



Tutorial

Optimization

Updated on: 05.10.2021

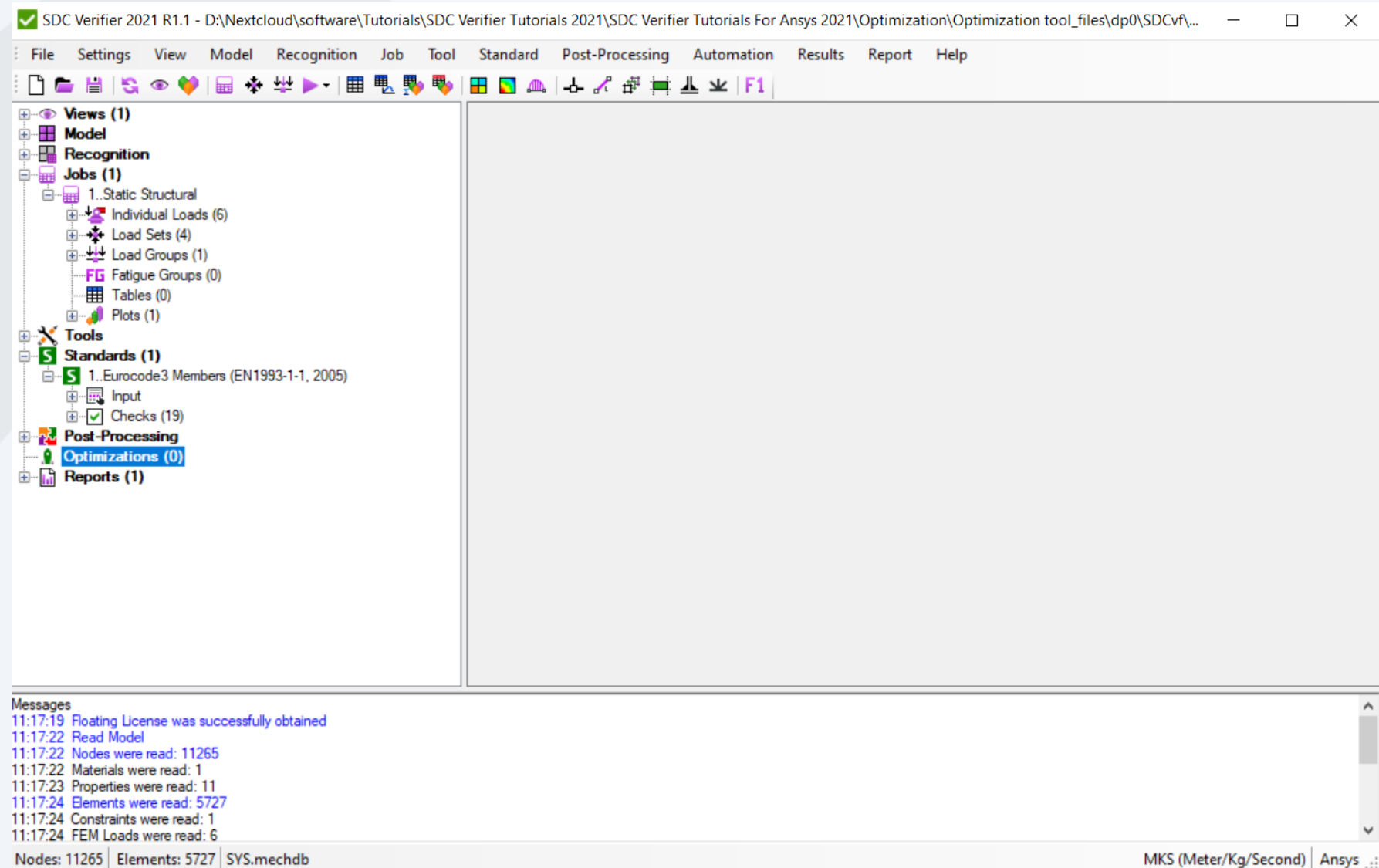
Tested with: SDC Verifier 2021R1.1

Femap 2021.1

- 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.

Project Description

This SDC Verifier project has predefined loading combinations, recognition of beam members, and AISC 360-10 Members check.

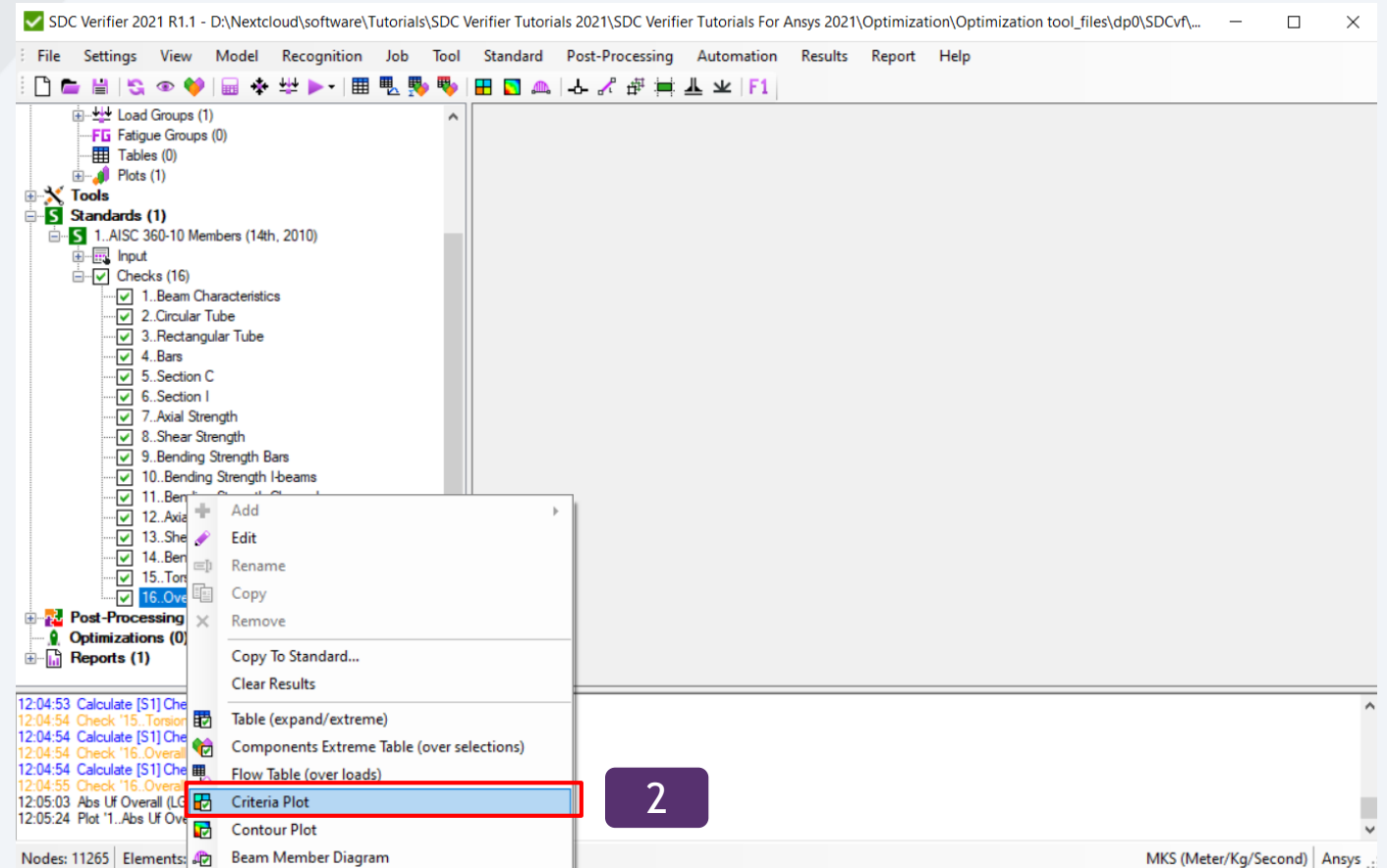


AISC Results Plot

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

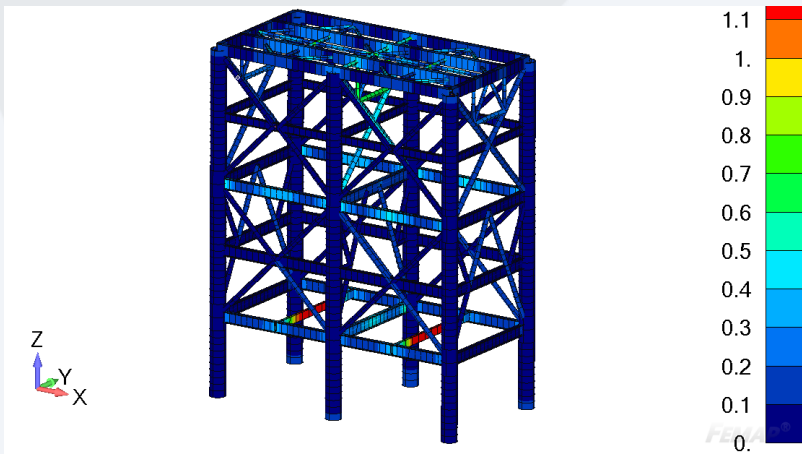
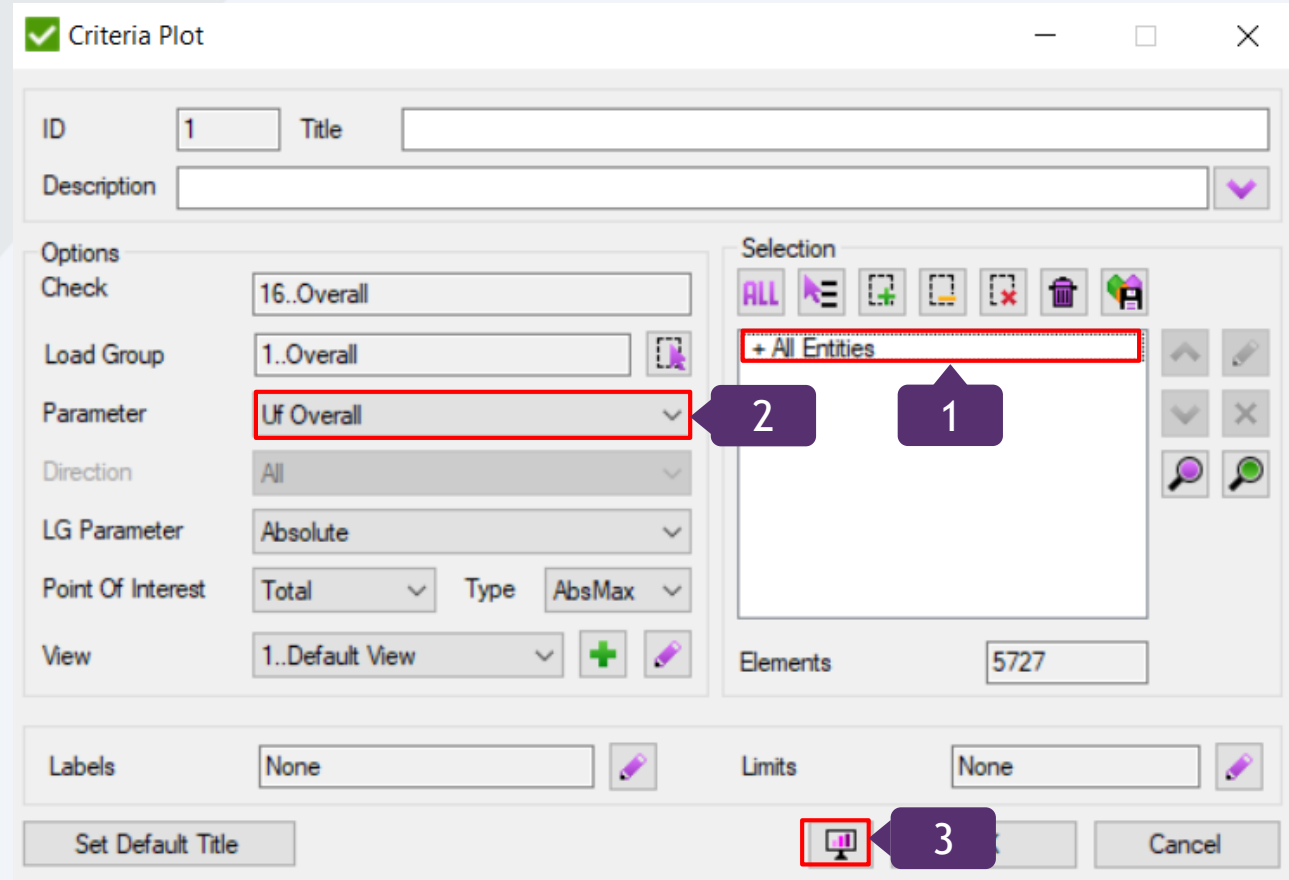
1 Selection: All Entities

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

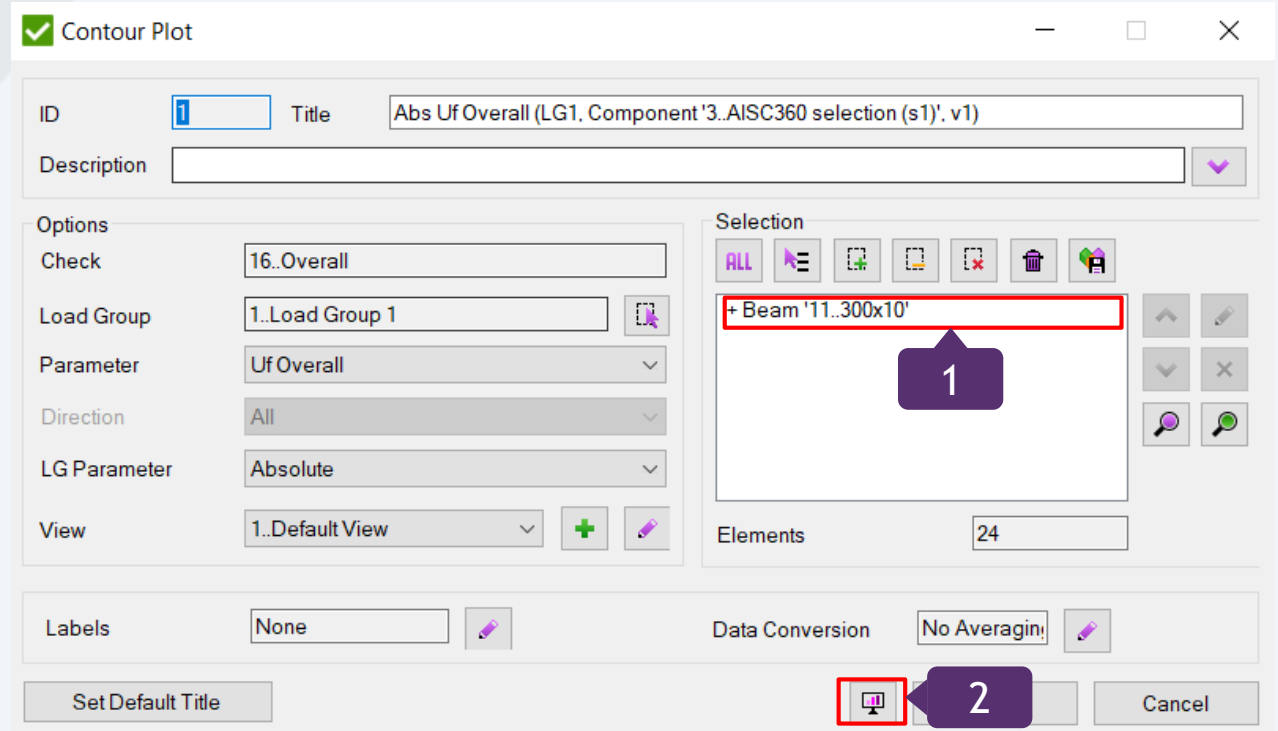
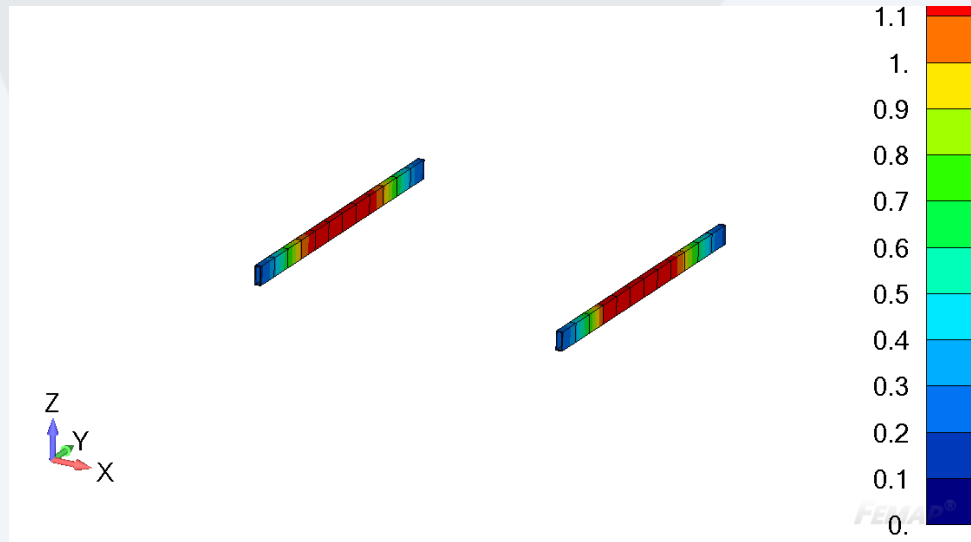
Selection: **Property Beam 11..300x10**

2

Press *Plot*




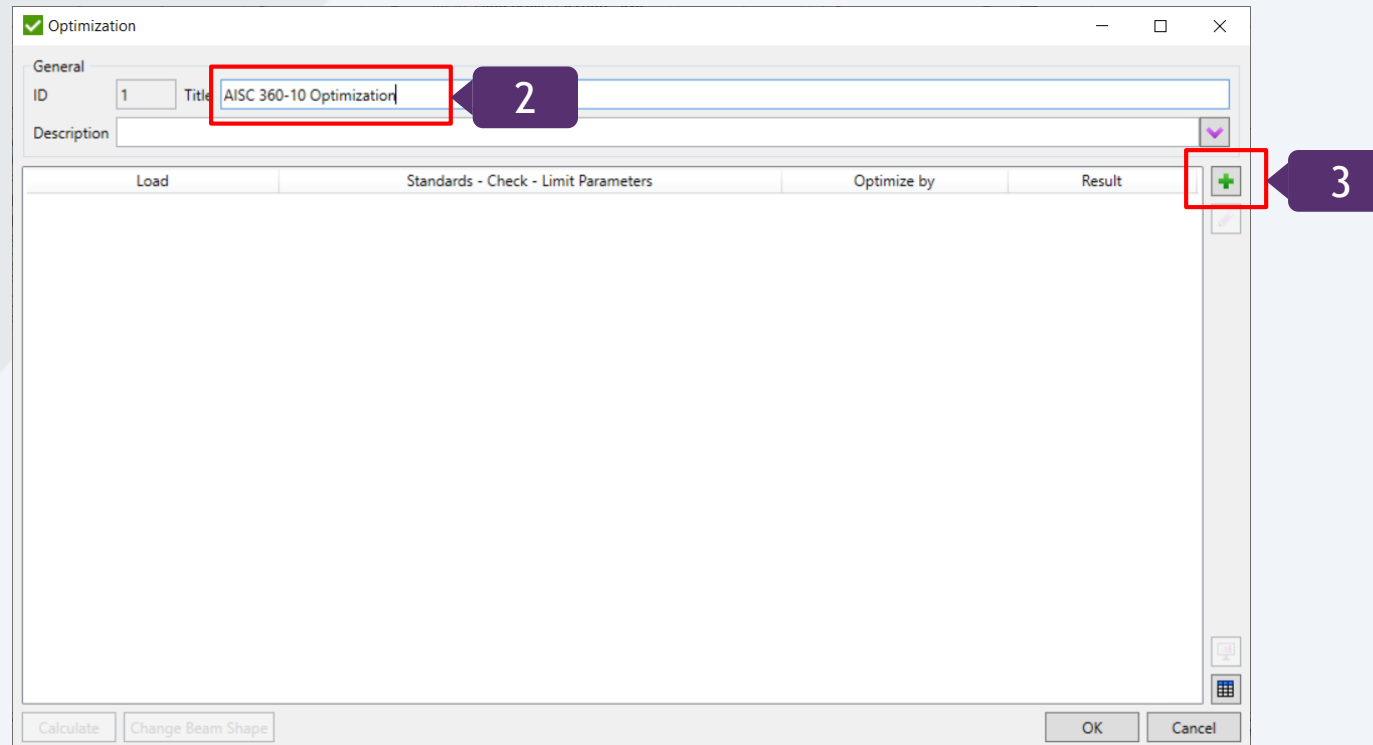
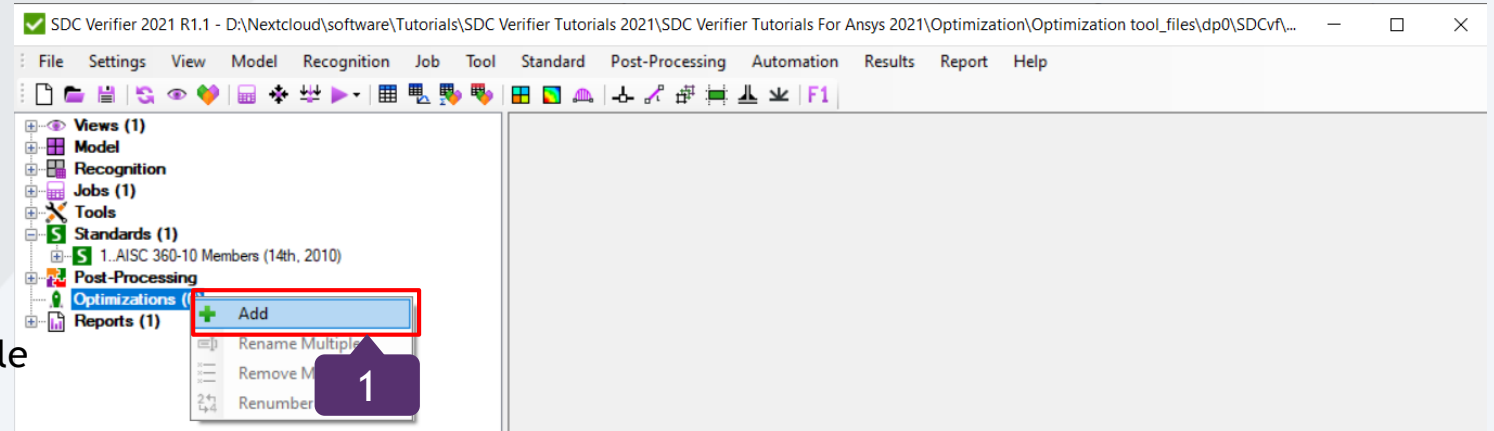
Plot will be displayed in Ansys Mechanical Window



Some members of property '11..300x10' have UF Overall value above 1. We're now going to create an Optimization rule for this members

Optimization Rule

- 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

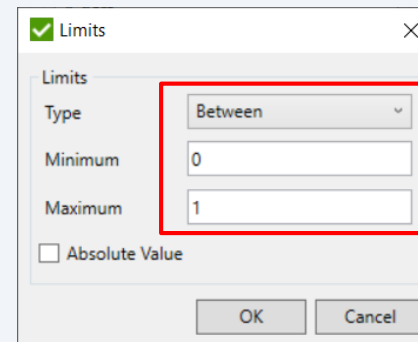
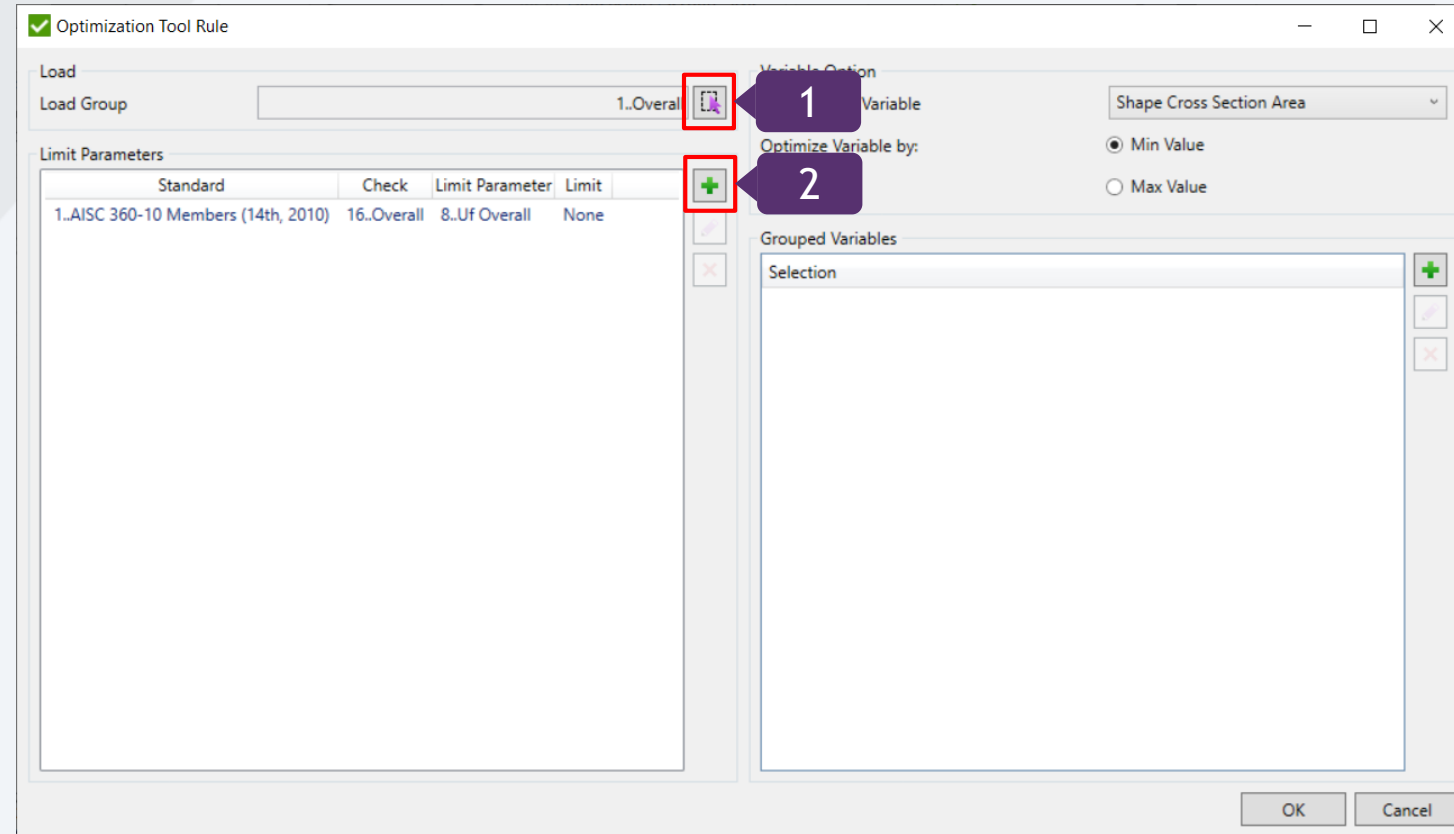
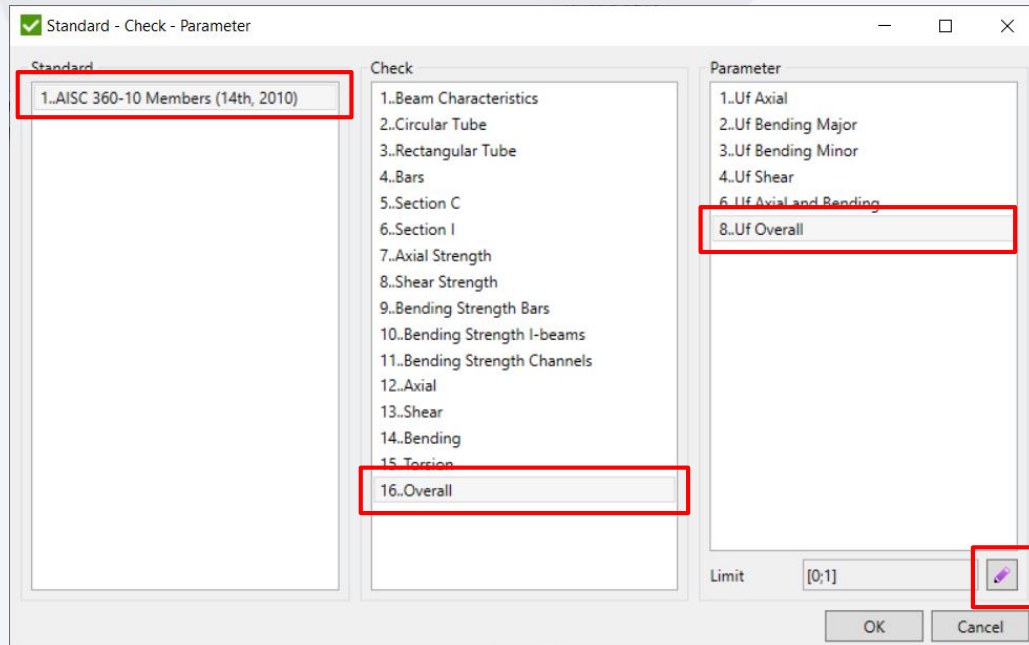
Click on **Select Limit Parameters** 

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**

Optimization Rule


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

Optimization Tool Rule

Load
Load Group: 1..Overall

Limit Parameters

| Standard | Check | Limit Parameter | Limit |
|-------------------------------------|-------------|-----------------|-------|
| 1..AISC 360-10 Members (14th, 2010) | 16..Overall | 8..Uf Overall | None |


Variable Option

Optimization Variable: 1 Shape Cross Section Area

Optimize Variable by: 2

☒ Min Value
☐ Max Value

Grouped Variables

Selection: 3 


OK Cancel

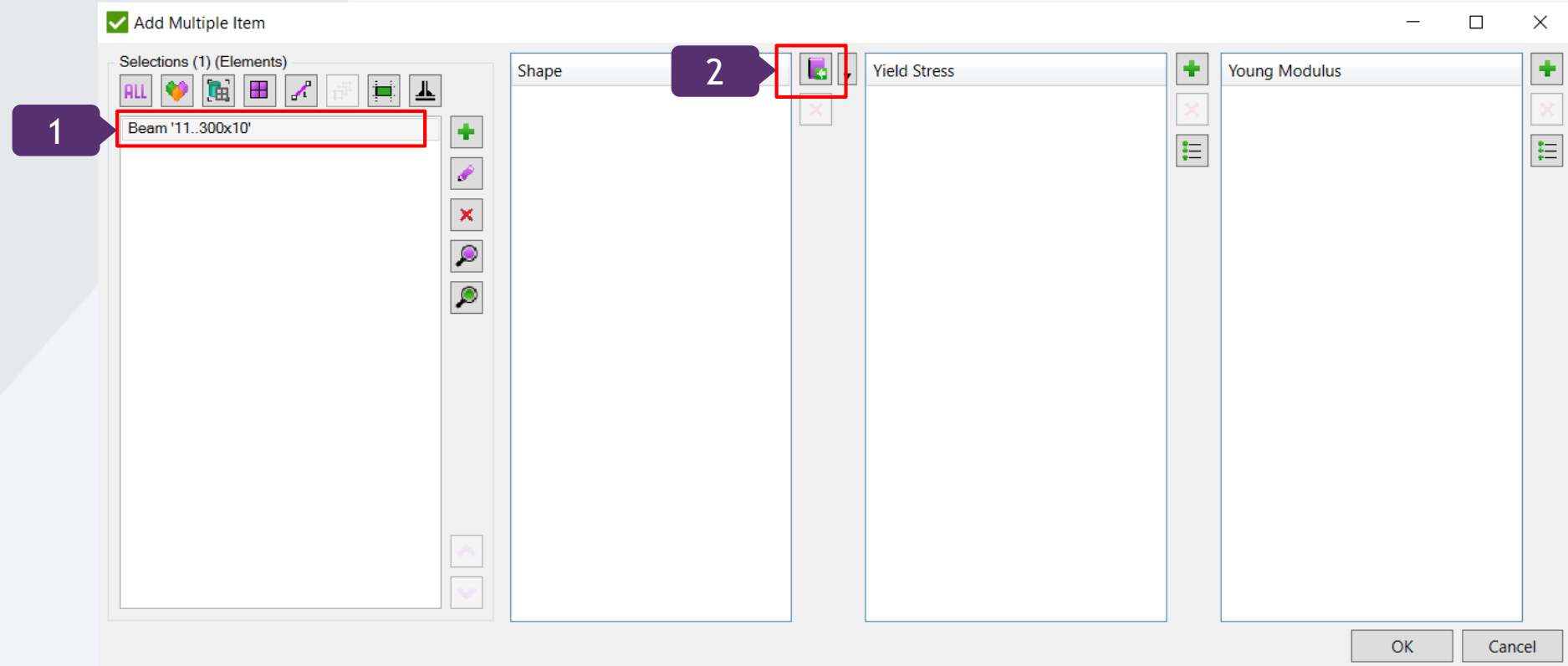
Optimization Rule

1

Using **Rule Based Selector**
Pick Property '11..300x10'

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] | I _{yy} , [m ⁴] | I _{zz} , [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 |

Selected Shape W40X397

Area, [m²] Y Shear Area, [m²]

Moment of Inertia, I_{zz}, [m⁴] Z Shear Area, [m²]

Moment of Inertia, I_{yy}, [m⁴] Nonstructural Mass/length, [kg/m]

Moment of Inertia, I_{zy}, [m⁴] Warping Constant, [m⁶]

Torsional Constant, [m⁴] Perimeter, [m]

☐ Show Selected Shapes (0) Displaying 6744 of 6744 shapes

OK Cancel

1

Filter the shapes by name or type

2

Select the cross sections to be used
For the optimization

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

Shape Library

Filter by

Shape Lists All

| Name | Type | Width, [m] | Height, [m] | Area, [m^2] | Iyy, [m^4] | Izz, [m^4] |
|---------------------------------------------------|------------------|------------|-------------|-------------|------------|------------|
| <input type="checkbox"/> HSS12X6X.250 | Rectangular Tube | 0.15 | 0.30 | 0.01 | 6.509e-05 | 2.210e-05 |
| <input checked="" type="checkbox"/> HSS12X6X.313 | Rectangular Tube | 0.15 | 0.30 | 0.01 | 7.988e-05 | 2.692e-05 |
| <input type="checkbox"/> HSS12X6X.375 | Rectangular Tube | 0.15 | 0.30 | 0.01 | 9.413e-05 | 3.148e-05 |
| <input checked="" type="checkbox"/> HSS12X6X.500 | Rectangular Tube | 0.15 | 0.30 | 0.01 | 1.211e-04 | 3.987e-05 |
| <input type="checkbox"/> HSS12X4X.500 | Rectangular Tube | 0.10 | 0.30 | 0.01 | 9.529e-05 | 1.553e-05 |
| <input checked="" type="checkbox"/> HSS12X6X.625 | Rectangular Tube | 0.15 | 0.30 | 0.01 | 1.460e-04 | 4.734e-05 |
| <input type="checkbox"/> HSS12X8X.250 | Rectangular Tube | 0.20 | 0.30 | 0.01 | 7.852e-05 | 4.203e-05 |
| <input type="checkbox"/> HSS12X8X.313 | Rectangular Tube | 0.20 | 0.30 | 0.01 | 9.649e-05 | 5.145e-05 |
| <input type="checkbox"/> HSS12X8X.375 | Rectangular Tube | 0.20 | 0.30 | 0.01 | 1.139e-04 | 6.048e-05 |
| <input checked="" type="checkbox"/> HSS12X8X.500 | Rectangular Tube | 0.20 | 0.30 | 0.01 | 1.468e-04 | 7.742e-05 |
| <input type="checkbox"/> HSS12X8X.625 | Rectangular Tube | 0.20 | 0.30 | 0.01 | 1.776e-04 | 9.291e-05 |
| <input type="checkbox"/> HSS12X10X.250 | Rectangular Tube | 0.25 | 0.30 | 0.01 | 9.195e-05 | 6.953e-05 |
| <input type="checkbox"/> HSS12X8X.188 | Rectangular Tube | 0.20 | 0.30 | 4.412e-03 | 5.961e-05 | 3.203e-05 |
| <input type="checkbox"/> HSS12X4X.375 | Rectangular Tube | 0.10 | 0.30 | 0.01 | 7.440e-05 | 1.253e-05 |
| <input type="checkbox"/> HSS12X4X.313 | Rectangular Tube | 0.10 | 0.30 | 0.01 | 6.327e-05 | 1.082e-05 |
| <input type="checkbox"/> HSS12X4X.250 | Rectangular Tube | 0.10 | 0.30 | 4.670e-03 | 5.166e-05 | 8.981e-06 |
| <input checked="" type="checkbox"/> HSS10X10X.188 | Rectangular Tube | 0.25 | 0.25 | 4.412e-03 | 4.582e-05 | 4.582e-05 |
| <input type="checkbox"/> HSS10X10X.250 | Rectangular Tube | 0.25 | 0.25 | 0.01 | 6.027e-05 | 6.027e-05 |
| <input type="checkbox"/> HSS10X10X.313 | Rectangular Tube | 0.25 | 0.25 | 0.01 | 7.397e-05 | 7.397e-05 |
| <input type="checkbox"/> HSS10X10X.375 | Rectangular Tube | 0.25 | 0.25 | 0.01 | 8.717e-05 | 8.717e-05 |
| <input type="checkbox"/> HSS10X10X.500 | Rectangular Tube | 0.25 | 0.25 | 0.01 | 1.121e-04 | 1.121e-04 |
| <input type="checkbox"/> HSS10X10X.625 | Rectangular Tube | 0.25 | 0.25 | 0.01 | 1.352e-04 | 1.352e-04 |
| <input type="checkbox"/> HSS12X2X.188 | Rectangular Tube | 0.05 | 0.30 | 3.065e-03 | 2.923e-05 | 1.508e-06 |
| <input type="checkbox"/> HSS12X2X.250 | Rectangular Tube | 0.05 | 0.30 | 4.069e-03 | 3.823e-05 | 1.886e-06 |
| <input checked="" type="checkbox"/> HSS12X2X.313 | Rectangular Tube | 0.05 | 0.30 | 0.01 | 4.666e-05 | 2.201e-06 |
| <input type="checkbox"/> HSS12X3X.188 | Rectangular Tube | 0.08 | 0.30 | 3.290e-03 | 3.429e-05 | 3.700e-06 |
| <input type="checkbox"/> HSS12X3X.250 | Rectangular Tube | 0.08 | 0.30 | 1.370e-03 | 1.405e-05 | 1.730e-06 |

Selected Shape HSS10X10X.188

Area, [m^2] 4.412e-03 Y Shear Area, [m^2] 0

Moment of Inertia, Izz, [m^4] 4.582e-05 Z Shear Area, [m^2] 0

Moment of Inertia, Iyy, [m^4] 4.582e-05 Nonstructural Mass/length, [kg/m] 0

Moment of Inertia, Izy, [m^4] 0 Warping Constant, [m^6] 0

Torsional Constant, [m^4] 6.937e-05 Perimeter, [m] 0

0.254 0.0047625

3 OK Cancel

Show Selected Shapes (8) Displaying 6744 of 6744 shapes

1

Execute *Calculate* to run the Optimization

Optimization

General

ID1TitleAISC 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 | |

1

CalculateChange Beam Shape

OKCancel

1

Click on *Table > All results*

Results for all variables

Result Table

| Group | Yield Stress | Young Modulus | Shape | 1..AISC 360-10 Members (1-16..Overall 8..Uf Overall |
|-------------------|----------------|----------------|-----------------------------|--------------------------------------------------------|
| Beam '11..300x10' | Original Model | Original Model | Original Model | 1.51 |
| Beam '11..300x10' | | | HSS20X8X.625 - Rectangular | 0.58 |
| Beam '11..300x10' | | | HSS20X4X.500 - Rectangular | 1.66 |
| Beam '11..300x10' | | | HSS20X4X.313 - Rectangular | 2.50 |
| Beam '11..300x10' | | | HSS16X8X.250 - Rectangular | 1.63 |
| Beam '11..300x10' | | | HSS14X10X.250 - Rectangular | 1.37 |

Close

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 HSS20x8x625. It will be used for changing the Beam shape

1

Click on *Plot Optimal Result*

Optimization

General

ID: 1 Title: AISC 360-10 Optimization

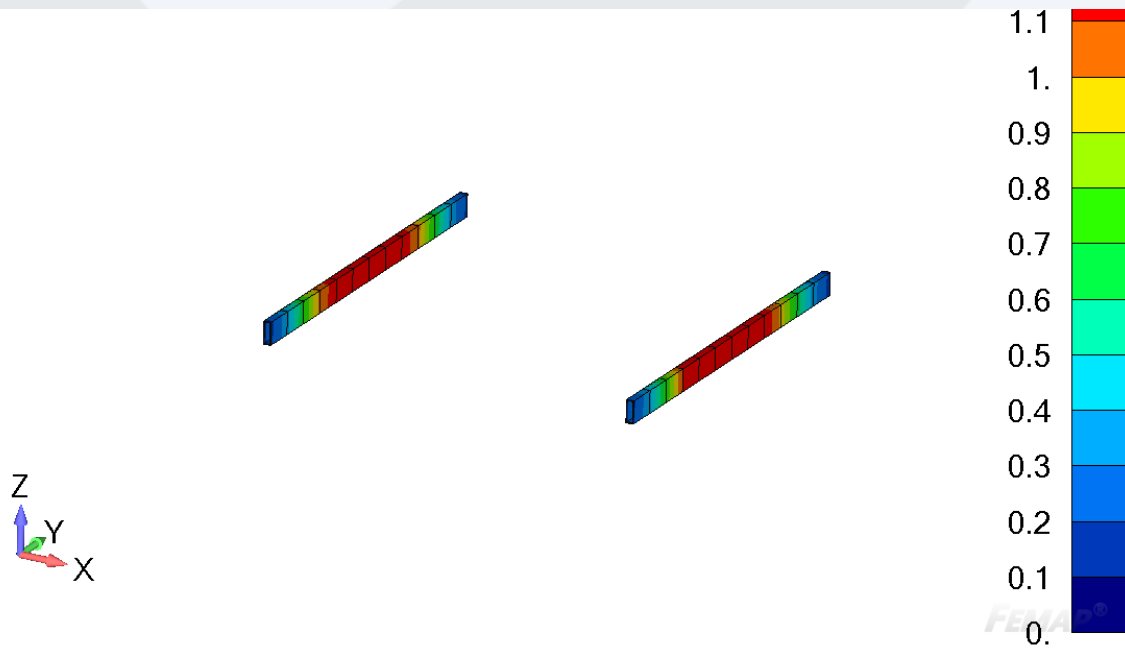
Description:

| 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 |

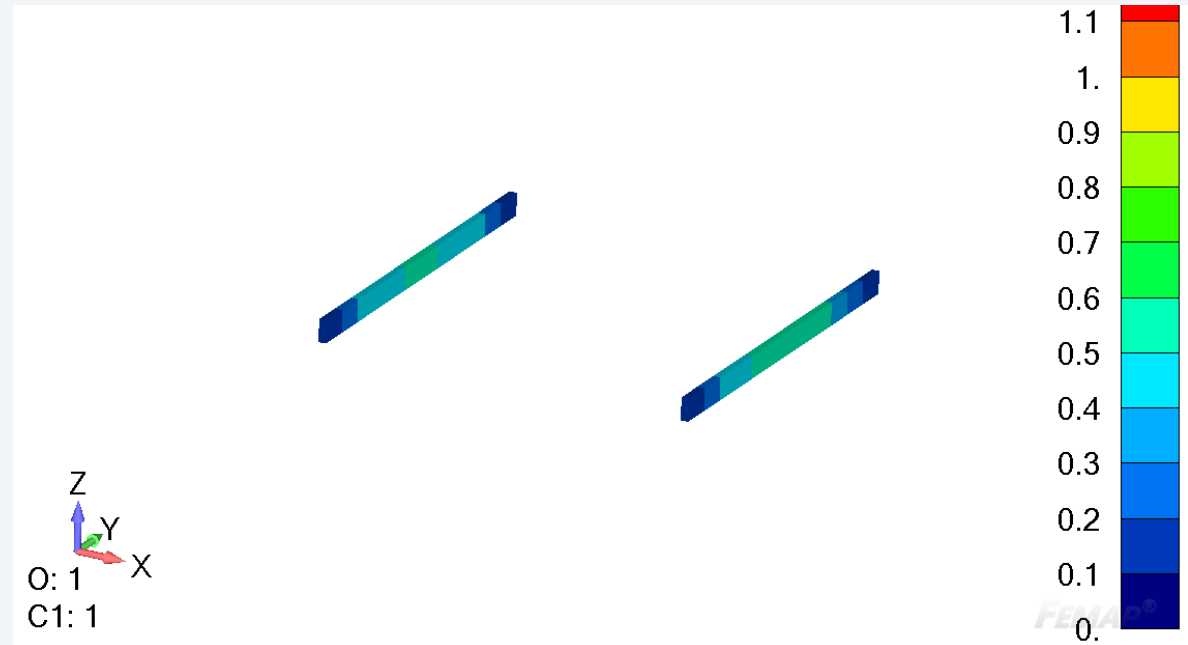
1

Calculate Change Beam Shape OK Cancel

Result Before the Optimization



Result After the Optimization

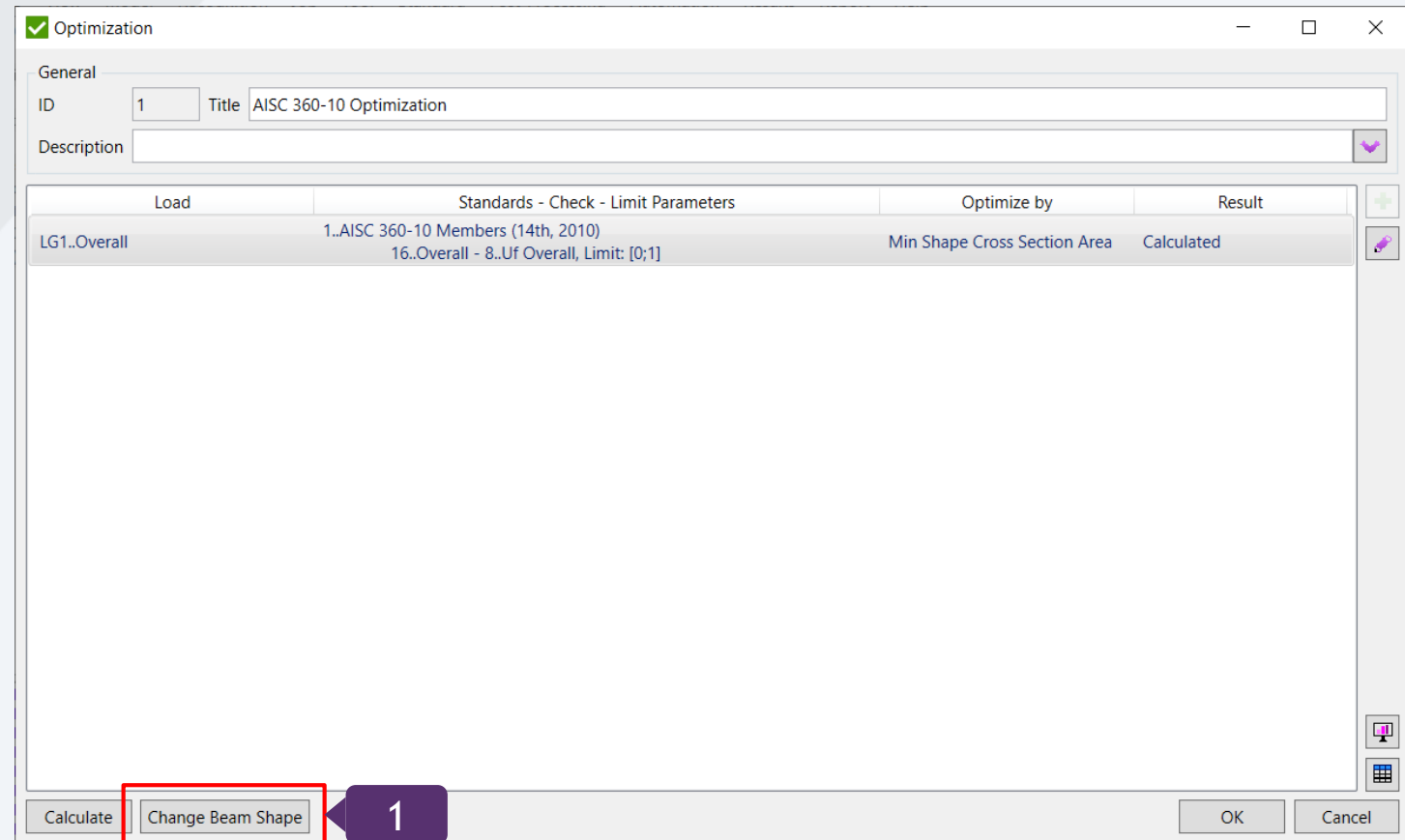
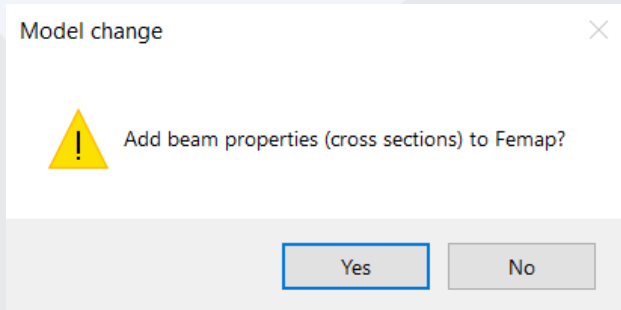


This Tutorial only demonstrates the workflow with Optimization Tool.
Optimization rule can be set more precisely. For Example, using the Peak Finder you can group only the overshooting elements into a Component and run the optimization on this Component. Multiple rules with different variables can be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

Changing the Beam Shape

1

Click on **Change Beam Shape**



Property 300x10 is automatically replaced by
HSS20x8x625(Optimal Result)