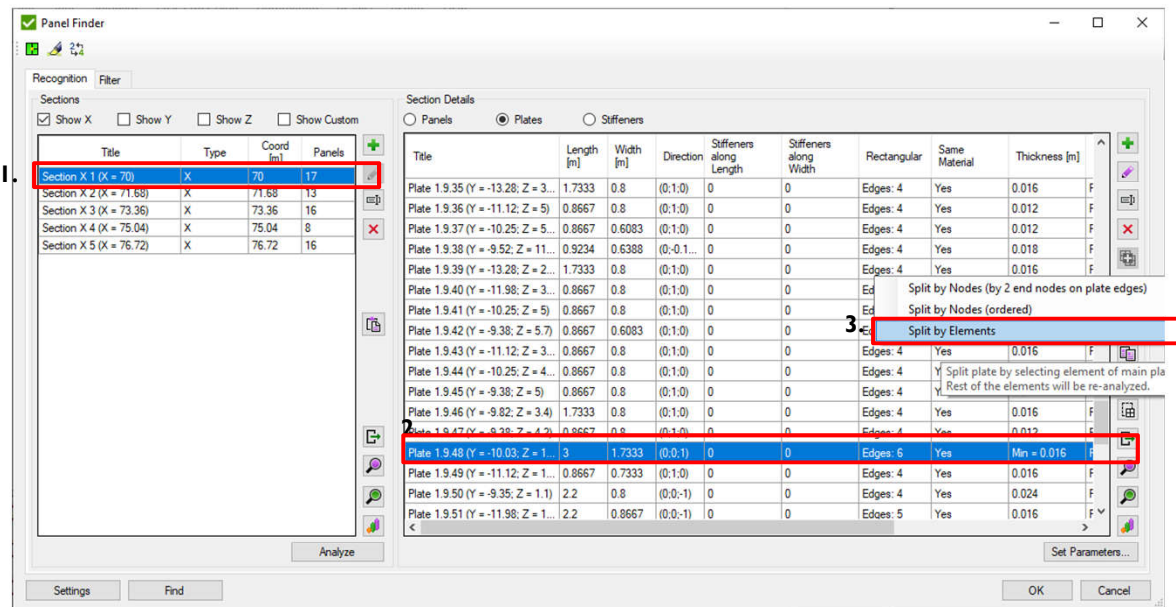
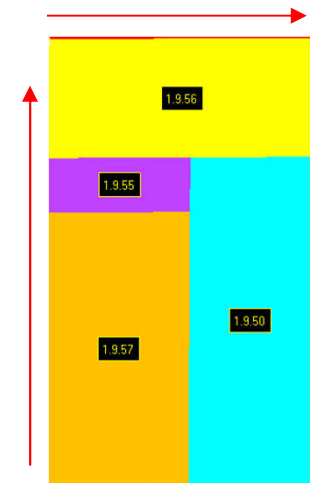


Plate 1.9.48 is replaced with Plates 1.9.55; 1.9.56 and 1.9.57
Dimensions and directions are updated automatically



Title
Plate 1.7.55 (Y = -9.8; Z = 2.6)
Plate 1.7.56 (Y = -10.22; Z = 1...



Add Plate Buckling ABS 2014 standard

1

In Standards Context menu execute *Add*
=> *ABS* => *ABS Plate Buckling (2014)*

2

Utilization Factor (Eta) = **0.8**

3

Use Plate Average Stress: **On**

4

Press *OK*

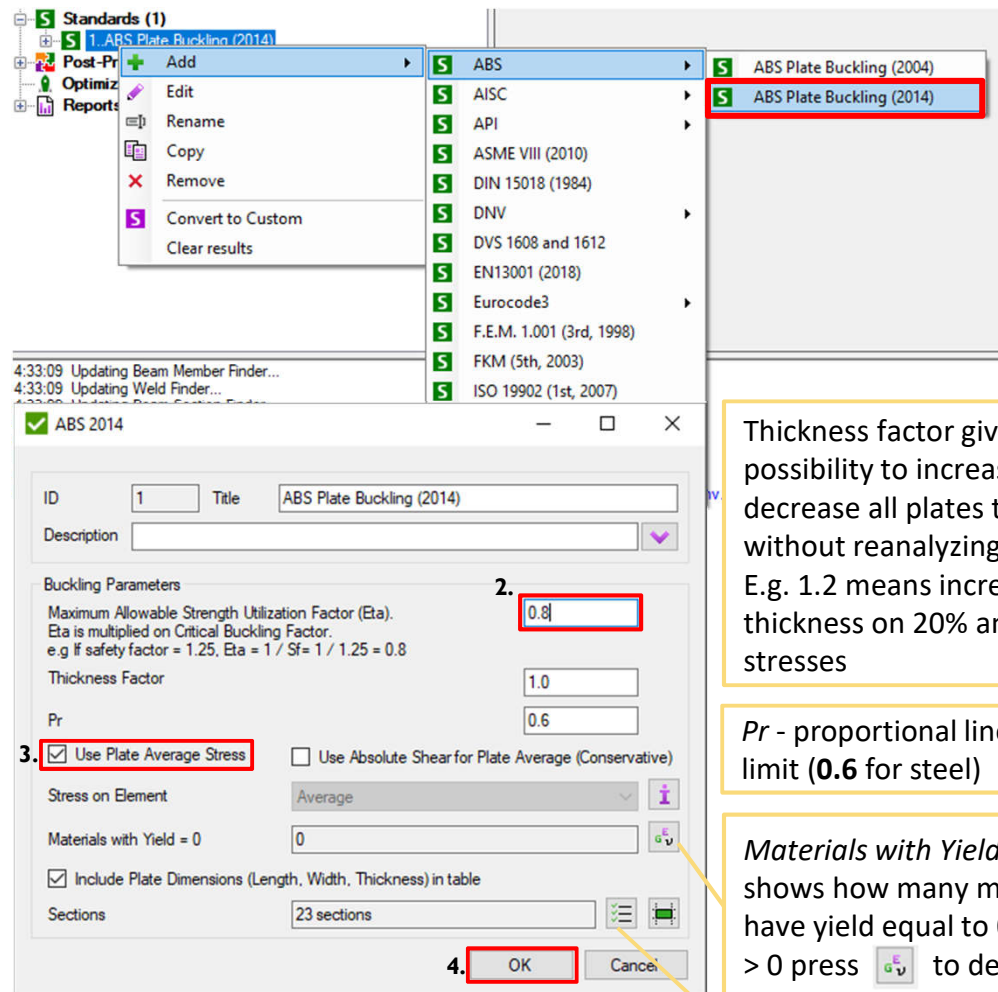


Plate Buckling transforms stresses automatically into plate direction. Options about element stresses and plate stresses are described on the next slide

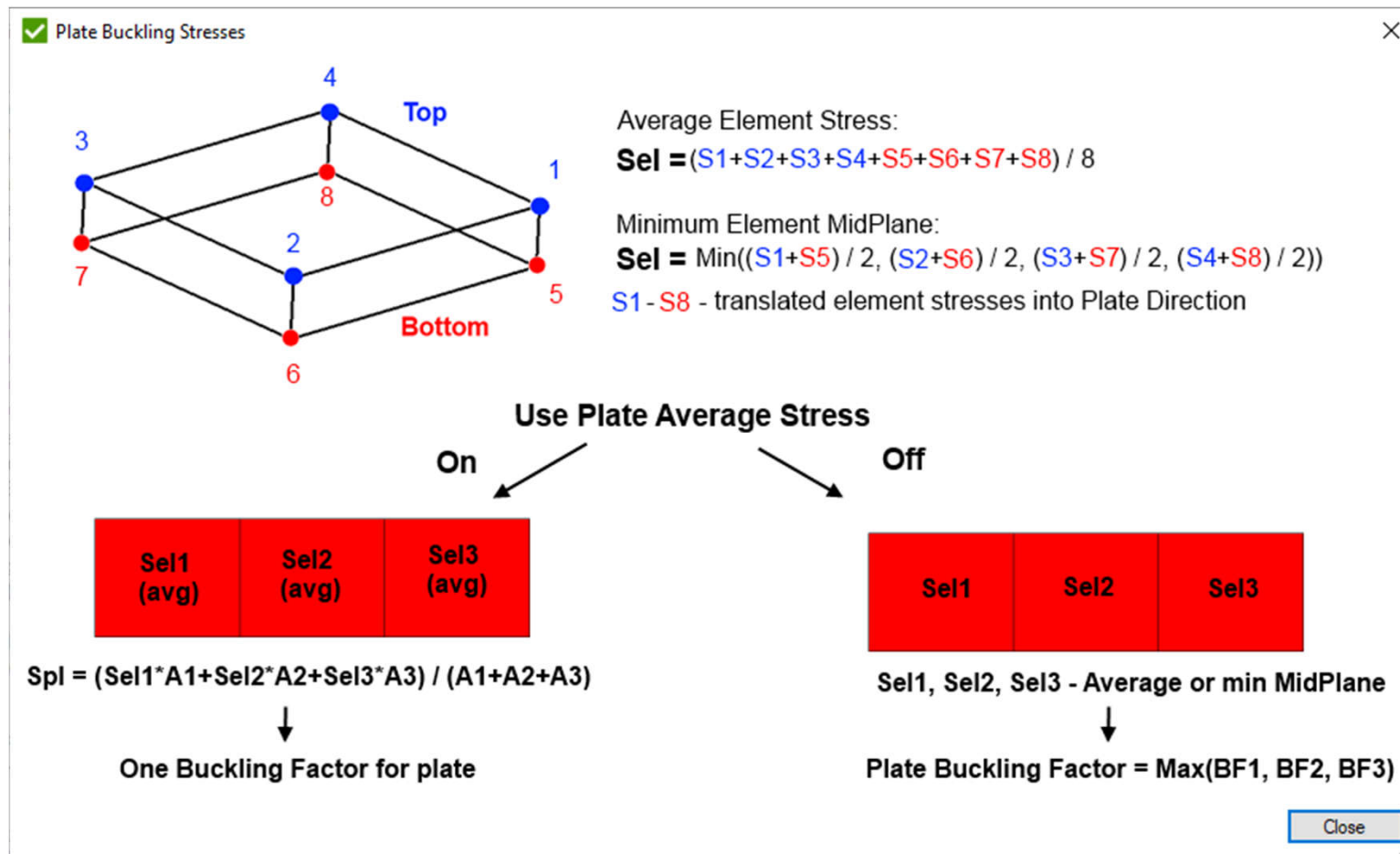
Thickness factor gives a possibility to increase / decrease all plates thicknesses without reanalyzing the model. E.g. 1.2 means increase thickness on 20% and decrease stresses

P_r - proportional linear elastic limit (**0.6** for steel)

Materials with Yield Stress = 0 shows how many materials have yield equal to 0. If value is > 0 press to define yield.

By default all sections will be checked. Click to modify.

Plate Buckling Stresses



Views

1 Execute Views => **Add**

2 Title: **Frames**

3 Orient model in Femap as shown on picture below (ZY plane)

4 Press **Get**

5 Press **OK**.

Repeat Steps 1-5 2 times to create view for Longitudinals (plane ZX) and Decks (plane XY)

To make nice plots first Views should be created (set of settings how to display plot).

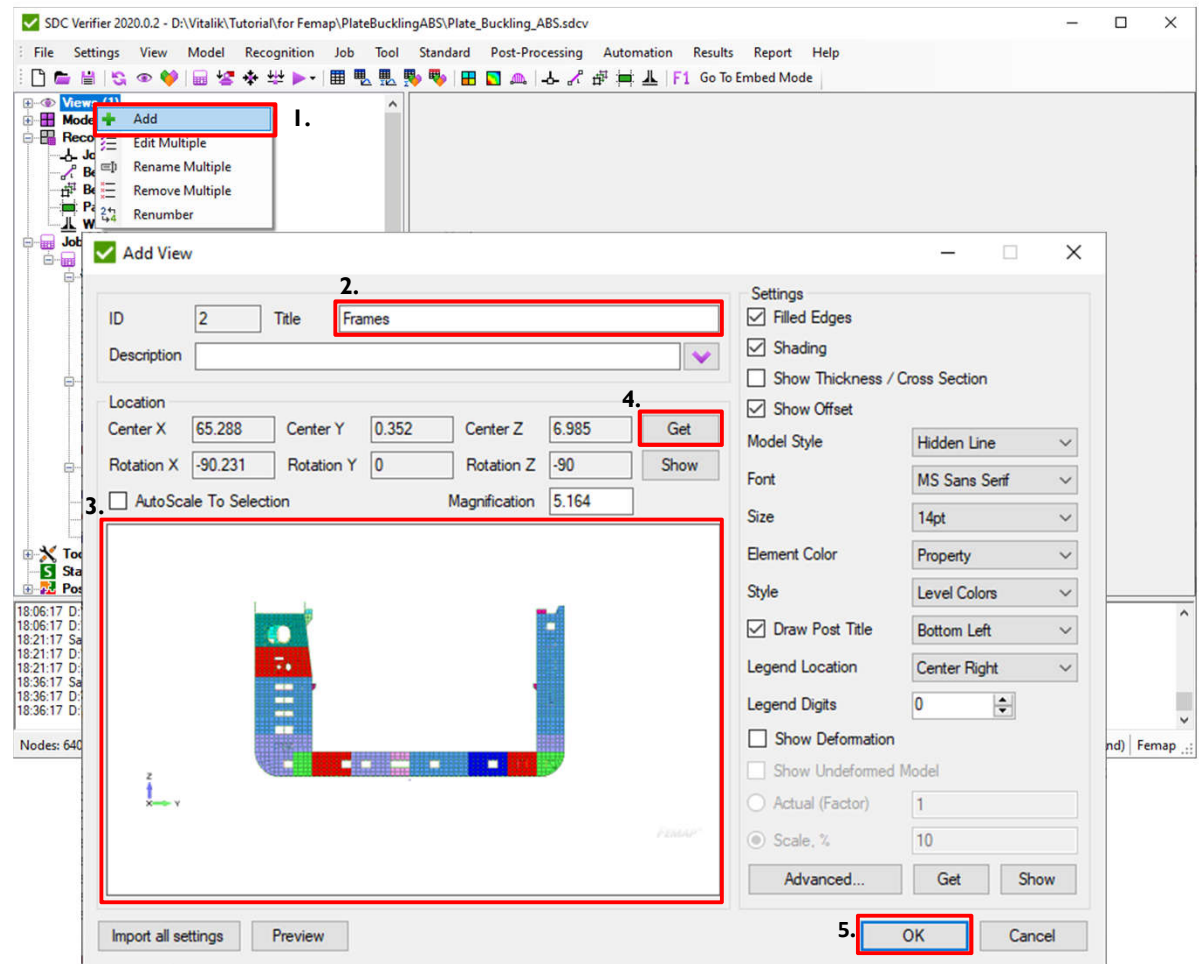




Plate Buckling Plot

- 1 Execute *Criteria Plot* from Plate Buckling ABS 2014 context menu
- 2 Load Group: 1..**Envelope**
- 3 View: **Frames**
- 4 Press  Select: **Section X3**
- 5 Press  *Preview*

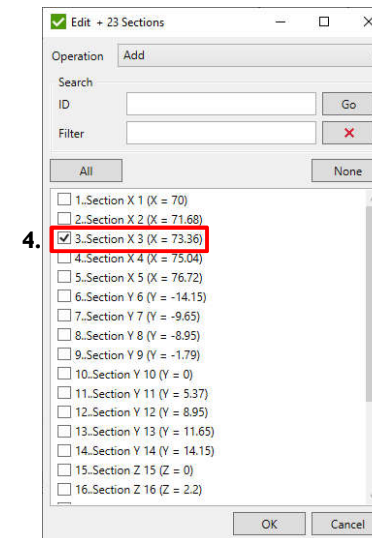
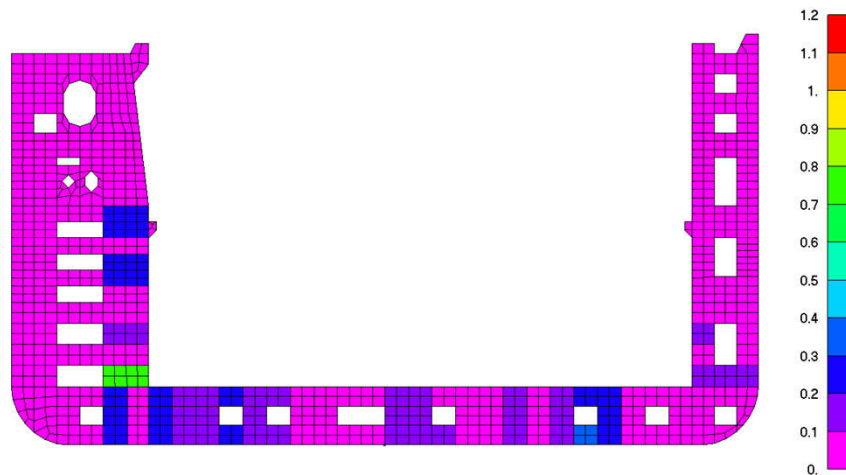
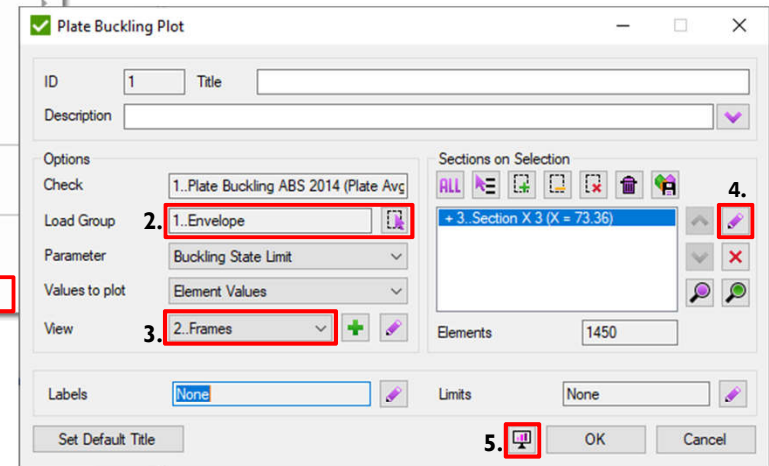
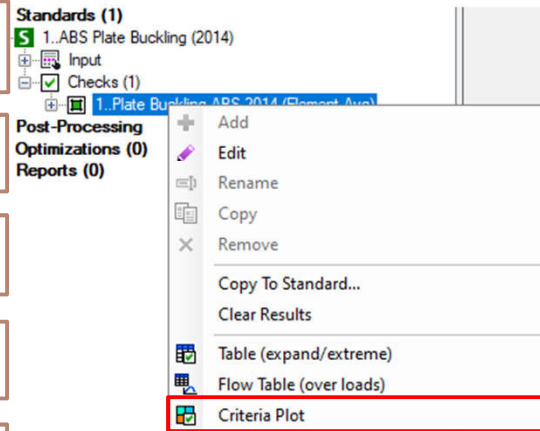


Plate Buckling Table

1

Execute **Table(expand/extreme)**
from Plate Buckling ABS 2014
context menu

2

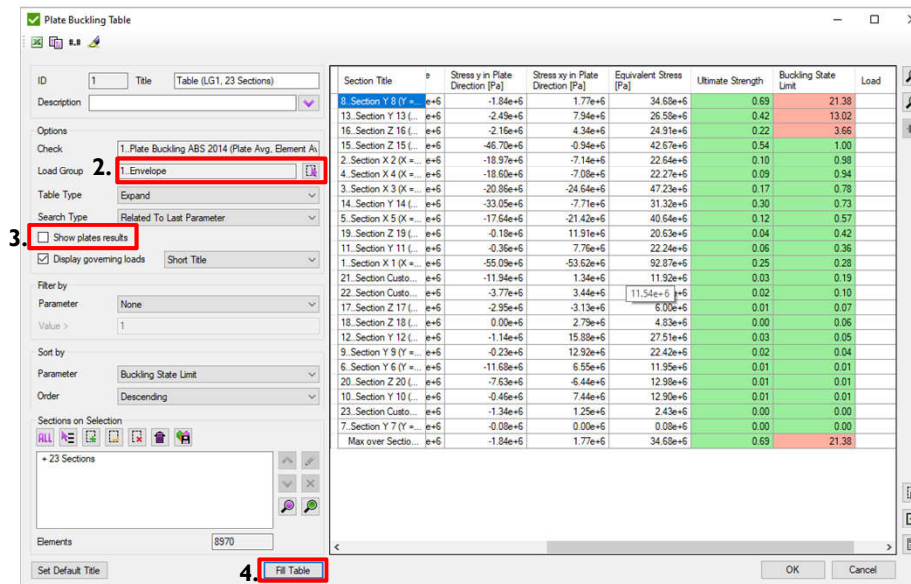
Load Group: 1..Envelope

3

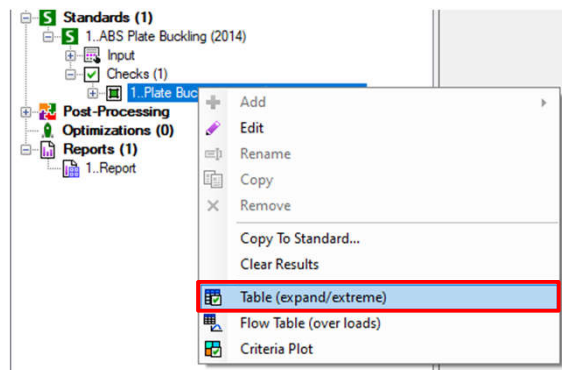
Show plates results: **OFF**

4

Press **Fill Table**



Use **Show plates results** for detailed
table with results for all plates.
Otherwise only the worst results
over Sections will be shown.



Section Title	Plate Length [m]	Plate Width [m]	Plate Thickness	Stress x in Plate Direction [Pa]	Stress y in Plate Direction [Pa]	Stress xy in Plate Direction [Pa]	Equivalent Stress [Pa]	Ultimate Strength	Buckling State Limit
1..Section X 1 (X = 70)	3.00	1.73	0.02	-4.42e+6	-17.43e+6	-21.13e+6	40.11e+6	0.12	0.55

All results(dimensions, stresses) are from the plate which cause highest BF=0.55
because Search Type = Related to Last Parameter

Report. Tables

1 Execute Reports => Add =>
Designer - Results

2 Results => Check Tables

3 Press => Check '1..Plate Buckling'
=>

4 Type: **Expand**

5 Press and select **LS; LG** loads.

6 Press **OK**

7 Press and Execute **From List**

8 Select all **X Sections**


9 Press **OK**

9 Press **OK**

The screenshot shows the SDC Verifier software interface. The 'Reports' menu is open, showing options like 'Add', 'Remove Multiple', 'Renumber', and 'Generate Multiple'. The 'Add' option is selected, leading to a submenu where 'Designer - Results' is highlighted (Step 1). The 'Report Designer' window is open, showing the 'Results' tab. The 'Check Tables' button is highlighted (Step 2). The 'Plate Buckling Table' dialog is open, showing the 'Settings' tab. The 'Table Type' is set to 'Expand' (Step 4). The 'Search Type' is set to 'Related To Last'. The 'Filter by' parameter is set to 'None'. The 'Sort by' parameter is set to 'Buckling State Limit'. The 'Order' is set to 'Descending'. The 'Loads' count is 5. The 'Select Items' dialog is open, showing a list of sections. The 'From List' button is highlighted (Step 7). The 'OK' button is highlighted (Step 9).


Report. Plots



1 Results => Check Plots

2 Press => Check '1..Plate Buckling'
=> 

3 Parameter: **Buckling Factor Overall.**

4 Views: **Frame.**

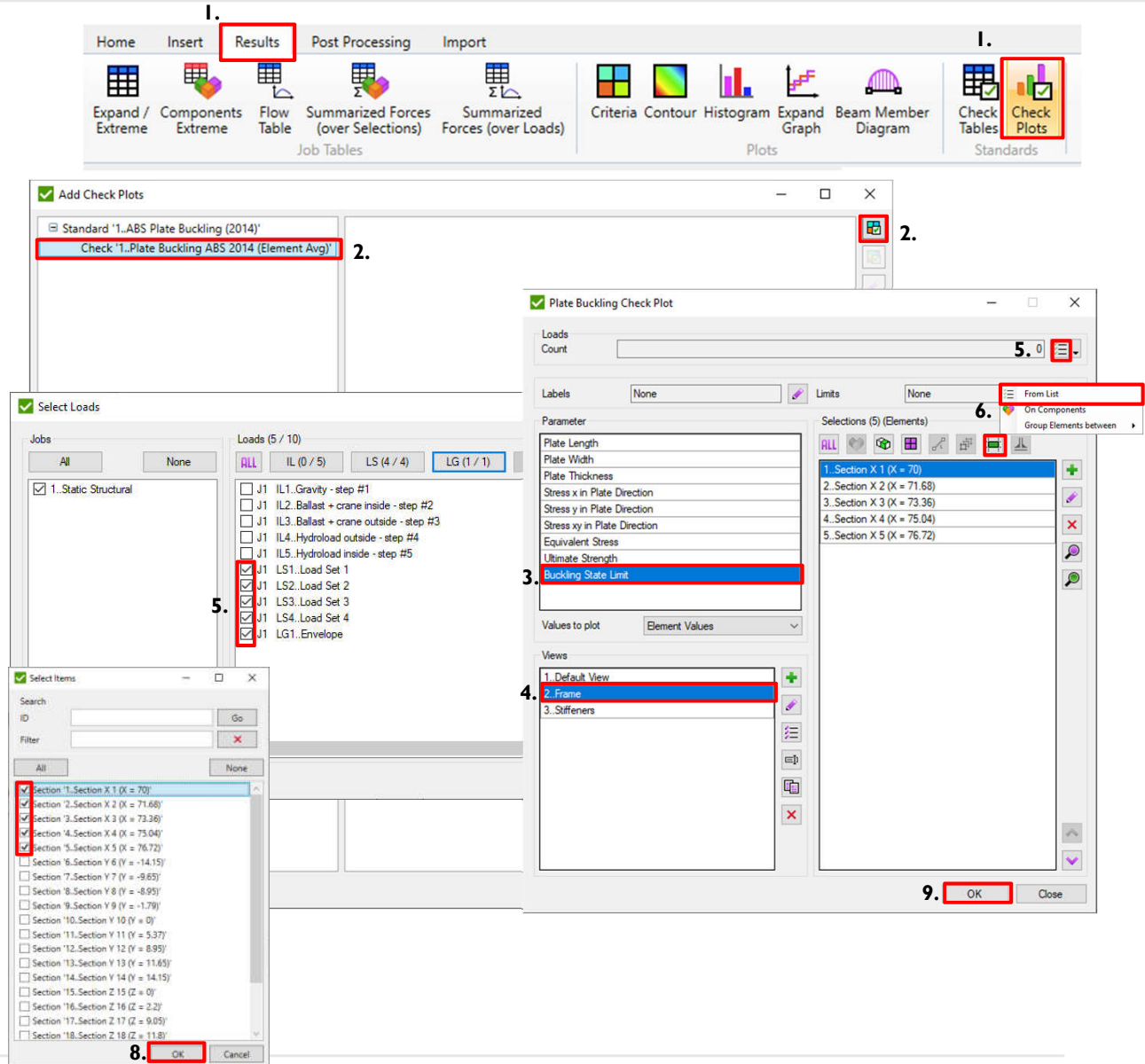
5 Press , select **LS; LG** Loads and Press **OK.**

6 Press  and Execute  **From List**

7 Select all **X** sections.

8 Press **OK.**

9 Press **OK.**



The screenshot illustrates the workflow for generating a buckling plot report in SDC Verifier. The process is guided by numbered steps 1 through 9, which correspond to the instructions on the left.

- Step 1:** The **Results** tab is selected in the main menu.
- Step 2:** The **Check Plots** icon is clicked in the **Standards** section of the ribbon.
- Step 3:** In the **Add Check Plots** dialog, the checkbox for **Check '1..Plate Buckling ABS 2014 (Element Avg)'** is selected.
- Step 4:** The **Plate Buckling Check Plot** dialog is shown. The **From List** button is clicked to select elements.
- Step 5:** In the **Select Loads** dialog, the **LG (1 / 1)** load set is selected.
- Step 6:** In the **Plate Buckling Check Plot** dialog, the **Buckling State Limit** parameter is selected.
- Step 7:** In the **Select Items** dialog, all **X** sections (e.g., Section 1, Section 2, etc.) are selected.
- Step 8:** The **OK** button is clicked in the **Select Items** dialog.
- Step 9:** The **OK** button is clicked in the **Plate Buckling Check Plot** dialog.

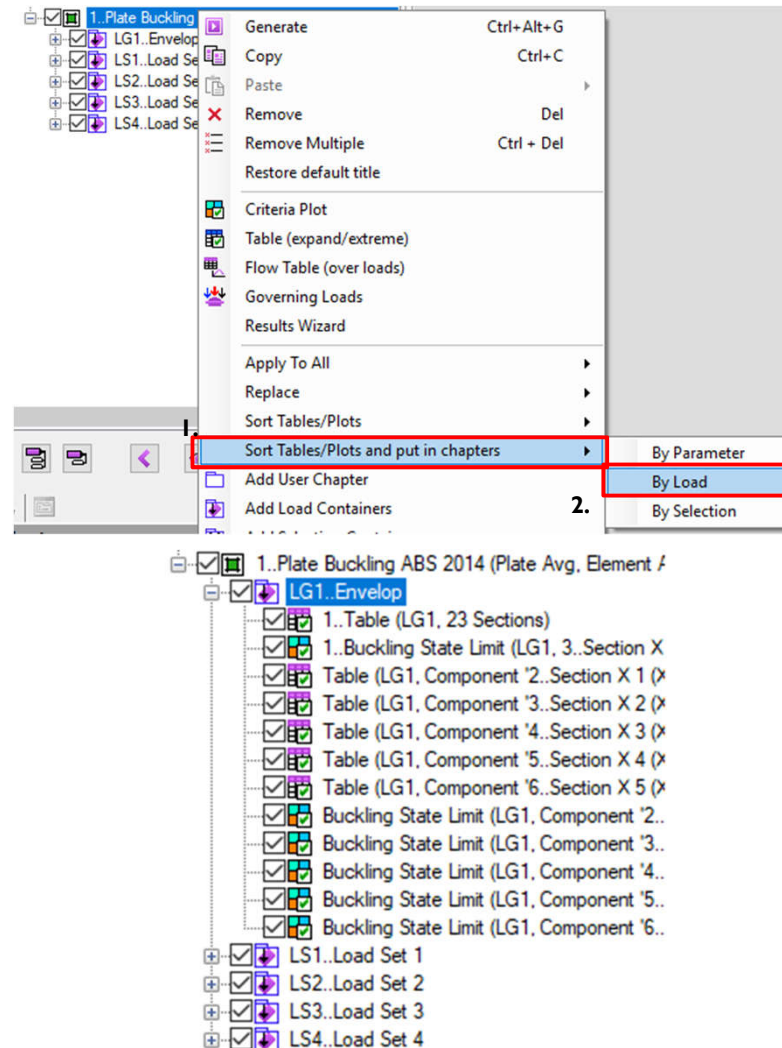
Report. Sort tables and plots by Load

1

Execute *Plate Buckling ABS 2014*
=> *Sort Tables/Plots and put in chapters*

2


Click => *By Load*



All tables and plots are sorted by loads. It is possible to sort it *By Parameter; By Selection; By section* as well.

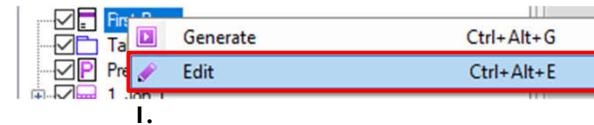
Report. First Page

1 Right click on *First Page* => **Edit**.

2 Press  to select engineer and custom from library


3 Select *Image From View* and pick '2..Frame'.


4 Press **OK**.



First Page Editor


Engineer details

Engineer: Support  2.




Company: SDC Verifier 

E-mail: support@sdcverifier.com

Phone: +31 15 30-10-310


Address: Zijlvest 25 [...] 


Web Site: sdcverifier.com

Logo:   

☒ Put logo on report plots


Customer details

Contact Person: customer 




Company: company 

E-mail: customer@company.com


Phone: +31 15 555-55-55


Address: Zijlvest 25 [...] 

Web Site: company.com

Logo:   

Image

☐ From file 

☒ From View 2..Frame  3.

Custom Fields

4. **OK** Cancel

Report

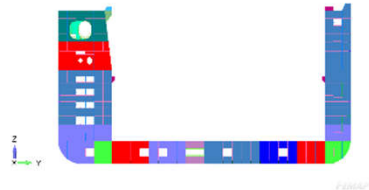


Press to generate complete report and press to convert report to word



Report

SDC Verifier License - For Demonstration Use Only



Prepared by:
SDC Verifier

+31 15 30-10-310
sdverifier.com
Zijvest 25
2011 VB Haarlem
The Netherlands

Engineer: Support
Customer: customer
Project Number:
Version: 1
Date: 11/12/2020

Prepared for:
company

+31 15 555-55-55
company.com
Zijvest 25
2011 VB Haarlem
The Netherlands



Checks

This paragraph contains checks descriptions with their results.

1..Plate Buckling ABS 2014 (Plate Avg, Element Avg)

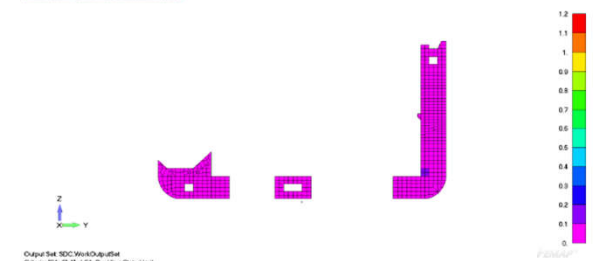
Property	Value
Category	Plate Buckling
Parameter Count	26
Use Absolute Shear	No
Convert Stresses into plate direction	Yes

LG1..Envelop

1..Table (LG1, 23 Sections)		1.ABS Plate Buckling (2014)			Check			[S1] 1..Plate Buckling ABS 2014 (Plate Avg, Element Avg)			23 Sections		
Load Group	LG1..Envelop	Related To Last			Selection								
Search Type	Section Title	Plate Length [m]	Plate Width [m]	Plate Thickness [mm]	Stress x in Plate Direction [Pa]	Stress y in Plate Direction [Pa]	Stress xy in Plate Direction [Pa]	Equivalent Stress [Pa]	Ultimate Strength [Pa]	Buckling State Limit	Load		
8..Section Y 8 (Y = -8.95)		9.05	3.36	0.01	-35.43e+5	-1.84e+5	1.77e+5	34.68e+5	0.69	21.38	LS4		
13..Section Y 13 (Y = 11.65)		2.20	1.68	0.01	-27.71e+5	-2.49e+5	7.94e+5	26.58e+5	0.42	13.02	LS3		
16..Section Z 16 (Z = 2.2)		7.16	3.36	0.02	-25.81e+5	-2.19e+5	4.34e+5	24.91e+5	0.22	3.66	LS4		
15..Section Z 15 (Z = 0)		3.36	0.89	0.01	-9.74e+5	-49.70e+5	-0.94e+5	42.67e+5	0.54	1.00	LS4		
2..Section X 2 (X = 71.68)		3.00	2.60	0.02	-0.76e+5	-18.97e+5	-7.14e+5	22.64e+5	0.10	0.98	LS4		
4..Section X 4 (X = 75.04)		3.00	2.60	0.02	-0.77e+5	-18.60e+5	-7.08e+5	22.27e+5	0.09	0.94	LS4		
3..Section X 3 (X = 73.36)		3.00	1.73	0.02	-4.77e+5	-20.86e+5	-24.84e+5	47.23e+5	0.17	0.78	LS4		
14..Section Y 14 (Y = 14.15)		3.36	0.92	0.01	-5.69e+5	-33.05e+5	-7.71e+5	31.32e+5	0.30	0.73	LS4		
5..Section X 5 (X = 76.72)		3.00	1.73	0.02	-4.50e+5	-17.64e+5	-21.42e+5	40.64e+5	0.12	0.57	LS4		
1..Section X 1 (X = 70)		3.00	1.73	0.02	-4.42e+5	-17.43e+5	-21.13e+5	40.11e+5	0.12	0.55	LS4		
19..Section Z 19 (Z = 13.3)		3.36	2.50	0.01	-2.08e+5	-0.18e+5	11.91e+5	20.63e+5	0.04	0.42	LS1		
11..Section Y 11 (Y = 5.37)		2.20	0.84	0.01	-17.84e+5	-0.36e+5	7.76e+5	22.24e+5	0.06	0.36	LS4		
21..Section Custom 21 (136 Elements)		3.36	2.77	0.02	-0.52e+5	-11.94e+5	1.34e+5	11.62e+5	0.03	0.19	LS4		
22..Section Custom 22 (64 Elements)		2.72	1.68	0.01	-11.21e+5	-3.77e+5	3.44e+5	11.54e+5	0.02	0.10	LS1		
17..Section Z 17 (Z = 9.05)		2.50	1.68	0.01	-1.54e+5	-2.95e+5	-3.13e+5	6.00e+5	0.01	0.07	LS1		
18..Section Z 18 (Z = 11.8)		4.87	3.36	0.01	-0.10e+5	0.00e+5	2.79e+5	4.83e+5	0.00	0.06	LS1		
12..Section Y 12 (Y = 8.95)		2.20	1.68	0.01	-0.95e+5	-1.14e+5	15.88e+5	27.51e+5	0.03	0.05	LS3		

Buckling State Limit (LS1, Component '3..Section X 2 (X = 71.68)', v2)

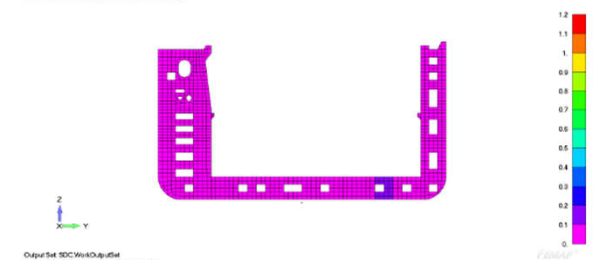
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Check	[S1] 1..Plate Buckling ABS 2014 (Plate Avg, Element Avg)	Load Set	LS1..Load Set 1
Parameter	Buckling State Limit	Selection	Component '3..Section X 2 (X = 71.68)'
View	2..Frames		

Buckling State Limit (LS1, Component '4..Section X 3 (X = 73.36)', v2)

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Check	[S1] 1..Plate Buckling ABS 2014 (Plate Avg, Element Avg)	Load Set	LS1..Load Set 1
Parameter	Buckling State Limit	Selection	Component '4..Section X 3 (X = 73.36)'
View	2..Frames		