SDC VERIFIER

Tutorial
## Plate Buckling ABS 2014

11 Dec 2020
version 2020.0.2

Content

▸ 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** ✅

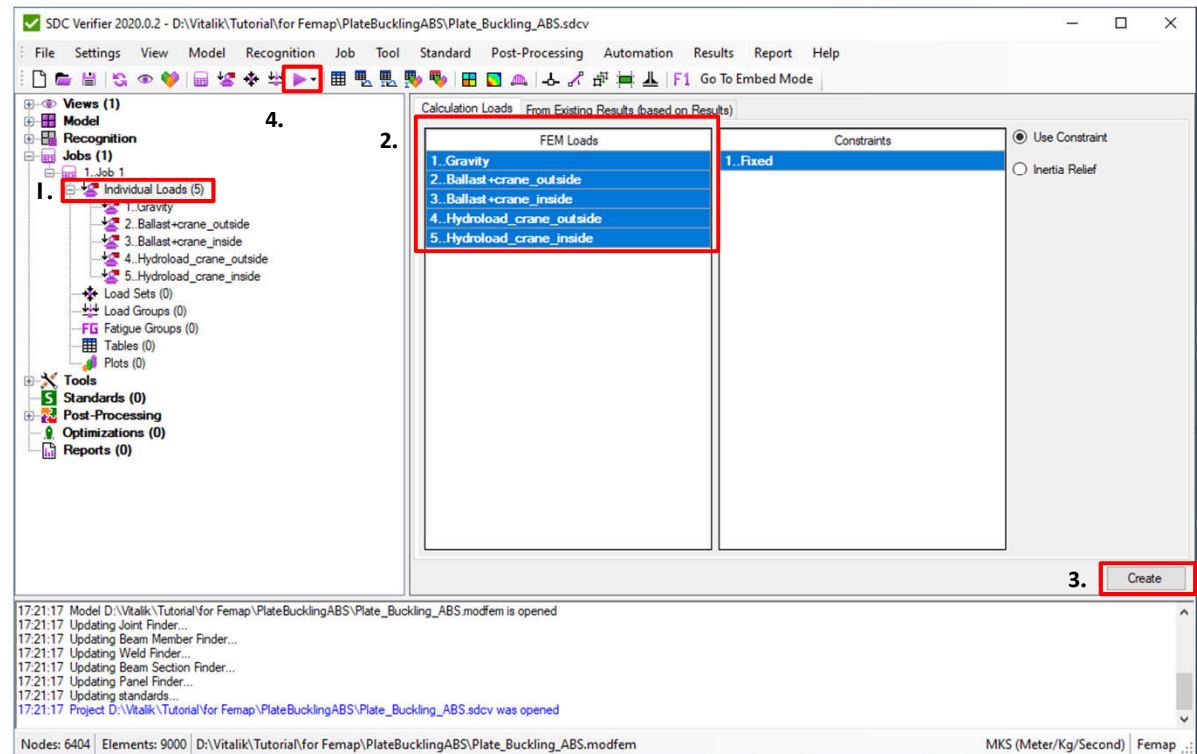**2** Open project *Plate_Buckling_ABS*
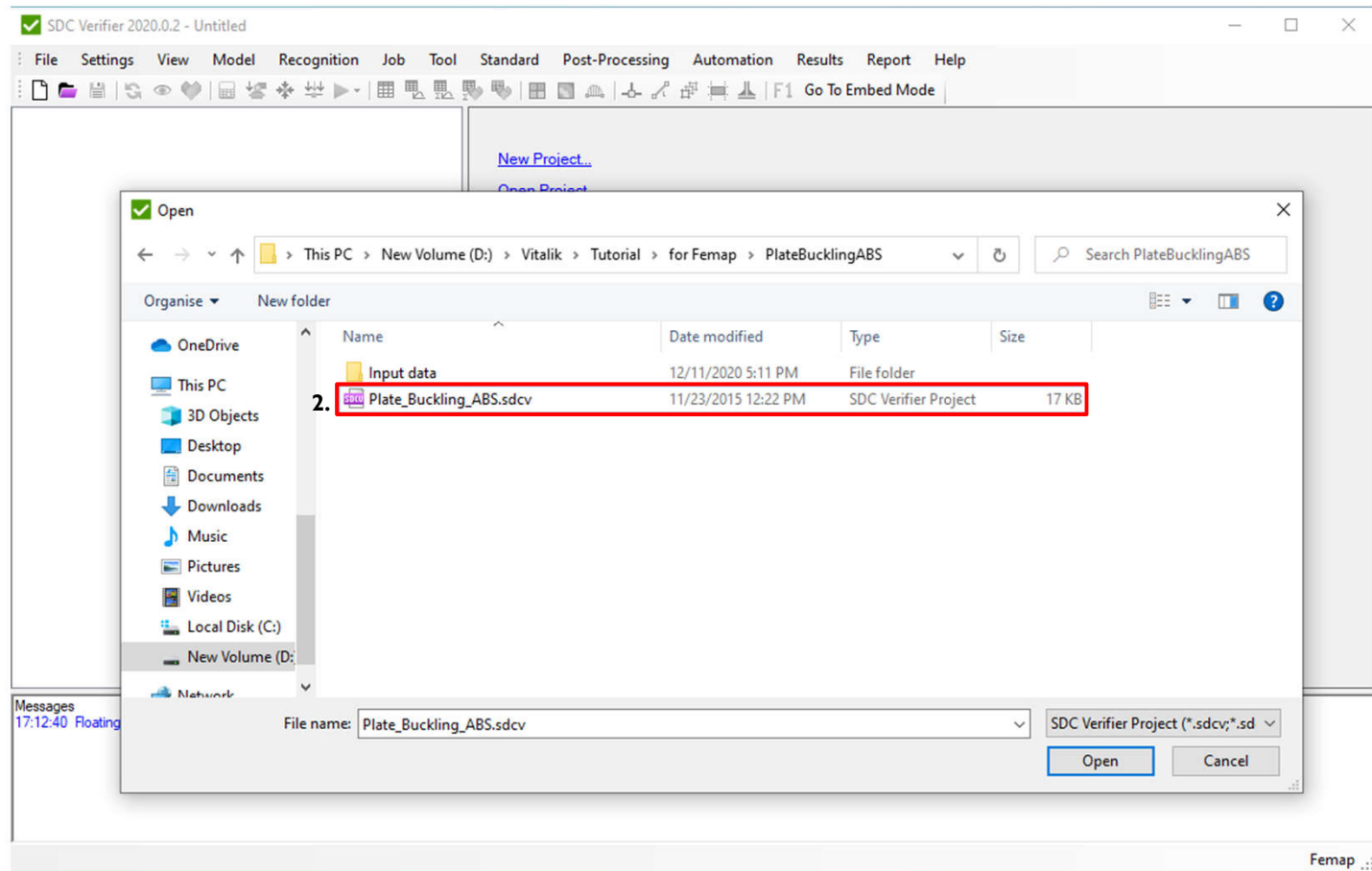
Individual Loads

1	Click on *Individual Loads*
2	Choose *5 FEM Loads*:
3	Press *Create*
4	Press ▶ on toolbar to analyze job

Load Sets

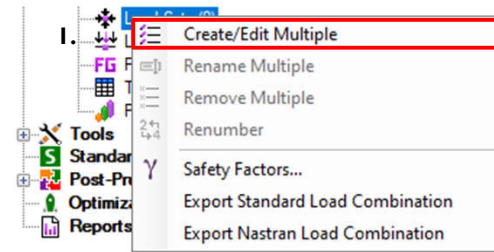**1** Right click on *Load Sets* => ***Create/Edit multiple***

2 Fill in "**4**" into *Count* and press to add four Load Sets.
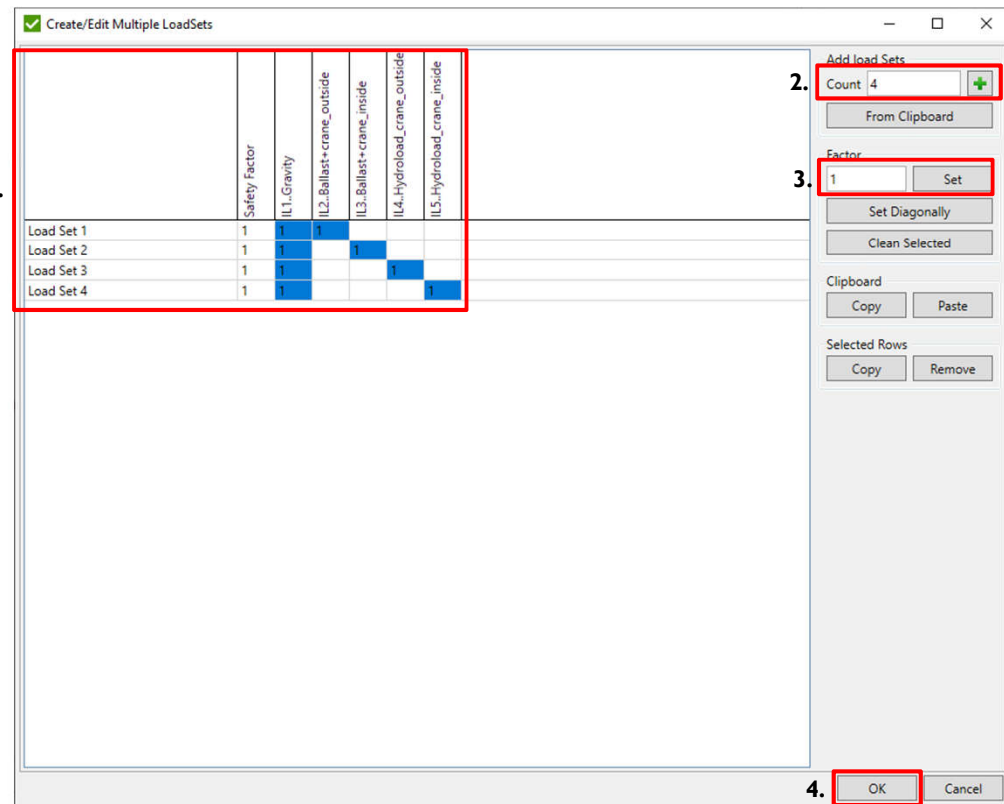
3 Select highlighted cells in table like shown on the picture and press *Set* to define Factors of Load Sets.

4 Press *OK.*

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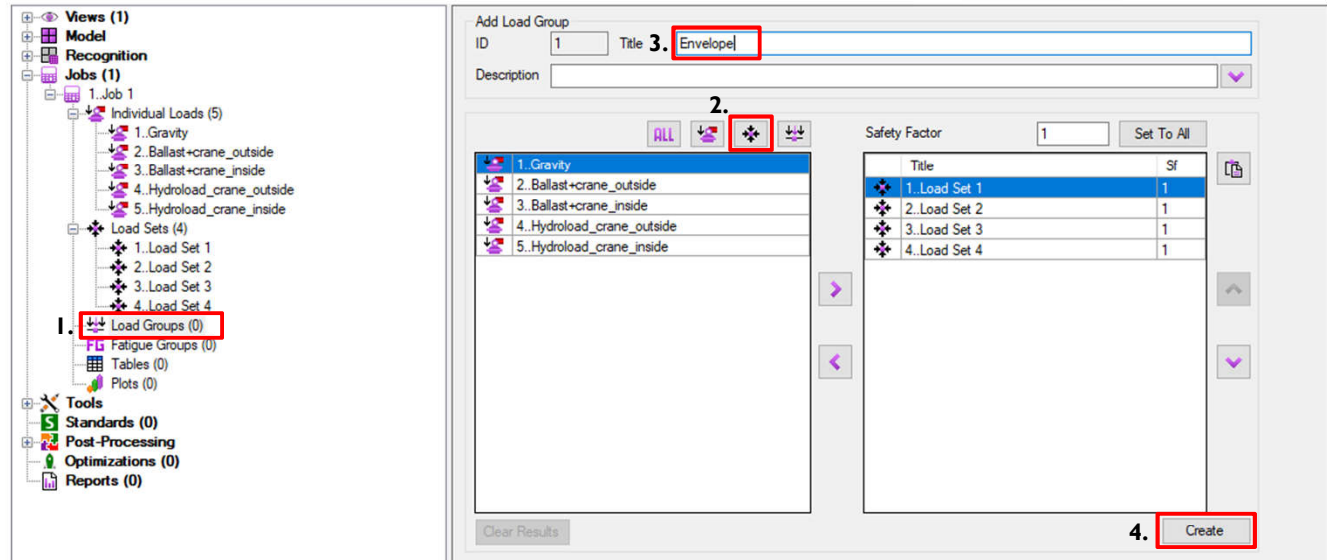Alternatively titles and factors can be pasted from Clipboard using *Paste* button.

Load Groups

1 Click on **Load Groups**

2 Press ⊕ to select all Load Sets

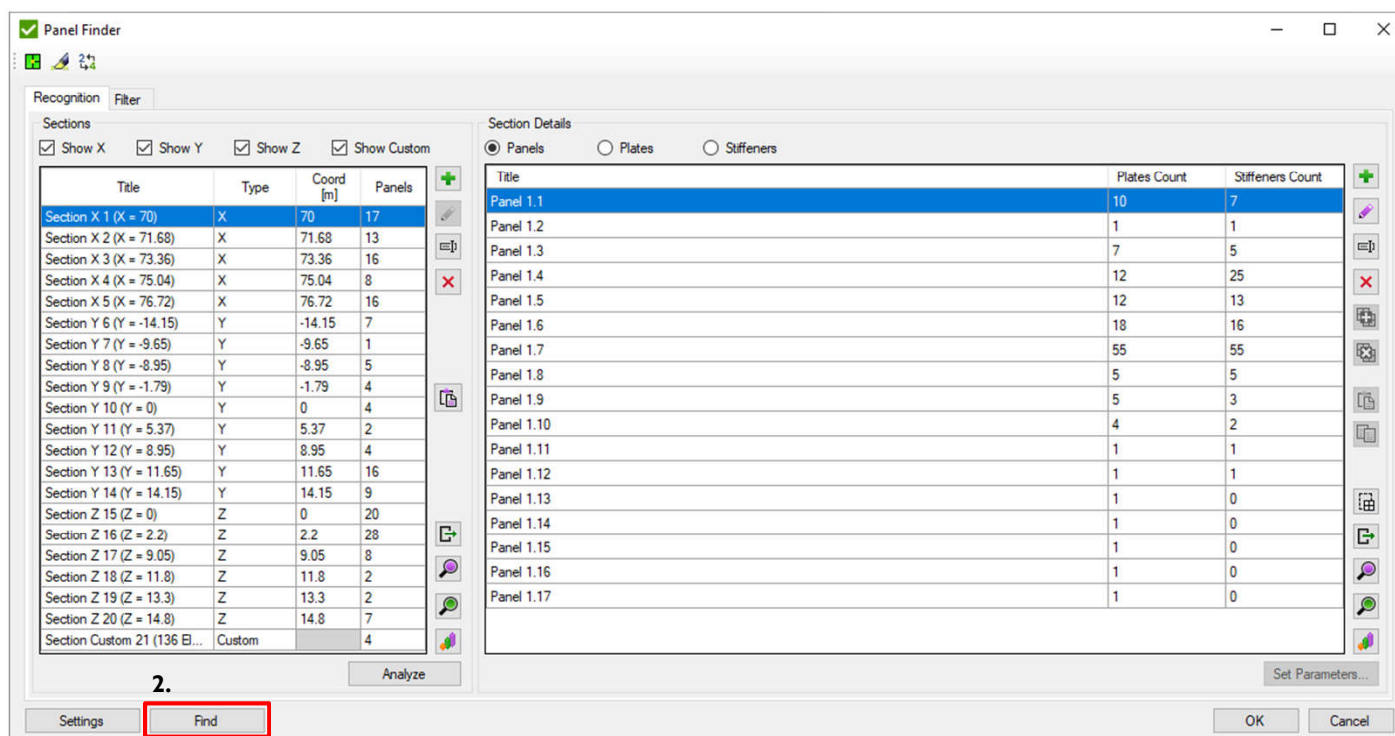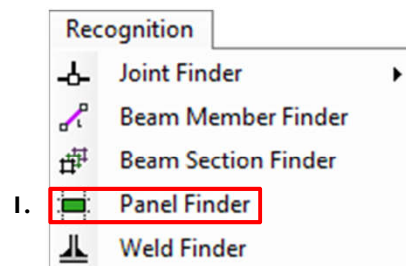**3** *Title*: **Envelope**;

4 Press **Create**

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*

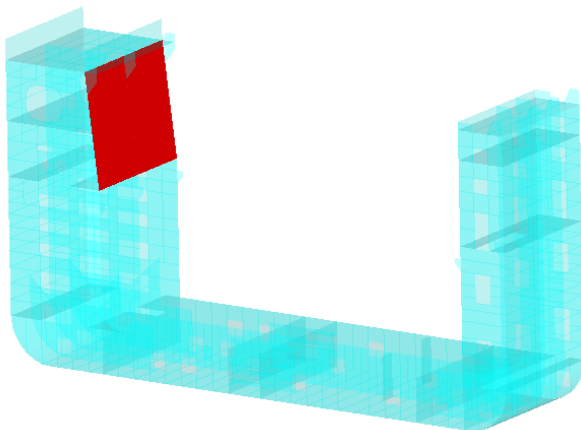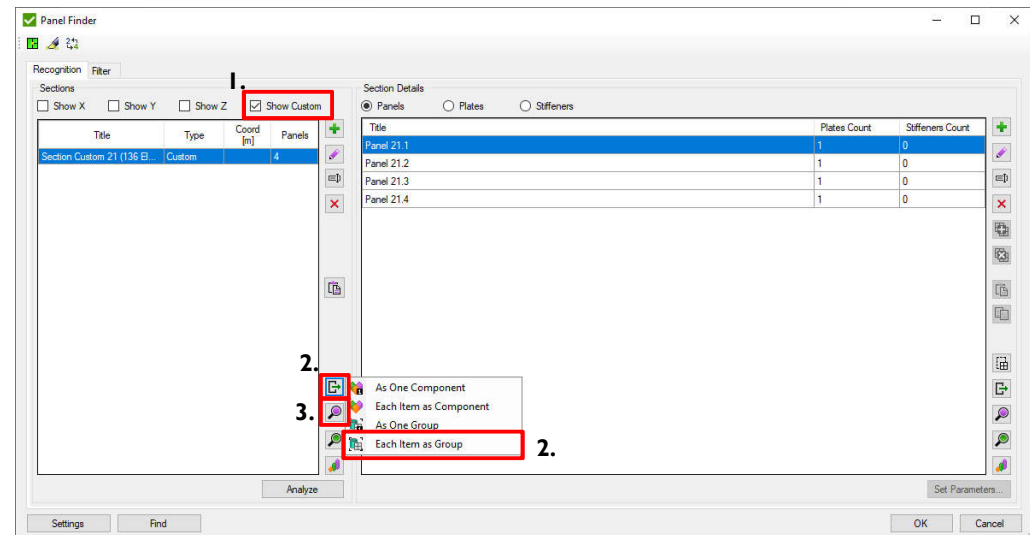All Frames, Longitudinals and Desks were automatically.

Recognition
- Joint Finder ▶
- Beam Member Finder
- Beam Section Finder
- **Panel Finder**   1.
- Weld Finder

Panel Finder. Custom Section

1 Show Custom: **ON** (rest OFF)
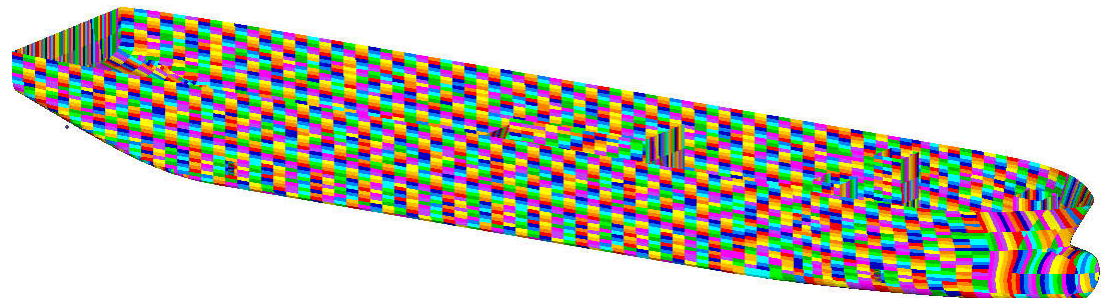
2 Press ⬜ and ⬜ to export selected sections to groups

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:
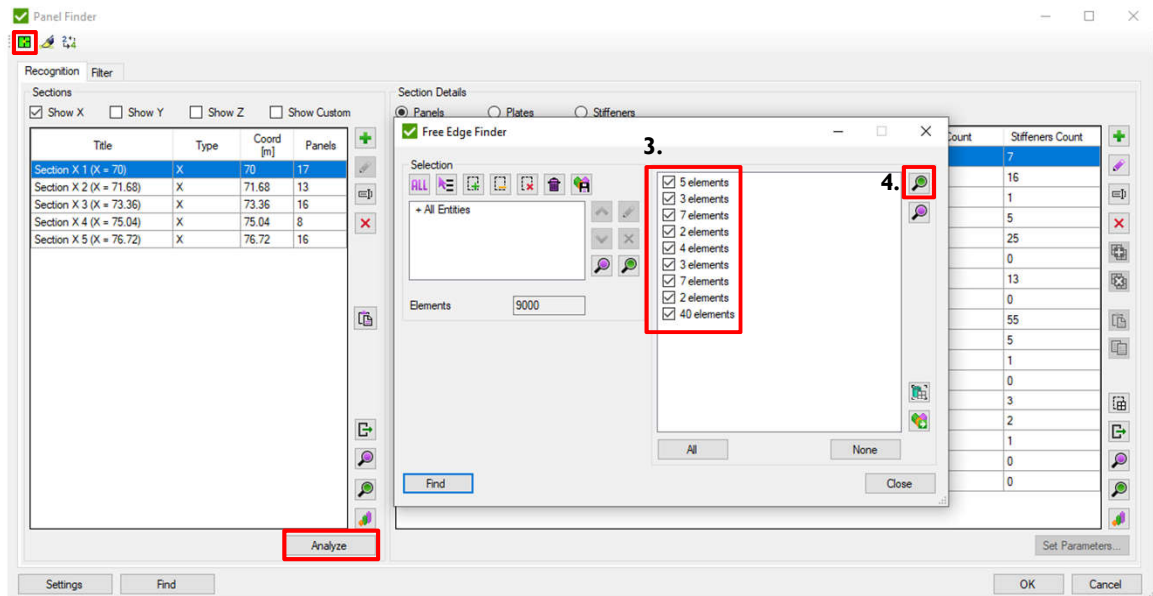
Panel Finder. Find Free Edges

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.
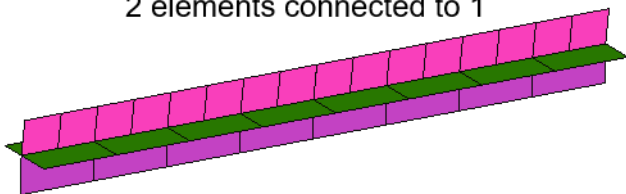
1 Click [icon] to Find Free edges

2 Press *Find*
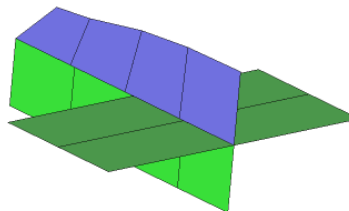
3 Select all free edges

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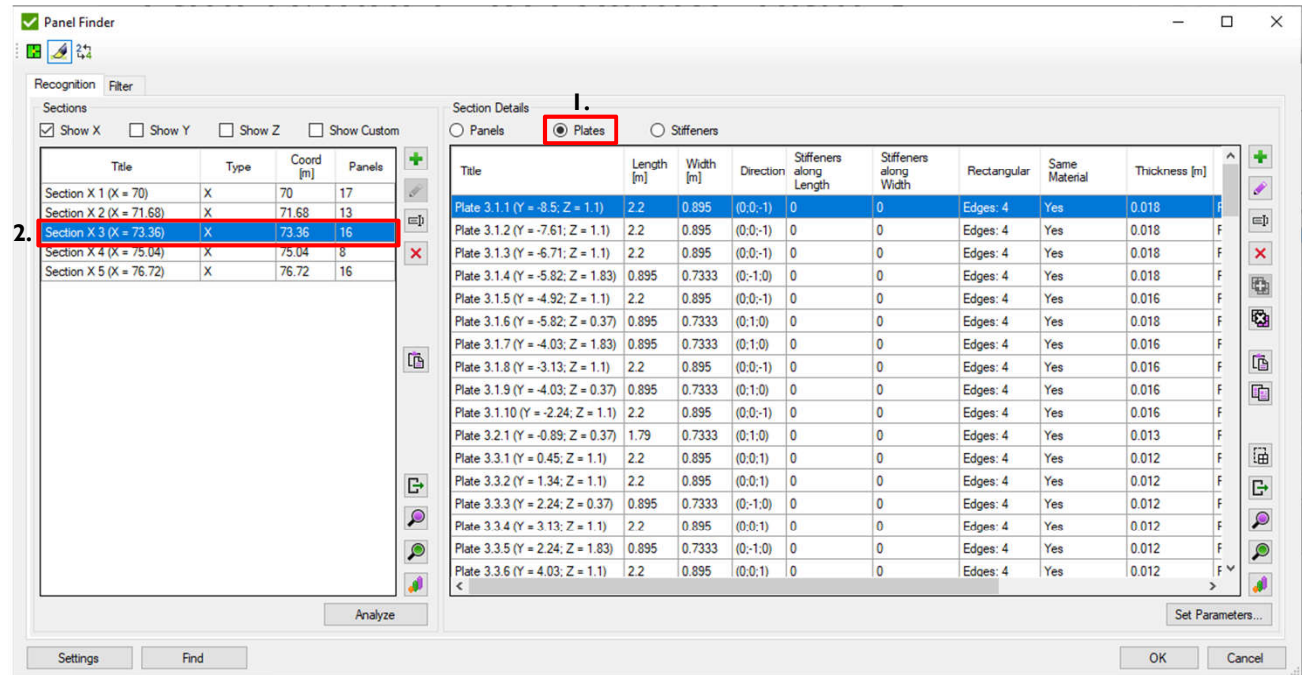
Title	Length [m]	Width [m]	Direction	Stiffeners along Length	Stiffeners along Width	Rectangular	Same Material	Thickness [m]
Plate 3.5.15 (Y = 13.73; Z = 1...	0.8333	0.75	(0;1;0)	0	0	Edges: 4	Yes	0.012
Plate 3.6.1 (Y = 12.9; Z = 2.39)	2.5	1.5333	(0;1;0)	0	0	Edges: 8	Yes	Min = 0.016

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:
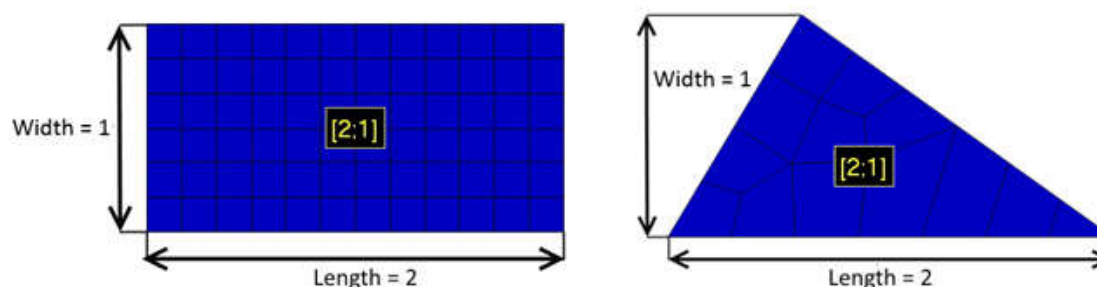

Plate Thickness: Calculations are performed on every element and thickness is taken directly from each element. It is possible to set thickness manually for plate, in this case element thickness will be ignored and user defined thickness will be used. Example: Plate with 2 properties 0.01 and 0.02 thicknesses.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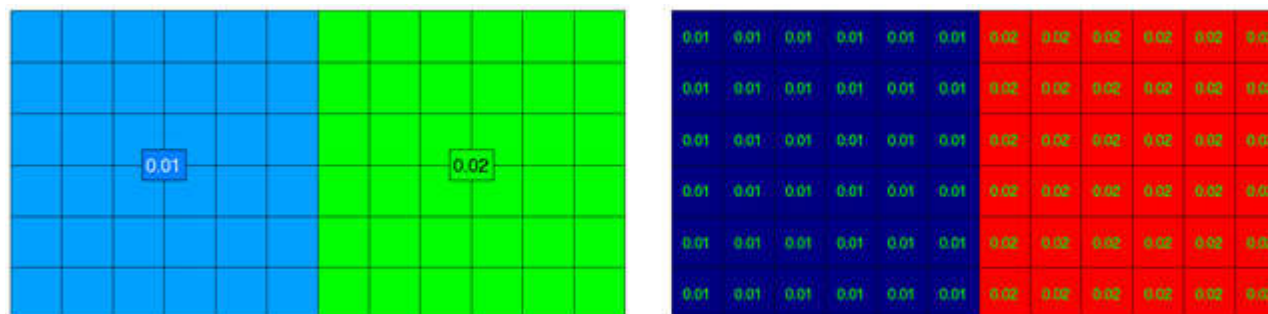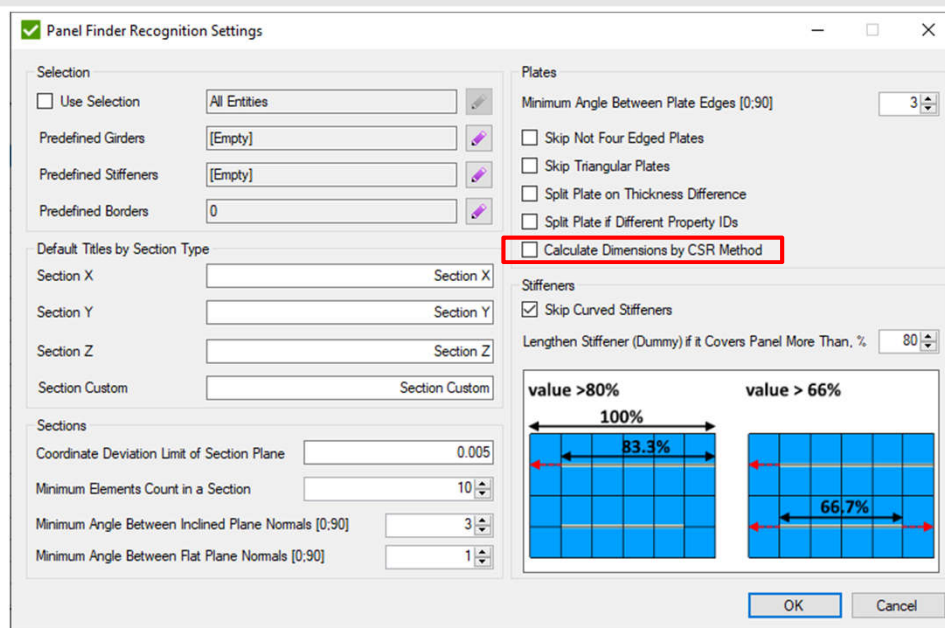
Plate Buckling Dimensions by CSR

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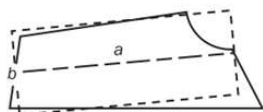
e) The length of shorter side, b in mm, is to be taken as:

$b = A/a$

where:

A : Area of the plate, in mm^2
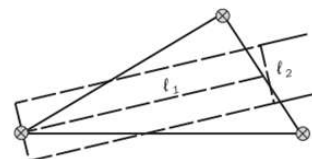
a : length defined in (d), in mm

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:

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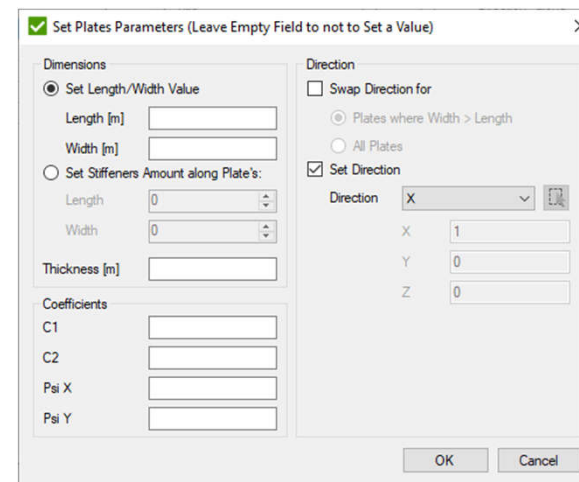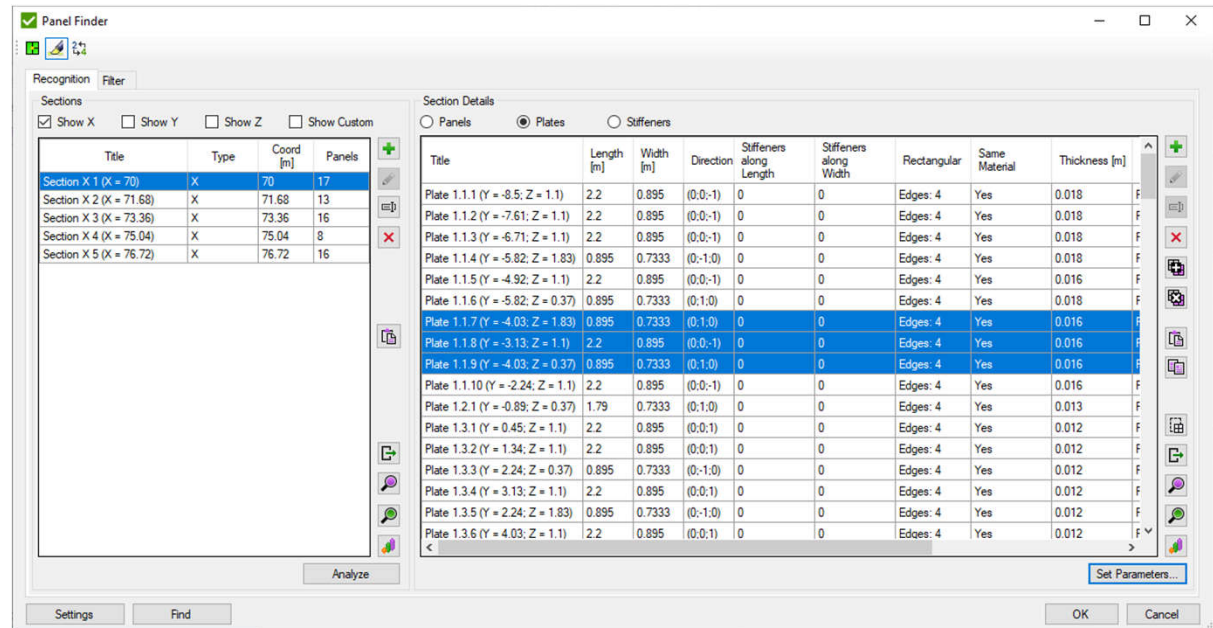
Panel Finder. Plates Plot

1	Select **Section X3**
2	Select All *Plates*
3	Press 📊
4	Click on *Colors + Labels of Ids*.

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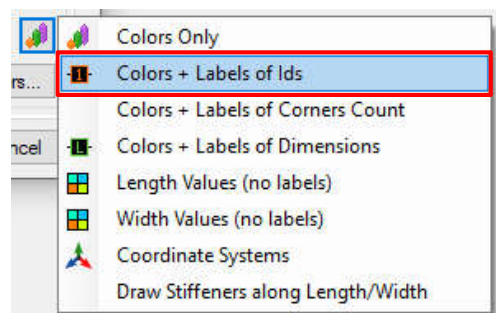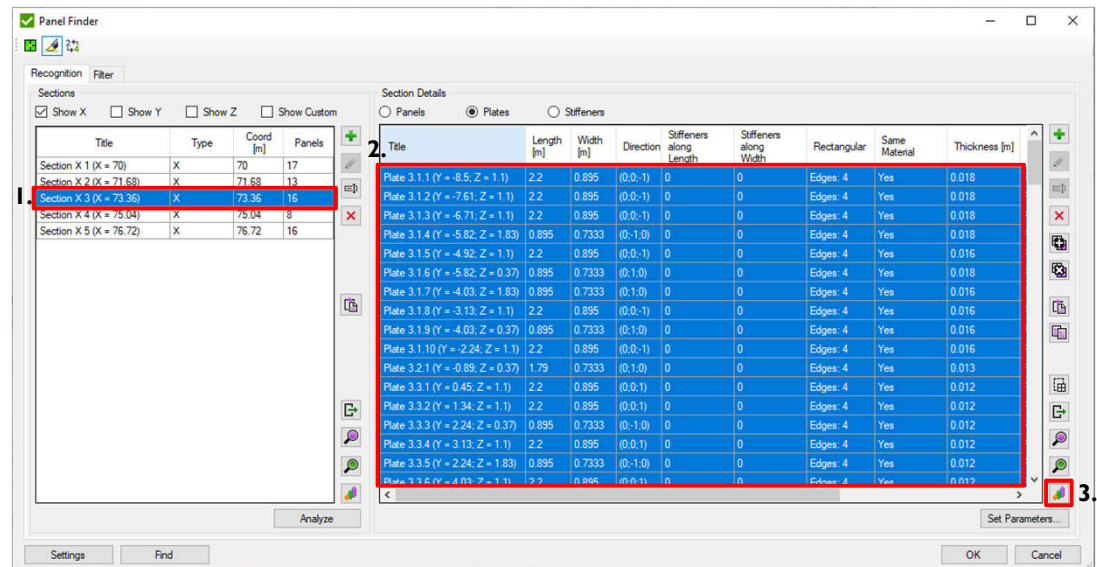
Panel Finder. Filter

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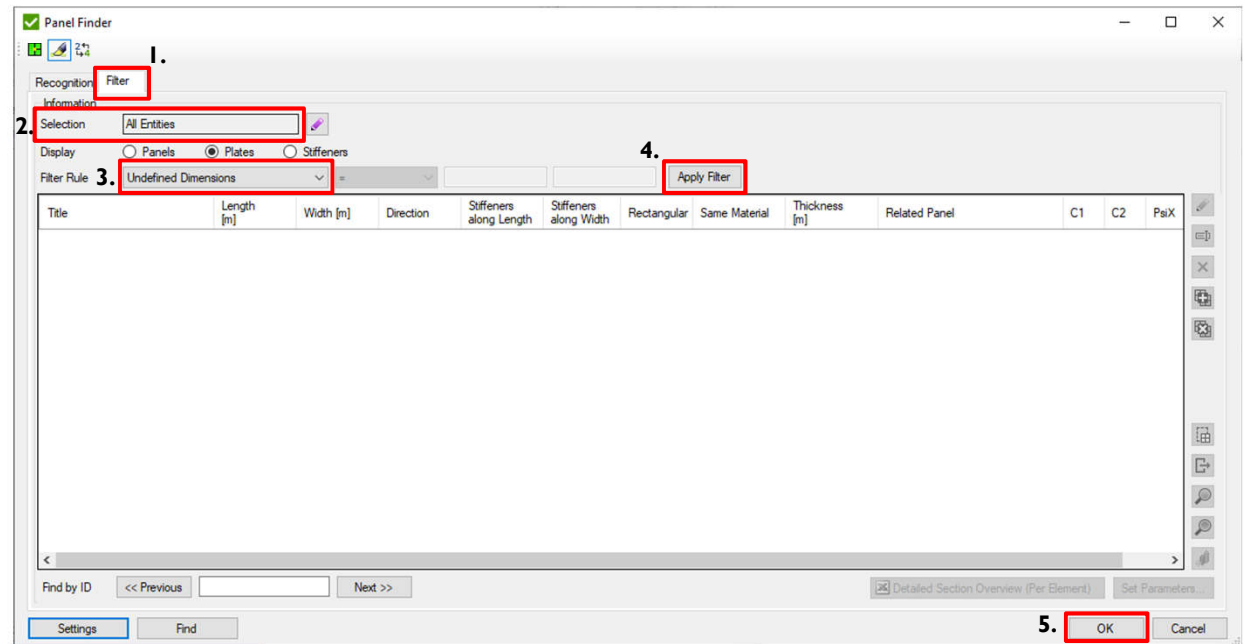
Tip: It is also possible to filter plates by shape (triangle, rectangular) or number of edges parameters.
E.g. Plates with numbers of edges > 4 can be displayed.
Control using Selection plates from which Sections should be filtered.
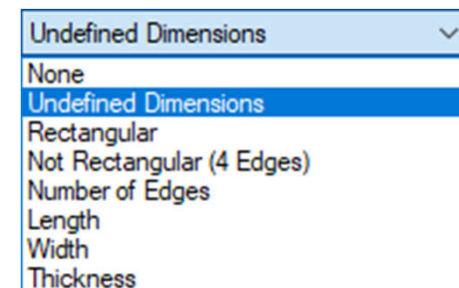
Panel Finder. Plot Options

> **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.

Colors Only	
Colors + Labels of Ids	
Colors + Labels of Corners Count	
Colors + Labels of Dimensions	
Length Values (no labels)	
Width Values (no labels)	
Coordinate Systems	
Draw Stiffeners along Length/Width	
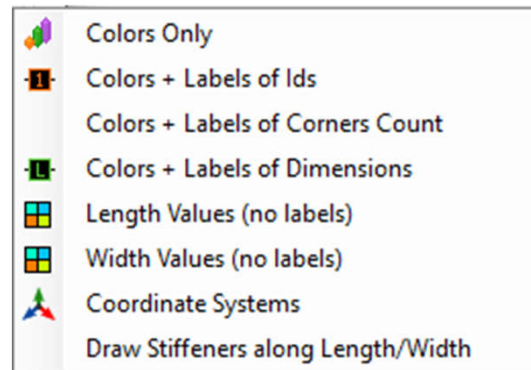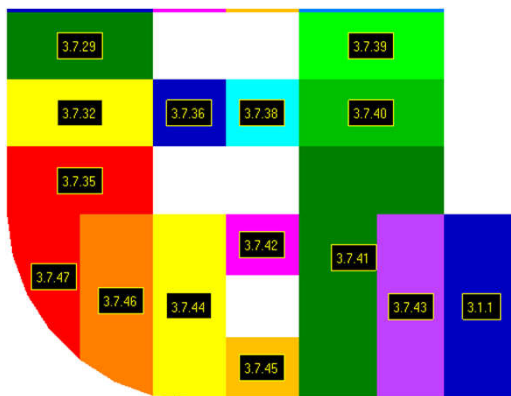
Labels of Ids

Labels of dimensions
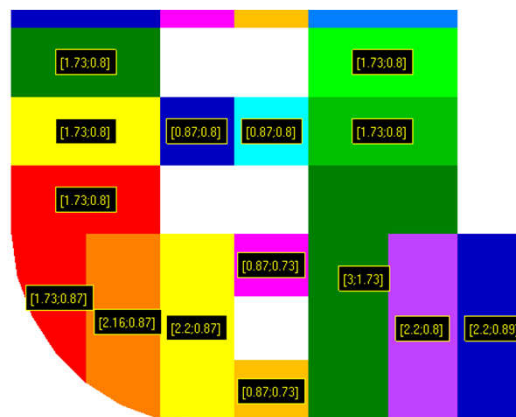
Labels of Corners Count
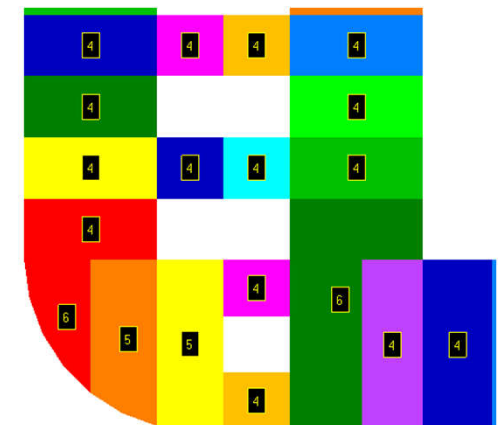
In some cases (e.g. stiffener is not modeled) plate is recognized not correctly, dimensions are bigger than in reality which leads to wrong results. Plate has to be updated manually. In Section X3 plate with Id = 3.7.41 should be split on 2 plates
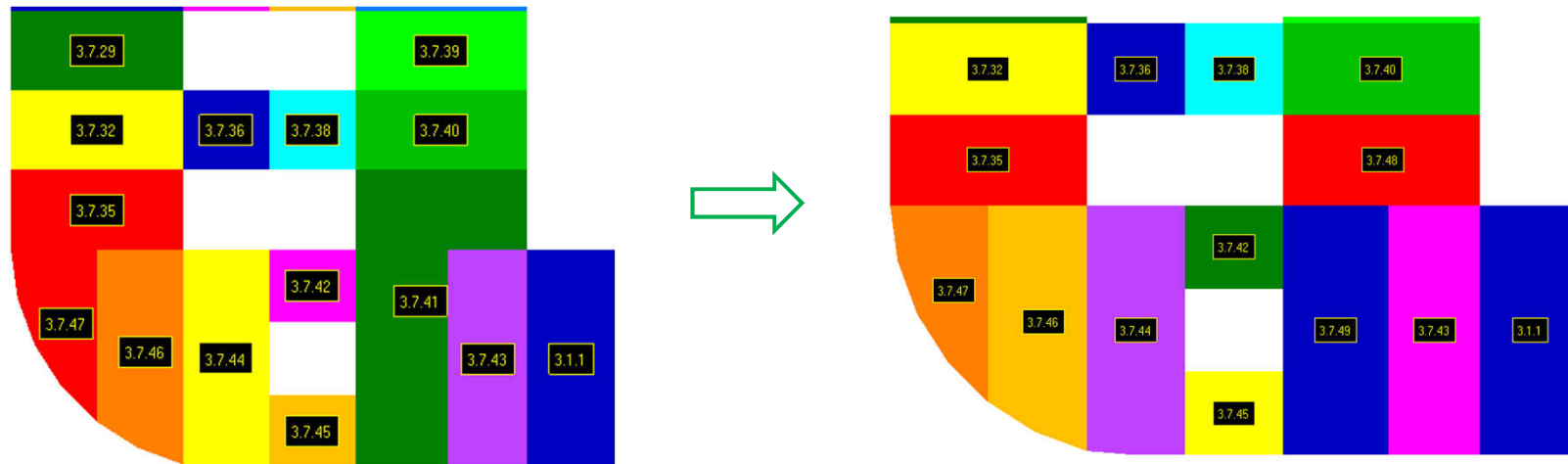
Note: if plates were modified manually and later user decided to run recognition of plates - Panel Finder will ask what to do with modified plates:
- Keep plates that was modified;
- Clear everything and recognition from scratch;
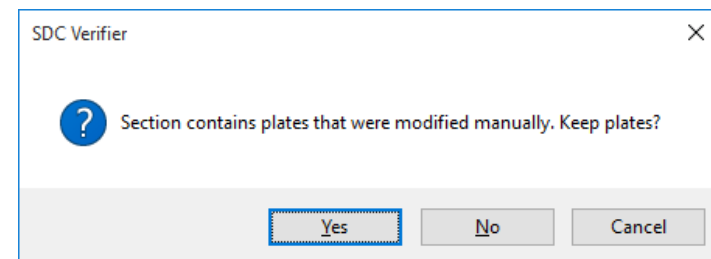
Panel Finder. Split Plate

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*
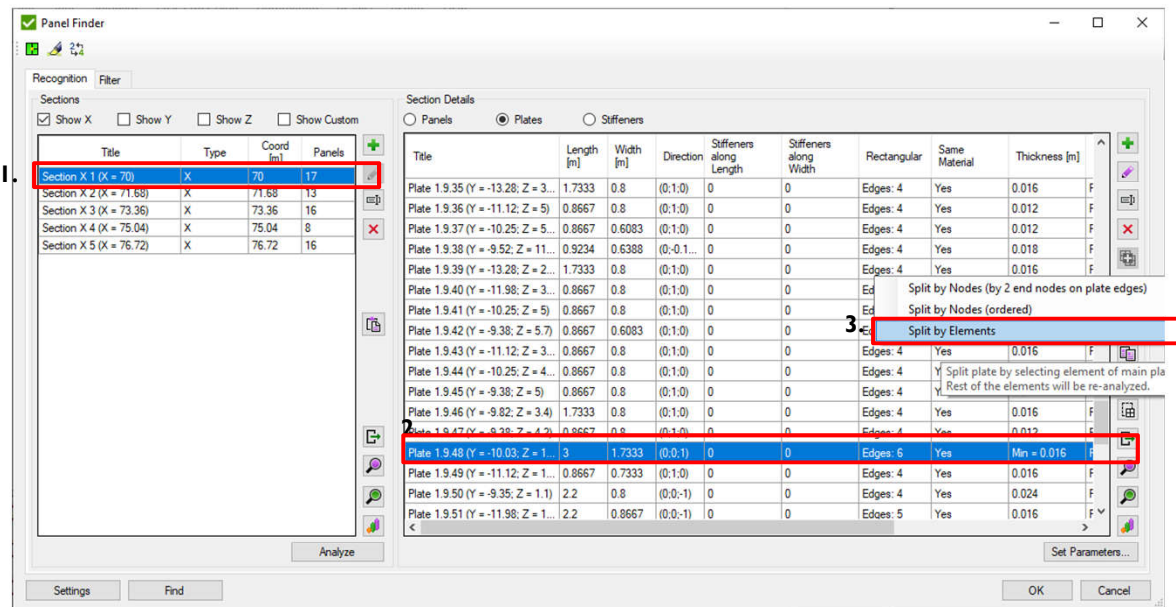
Plate 1.9.48 is replaced with Plates 1.9.55; 1.9.56 and 1.9.57
Dimensions and directions are updated automatically
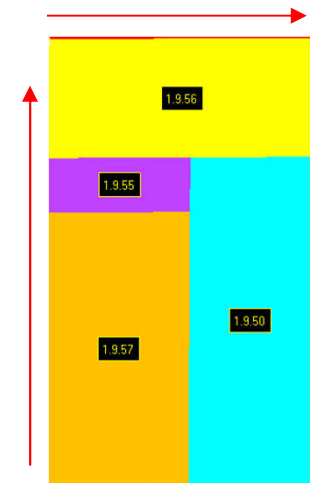
Add Plate Buckling ABS 2014 standard

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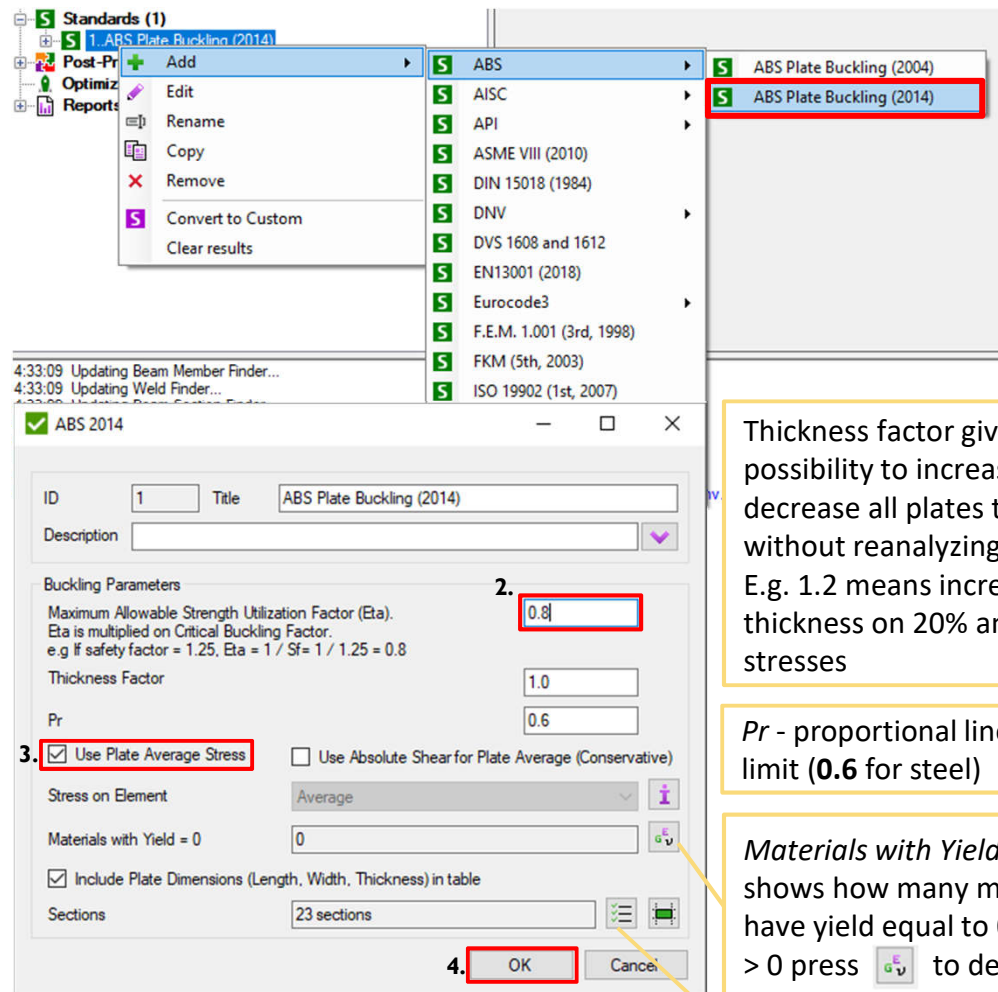
Plate Buckling transforms stresses automatically into plate direction.
Options about element stresses and plate stresses are described on the next slide

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

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 [icon] to define yield.

By default all sections will be checked. Click [icon] to modify.

Plate Buckling Stresses

4
Top
3
1
8
2
7
5
Bottom
6

Average Element Stress:
$$Sel = (S1+S2+S3+S4+S5+S6+S7+S8) / 8$$

Minimum Element MidPlane:
$$Sel = Min((S1+S5) / 2, (S2+S6) / 2, (S3+S7) / 2, (S4+S8) / 2))$$

$S1 - S8$ - translated element stresses into Plate Direction

Use Plate Average Stress

On → Off →

| Sel1 (avg) | Sel2 (avg) | Sel3 (avg) |

$$Spl = (Sel1*A1+Sel2*A2+Sel3*A3) / (A1+A2+A3)$$

↓

One Buckling Factor for plate

| Sel1 | Sel2 | Sel3 |

Sel1, Sel2, Sel3 - Average or min MidPlane

↓

Plate Buckling Factor = Max(BF1, BF2, BF3)

Close

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

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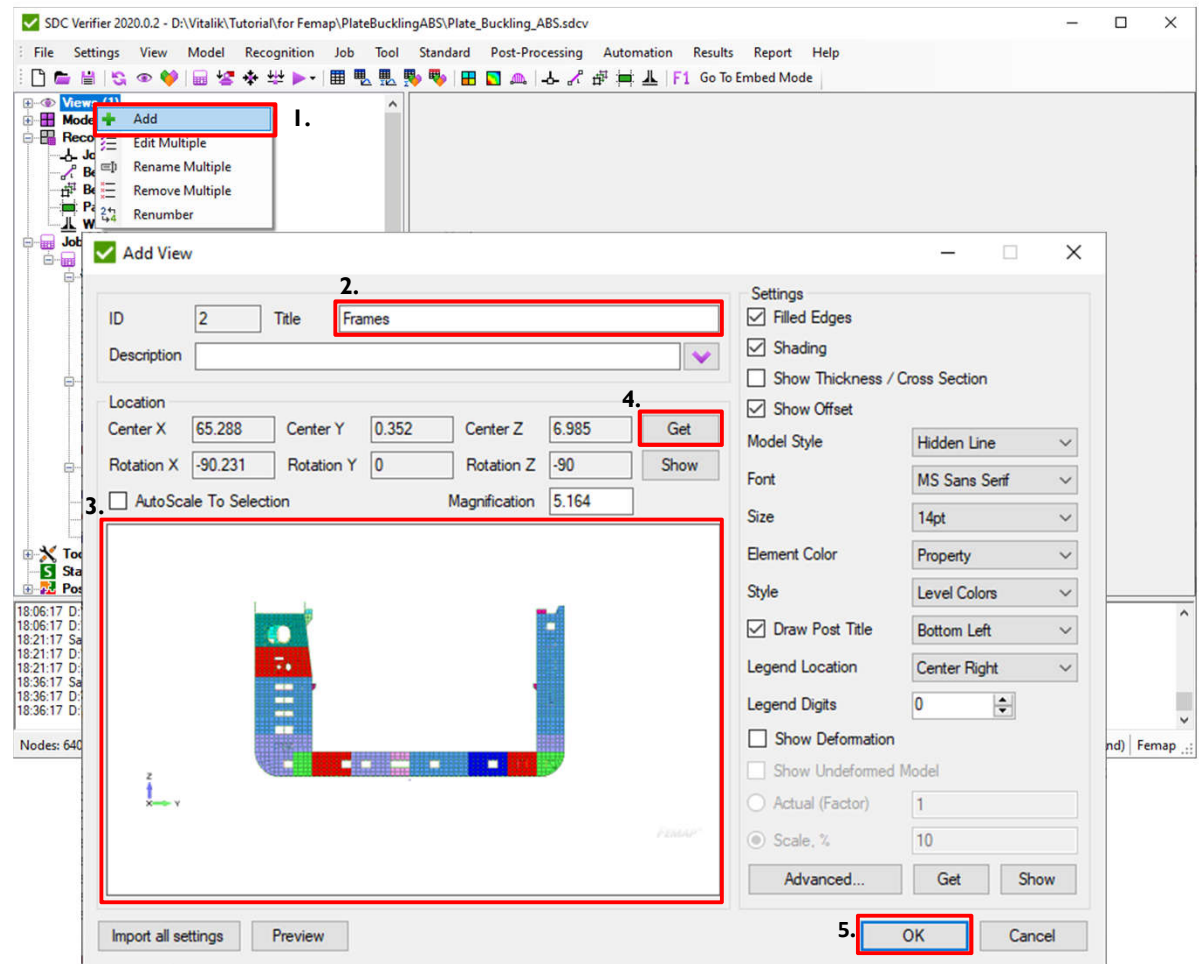
1	Execute *Criteria Plot* from Plate Buckling ABS 2014 context menu
2	Load Group: 1..**Envelope**
3	View: **Frames**
4	Press 🖊 Select: **Section X3**
5	Press 🖥 *Preview*

Standards (1)
- 1..ABS Plate Buckling (2014)
  - Input
  - Checks (1)
    - 1..Plate Buckling ABS 2014 (Element Avg)
- Post-Processing
- Optimizations (0)
- Reports (0)

Context menu:
- Add
- Edit
- Rename
- Copy
- Remove
- Copy To Standard...
- Clear Results
- Table (expand/extreme)
- Flow Table (over loads)
- **Criteria Plot**

Plate Buckling Plot

ID: 1 Title:

Description:

Options
- Check: 1..Plate Buckling ABS 2014 (Plate Avg)
- Load Group: **2.** 1..Envelope
- Parameter: Buckling State Limit
- Values to plot: Element Values
- View: **3.** 2..Frames

Sections on Selection: **4.**
+ 3..Section X 3 (X = 73.36)

Elements: 1450

Labels: None   Limits: None

Set Default Title   **5.** 🖥   OK   Cancel

Edit + 23 Sections

Operation: Add

Search
- ID: [ ] Go
- Filter: [ ] ✕

All   None

- 1..Section X 1 (X = 70)
- 2..Section X 2 (X = 71.68)
- **4.** ☑ 3..Section X 3 (X = 73.36)
- 4..Section X 4 (X = 75.04)
- 5..Section X 5 (X = 76.72)
- 6..Section Y 6 (Y = -14.15)
- 7..Section Y 7 (Y = -9.65)
- 8..Section Y 8 (Y = -8.95)
- 9..Section Y 9 (Y = -1.79)
- 10..Section Y 10 (Y = 0)
- 11..Section Y 11 (Y = 5.37)
- 12..Section Y 12 (Y = 8.95)
- 13..Section Y 13 (Y = 11.65)
- 14..Section Y 14 (Y = 14.15)
- 15..Section Z 15 (Z = 0)
- 16..Section Z 16 (Z = 2.2)

OK   Cancel

Color scale: 1.2, 1.1, 1., 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1, 0.

Plate Buckling Table

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

2 — Load Group: 1..**Envelop**

3 — Show plates results: **OFF**

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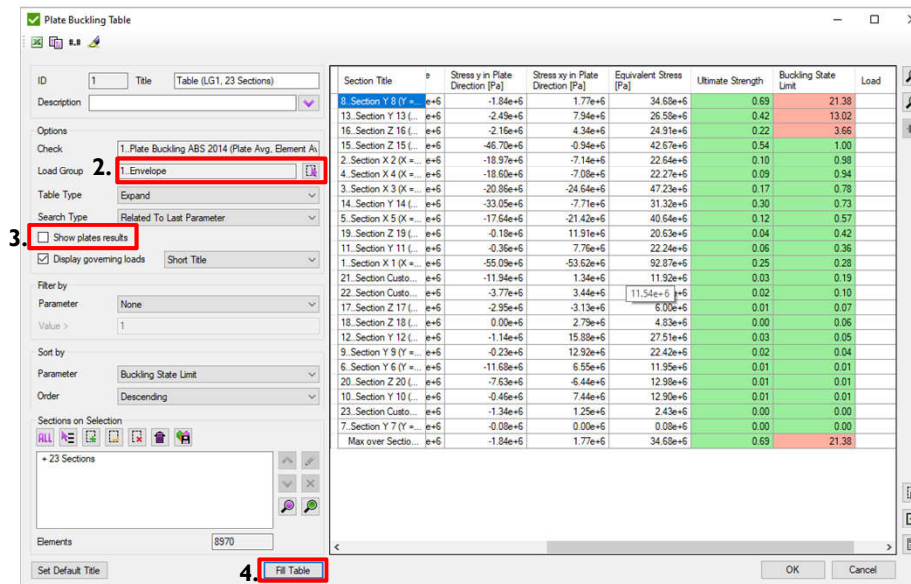
Use **Show plates results** for detailed table with results for all plates. Otherwise only the worst results over Sections will be shown.

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
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.*
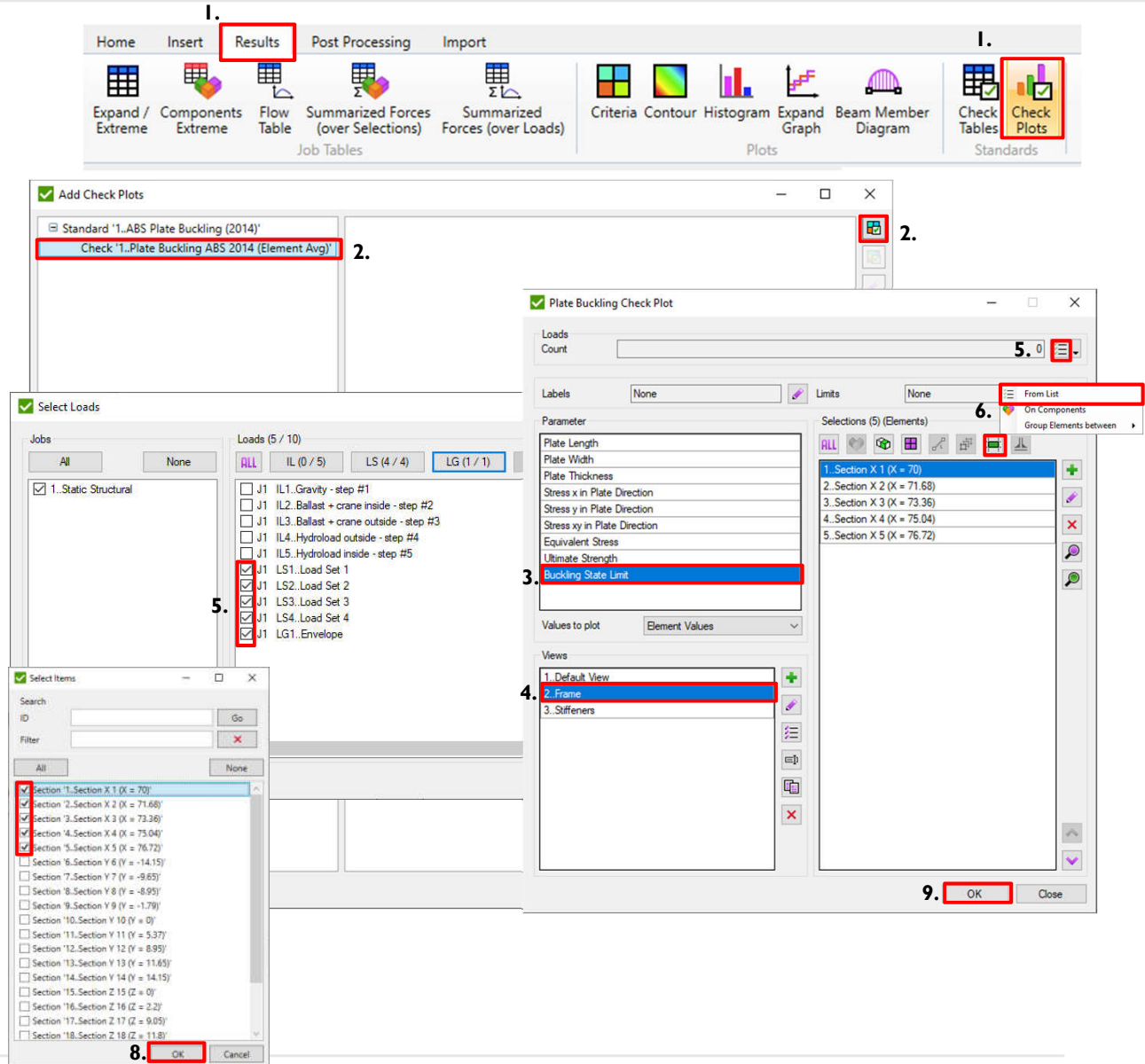
Report. Sort tables and plots by Load

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

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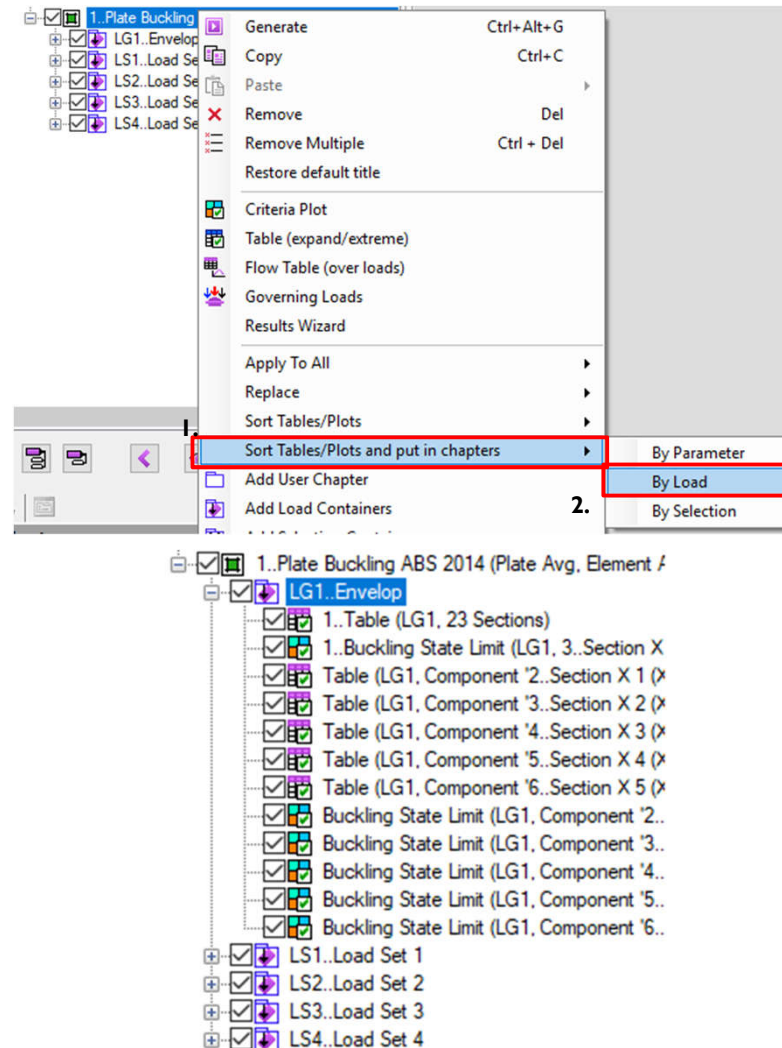
All tables and plots are sorted by loads. It is possible to sort it *By Parameter; By Selection; By section* as well.

Report. First Page

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1	Right click on *First Page* => **Edit**.
2	Press [icon] to select engineer and custom from library
3	Select Image *From View* and pick '*2..Frame*'.
4	Press *OK*.
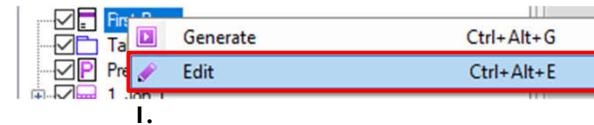
Report

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