

SDC
V E R I F I E R



Tutorial

Optimization

Updated on: 05.10.2021

Tested with: SDC Verifier 2021R1.1

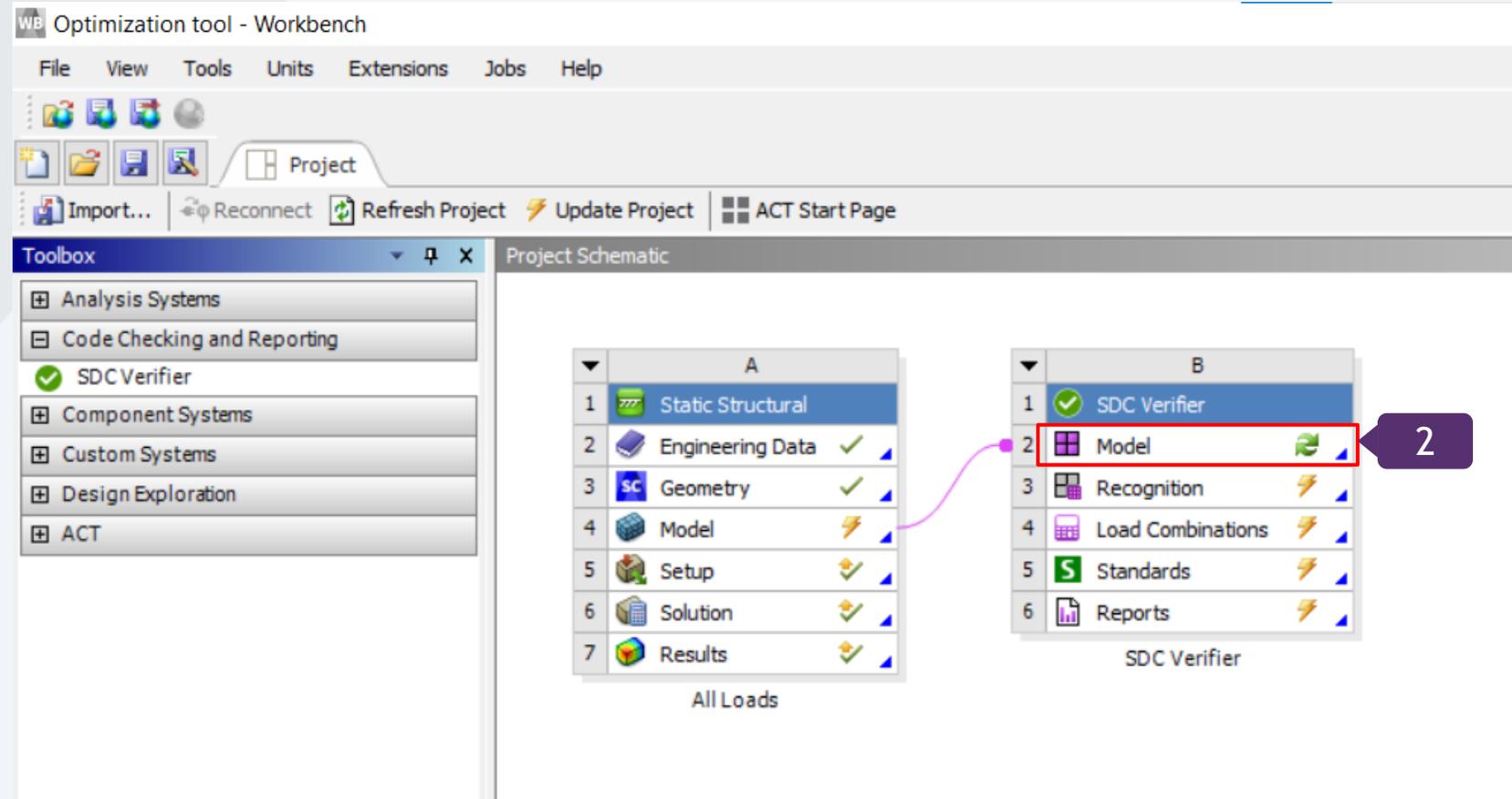
Ansys Workbench 2020R2

- This step-by-step tutorial demonstrates the interface of SDC Verifier Optimization
- Jacket Model members are Optimized based on AISC 360-10 results;
- Shape Library Overview;
- Optimization Rules Overview;
- Results Comparison;
- Automatic Beam Cross Section Change.

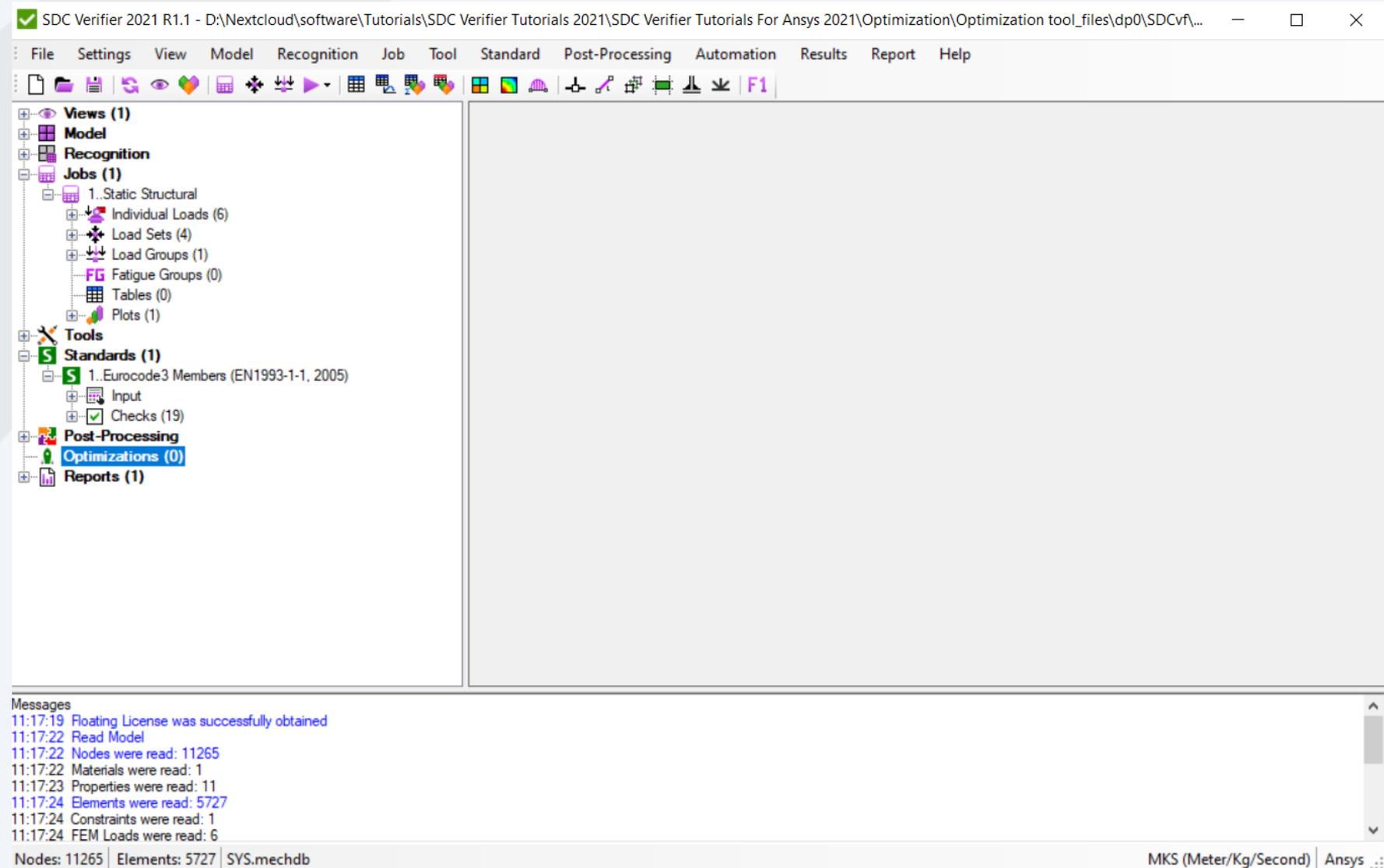
Open the starter model

1 Open in ANSYS Workbench the following file **Optimization_tool.wbpz**

2 Double Click on  or in context menu click Edit



Ansys analysis in this file is already solved. This SDC Verifier project has predefined loading combinations, recognition of beam members, and AISC 360-10 Members check.



The screenshot displays the SDC Verifier 2021 R1.1 software interface. The main window shows a project tree on the left and a large empty workspace on the right. The project tree is organized as follows:

- Views (1)
- Model
- Recognition
- Jobs (1)
 - 1..Static Structural
 - Individual Loads (6)
 - Load Sets (4)
 - Load Groups (1)
 - Fatigue Groups (0)
 - Tables (0)
 - Plots (1)
- Tools
- Standards (1)
 - 1..Eurocode3 Members (EN1993-1-1, 2005)
 - Input
 - Checks (19)
- Post-Processing
- Optimizations (0)
- Reports (1)

The Messages pane at the bottom shows the following log:

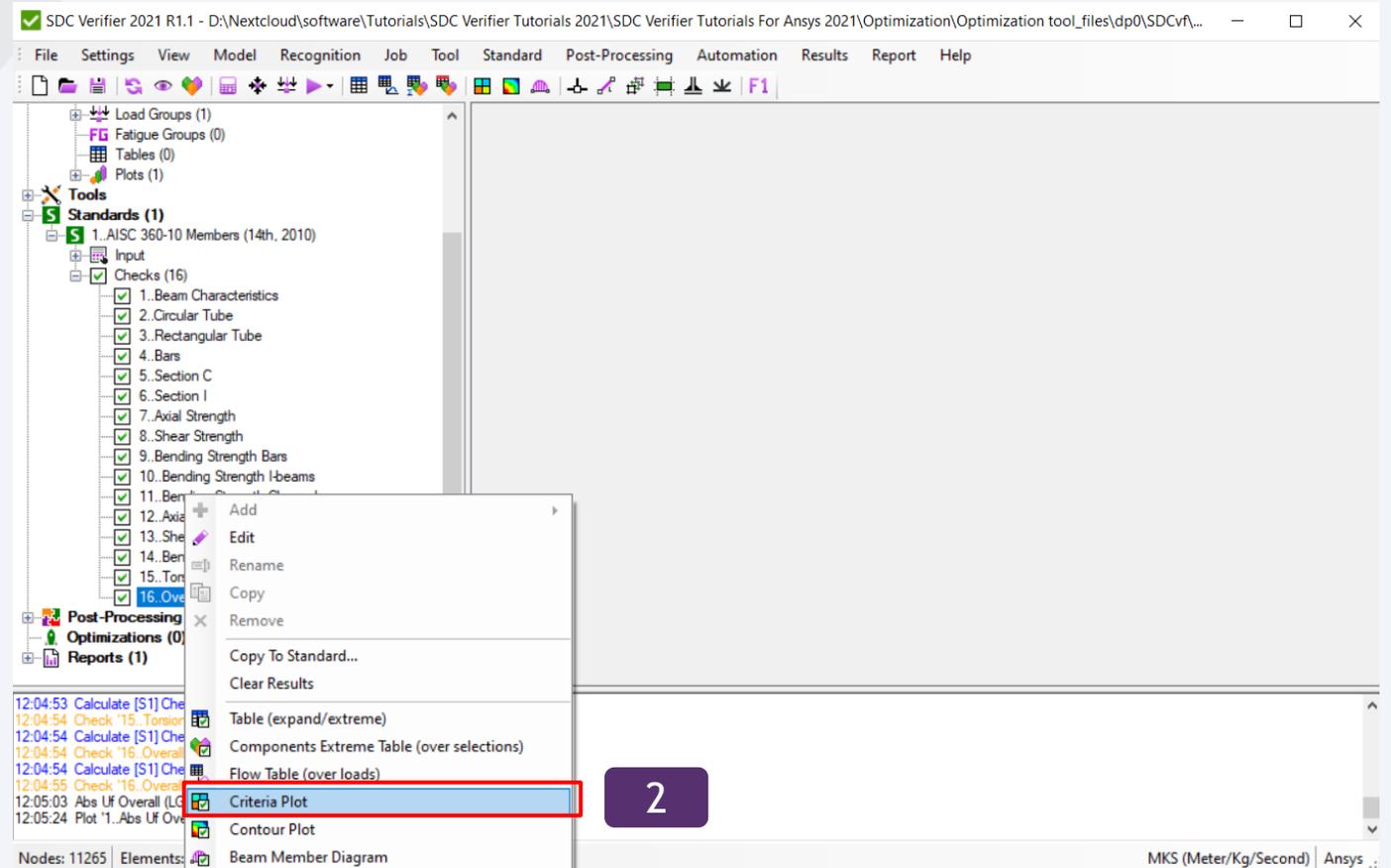
```
11:17:19 Floating License was successfully obtained
11:17:22 Read Model
11:17:22 Nodes were read: 11265
11:17:22 Materials were read: 1
11:17:23 Properties were read: 11
11:17:24 Elements were read: 5727
11:17:24 Constraints were read: 1
11:17:24 FEM Loads were read: 6
```

The status bar at the bottom indicates: Nodes: 11265 | Elements: 5727 | SYS.mechdb | MKS (Meter/Kg/Second) | Ansys ..

1 Select AISC 360-10 Members > Checks > Overall

2 Right Click and Select Criteria Plot

Let's create a plot to preview the results of AISC Members check and pick the members for Optimization



AISC Results Plot

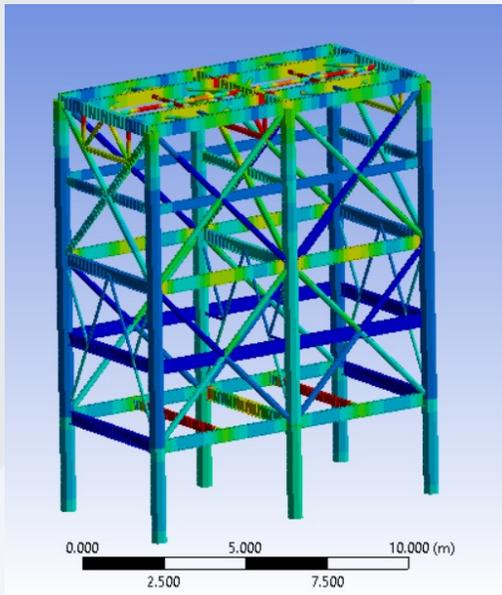
1 Selection: All Entities

2 Parameter: UF Overall

Creating a plot to see the Overall UF result on a full model

3 Press Plot 

Plot will be displayed in Ansys Mechanical Window

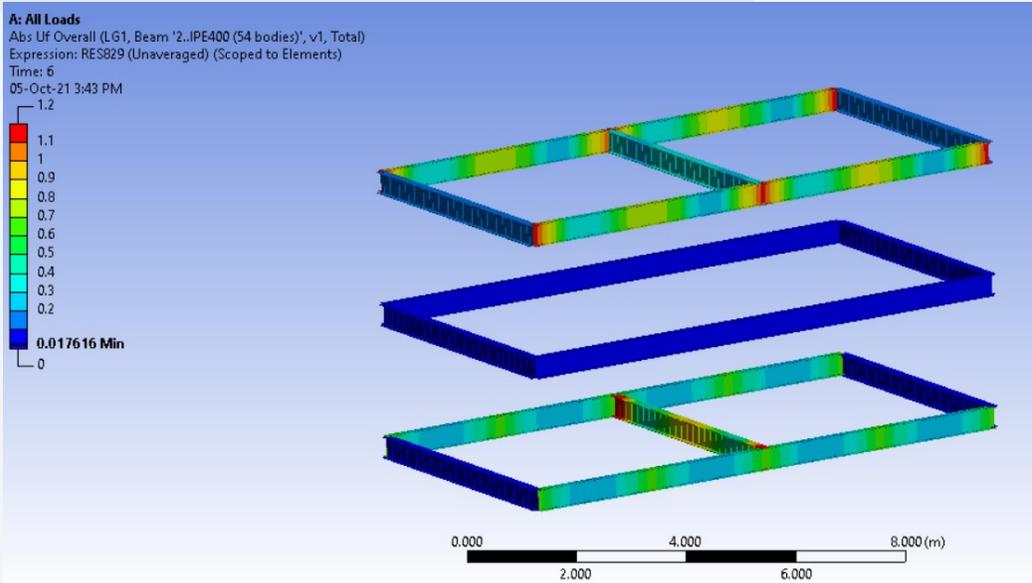
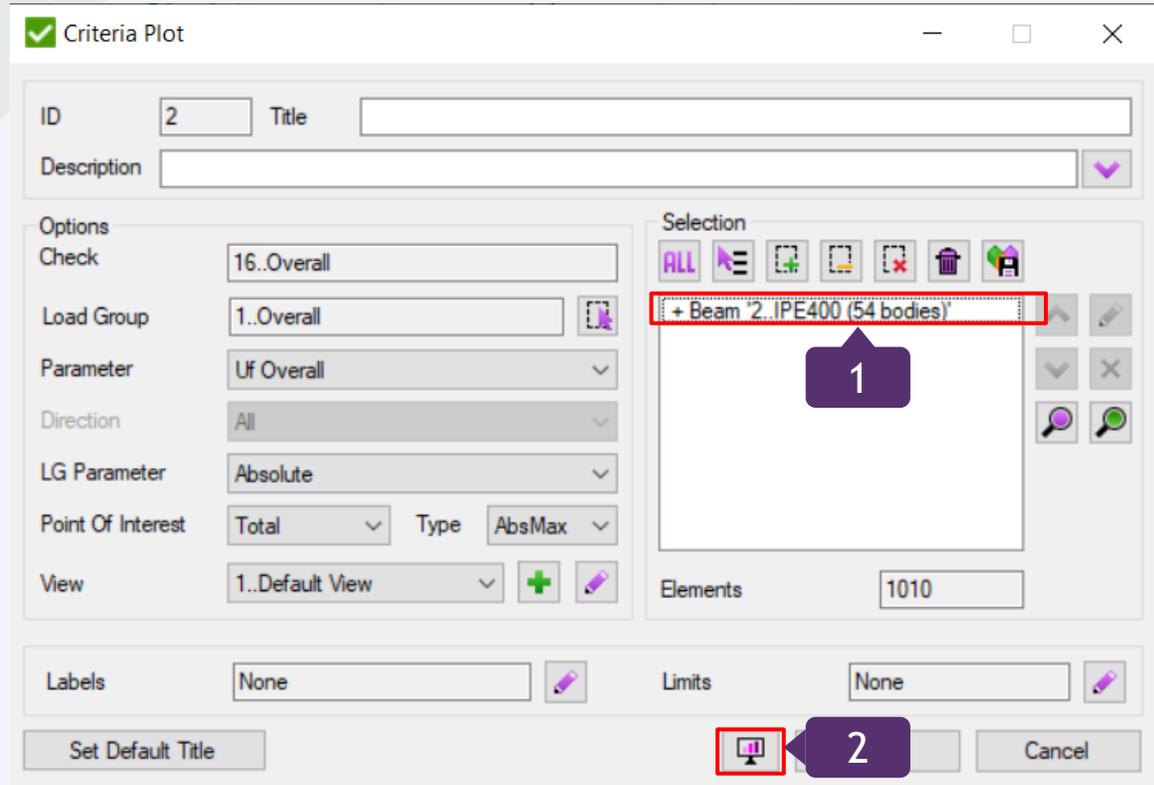


Let's preview the plot for one property

1 Selection: Property Beam 2..IPE400

2 Press Plot

Plot will be displayed in Ansys Mechanical Window

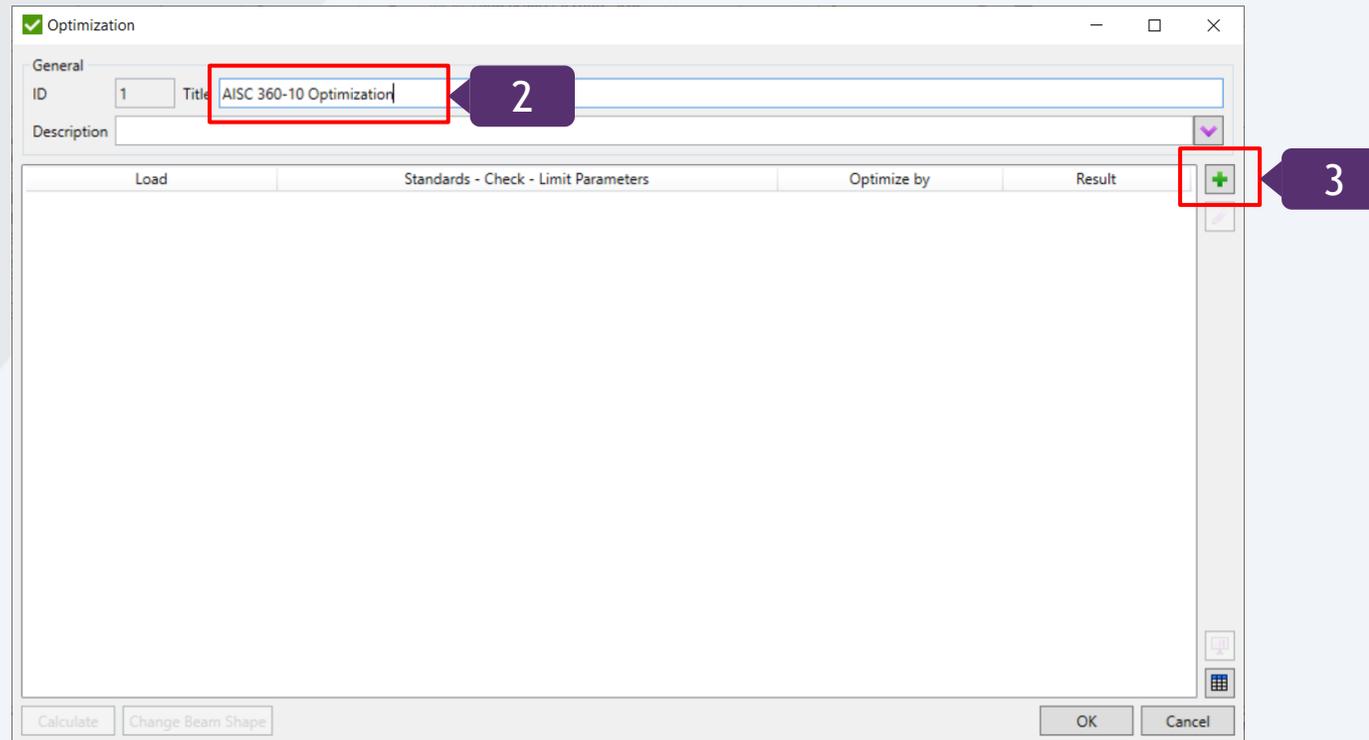
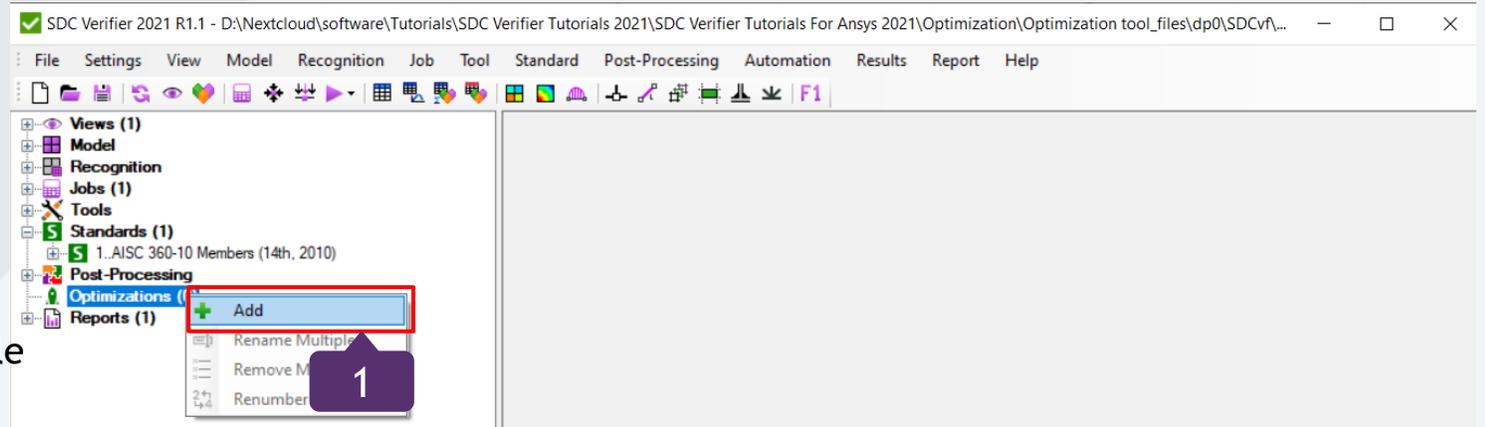


Some members of property '2..IPE400' have Uf Overall value above 1. We're now going to create an Optimization rule for this members

1 Select Optimizations > Add

2 Title: AISC 360-10 Optimization

3 Press  To create your first Optimization Rule



Optimization Rule

1

Click on **Select Load**

In the opened window select Load Group 1

2

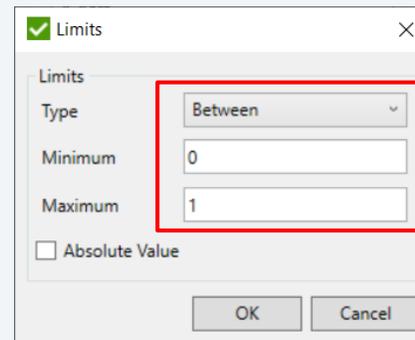
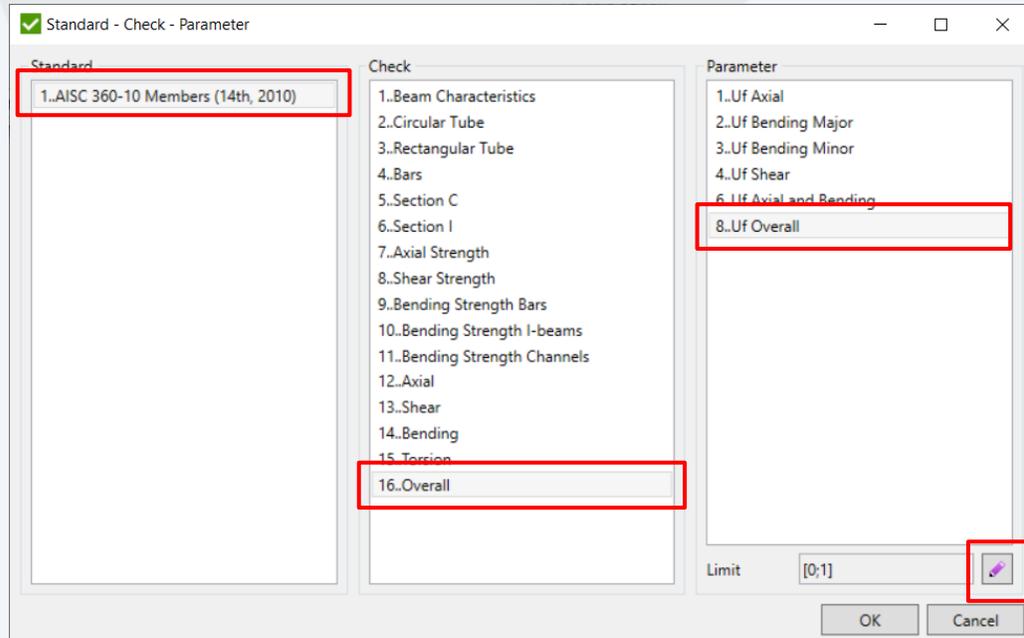
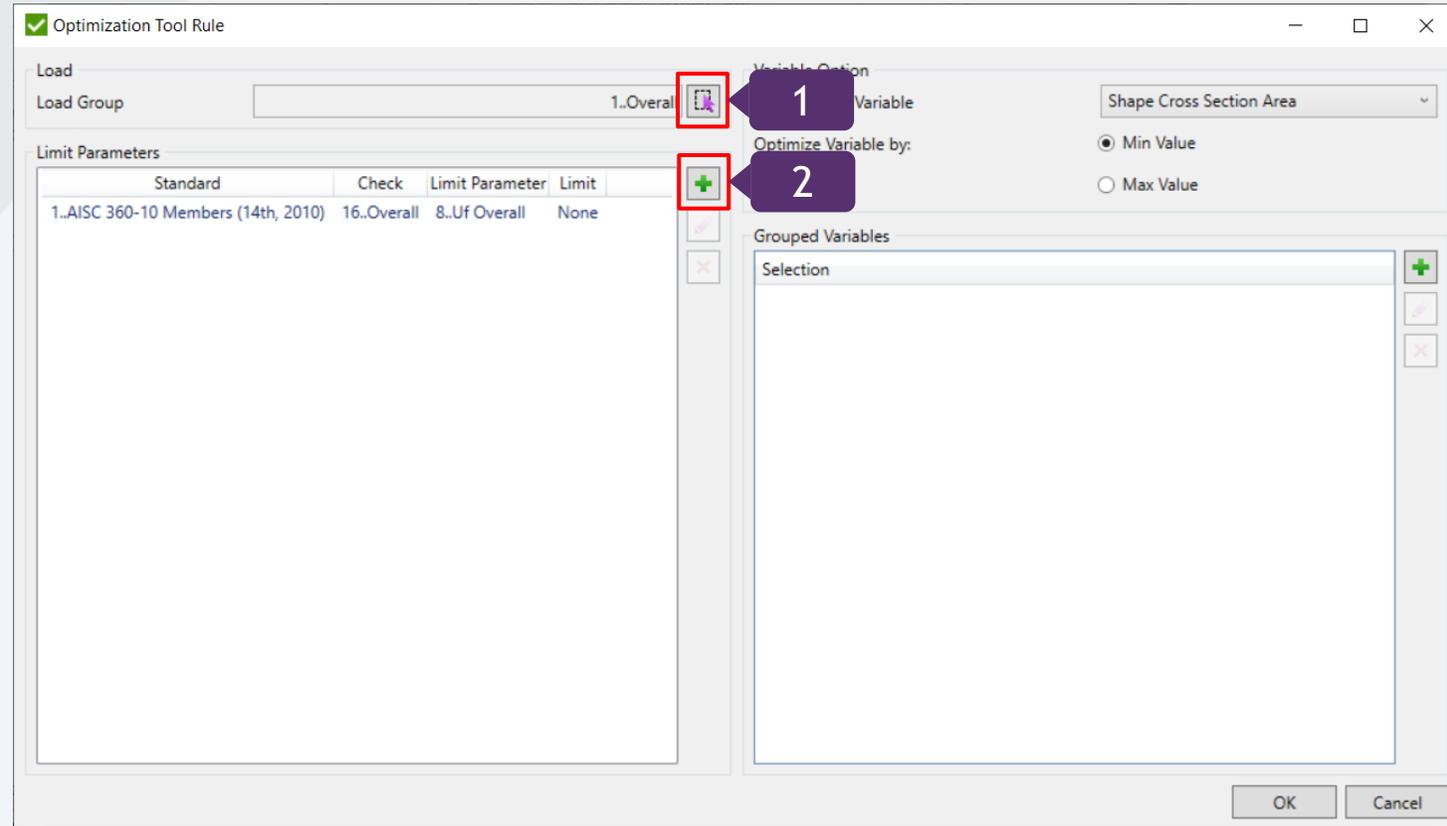
Click on **Select Limit Parameters**

3

In the opened window select Standard / Check / Parameter as shown below

4

Click on **Limits**. Set Between 0 and 1



Note: If you have multiple Standards calculated in your SDC Verifier Project you will have all of them listed in **Select Limit Parameters**

1

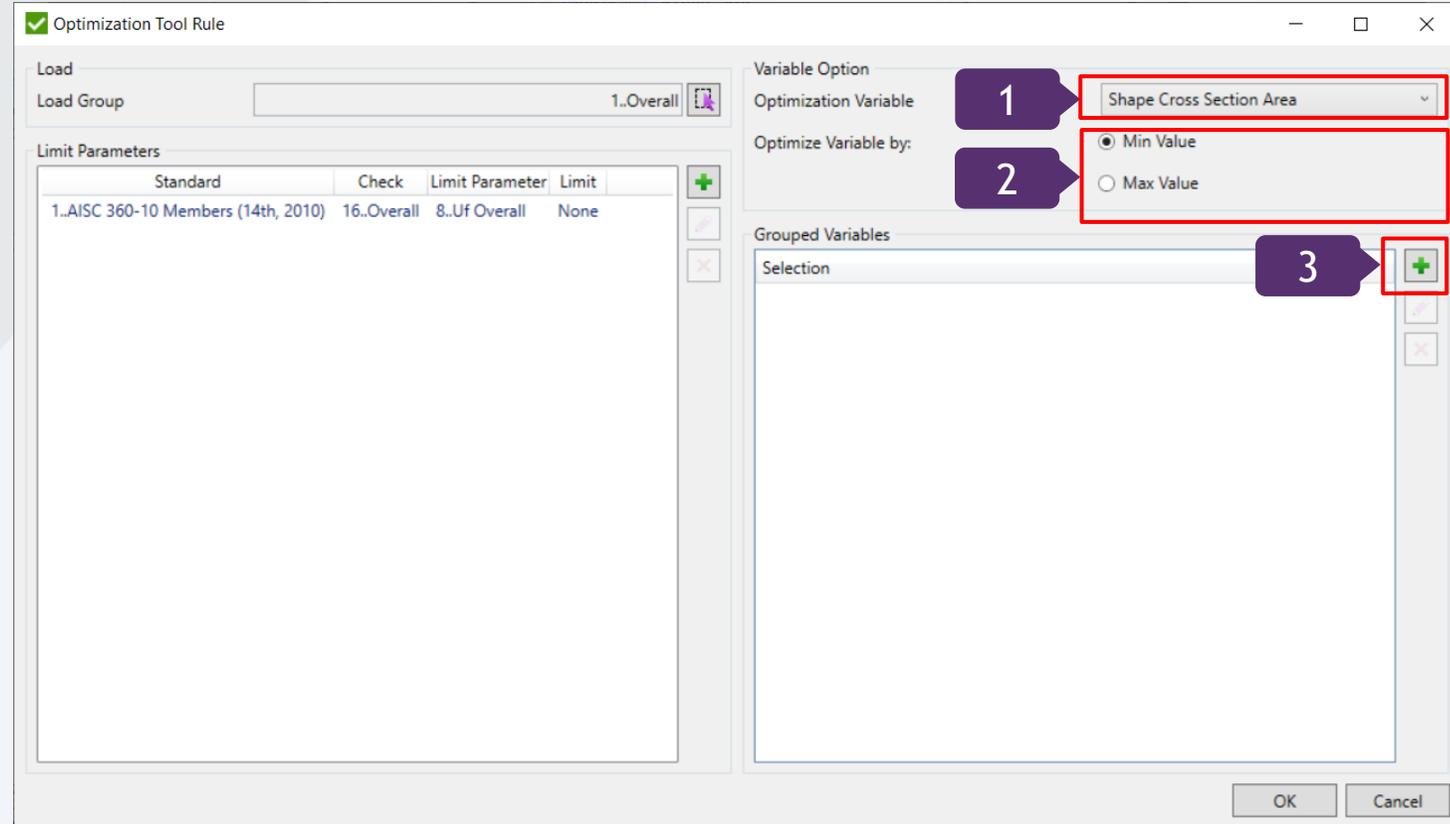
Set *Optimization Variable*:
Shape Cross Section Area

2

Set *Optimize Variable By*:
Min Value

3

Click on  to Select the
Variables to be Optimized

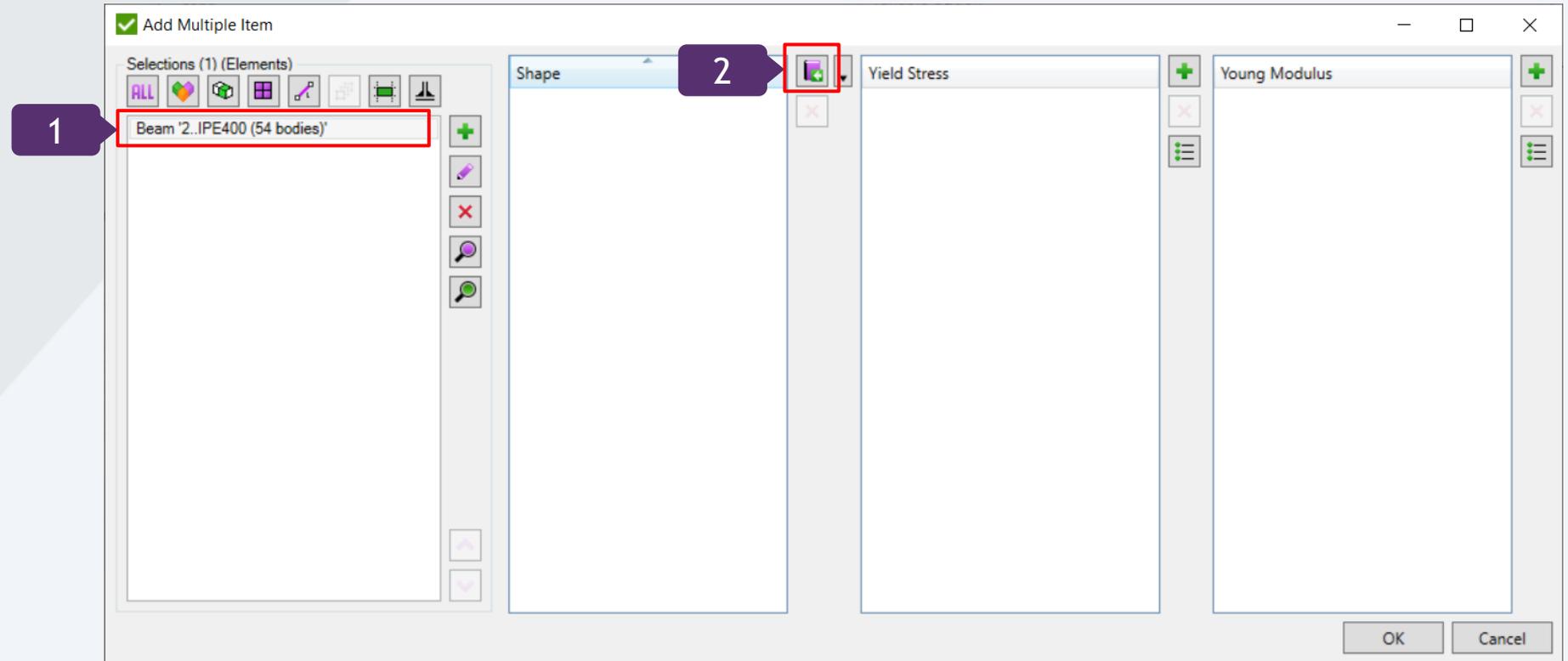


1

Using *Rule Based Selector*
Pick Property '2..IPE400'

2

Click on  to open
Shape Library



Shape Library contains a list of predefined or user defined shapes that can be used in the Optimization, Shapes can be filtered, Organized in Lists, Added or Modified.

Shape Library

Filter by
Name Shape Lists All

	Name	Type	Width, [m]	Height, [m]	Area, [m ²]	lyy, [m ⁴]	lzz, [m ⁴]
<input type="checkbox"/>	W44X335	I-Beam	0.40	1.12	0.06	0.01	4.952e-04
<input type="checkbox"/>	W44X290	I-Beam	0.40	1.11	0.06	0.01	4.333e-04
<input type="checkbox"/>	W44X262	I-Beam	0.40	1.10	0.05	0.01	3.893e-04
<input type="checkbox"/>	W44X230	I-Beam	0.40	1.09	0.04	0.01	3.344e-04
<input type="checkbox"/>	W40X593	I-Beam	0.42	1.09	0.11	0.02	1.052e-03
<input type="checkbox"/>	W40X503	I-Beam	0.42	1.07	0.10	0.02	8.498e-04
<input type="checkbox"/>	W40X431	I-Beam	0.41	1.05	0.08	0.01	6.996e-04
<input checked="" type="checkbox"/>	W40X397	I-Beam	0.41	1.04	0.08	0.01	6.396e-04
<input type="checkbox"/>	W40X372	I-Beam	0.41	1.03	0.07	0.01	5.959e-04
<input type="checkbox"/>	W40X362	I-Beam	0.41	1.03	0.07	0.01	5.733e-04
<input type="checkbox"/>	W40X324	I-Beam	0.40	1.02	0.06	0.01	5.063e-04
<input type="checkbox"/>	W40X297	I-Beam	0.40	1.01	0.06	0.01	4.528e-04
<input type="checkbox"/>	W40X277	I-Beam	0.40	1.01	0.05	0.01	4.333e-04
<input type="checkbox"/>	W40X249	I-Beam	0.40	1.00	0.05	0.01	3.893e-04
<input type="checkbox"/>	W40X215	I-Beam	0.40	0.99	0.04	0.01	3.344e-04
<input type="checkbox"/>	W40X199	I-Beam	0.40	0.98	0.04	0.01	2.933e-04
<input type="checkbox"/>	W40X392	I-Beam	0.31	1.06	0.07	0.01	3.375e-04
<input type="checkbox"/>	W40X331	I-Beam	0.31	1.04	0.06	0.01	2.710e-04
<input type="checkbox"/>	W40X327	I-Beam	0.31	1.04	0.06	0.01	2.643e-04
<input type="checkbox"/>	W40X294	I-Beam	0.30	1.03	0.06	0.01	2.332e-04
<input type="checkbox"/>	W40X278	I-Beam	0.30	1.02	0.05	0.01	2.187e-04
<input type="checkbox"/>	W40X264	I-Beam	0.30	1.02	0.05	0.01	2.037e-04
<input type="checkbox"/>	W40X235	I-Beam	0.30	1.01	0.04	0.01	1.857e-04
<input type="checkbox"/>	W40X211	I-Beam	0.30	1.00	0.04	0.01	1.626e-04
<input type="checkbox"/>	W40X183	I-Beam	0.30	0.99	0.03	0.01	1.373e-04
<input type="checkbox"/>	W40X167	I-Beam	0.30	0.98	0.03	4.841e-03	1.180e-04

Show Selected Shapes (0) Displaying 6744 of 6744 shapes

Selected Shape W40X397

Area, [m ²]	0.08	Y Shear Area, [m ²]	0
Moment of Inertia, Izz, [m ⁴]	6.396e-04	Z Shear Area, [m ²]	0
Moment of Inertia, Iyy, [m ⁴]	0.01	Nonstructural Mass/length, [kg/m]	0
Moment of Inertia, Izy, [m ⁴]	0	Warping Constant, [m ⁶]	1.530e-04
Torsional Constant, [m ⁴]	6.039e-05	Perimeter, [m]	0

OK Cancel

1 Type In **Filter by Name:** IPE
(With the SPACE after E, to filter out the Pipe sections)

2 Select Following Cross Sections:
IPE 360, 400, 450, 500, 550, 600

3 Click OK to close the Shape Library

4 Click OK to close the Variables Selector And OK to close Optimization Rule

Now Optimization Rule is ready to be calculated

Name	Type	Width, [m]	Height, [m]	Area, [m ²]	I _{yy} , [m ⁴]	I _{zz} , [m ⁴]
<input type="checkbox"/> IPE O 330	I-Beam	0.16	0.33	0.01	1.391e-04	9.604e-06
<input type="checkbox"/> IPE A 360	I-Beam	0.17	0.36	0.01	1.452e-04	9.443e-06
<input checked="" type="checkbox"/> IPE 360	I-Beam	0.17	0.36	0.01	1.627e-04	1.043e-05
<input type="checkbox"/> IPE O 360	I-Beam	0.17	0.36	0.01	1.905e-04	1.251e-05
<input type="checkbox"/> IPE A 400	I-Beam	0.18	0.40	0.01	2.030e-04	1.171e-05
<input checked="" type="checkbox"/> IPE 400	I-Beam	0.18	0.40	0.01	2.313e-04	1.318e-05
<input type="checkbox"/> IPE O 400	I-Beam	0.18	0.40	0.01	2.675e-04	1.564e-05
<input type="checkbox"/> IPE A 450	I-Beam	0.19	0.45	0.01	2.976e-04	1.502e-05
<input checked="" type="checkbox"/> IPE 450	I-Beam	0.19	0.45	0.01	3.375e-04	1.676e-05
<input type="checkbox"/> IPE O 450	I-Beam	0.19	0.46	0.01	4.093e-04	2.085e-05
<input type="checkbox"/> IPE A 500	I-Beam	0.20	0.50	0.01	4.294e-04	1.939e-05
<input checked="" type="checkbox"/> IPE 500	I-Beam	0.20	0.50	0.01	4.821e-04	2.142e-05
<input type="checkbox"/> IPE O 500	I-Beam	0.20	0.51	0.01	5.778e-04	2.622e-05
<input type="checkbox"/> IPE A 550	I-Beam	0.21	0.55	0.01	5.999e-04	2.432e-05
<input checked="" type="checkbox"/> IPE 550	I-Beam	0.21	0.55	0.01	6.713e-04	2.668e-05
<input type="checkbox"/> IPE O 550	I-Beam	0.21	0.56	0.02	7.917e-04	3.224e-05
<input type="checkbox"/> IPE A 600	I-Beam	0.22	0.60	0.01	8.293e-04	3.116e-05
<input checked="" type="checkbox"/> IPE 600	I-Beam	0.22	0.60	0.02	9.210e-04	3.387e-05
<input type="checkbox"/> IPE O 600	I-Beam	0.22	0.61	0.02	1.183e-03	4.521e-05
<input type="checkbox"/> IPE 750 x 134	I-Beam	0.26	0.75	0.02	1.507e-03	4.766e-05
<input type="checkbox"/> IPE 750 x 147	I-Beam	0.27	0.75	0.02	1.661e-03	5.289e-05
<input type="checkbox"/> IPE 750 x 173	I-Beam	0.27	0.76	0.02	2.058e-03	6.873e-05
<input type="checkbox"/> IPE 750 x 196	I-Beam	0.27	0.77	0.03	2.403e-03	8.175e-05
<input type="checkbox"/> IPE A 160	I-Beam	0.08	0.16	1.548e-03	6.546e-06	5.430e-07
<input type="checkbox"/> IPE A 180	I-Beam	0.09	0.18	1.888e-03	1.018e-05	8.175e-07
<input type="checkbox"/> IPE A 200	I-Beam	0.10	0.20	2.224e-03	1.494e-05	1.168e-06

1 Execute *Calculate* to run the Optimization

Load	Standards - Check - Limit Parameters	Optimize by	Result
LG1..Overall	1..AISC 360-10 Members (14th, 2010) 16..Overall - 8..Uf Overall, Limit: [0;1]	Min Shape Cross Section Area	

1 Click on *Table* > *All results*

Results for all variables

Group	Yield Stress	Young Modulus	Shape	1..AISC 360-10 Members (1..16..Overall 8..Uf Overall)
Beam '2..IPE400 (54 bodies)'	Original Model	Original Model	Original Model	1.4996
Beam '2..IPE400 (54 bodies)'			IPE 360 - I-Beam	1.8925
Beam '2..IPE400 (54 bodies)'			IPE 400 - I-Beam	1.3989
Beam '2..IPE400 (54 bodies)'			IPE 450 - I-Beam	1.0489
Beam '2..IPE400 (54 bodies)'			IPE 500 - I-Beam	0.7906
Beam '2..IPE400 (54 bodies)'			IPE 550 - I-Beam	0.6087
Beam '2..IPE400 (54 bodies)'			IPE 600 - I-Beam	0.4686

Optimization

General

ID: 1 Title: AISC 360-10 Optimization

Description:

Load	Standards - Check - Limit Parameters	Optimize by	Result
LG1..Overall	1..AISC 360-10 Members (14th, 2010) 16..Overall - 8..Uf Overall, Limit: [0;1]	Min Shape Cross Section Area	Calculated

Calculate Change Beam Shape

Optimal Result
All Result

Optimal result is Beam IPE 500. It will be used for changing the Beam shape

1

Click on *Plot Optimal Result*

Optimization

General

ID: 1 Title: AISC 360-10 Optimization

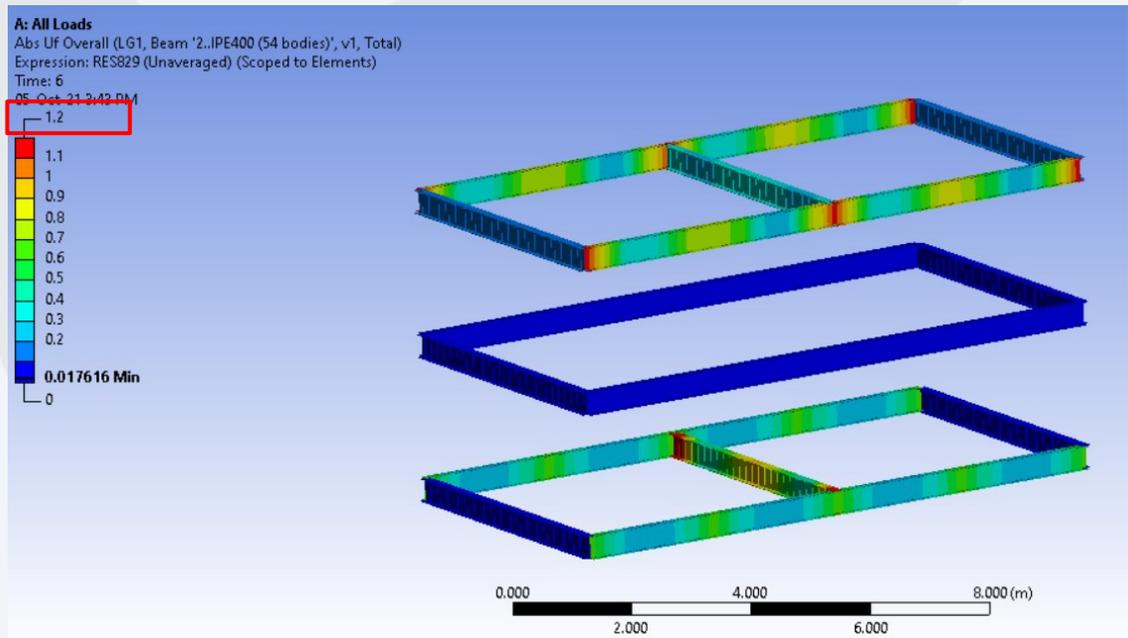
Description:

Load	Standards - Check - Limit Parameters	Optimize by	Result
LG1..Overall	1..AISC 360-10 Members (14th, 2010) 16..Overall - 8..Uf Overall, Limit: [0;1]	Min Shape Cross Section Area	Calculated

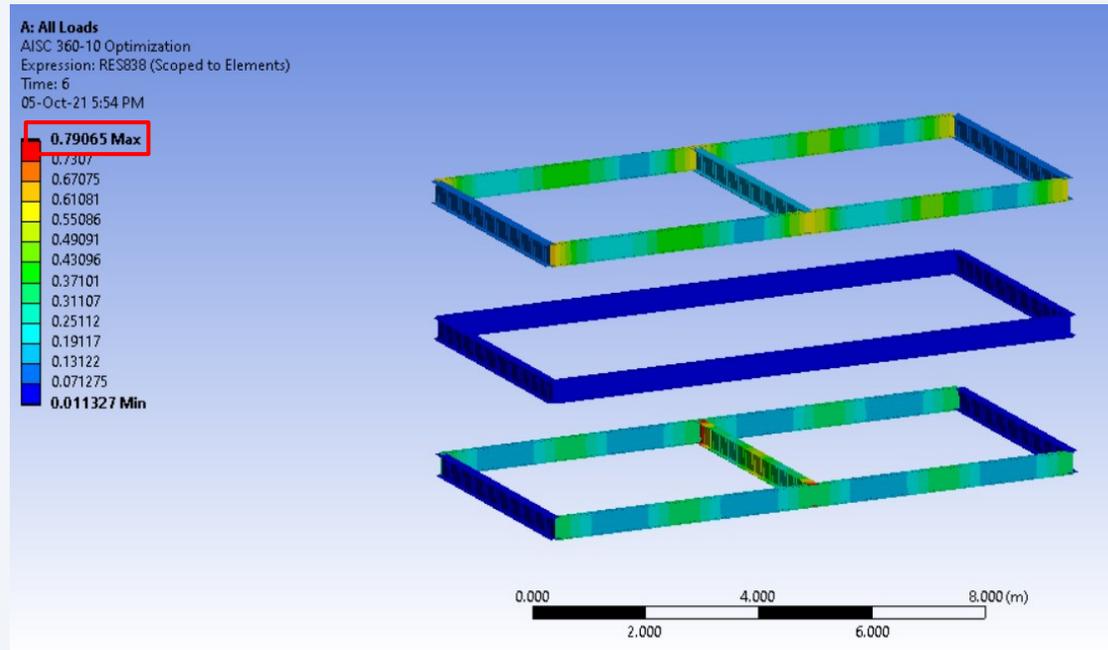
Buttons: Calculate, Change Beam Shape, OK, Cancel

Callout 1 points to the Plot Optimal Result button.

Result Before the Optimization



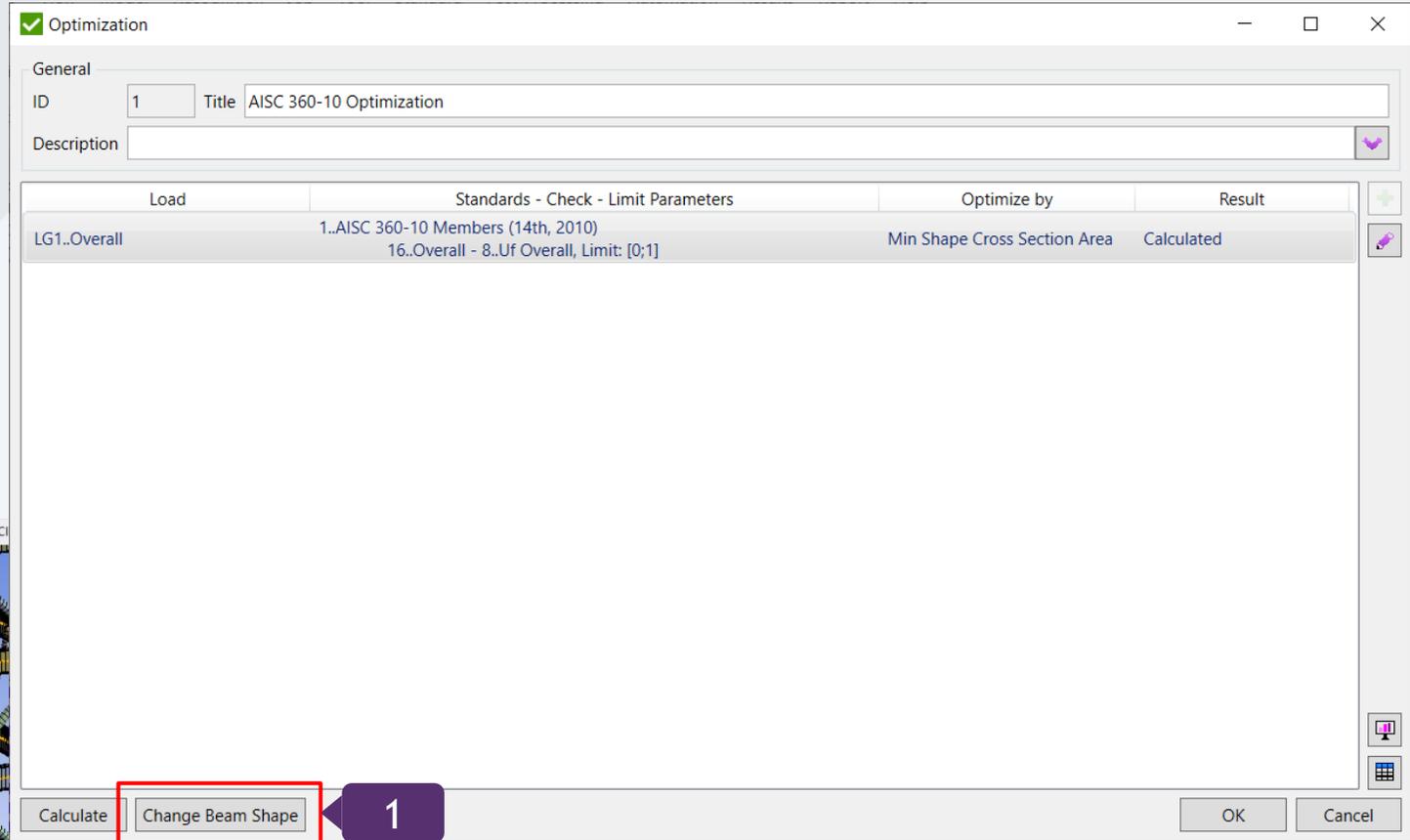
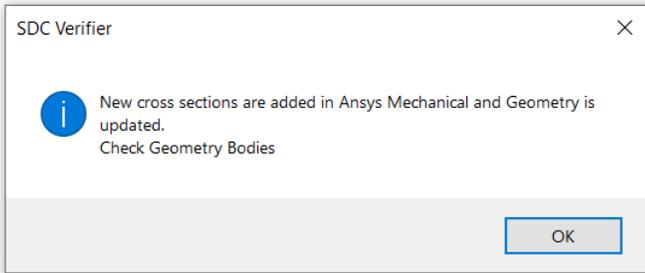
Result After the Optimization



This Tutorial only demonstrates the workflow with Optimization Tool. Optimization rule can be set more precisely. For Example, using the Peak Finder you can group only the overshooting elements into a Component and run the optimization on this Component. Multiple rules with different variables can be set.

Changing the Beam Shape

1 Click on *Change Beam Shape*



Property IPE400 is automatically replaced by IPE 500 (Optimal Result)