SDC VERIFIER

Tutorial
Plate Buckling ABS 2014

ANSYS®

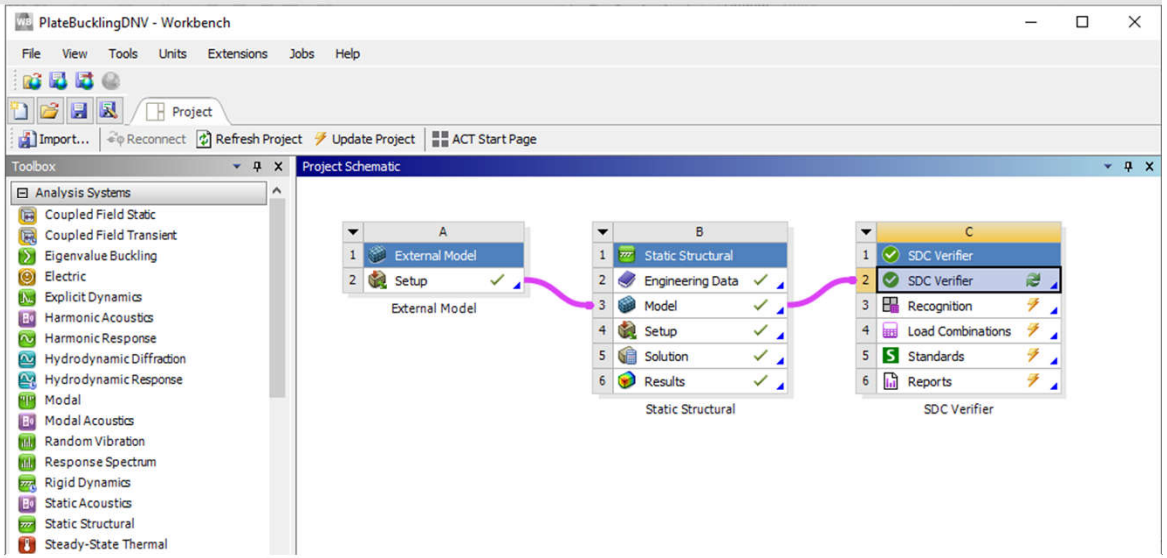
7 Dec 2020
version 2020.0.2

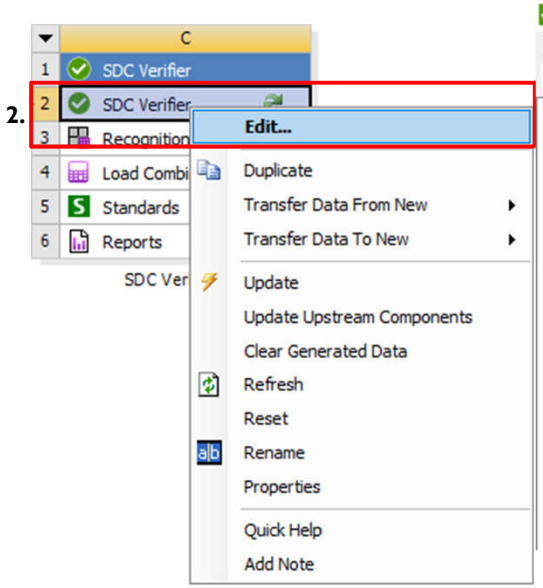
Content

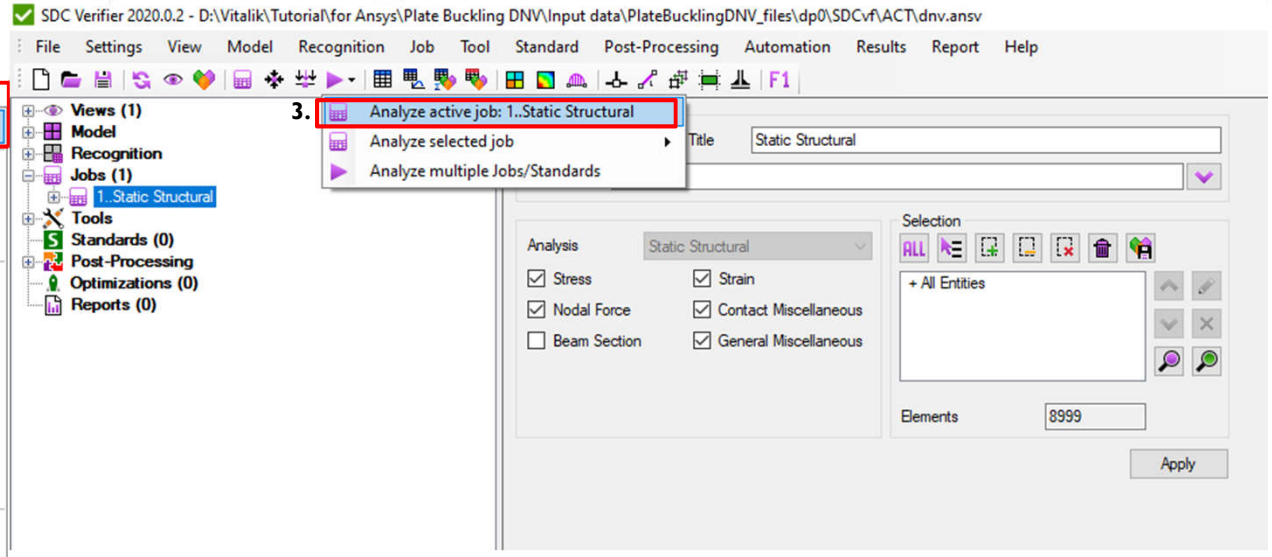
- In this tutorial an ABS 2014 Plate Buckling Check is reviewed in details.
- A part of a plate model of the ship has been used as a start FEM model.
- Load Sets and Load Group (Envelope) are created.
- Recognition of plates using Panel Finder.
- Plate Buckling tables and plots.
- Reporting: preparing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

Launch SDC Verifier

1. Open in **Ansys Workbench** **PlateBucklingDNV.wbpj**
2. Double Click on 2 SDC Verifier or execute *Edit* from context menu
3. Press ▶ on toolbar and "*Analyze active job: 1.. Static Structural*"

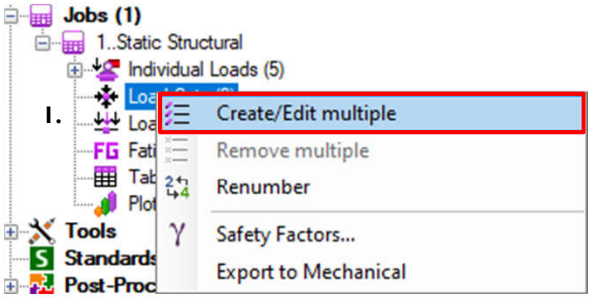


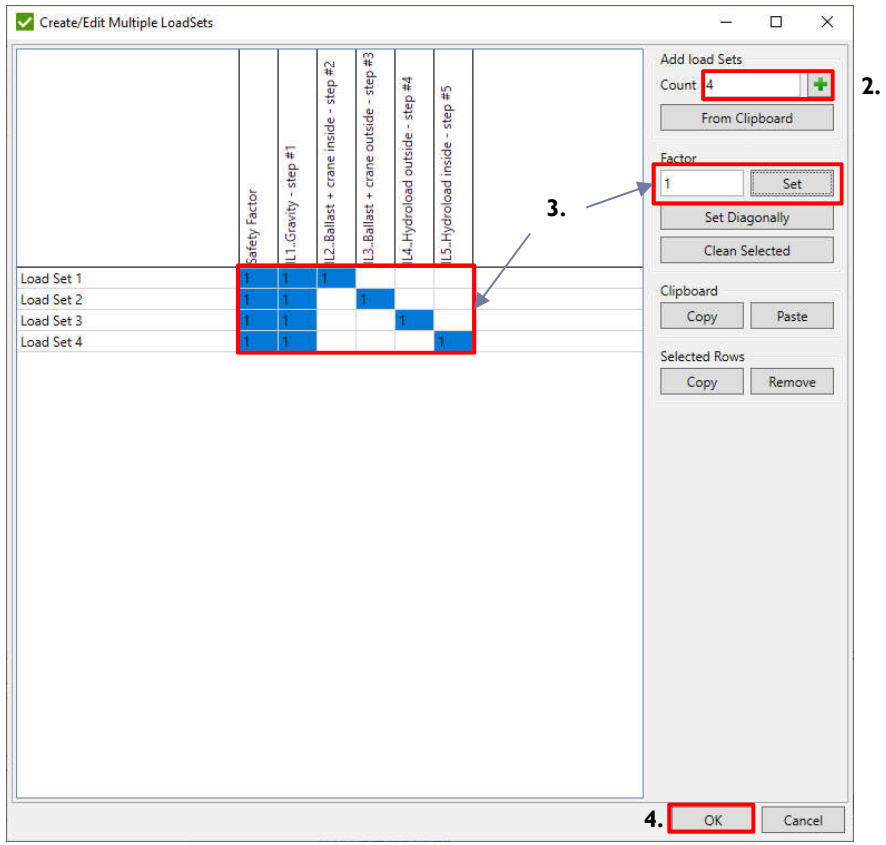




Load Sets

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 the table like shown on the picture and press *Set* to define Factors of Load Sets.(By default LS Factor is **1**)
4. Press *OK*

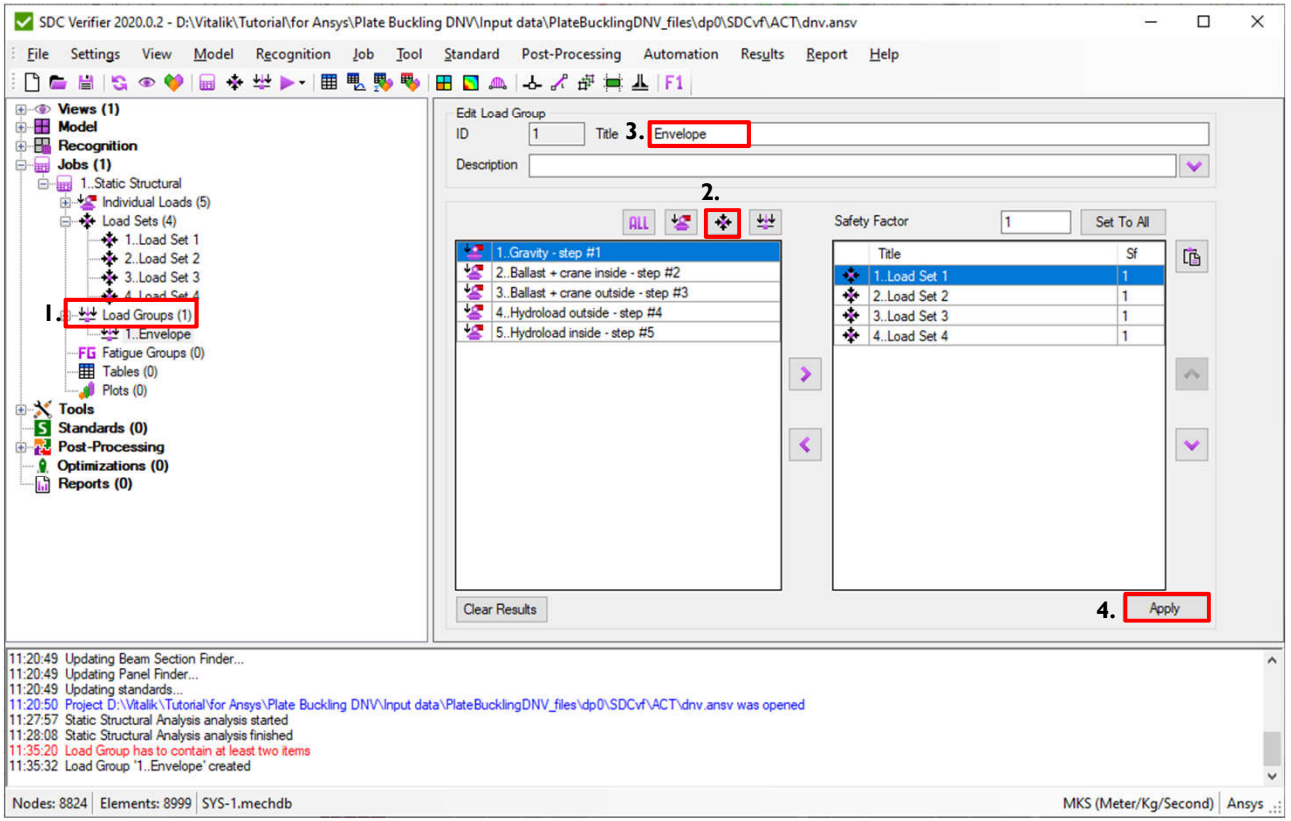




Load Sets are created with default titles "Load Set #". It is possible to rename them by double-click on the respective load set title. Alternatively, the titles and factors can be pasted from the Clipboard using *Paste* button.

Load Groups

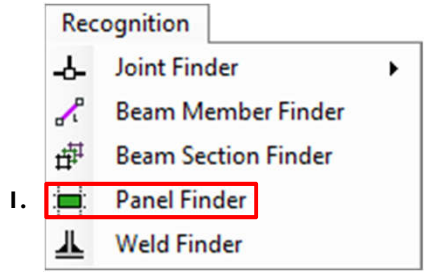
1. Click on *Load Groups.*
2. Press  to select all Load Sets.
3. *Title*: **Envelope**
4. Press *Create*

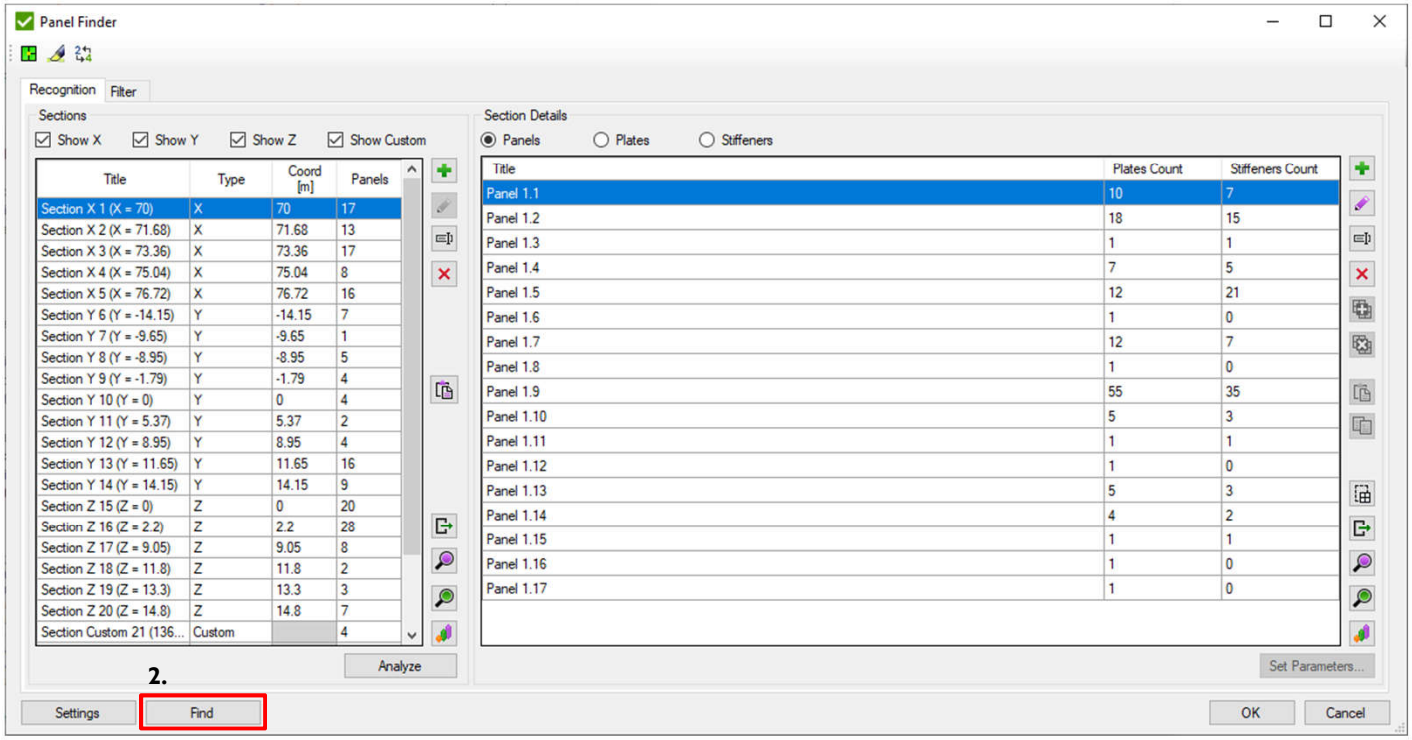


Load Sets and Load Groups are analyzed by SDC Verifier.

Panel Finder. Recognize Sections.

1. Execute *Recognition - Panel Finder* from main menu
2. Click on *Find*

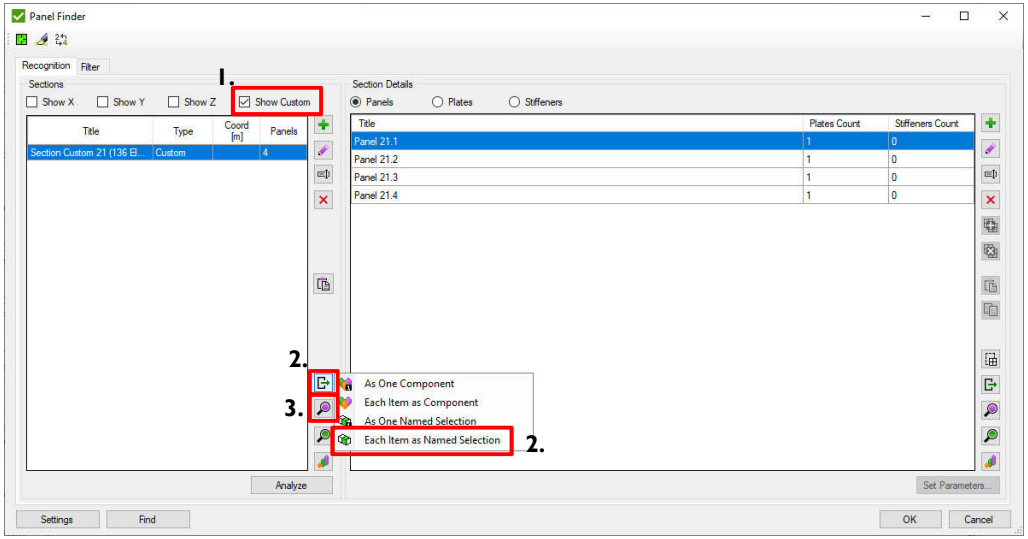


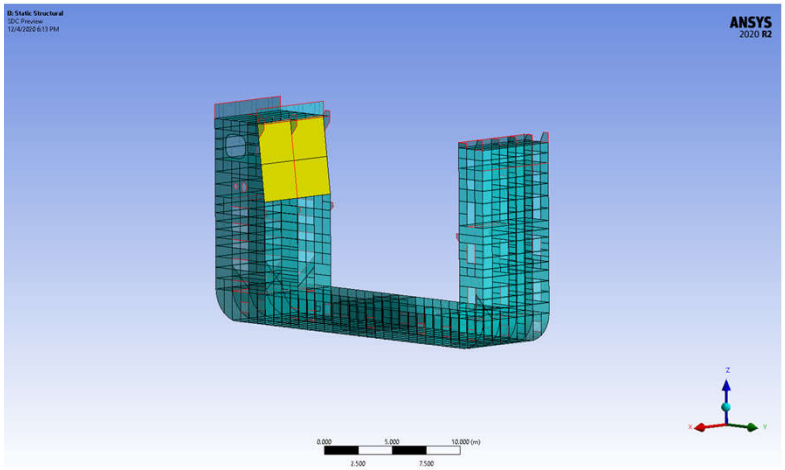


Panel Finder. Custom Section

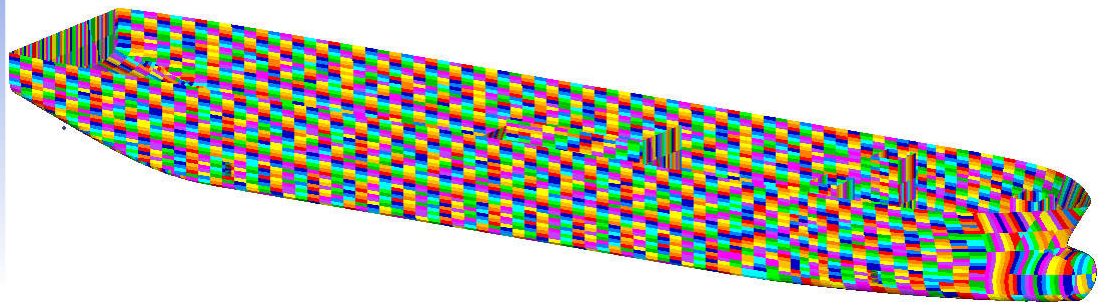
1. Show Custom: **ON** (rest OFF)
2. Press  and  to export selected sections to named sel.
3. Press 

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





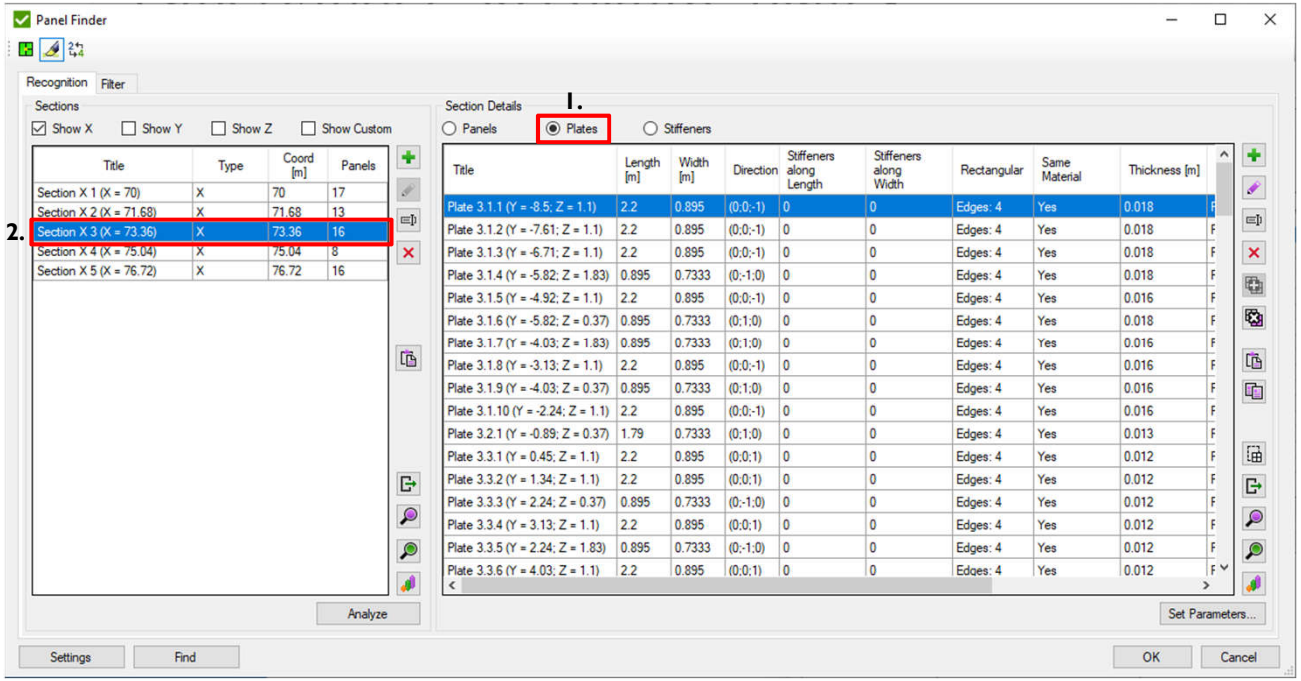
Example: It is possible to create custom section based on hull selection:



Panel Finder. 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

Title	Length	Width	Direction	Rectangular	Yield Stress	Thickness
Plate 9 (Y = 12.07; Z = 11.34)	0.9167	0.8333	(0;0;1)	Yes	2.4E+08	0.012
Plate 10 (Y = 12.9; Z = 2.39)	2.5	1.5333	(0;1;0)	Edges: 8	2.4E+08	Min = 0.016

Plate ID

Plate is rectangle with all corners = 90 degrees

Plate has elements more than from one property

Dimensions: the 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:

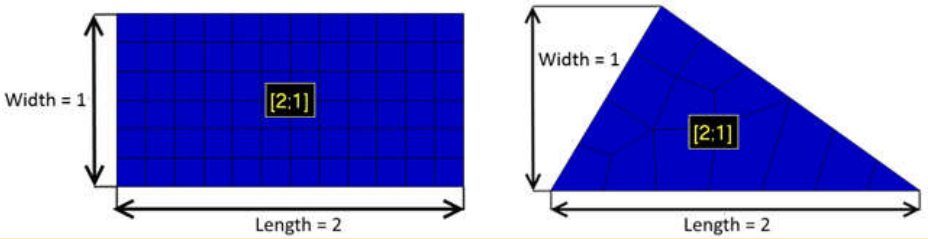


Plate Thickness: the calculations are performed on every element and thickness is taken directly from each element. It is possible to set thickness manually for a plate, in this case, the element thickness will be ignored and the user defined thickness will be used.
Example: Plate with 2 properties 0.01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

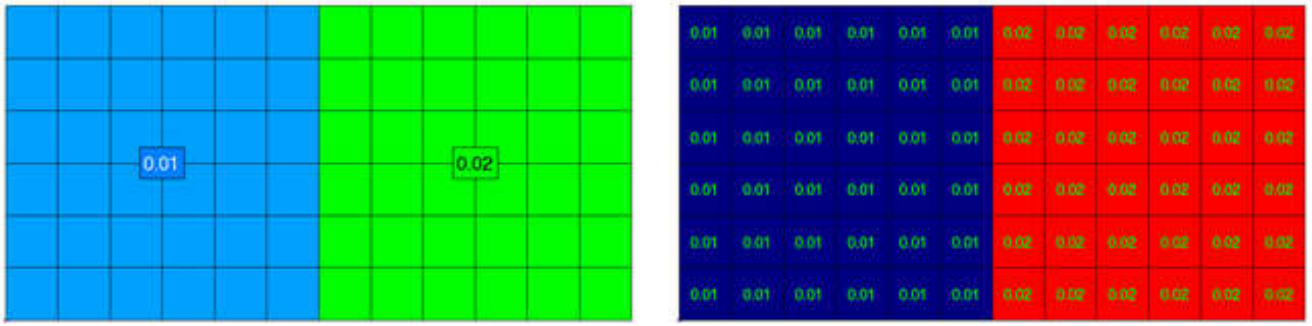
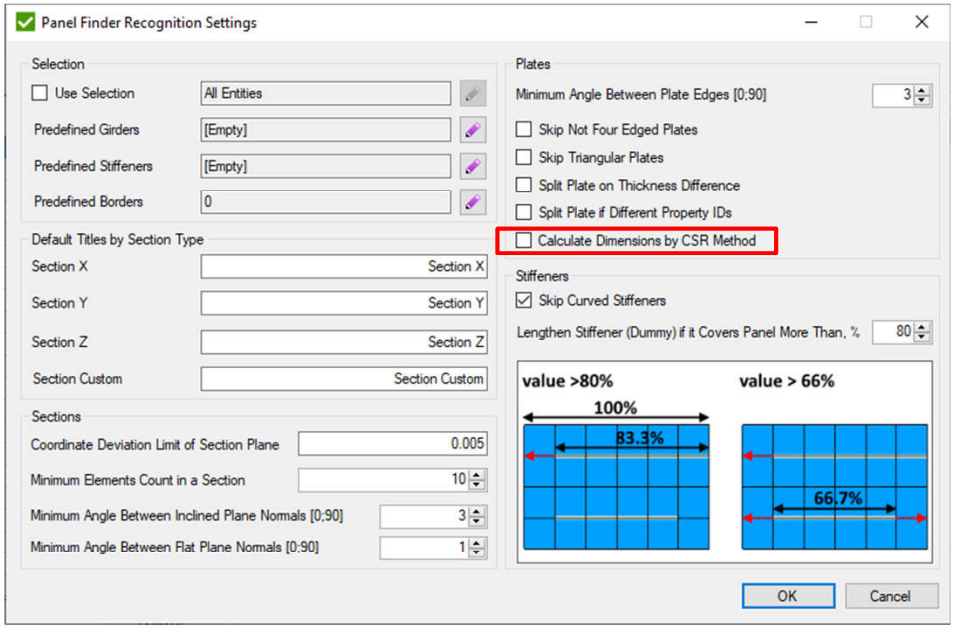


Plate Buckling Dimensions by CSR



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:

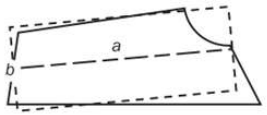
e) The length of shorter side, b in mm, is to be taken as:

$b = A/a$

where:

A : Area of the plate, in mm^2

a : length defined in (d), in mm

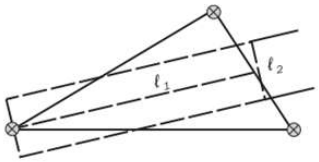


c) The width of the model, ℓ_2, in mm, is to be taken as:

$\ell_2 = A/\ell_1$

where:

A : Area of the plate, in mm^2



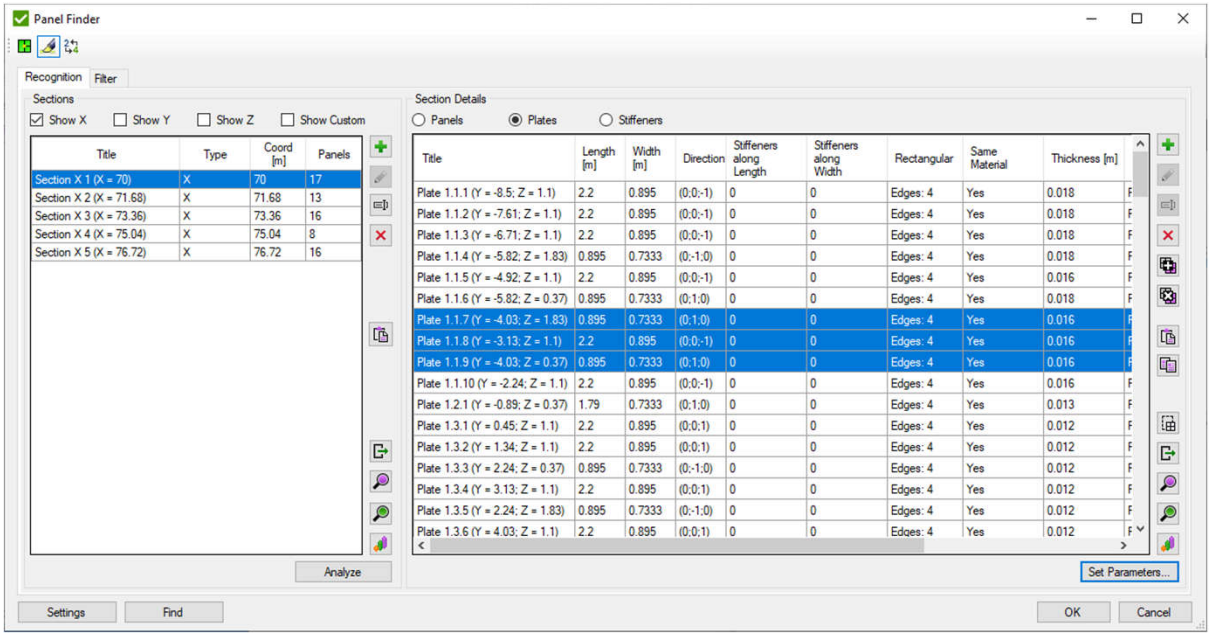
Editing plates manually

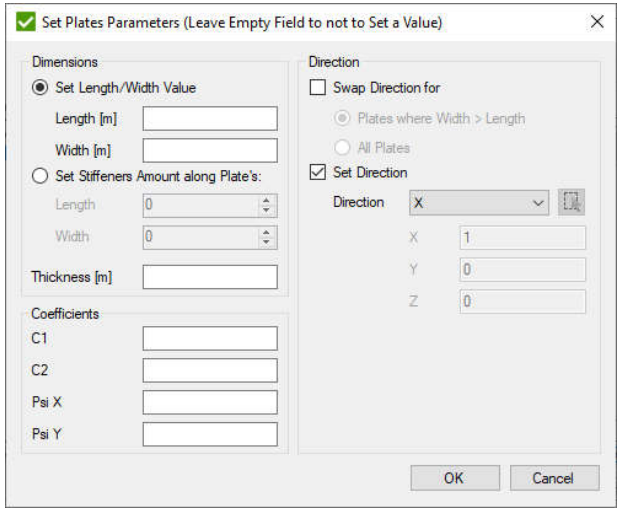
To modify plates select them from the list and press *Set Parameters*. It is possible to edit (Length / Width / Thickness / Coefficients / Direction).

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)

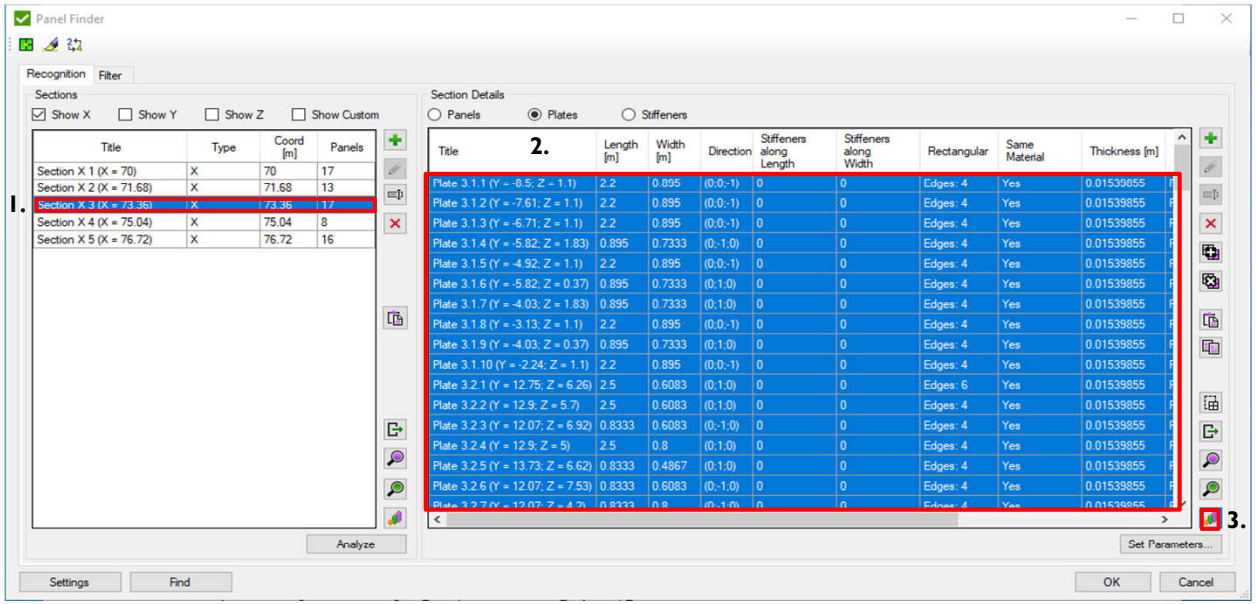


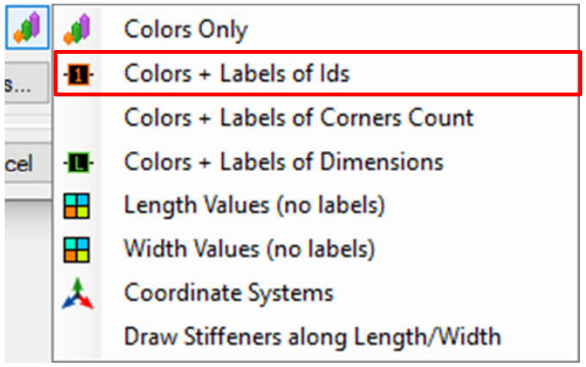


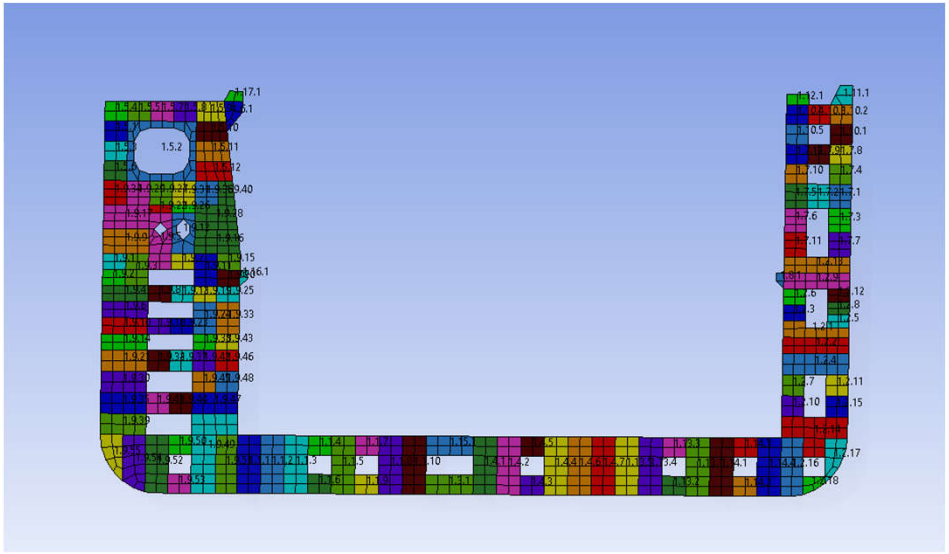
Usually you should not modify plate directions. But in case it is required press *Set Direction.*

Panel Finder. Plates Plot

1. Select **Section X1**
2. Select All *Plates (Ctrl+A)*
3. Press 
4. Click on  Colors + Labels of Ids

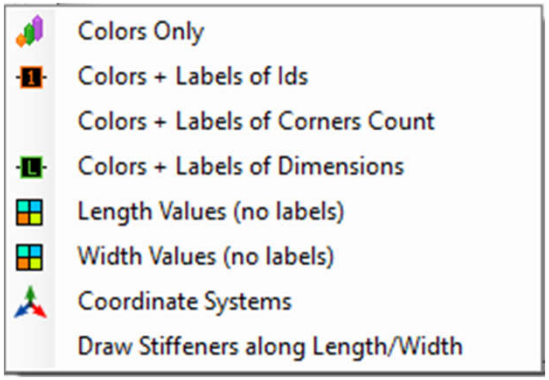




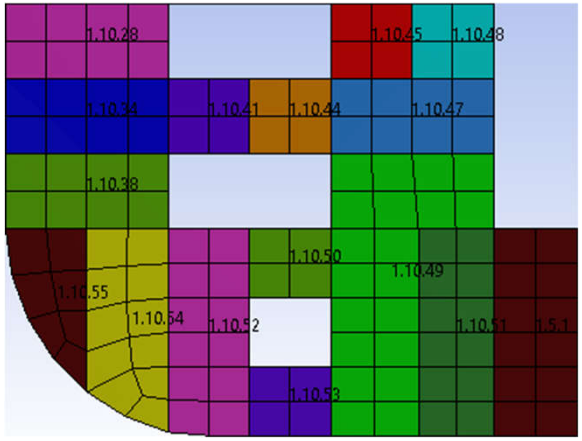


Panel Finder. Plot Options

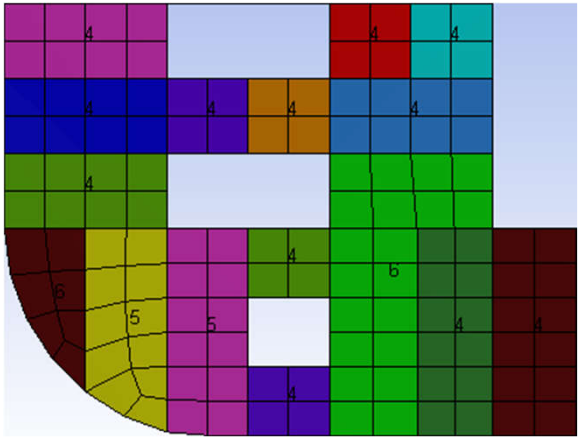
Note: Plate Plot can be displayed with different colors labels (labels of ids, labels of corners count or labels of dimensions). Also it is possible to show plates in length and width, coordinate systems etc.



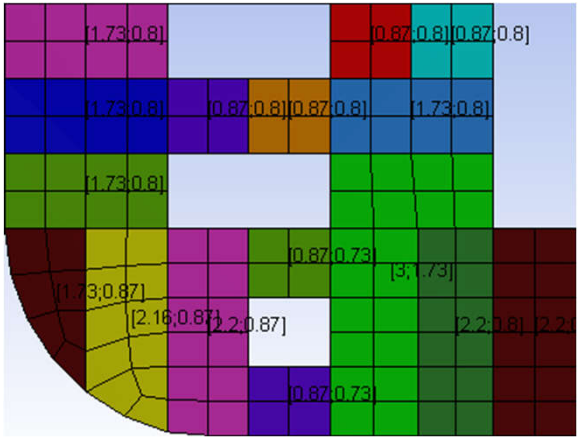
Labels of Ids



Labels of Corners Count

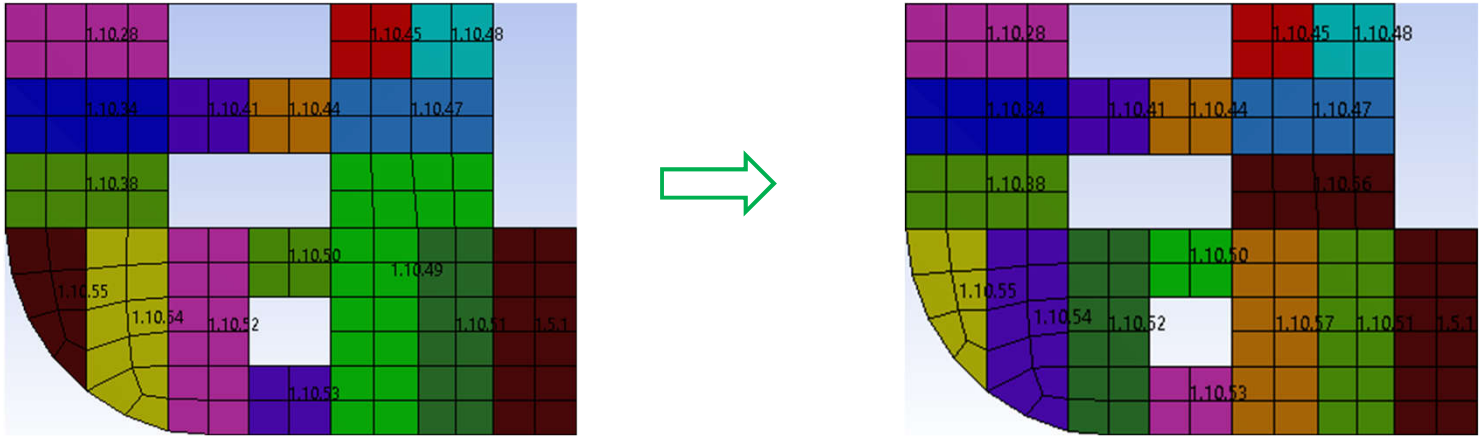


Labels of dimensions



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 X1 plate with Id = 1.10.49 should be split on 2 plates

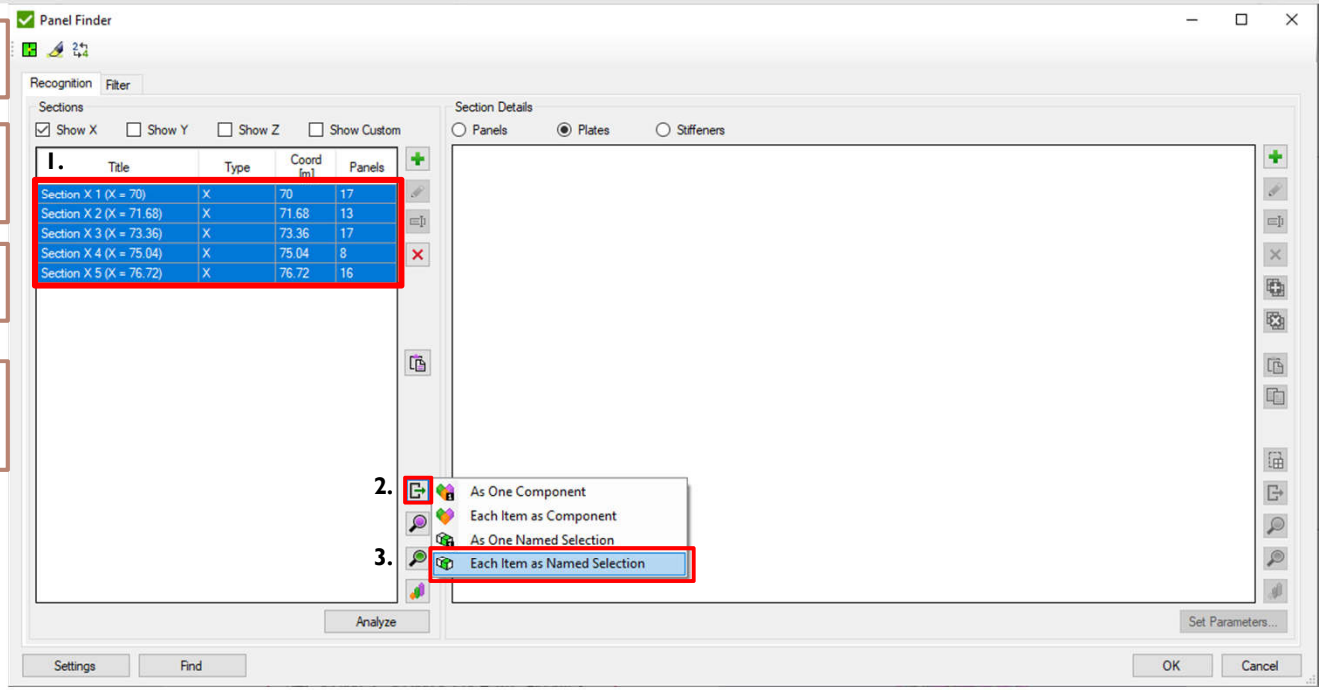


If plates were modified manually and later user decided to run recognition of plates, Panel Finder will ask what to do with the modified plates:

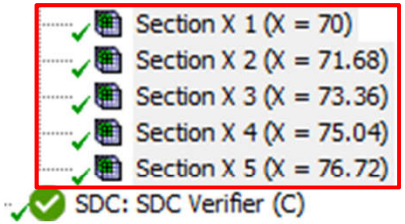
- Keep plates that was modified;
- Clear everything and recognize from scratch;

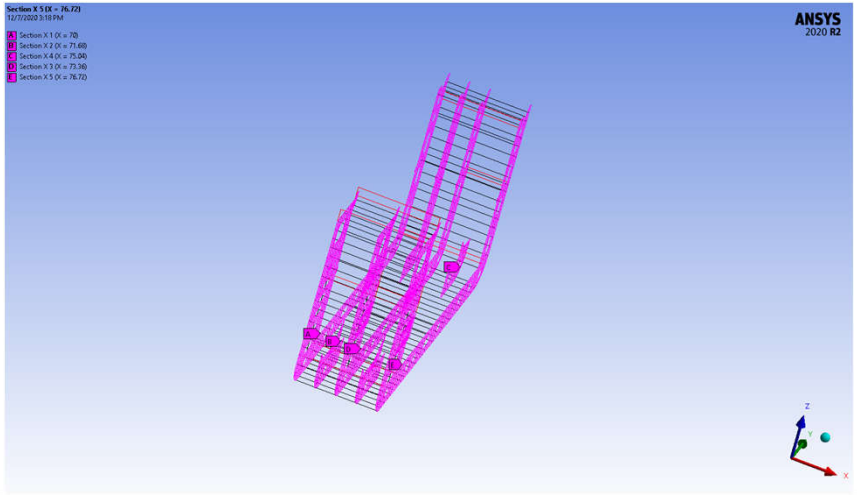
Panel Finder. Export Plates

1. Select *All X sections.*
2. Press => Each Item as named Selection
3. Pick *Export by section*.
4. 5 Named Selection will be created for 5 Sections .



4.

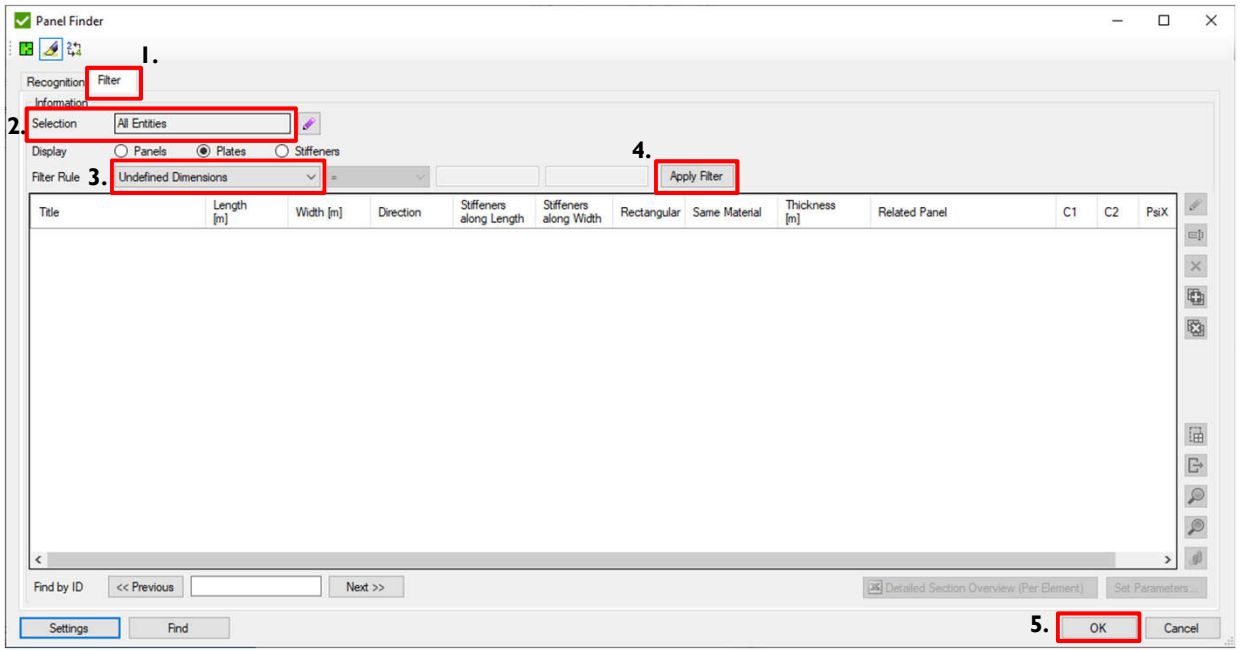




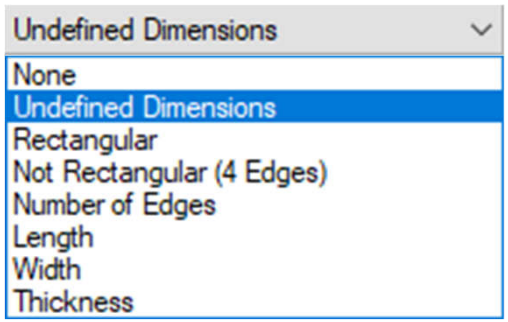
Panel Finder. Filter

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*

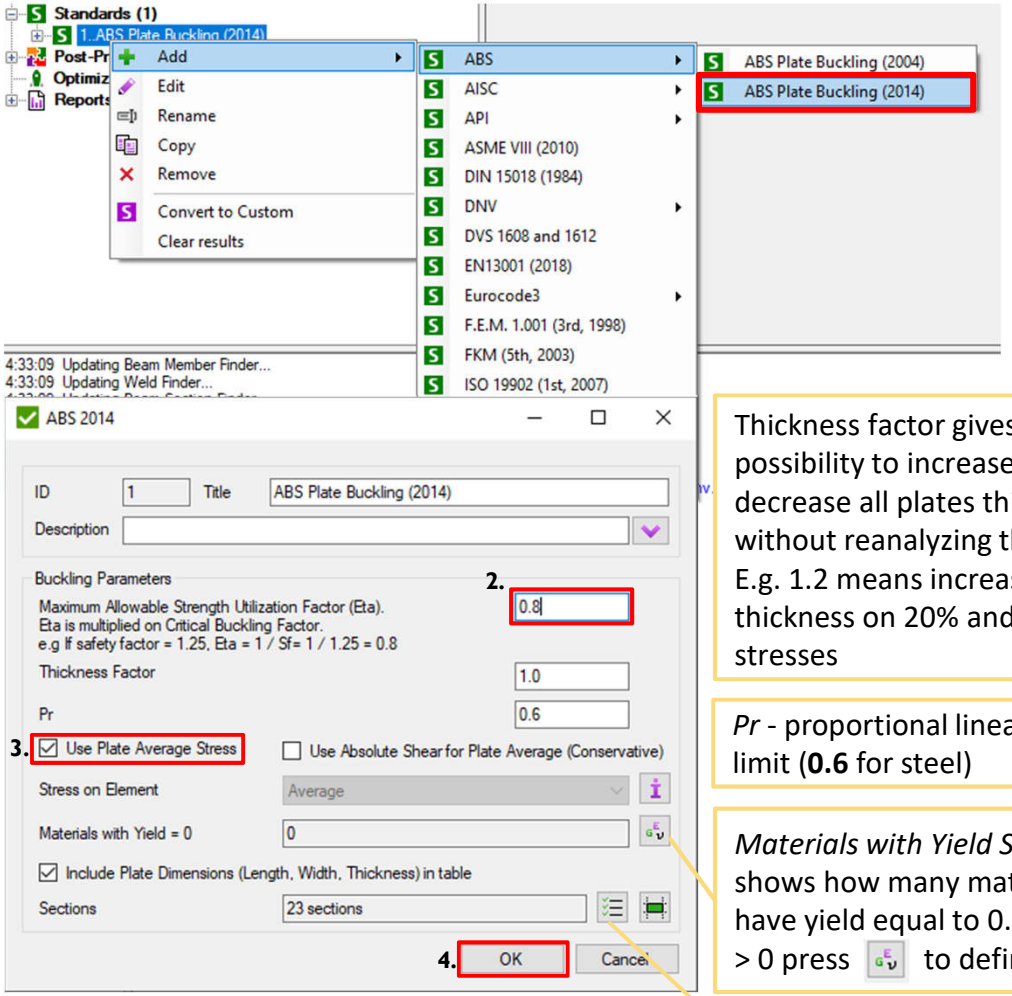


Tip: It is also possible to filter plates by shape (triangle, rectangular) or number of edges parameters.
E.g. Plates with numbers of edges > 4 can be displayed.
Control using Selection plates from which Sections should be filtered.



Add Plate Buckling ABS 2014

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*



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

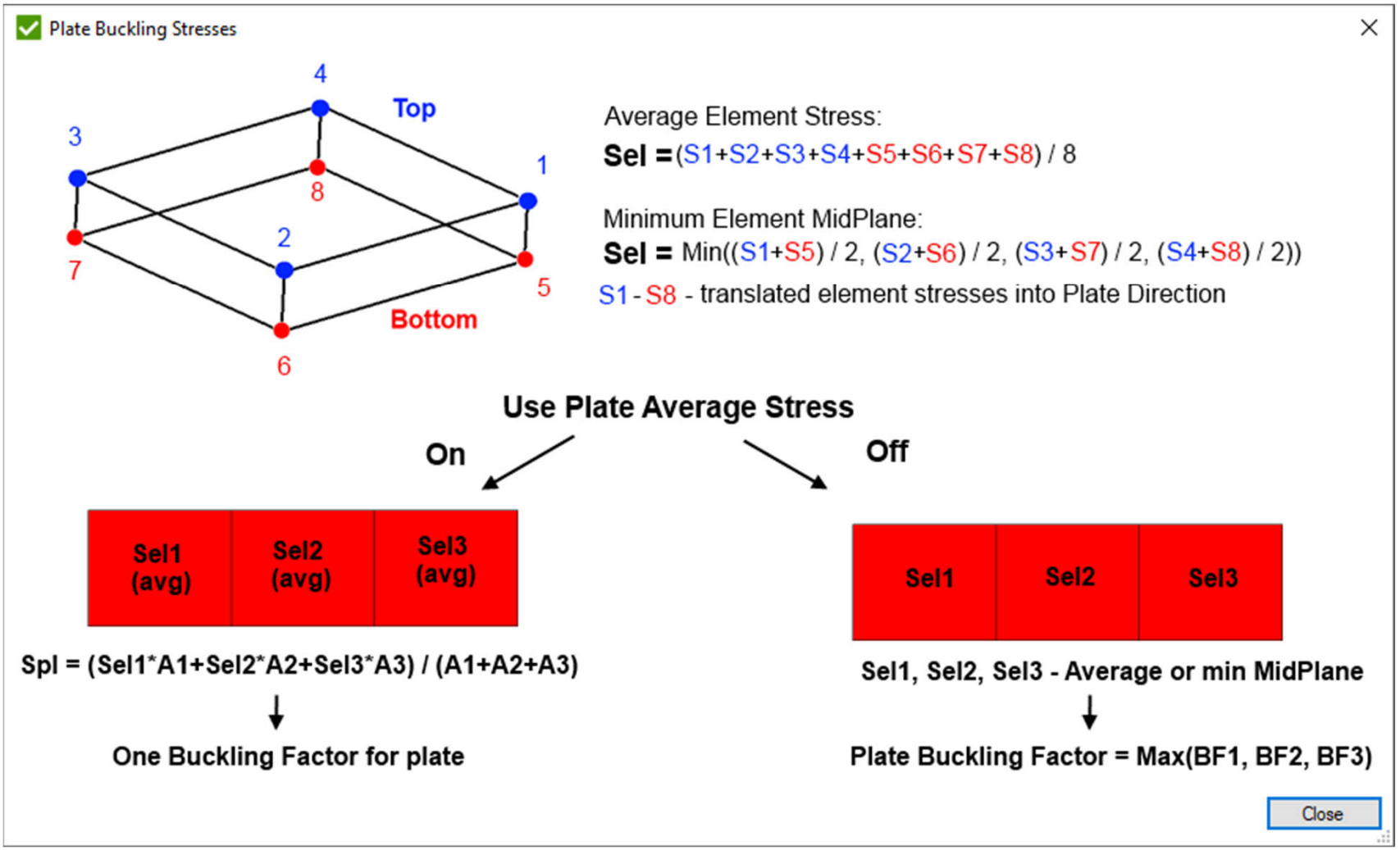
Pr - proportional linear elastic limit (**0.6** for steel)

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

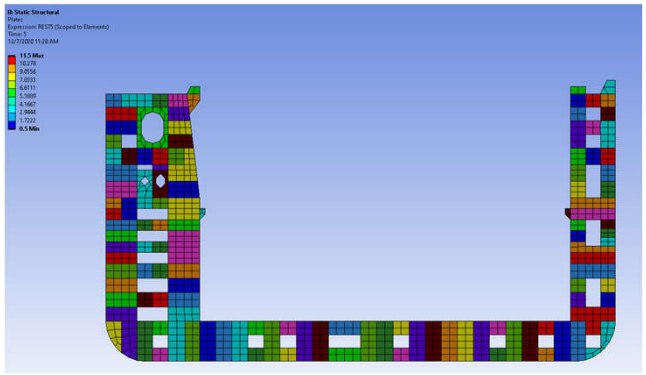
Plate Buckling Stresses



Views

1. Execute Views => **Add**
2. Title: **Frame**
3. Orient model in Ansys as shown on picture below (ZY plane)
4. Press ***Get***
5. Press *OK*

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



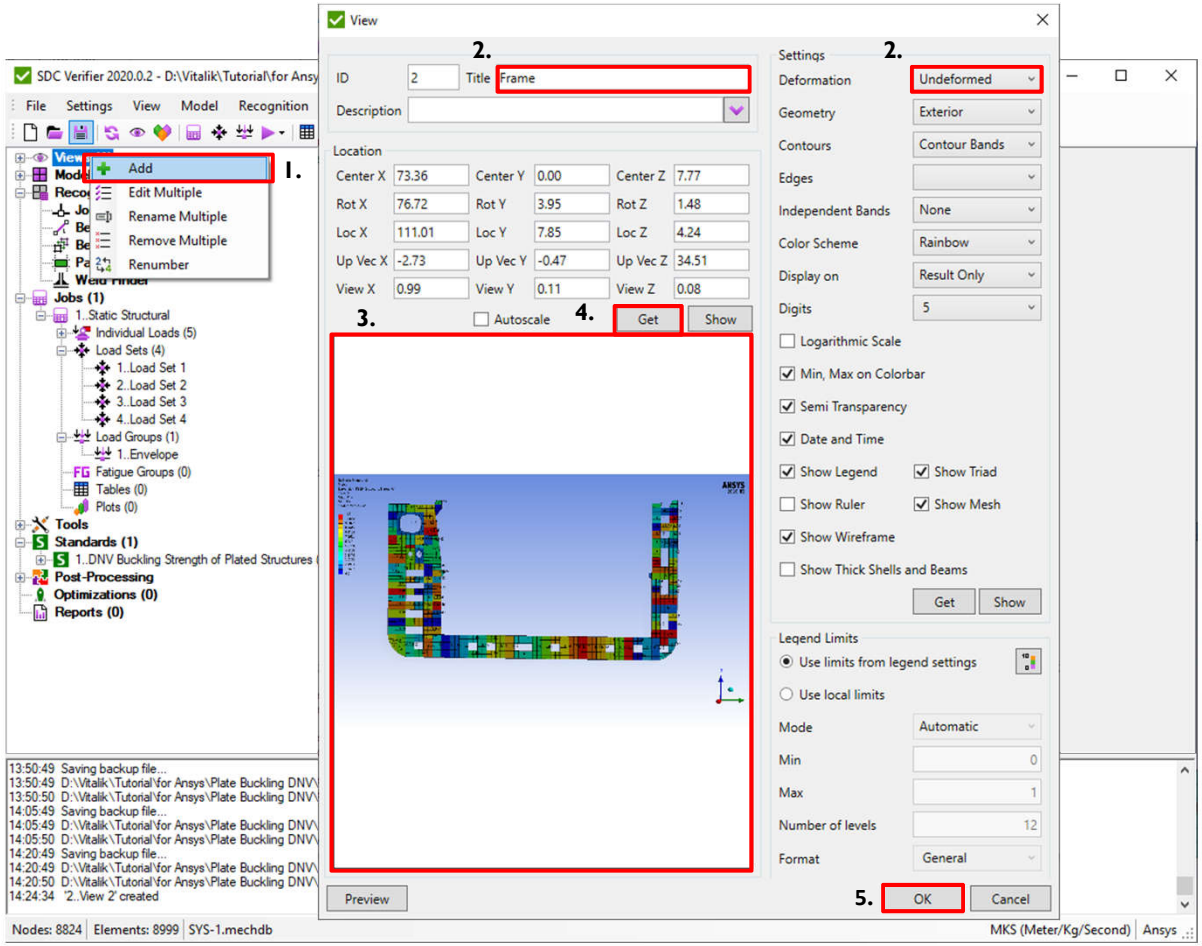
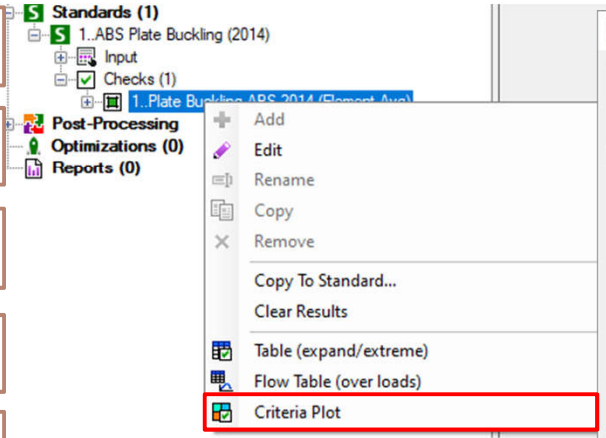
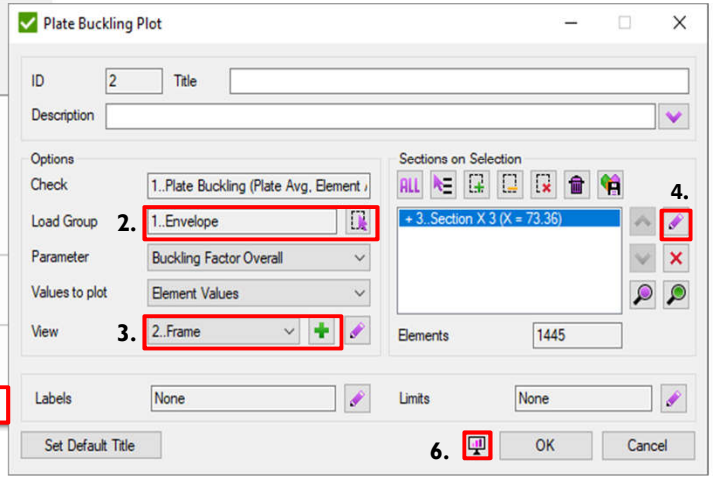
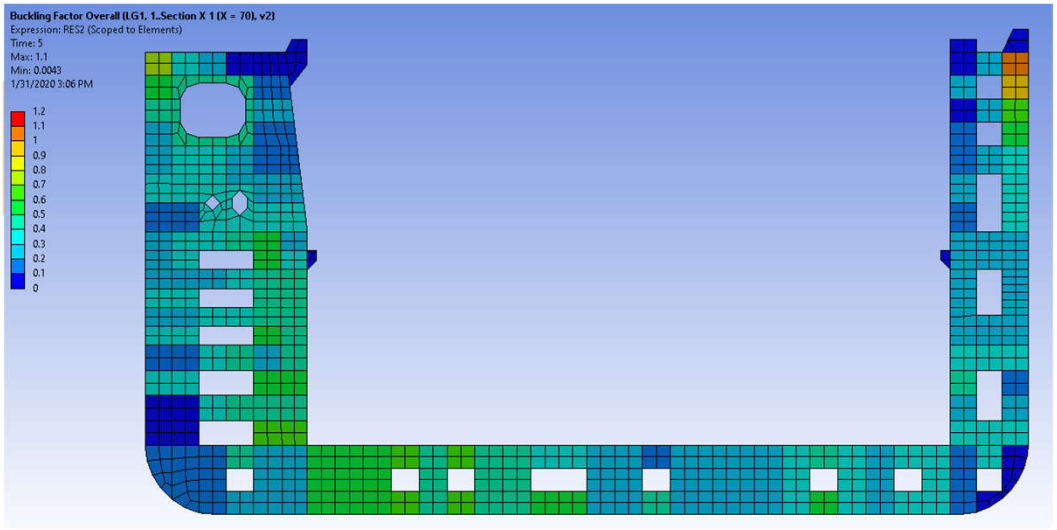


Plate Buckling Plot

1. Execute *Criteria Plot* from Plate Buckling DNV 2010 context menu
2. Load Group: **1..Envelope**
3. View: **2..Frame**
4. Press  and Select:**3..Section X3**
5. Press *OK*
6. Press *Preview*







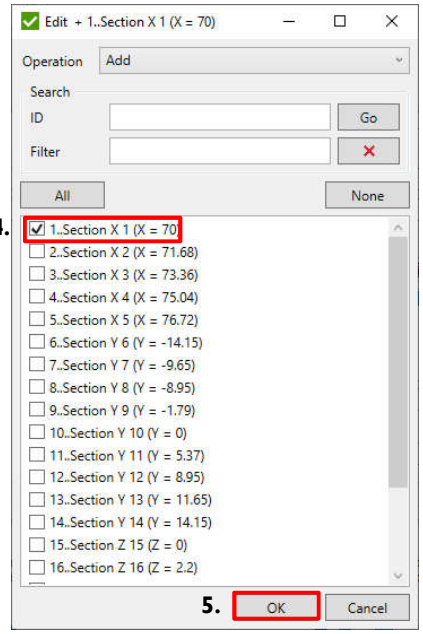
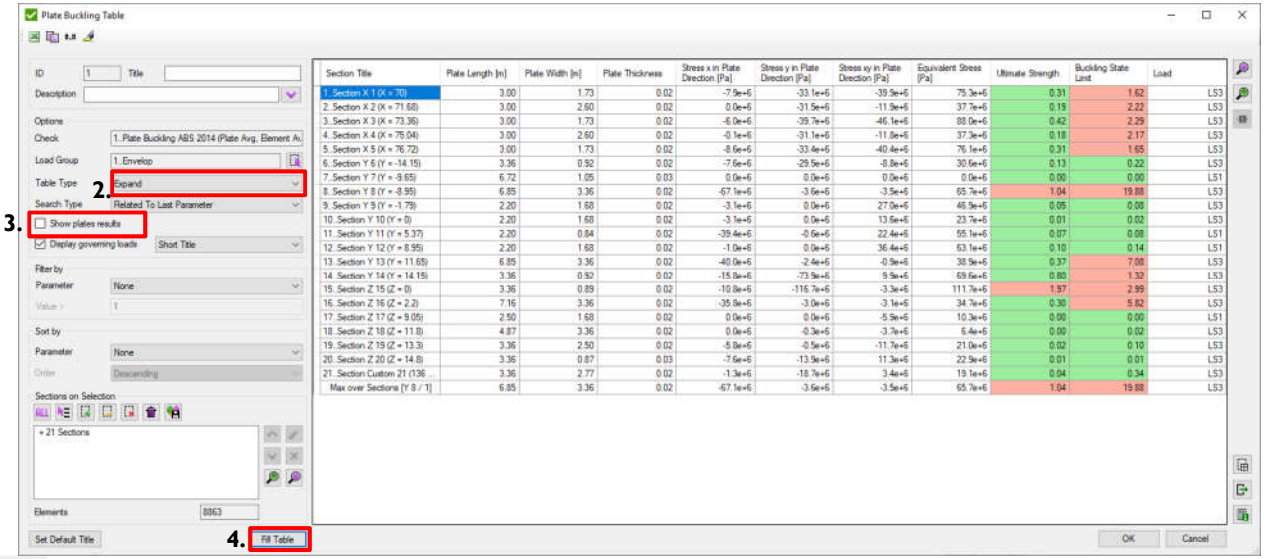
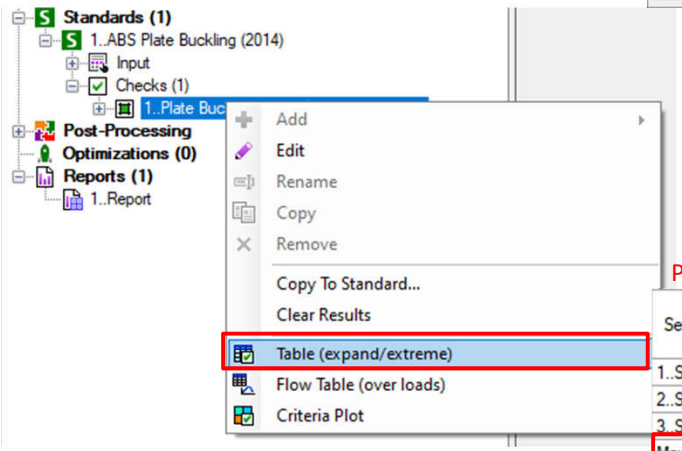


Plate Buckling Table

1. Execute *Table(expand/extreme)* from Plate Buckling DVN 2010 context menu
2. Load Group: **1..Envelop**
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.

Plate with ID = 70 has the highest result in Section X 1

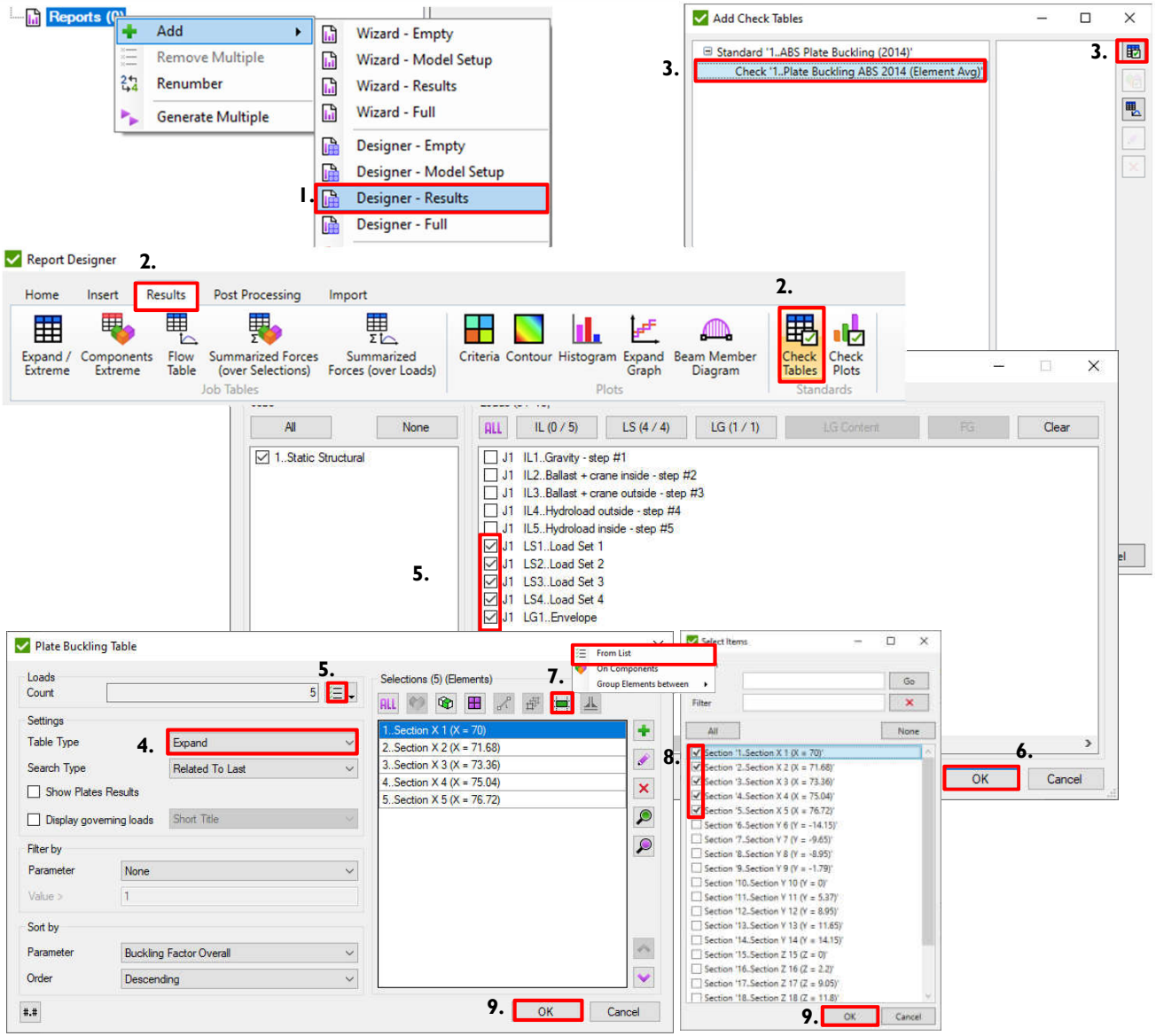
Section Title	Plate Length	Plate Width	Plate Thickness	Sx in plate direction	Sy in plate direction	Sxy in plate direction	Seqv	Buckling Factor Combined	Buckling Factor Overall
1..Section X 1 (X = 70000) [MaxID=70]	833.33	750.00	12.00	-0.02e+6	-0.06e+6	-0.05e+6	0.09e+6	0.22	0.47
2..Section X 2 (X = 71680) [MaxID=46]	3000.00	2600.00	16.00	0.00e+6	-0.02e+6	-0.01e+6	0.02e+6	0.12	0.35
3..Section X 3 (X = 73360) [MaxID=92]	895.00	733.33	14.00	-0.04e+6	-0.01e+6	-0.05e+6	0.10e+6	0.22	0.47
Max over Sections [3 / 92]	895.00	733.33	14.00	-0.04e+6	-0.01e+6	-0.05e+6	0.10e+6	0.22	0.47

Section ID = 3 / Plate ID = 92
worst result among sections

All results (dimensions, stresses) are from the plate which causes higher BF = 0.47 because Search Type = Related to Last Parameter

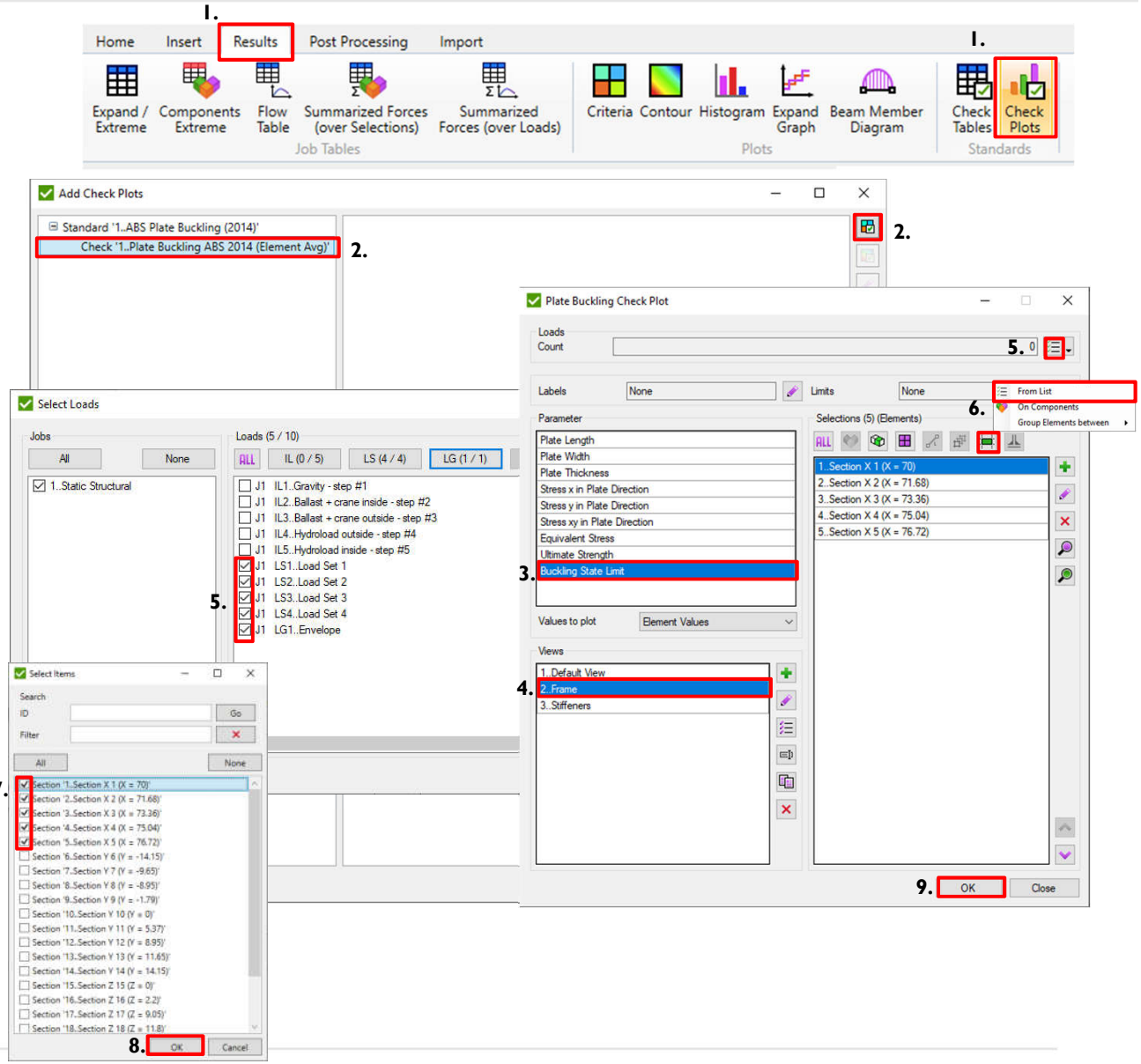
Report. Tables

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*



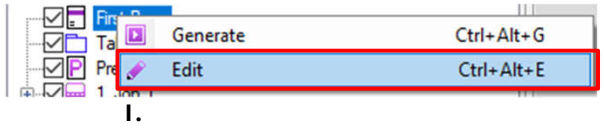
Report. Plots

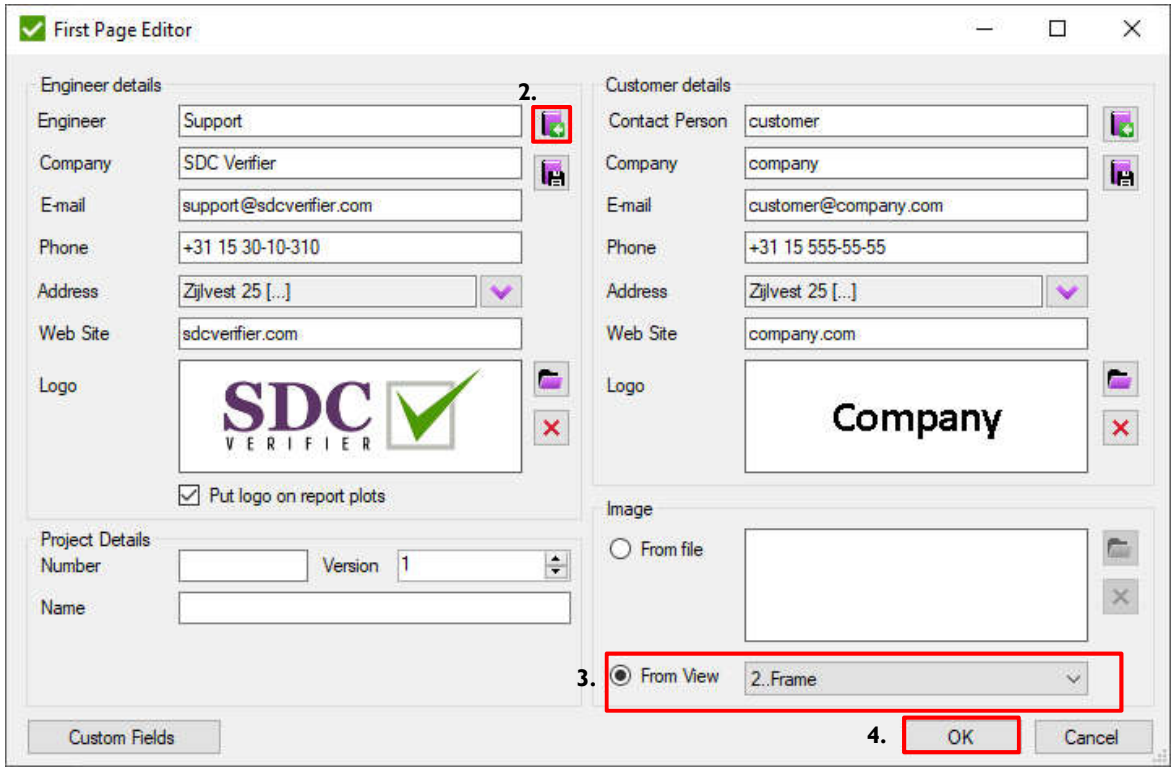
1. Results => *Check Plots*
2. *Press => Check '1..Plate Buckling' =>*
3. Parameter: **Buckling Factor Overall.**
4. Views: **Frame**.
5. Press , select **LS**; **LG** Loads and Press *OK*.
6. Press and Execute From List
7. Select all **X sections**.
8. Press *OK*.
9. Press *OK*.



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*.





Report

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

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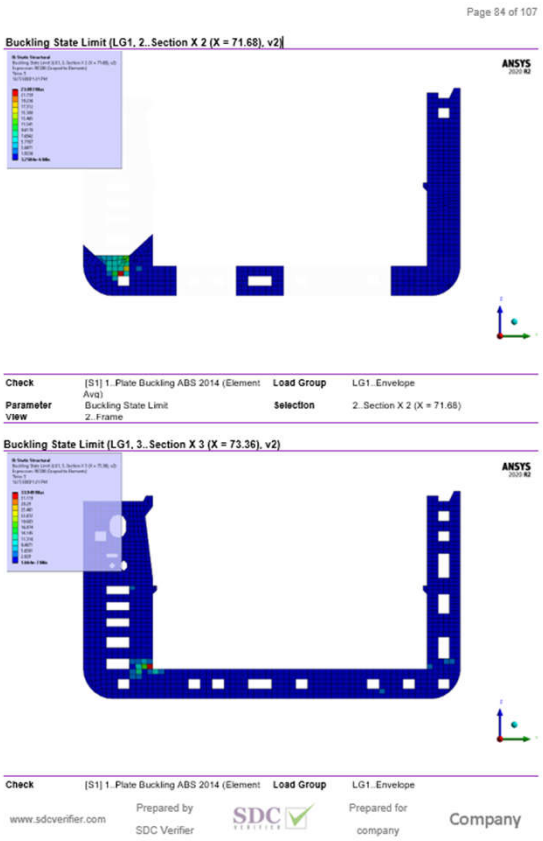
Engineer:	Support
Customer:	customer
Project Number:	
Version:	1
Date:	03/02/2020

1..ABS Plate Buckling (2014)

1..Table (LG1, 25 Sections)

Standard	1..ABS Plate Buckling (2014)	**Check**	[S1] 1..Plate Buckling ABS 2014 (Element Avg)
Load Group	LG1..Envelope	**Selection**	25 Sections
Search Type	Related To Last		

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	Load
16..Section Z 16 (Z = 2.2)	7.16	3.36	0.02	-148.2e+6	-22.6e+6	-13.9e+6	140.3e+6	5.07	108.76	LS3
8..Section Y 8 (Y = -8.95)	9.05	3.36	0.02	-141.0e+6	-18.8e+6	-8.1e+6	133.3e+6	4.55	98.41	LS3
3..Section X 3 (X = 73.36)	3.00	1.73	0.02	-157.1e+6	-138.0e+6	-127.8e+6	266.6e+6	5.70	33.95	LS3
5..Section X 5 (X = 76.72)	3.00	1.73	0.02	-177.1e+6	-124.8e+6	-116.8e+6	256.4e+6	5.44	31.23	LS3
13..Section Y 13 (Y = 11.65)	6.85	3.36	0.02	-76.5e+6	-13.5e+6	6.9e+6	71.7e+6	1.37	29.85	LS3
2..Section X 2 (X = 71.68)	3.00	2.60	0.02	-24.0e+6	-100.0e+6	-29.4e+6	103.8e+6	1.81	23.08	LS3
4..Section X 4 (X = 75.04)	3.00	2.60	0.02	-23.9e+6	-99.2e+6	-29.4e+6	103.1e+6	1.79	22.71	LS3
1..Section X 1 (X = 70)	2.60	2.25	0.02	-46.6e+6	-68.9e+6	25.3e+6	75.0e+6	0.90	7.88	LS3
15..Section Z 15 (Z = 0)	3.36	0.89	0.02	-10.6e+6	-122.9e+6	-4.4e+6	118.2e+6	2.07	3.32	LS3
14..Section Y 14 (Y = 14.15)	3.36	0.76	0.03	-96.5e+6	-237.1e+6	123.0e+6	296.6e+6	2.36	2.63	LS3
6..Section Y 6 (Y = -14.15)	3.36	0.75	0.03	-35.7e+6	-226.1e+6	-59.4e+6	234.4e+6	1.52	1.55	LS3
19..Section Z 19 (Z = 13.3)	3.36	2.50	0.02	-5.8e+6	-15.7e+6	-11.3e+6	23.9e+6	0.07	0.83	LS3
18..Section Z 18 (Z = 11.8)	4.87	3.36	0.02	-3.5e+6	-7.9e+6	1.1e+6	7.1e+6	0.02	0.81	LS3
20..Section Z 20 (Z = 14.8)	3.36	0.87	0.03	-47.5e+6	-130.3e+6	60.1e+6	154.6e+6	0.72	0.76	LS3
21..Section Custom 21 (136 Elements)	3.36	2.77	0.02	0.0e+6	-23.4e+6	0.4e+6	23.4e+6	0.06	0.53	LS3
12..Section Y 12 (Y = 8.95)	2.20	1.68	0.02	0.0e+6	0.0e+6	42.7e+6	73.9e+6	0.13	0.18	LS1
11..Section Y 11 (Y = 5.37)	2.20	0.84	0.02	-66.5e+6	-1.1e+6	21.9e+6	76.0e+6	0.13	0.15	LS1
9..Section Y 9 (Y = -1.79)	2.20	1.68	0.02	-10.4e+6	-2.7e+6	31.4e+6	55.2e+6	0.08	0.13	LS3
10..Section Y 10 (Y = 0)	2.20	1.68	0.02	-7.9e+6	-7.9e+6	14.4e+6	26.1e+6	0.02	0.07	LS3
17..Section Z 17 (Z = 9.05)	3.36	2.60	0.02	0.0e+6	0.0e+6	-8.2e+6	14.2e+6	0.01	0.03	LS3
24..Section Custom 24 (16 Elements)	1.68	0.43	0.02	-0.4e+6	0.0e+6	-11.9e+6	20.6e+6	0.01	0.01	LS3
22..Section Custom 22 (16 Elements)	1.68	0.42	0.02	0.0e+6	-8.3e+6	9.0e+6	17.6e+6	0.01	0.01	LS3
25..Section Custom 25 (16	1.68	0.49	0.02	-2.9e+6	0.0e+6	-10.3e+6	18.0e+6	0.01	0.01	LS3



Buckling State Limit (LG1, 2..Section X 2 (X = 71.68), v2)

Check	[S1] 1..Plate Buckling ABS 2014 (Element Avg)	**Load Group**	LG1..Envelope
Parameter	Buckling State Limit	**Selection**	2..Section X 2 (X = 71.68)
View	2..Frame		

Buckling State Limit (LG1, 3..Section X 3 (X = 73.36), v2)

Check	[S1] 1..Plate Buckling ABS 2014 (Element	**Load Group**	LG1..Envelope