SDC VERIFIER

Tutorial

AISC 360-10 and Eurocode3

Updated on: January 17th 2024

Tested with: SDC Verifier 2023 R2

Simcenter3D 2306

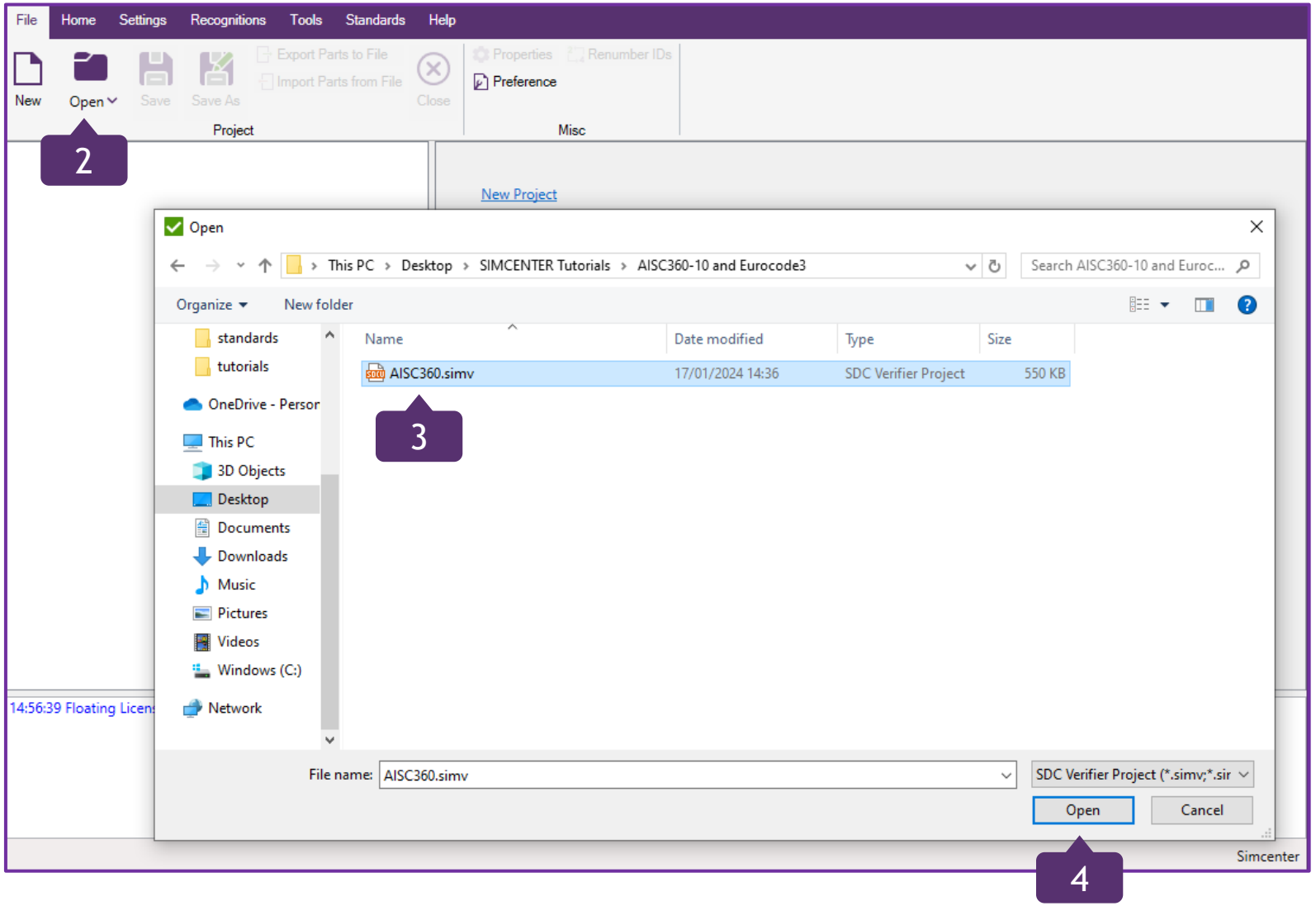
Content

SDC Verifier is a powerful Simcenter add-on that helps verify structures according to standards and generates full calculations reports.

- In this tutorial, AISC 360-10 Members (14th, 2010) & Eurocode3 Members (EN 1993-1-1, 2005) are added;
- Beam Design Checks are reviewed in details;
- A beam model structure has been used as a start FEM model;
- Beam member finder was used to recognize beam member dimensions;
- The functionality of SDC Verifier Report Designer can be checked via the link to a separate tutorial (Slide 31).

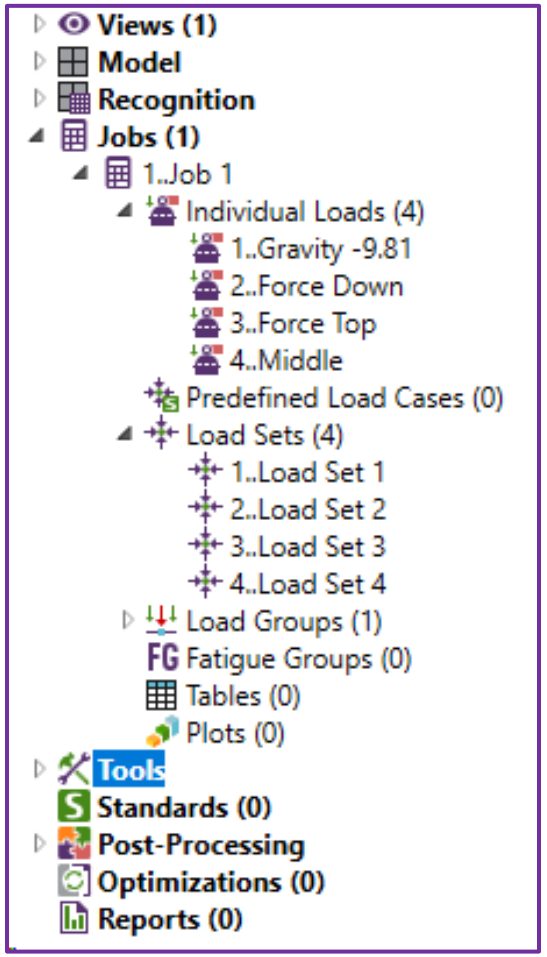
Open the Starter Model

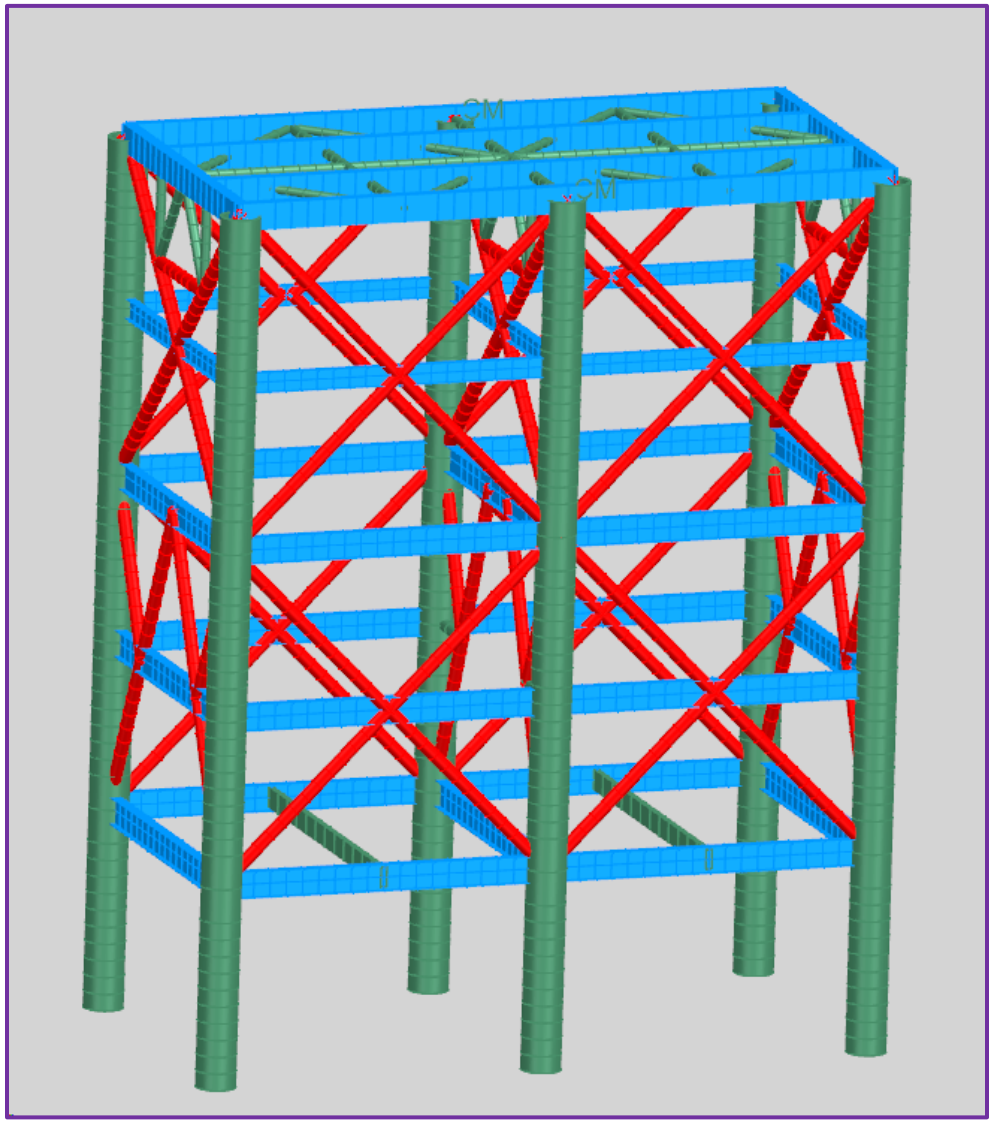
1. **Launch SDC Verifier for Simcenter 3D**
2. In *File* section, press *Open*
3. Select a project *AISC360.simv*
4. Press *Open*



Predefined Project

This tutorial presents the project with predefined Boundary Conditions, Load Combinations and Load Group.
The model contains only beam elements of the following types: I-Beam, Circular and Rectangular Tubes.

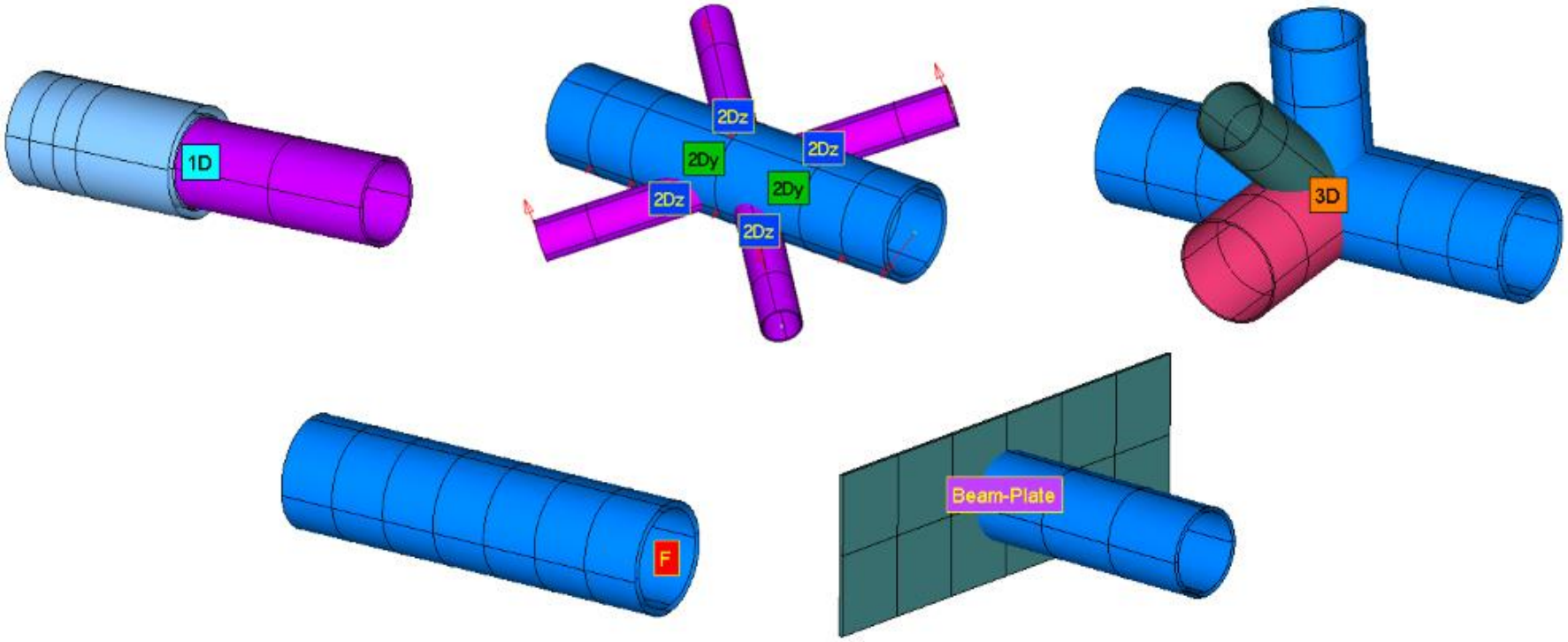




Explanation of Joints

Joint is a location where different Beam Members connect.
They are used to recognize beam member length by Beam Member Finder Tool.

There are 6 types of Joints:
1D Joint – 2 beam members that lie on the curve, but with different properties;
2D Joint – beam members connected in one plane;
3D Joint – beam members connected in space;
Free Joint – a node which belongs only to one element (free);
Beam-Plate Joint – a beam member connected to plates (perpendicularly);
User Defined;



Joints Recognition

1. In the *Model Tree*, expand *Recognition* and select *Joint Finder*
2. Execute right click on *Joint Finder* and select *Edit*
3. Press *Find*
4. Press *OK*

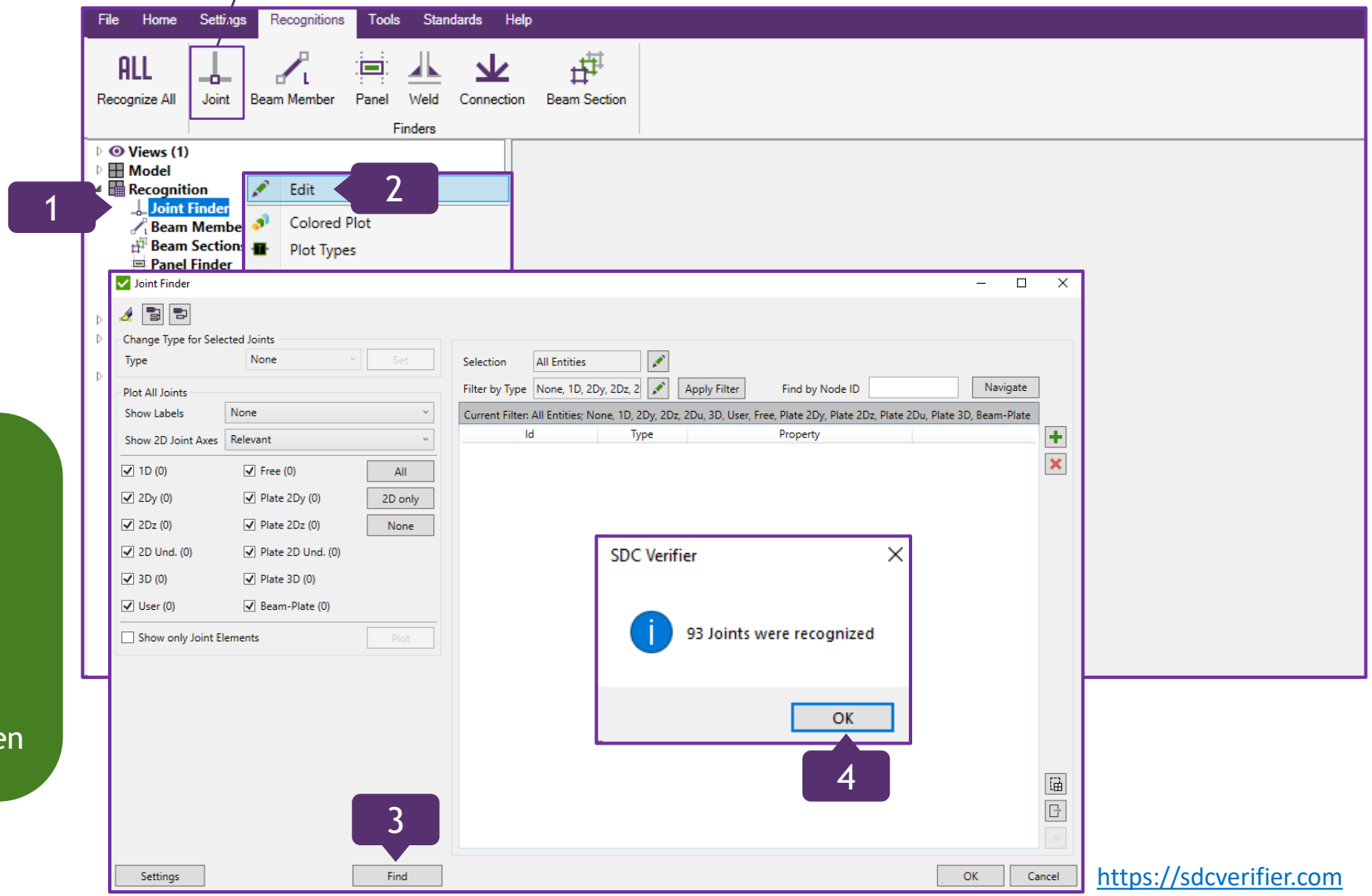
When performing Joint Recognition, there are 3 options for existing joints:

Default option - Keep only modified;

Remove All joints (except for those, edited by a user);

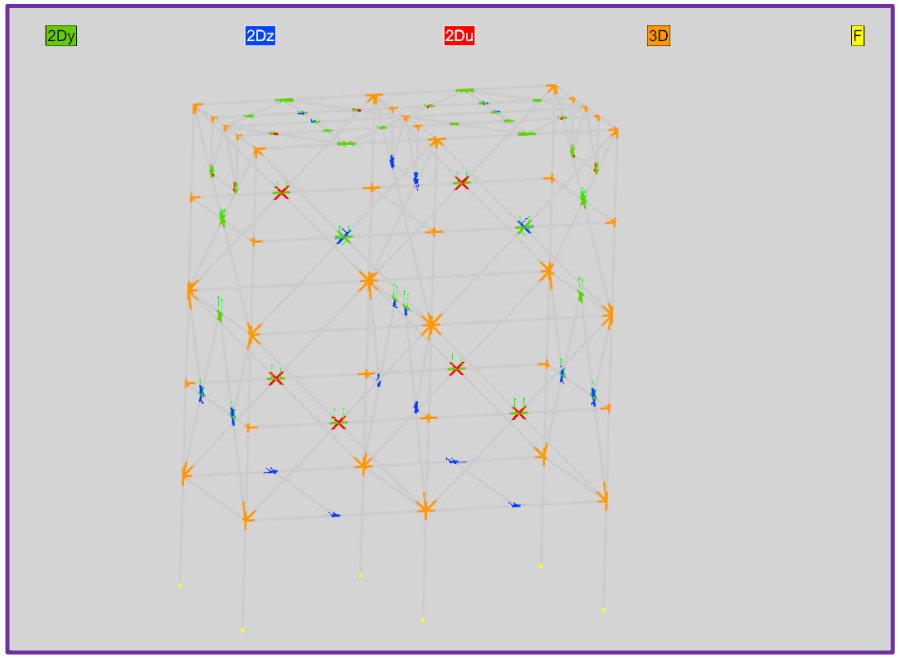
Keep All Existing options - it should be used, when additional elements were added to the model.

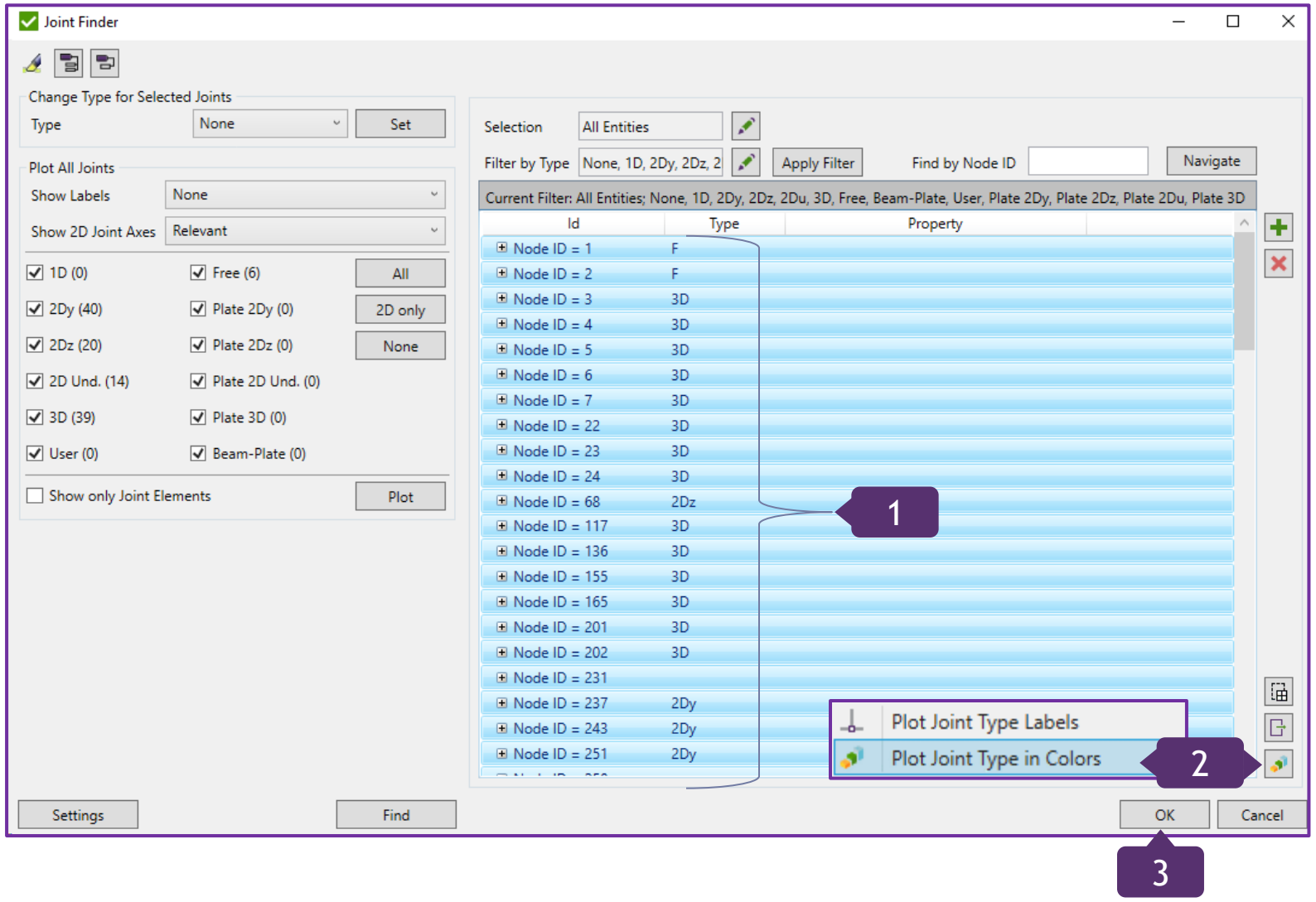
An alternative method of using a Joint Finder Tool is to press Joint in the Recognition section of the Toolbar.



Plot Joints

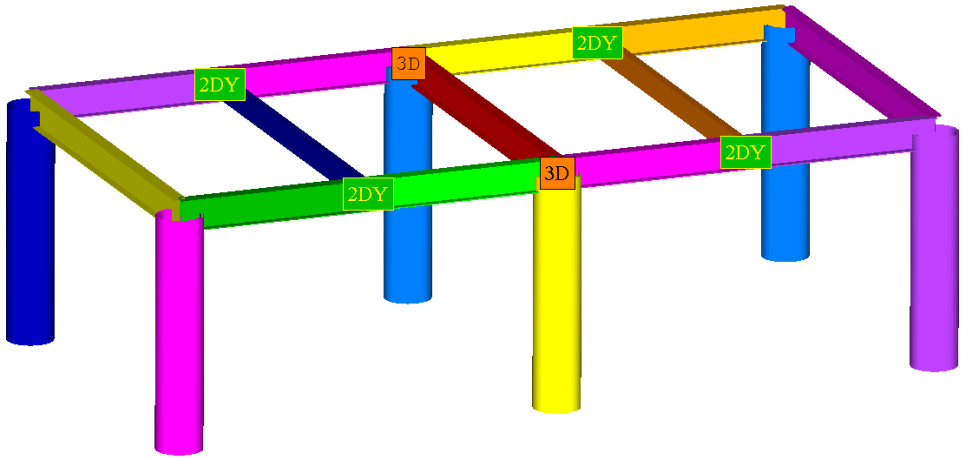
1. Select all Joints *(Ctrl+A)*
2. Press and select *Plot Joint Type in Colors*
3. Press *OK*

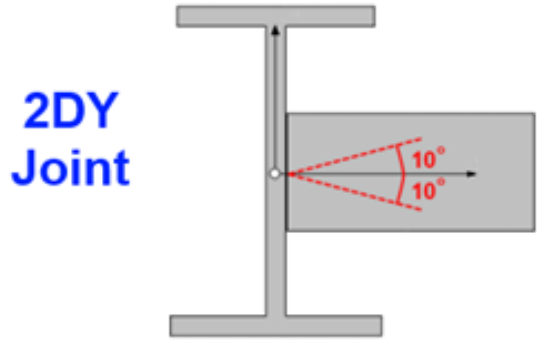




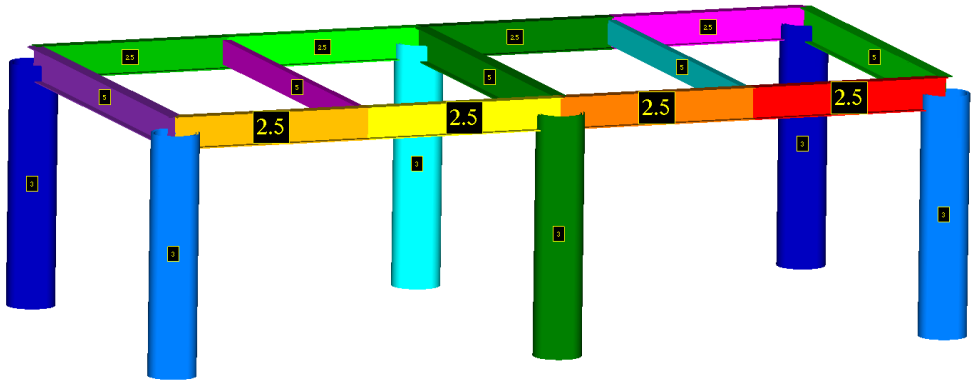
Beam Member Lengths in two Directions

Beam Member Finder recognizes Beam members and (buckling) Lengths for different directions (Y, Z and Torsional).

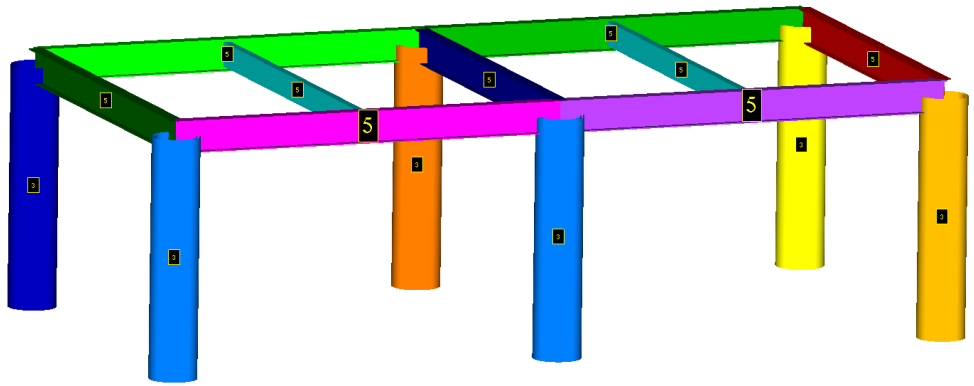




Length Y – 4 Beam Members with L = 2.5



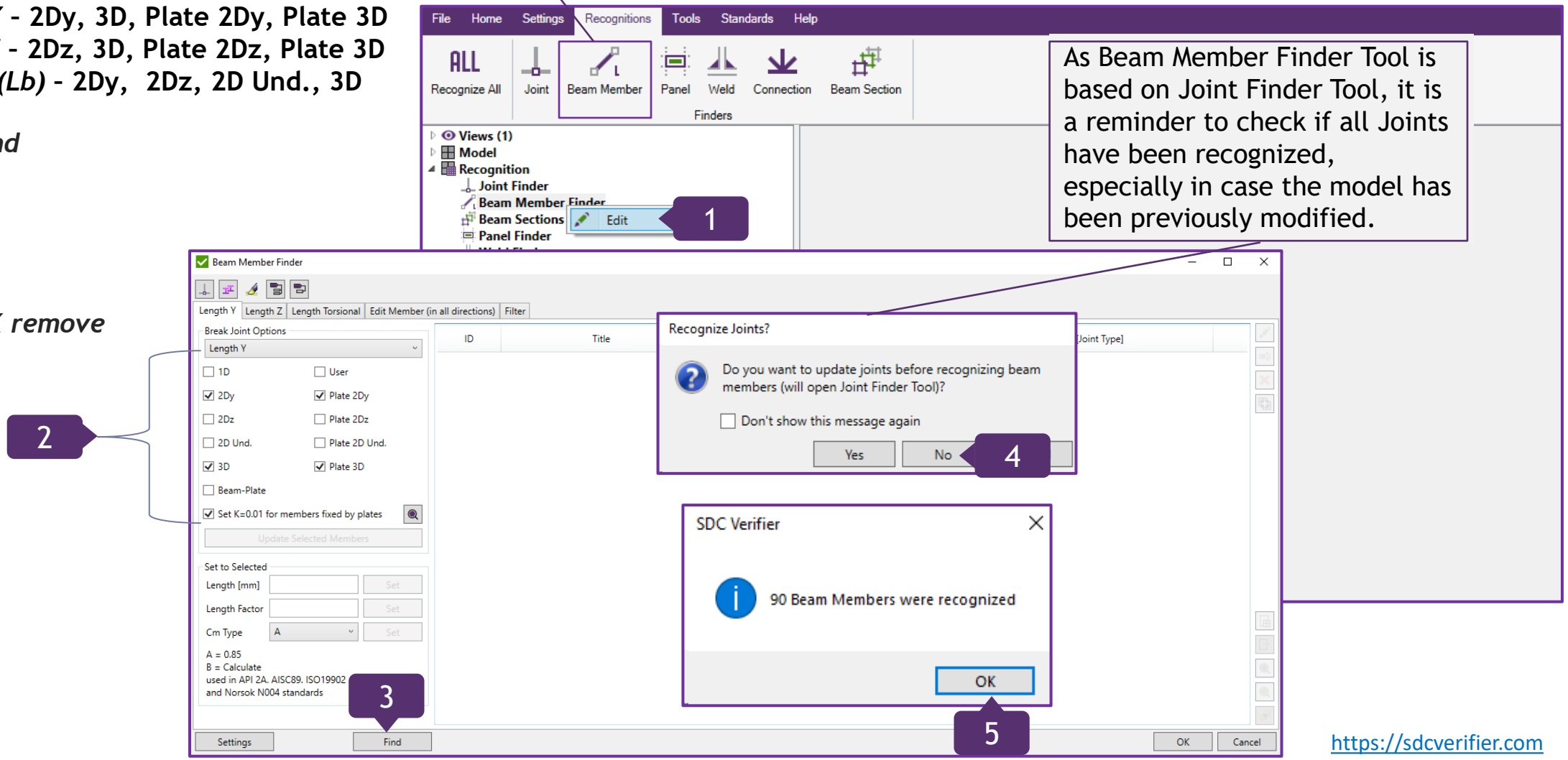
Length Z – 2 Beam Members with L = 5



Recognize Length Y

1. In *Recognition* section of the *Model Tree*, execute right click on *Beam Member Finder* and press *Edit*
2. *Length Y* - 2Dy, 3D, Plate 2Dy, Plate 3D
   Length Z - 2Dz, 3D, Plate 2Dz, Plate 3D
   Torsion (Lb) - 2Dy, 2Dz, 2D Und., 3D
3. Press *Find*
4. Press *No*
5. Press *OK remove*

An alternative method of using a Beam Member Finder Tool is to press Beam Member in the Recognition section of the Toolbar.



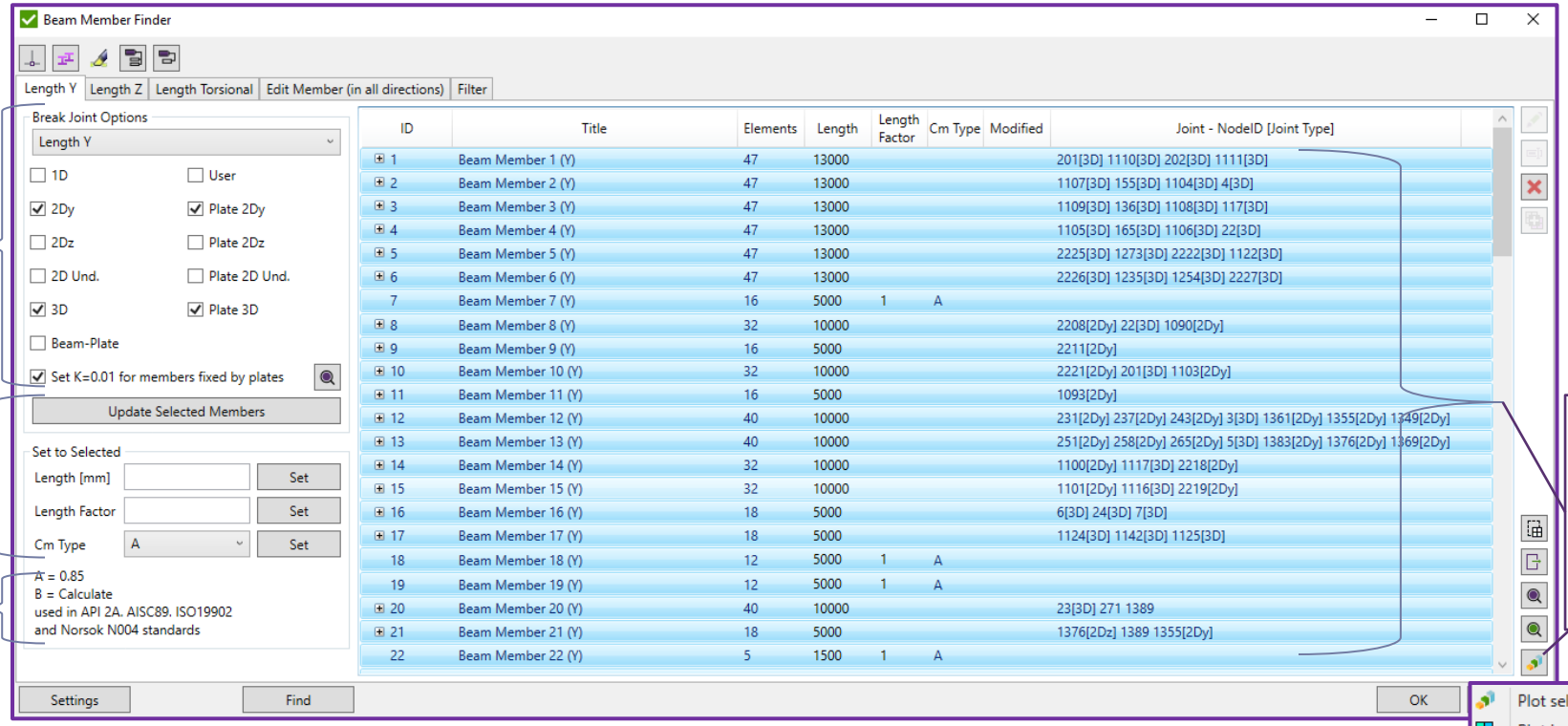
Beam Member Finder Interface Explanation

Beam Member is a straight line. If it contains joints, it is split on sub members.

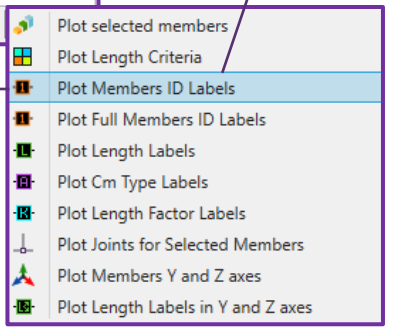
Break Joint Options define what joints are used to split Beam Members.

Change Length/Factor for selected beam members.

Cm Type is used in API 2A, ISO 19902 and Norsok N004 standards.



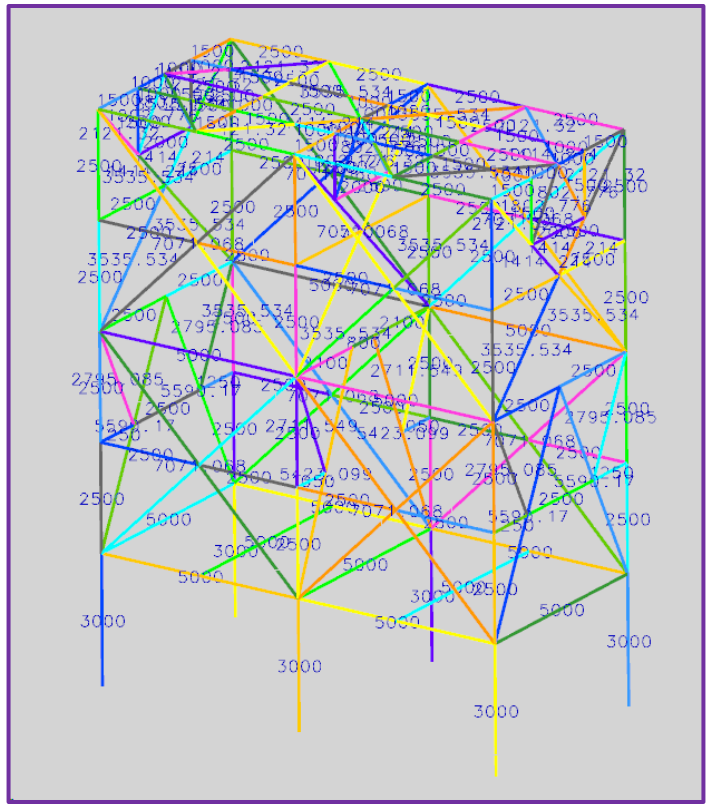
Select all Beam Members and press Select Plot Members ID Labels.

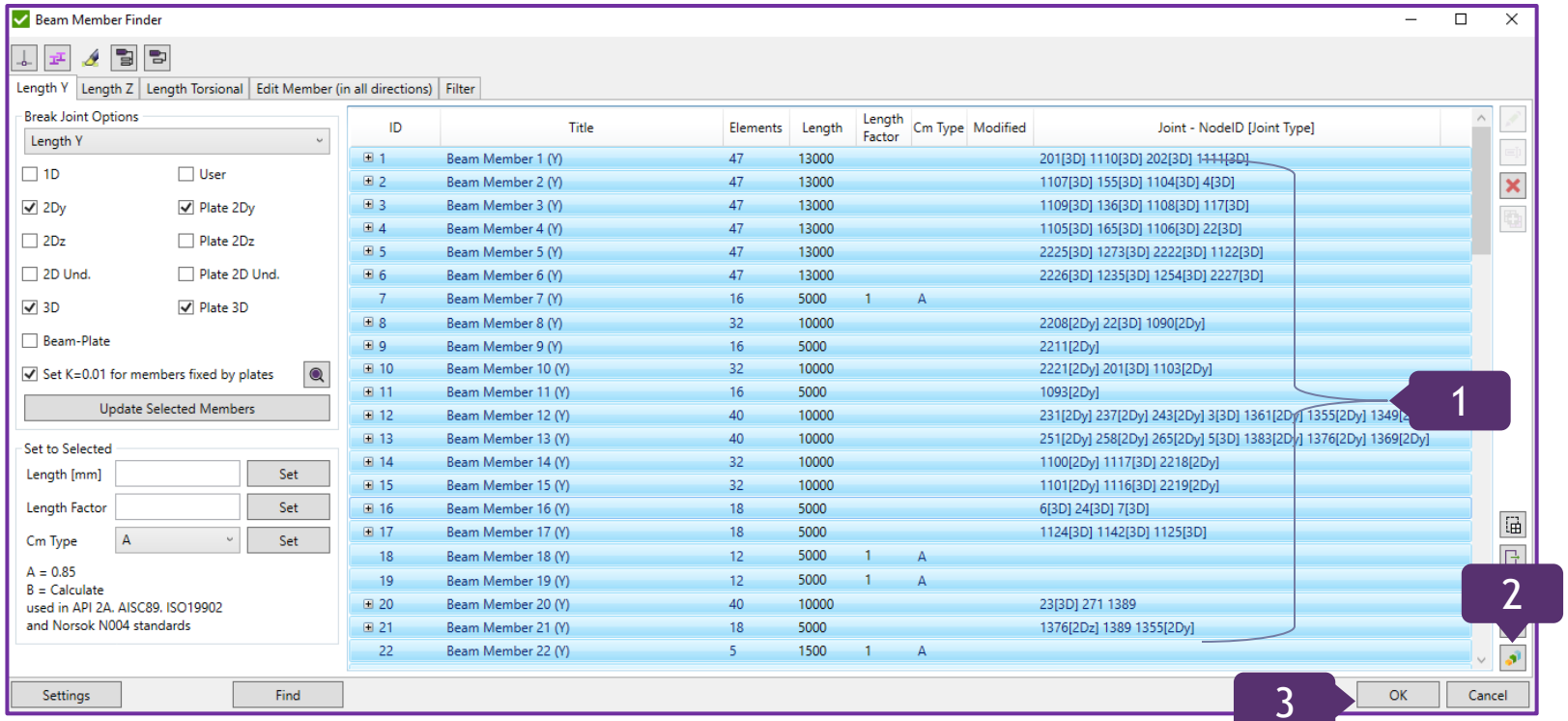


14	Beam Member 14 (Y)	32	10000			1100[2Dy] 1117[3D] 2218[2Dy]
14.1	Beam Member 14.1 (Y)	8	2500	1	A	
14.2	Beam Member 14.2 (Y)	8	2500	1	A	
14.3	Beam Member 14.3 (Y)	8	2500	1	A	
14.4	Beam Member 14.4 (Y)	8	2500	1	A	

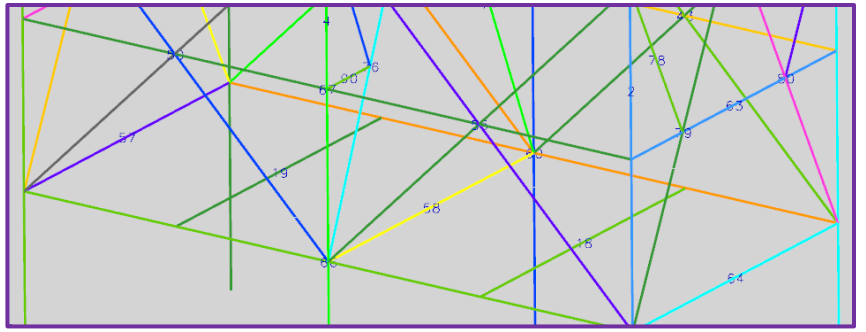
Beam Member's Length Plot

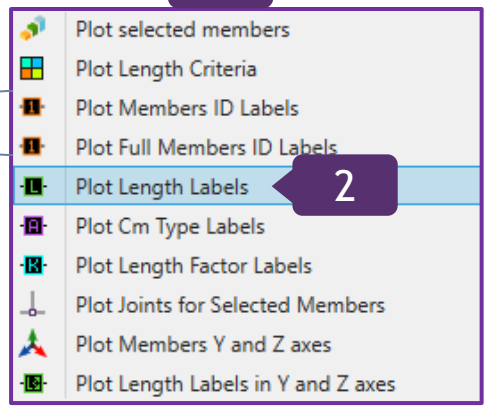
1. Select all Beam Members *(Ctrl+A)*
2. Press and select *Plot Length Labels*
3. Press *OK*





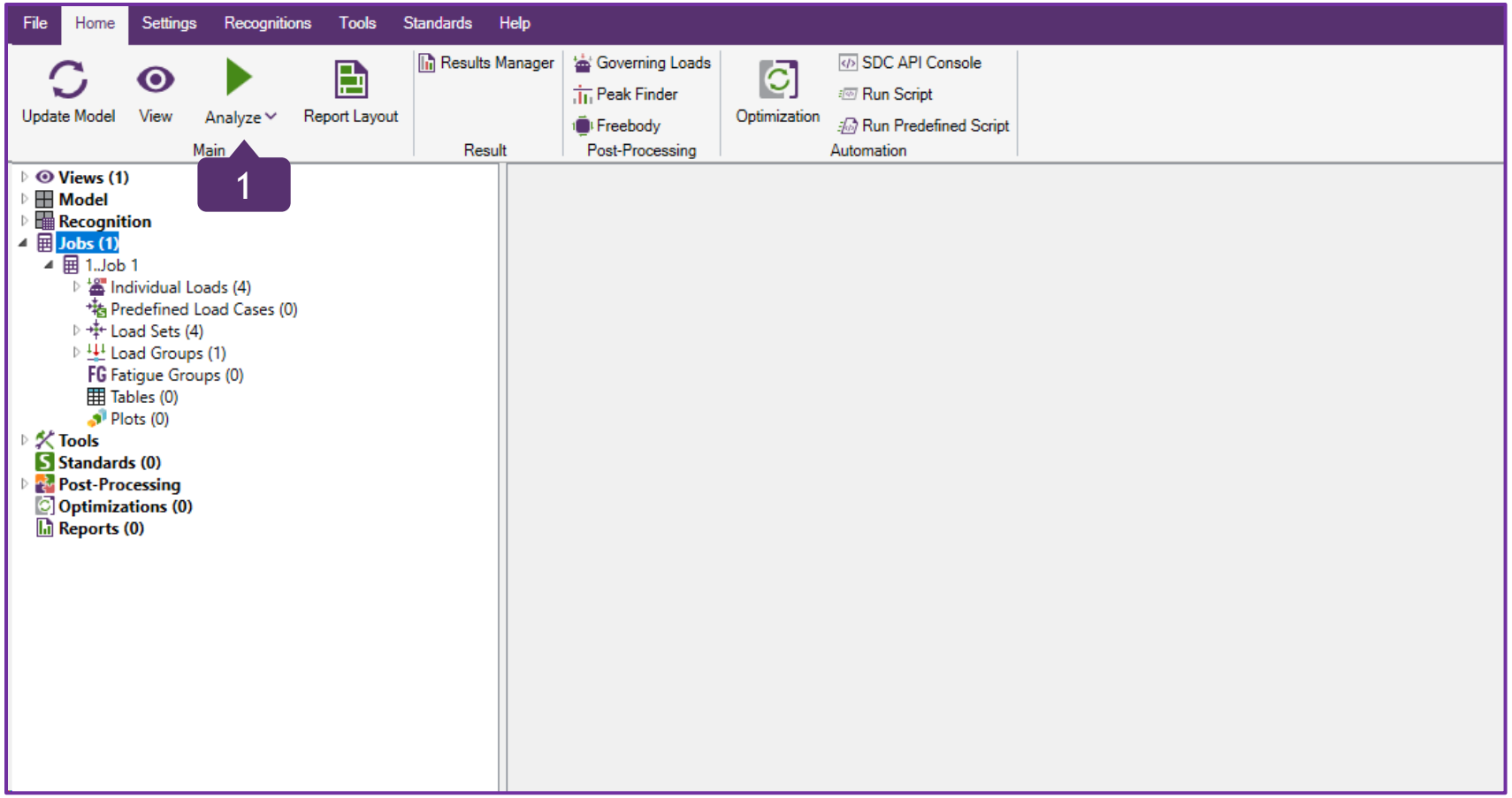
Also, it is possible to display Beam Members IDs by pressing





Analyze Job

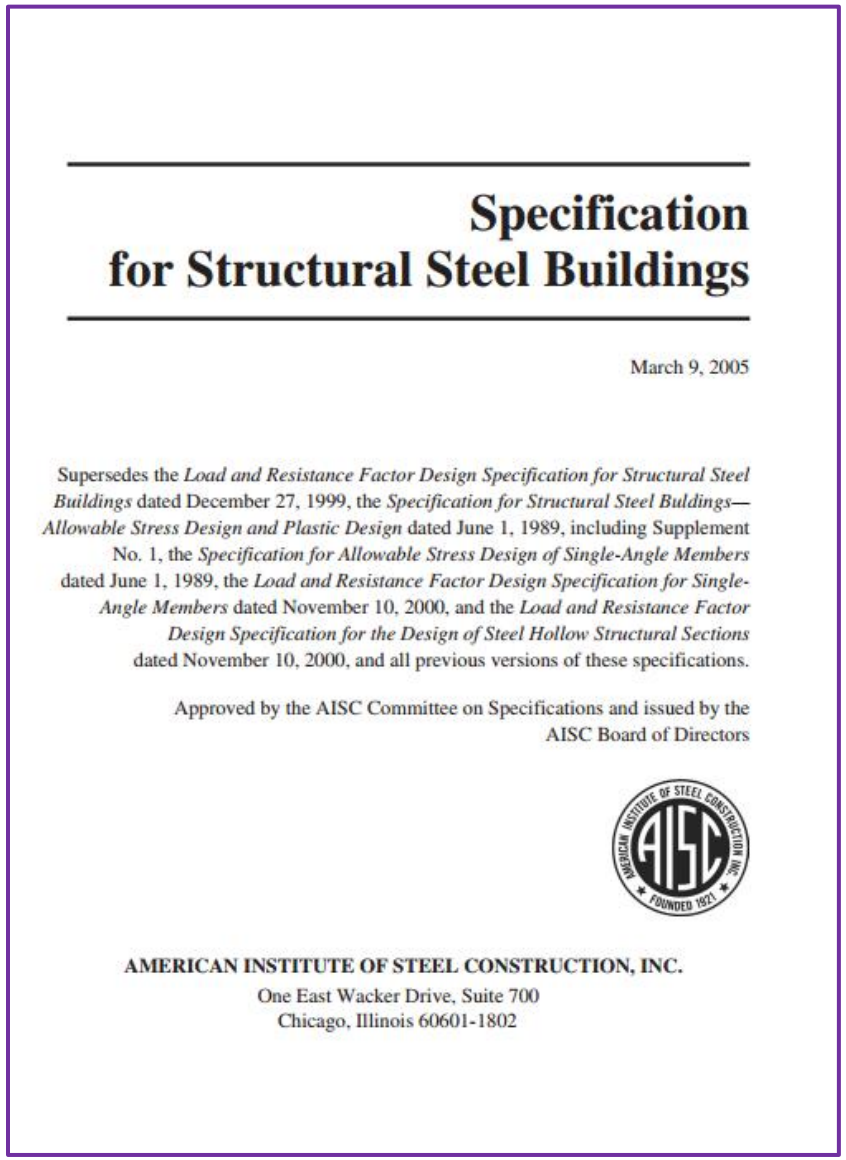
1 In *Home* section, press *Analyze*



ANSI/AISC LRDF 360-10

ANSI/AISC 360-10 is an American national standard "Specification for Structural Steel Buildings“, released on June 22, 2010. Checks are performed according to the provisions for load and resistance factor design (LRFD) and allowable strength design (ASD).

The standard implements Checks for design of members for tension, compression, bending, shear and combined.



Specification for Structural Steel Buildings

March 9, 2005

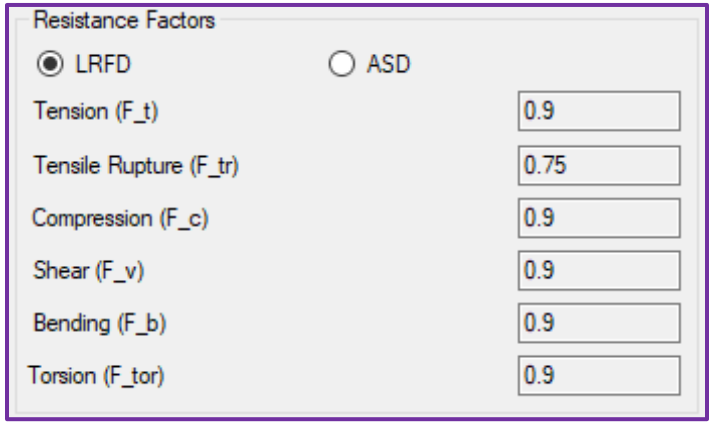
Supersedes the *Load and Resistance Factor Design Specification for Structural Steel Buildings* dated December 27, 1999, the *Specification for Structural Steel Buildings—Allowable Stress Design and Plastic Design* dated June 1, 1989, including Supplement No. 1, the *Specification for Allowable Stress Design of Single-Angle Members* dated June 1, 1989, the *Load and Resistance Factor Design Specification for Single-Angle Members* dated November 10, 2000, and the *Load and Resistance Factor Design Specification for the Design of Steel Hollow Structural Sections* dated November 10, 2000, and all previous versions of these specifications.

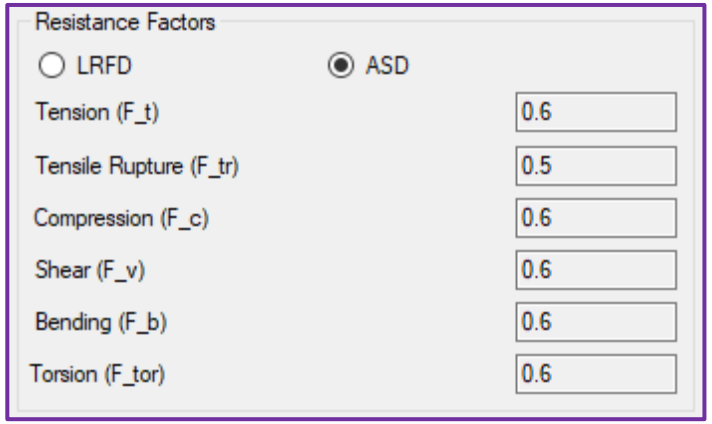
Approved by the AISC Committee on Specifications and issued by the AISC Board of Directors

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.
One East Wacker Drive, Suite 700
Chicago, Illinois 60601-1802

ASD vs LRFD

It is possible to check a design according to Load and Resistance Factor Design (LRFD) or Allowable Strength Design (ASD). The difference between 2 designs is in load combinations and resistance factors:





Design for Strength Using Load and Resistance Factor Design (LRFD)
Design will be performed in accordance with Equation B3-1:
$Ru \leq \varphi Rn$ (B3-1),
where:
Ru = required strength using LRFD load combinations;
Rn = nominal strength, specified in Chapters B through K;
φ = resistance factor, specified in Chapters B through K;
φRn = design strength

Design for Strength Using Allowable Strength Design (ASD)
Design will be performed in accordance with Equation B3-2:
$Ra \leq Rn/\Omega$ (B3-2),
where:
Ra = required strength using ASD load combinations;
Rn = nominal strength, specified in Chapters B through K;
Ω = safety factor, specified in Chapters B through K;
Rn/Ω = allowable strength

According to the standard, Design Strength is multiplied by LRFD factor and divided by ASD factor.
For tensile yielding in the gross section:

$$P_n = F_y A_g \qquad \text{(D2-1)}$$

$\phi_t = 0.90$ (LRFD) $\quad \Omega_t = 1.67$ (ASD)

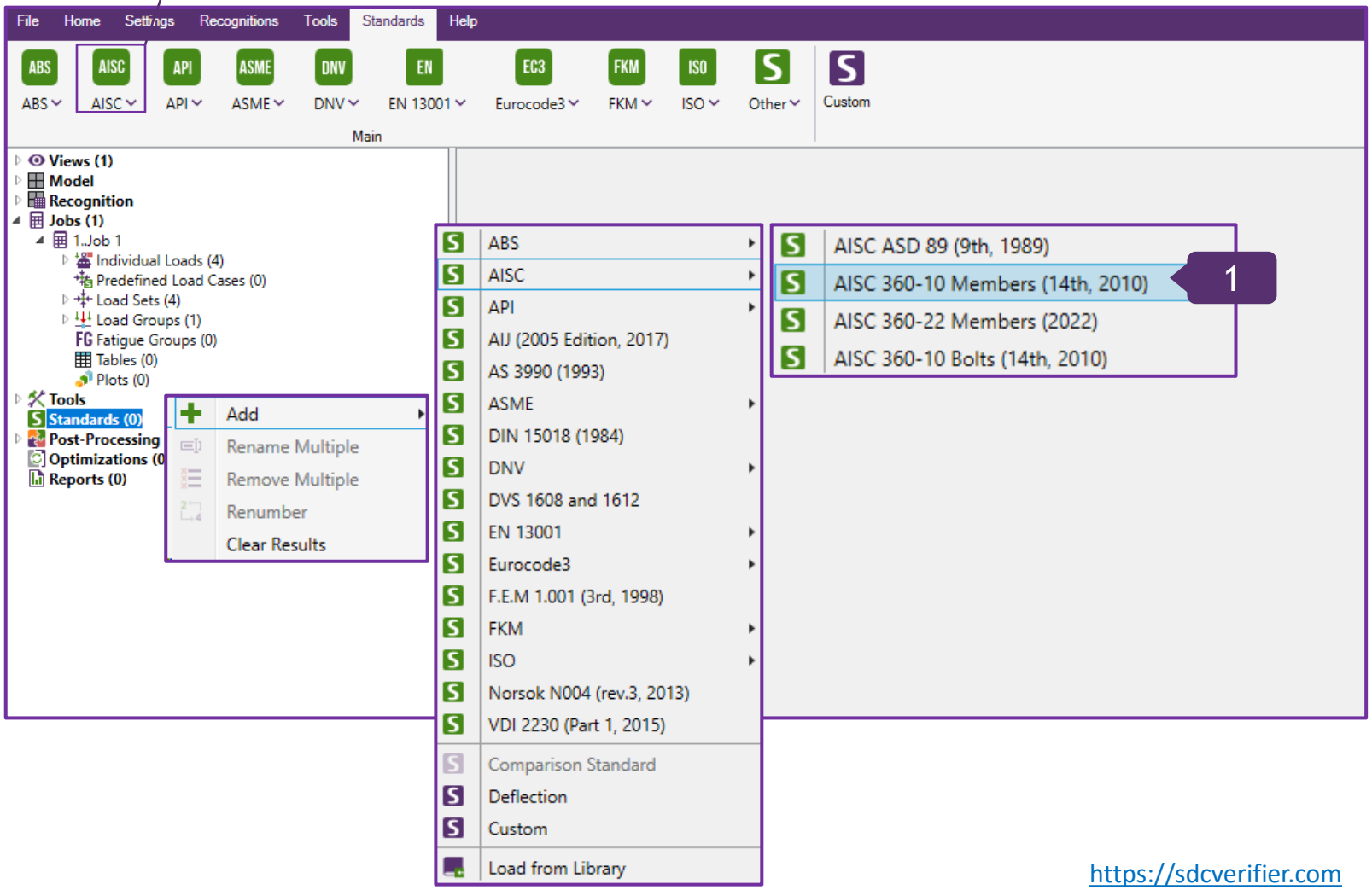
In SDC Verifier, multiplication is always used and ASD factor is converted to 1 / Sf (ASD). For example: tensile resistance factor (F_t) = 1/1.67 = 0.6

Add AISC 360-10 LRDF Standard

1

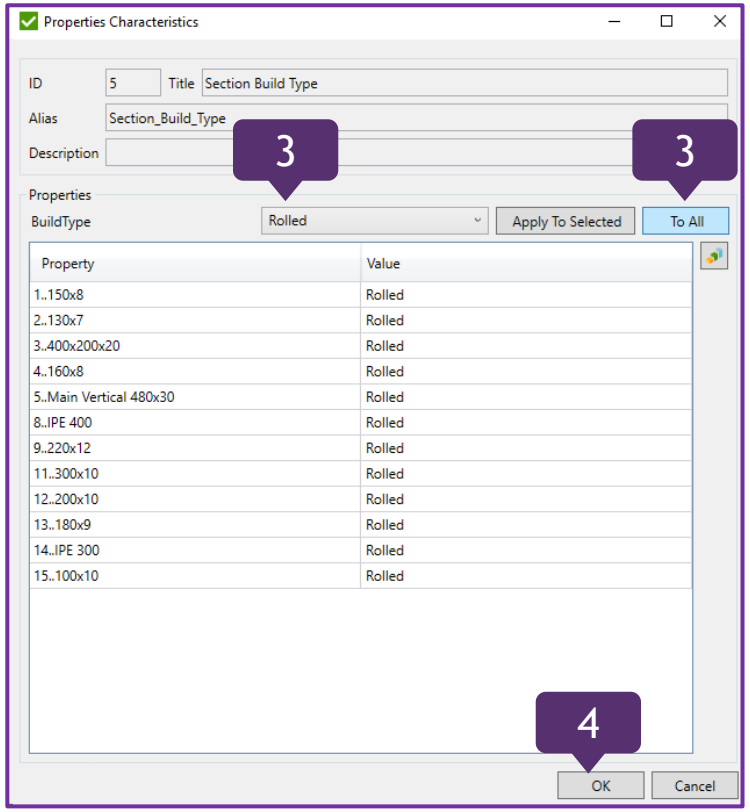
Execute right click on *Standards* and select *Add => AISC => AISC 360-10 Members (14th, 2010)*

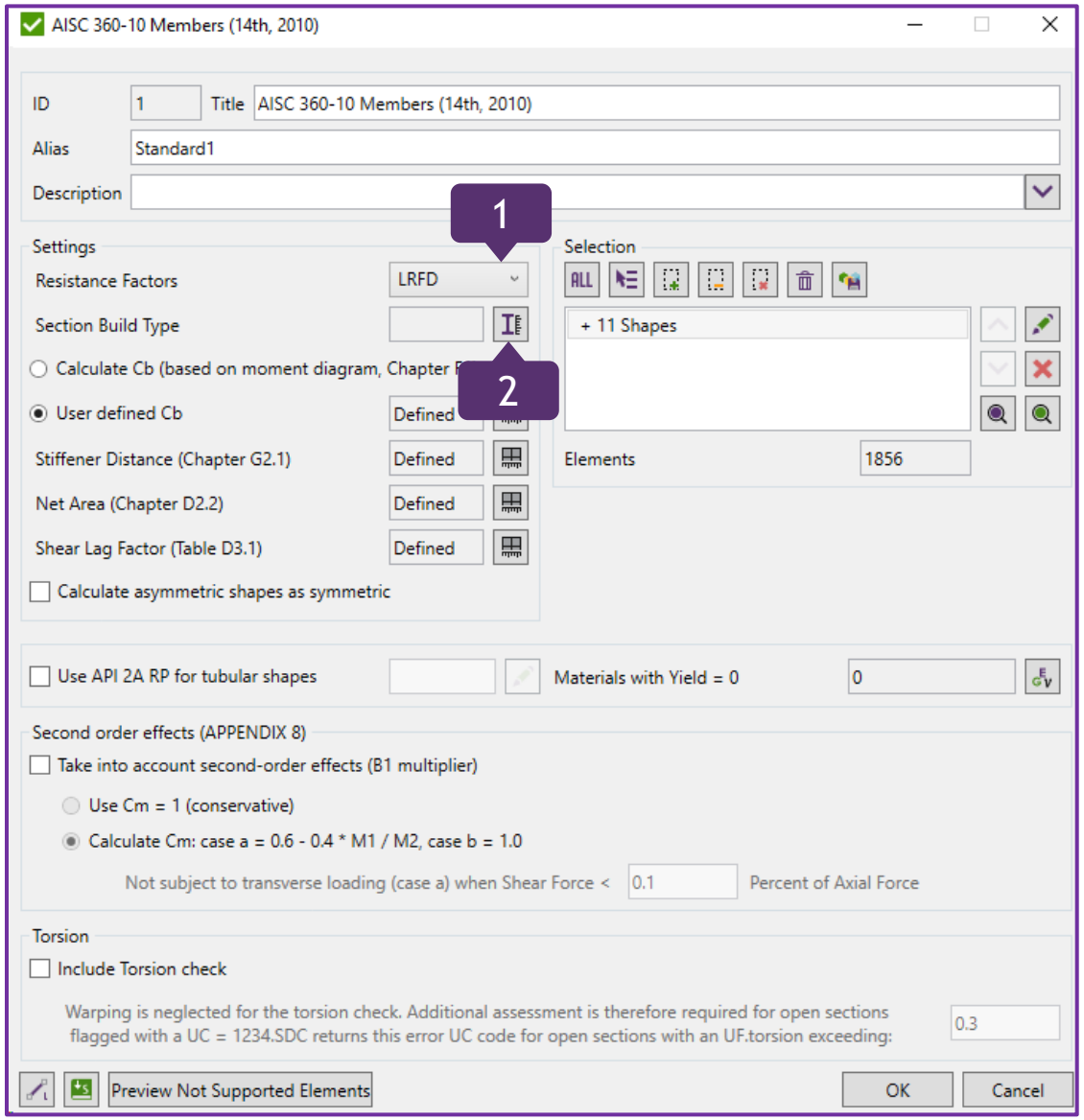
An alternative method of adding Standards is to select AISC (in this case) in the Standards section of the Toolbar.



Define AISC 360-10 LRDF Standard

1. Resistance Factors: *LRFD*
2. Press to set *Section Build Type*
3. BuildType: *Rolled*;
   Press *To All*
4. Press *OK*

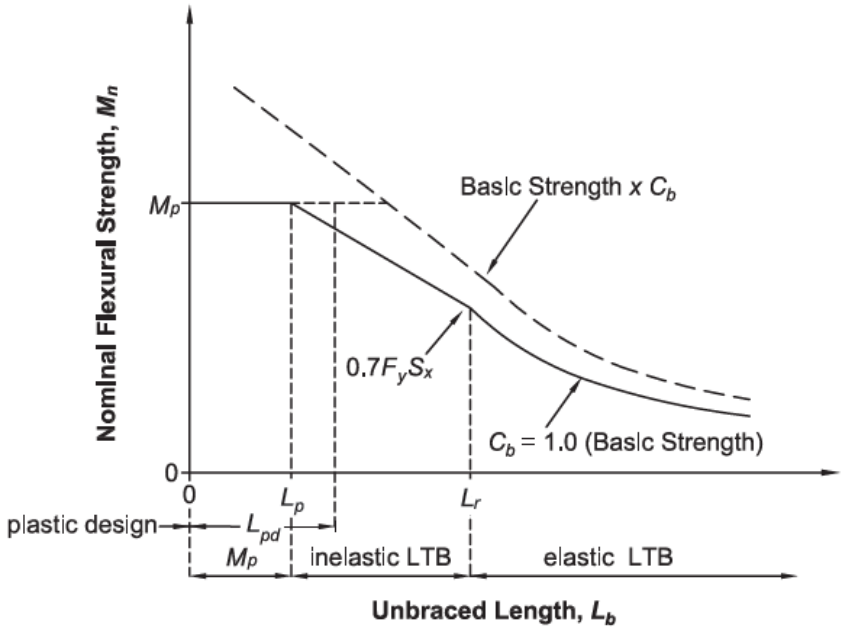


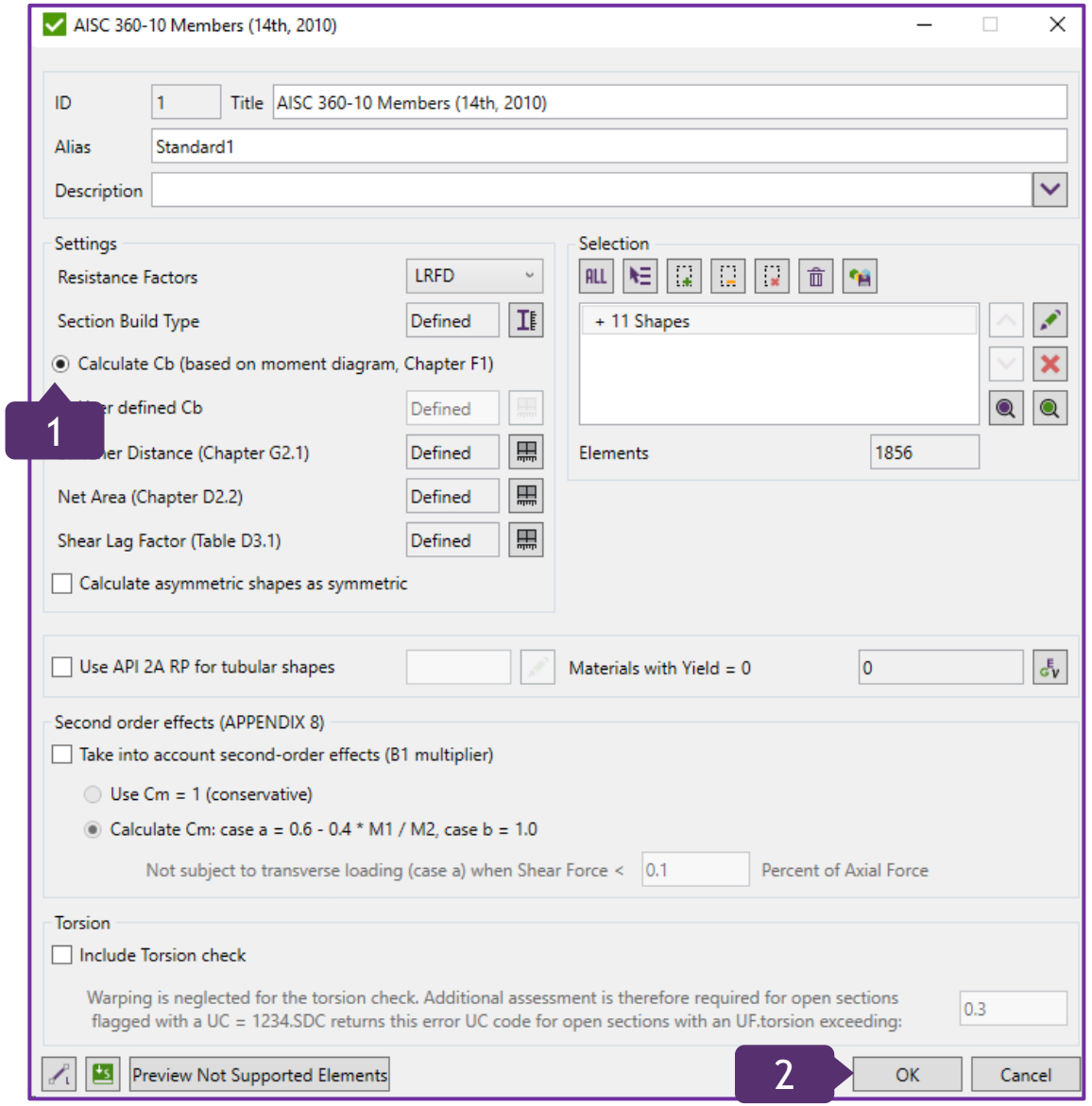


Lateral-Torsional Buckling Modification Factor (Cb)

1. Select *Calculate Cb (based on moment diagram, Chapter F1)*
2. Press *OK*

SDC Verifier follows a conservative approach and uses Cb = 1.0. Cb is implemented as a characteristic which can be modified. For the details, see Chapter F “Design of members for Flexure”, F1 General Provisions.



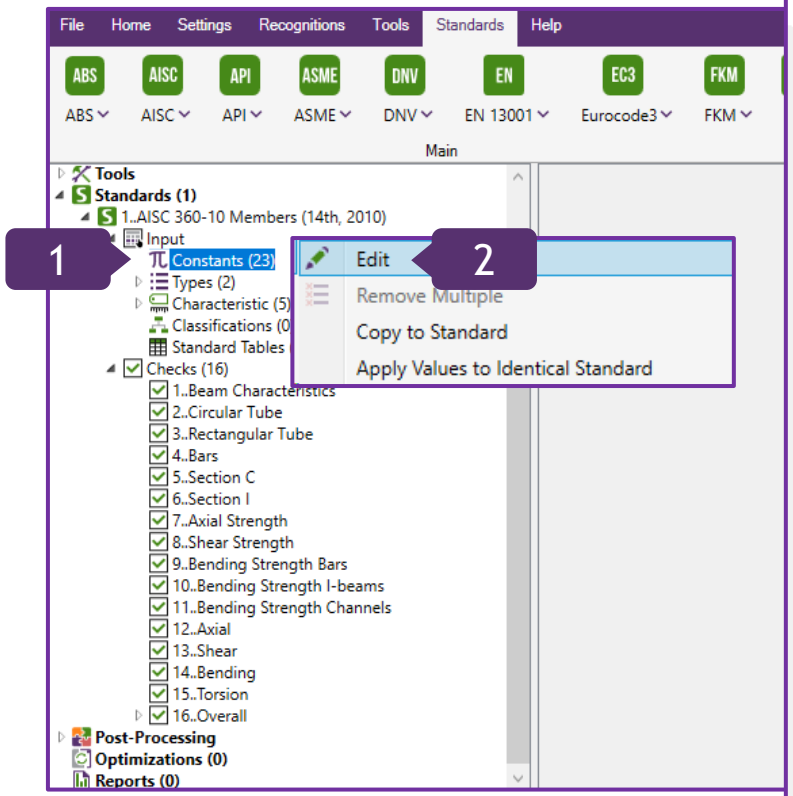


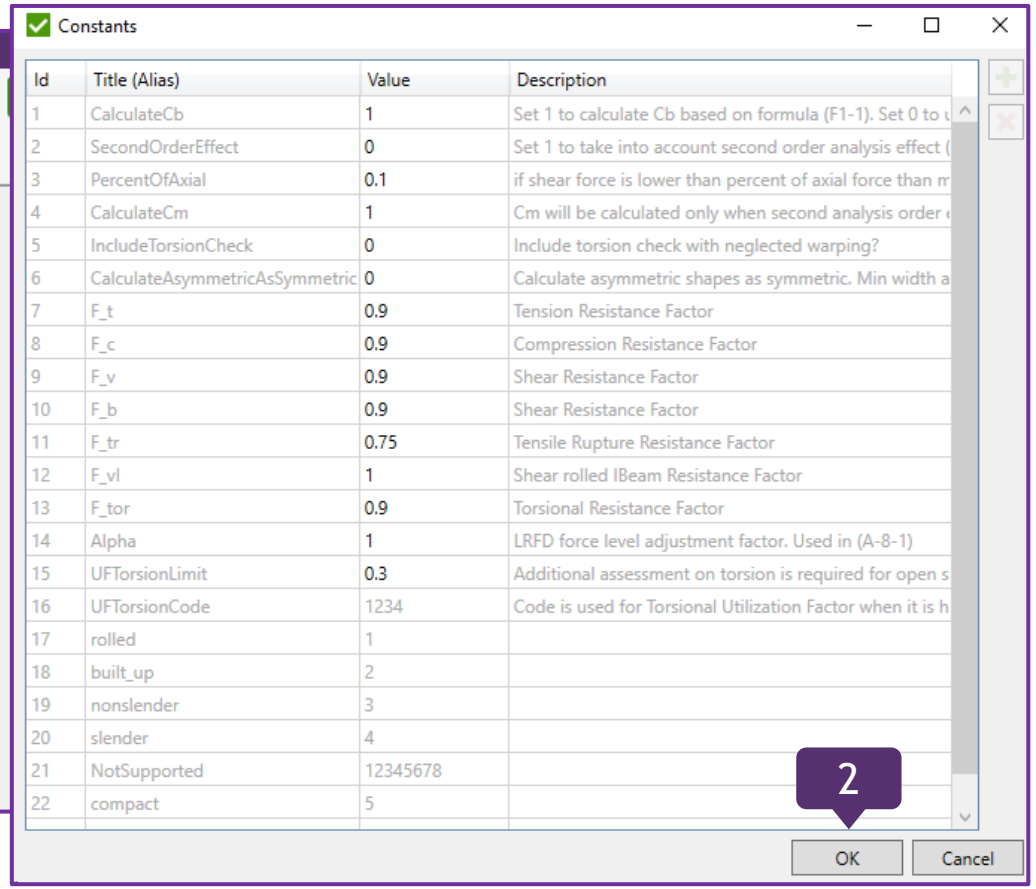
Standard has been created

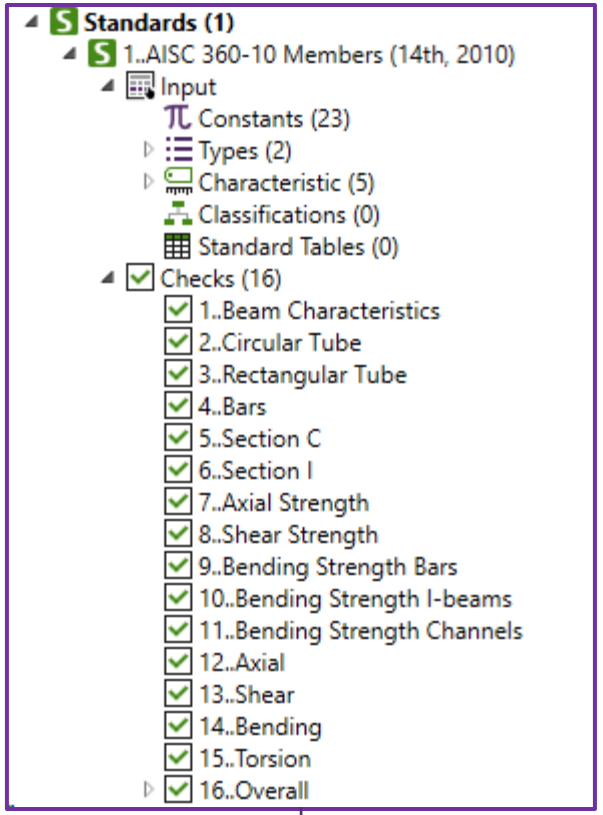
1. To check *Constants*, expand *Standards* => *1.. AISC 360-10 Members (14th, 2010)* => *Input* and select *Constants*

2. Execute right click on *Constants* and select *Edit*; Press *OK*

It is possible to modify Safety Factors in Constants section.



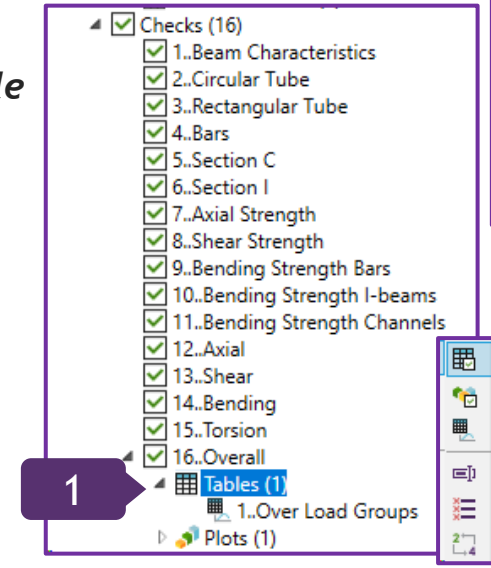


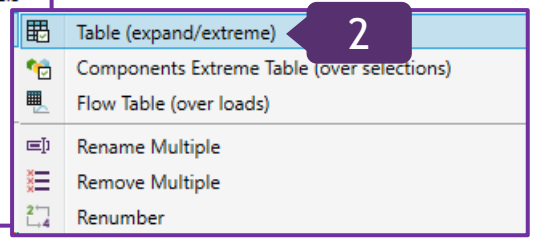


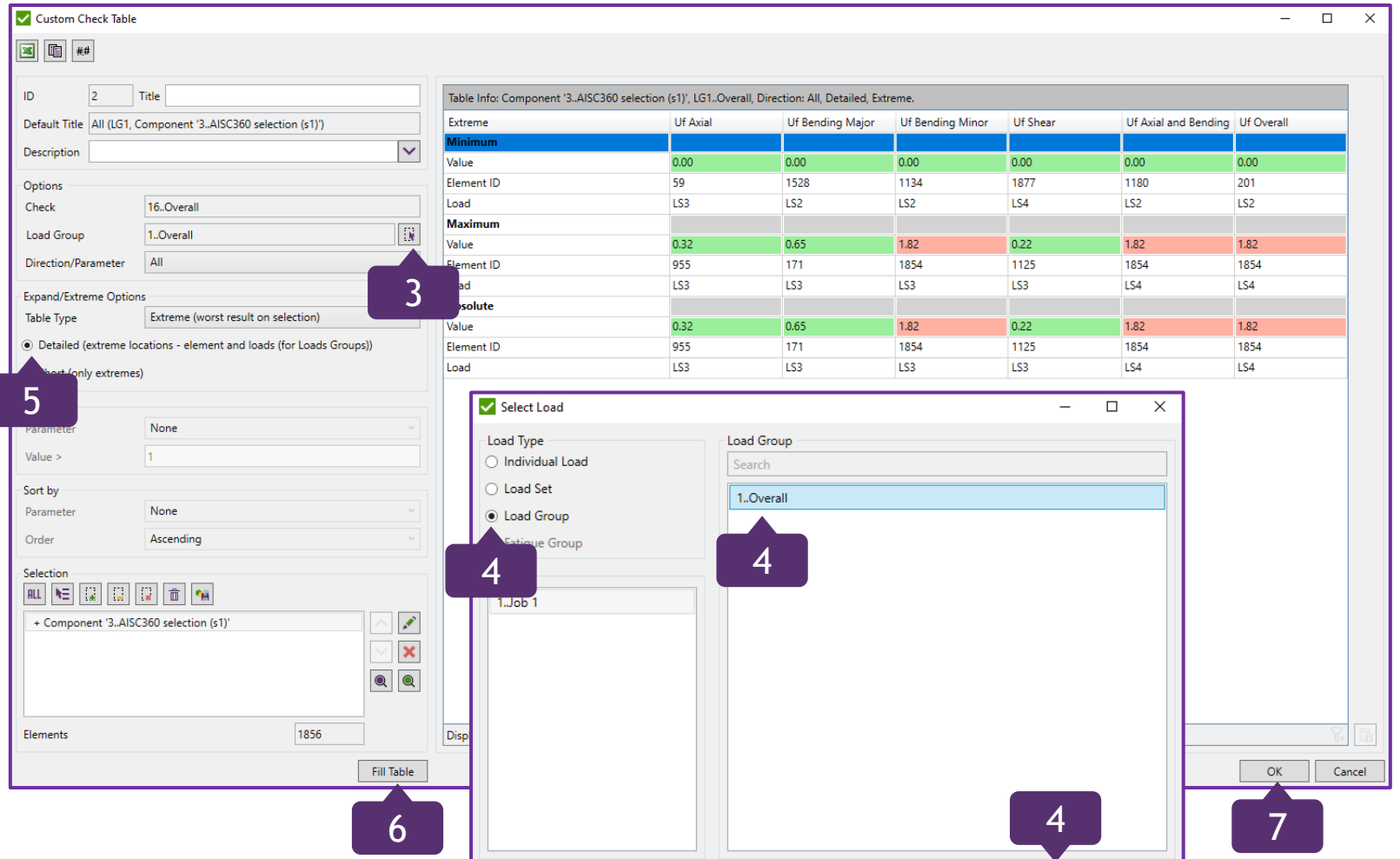
16 Checks have been created.

Preview Table Results

1. In *Checks* section, expand *16..Overall* and select *Tables*
2. Execute right click on *Tables* and select *Table (expand/extreme)*
3. In Load Group, press
4. Select *Load Group => 1..Overall* and press *OK*
5. *Detailed (extreme locations - element and loads (for Loads Groups))* is *ON*
6. Press *Fill Table*
7. Press *OK*





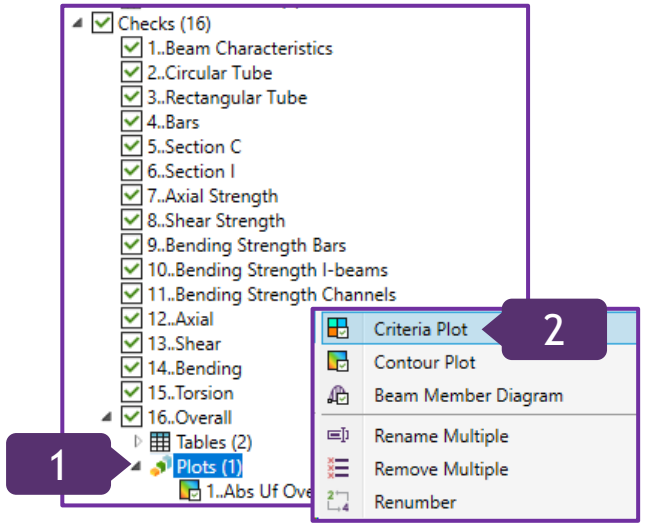


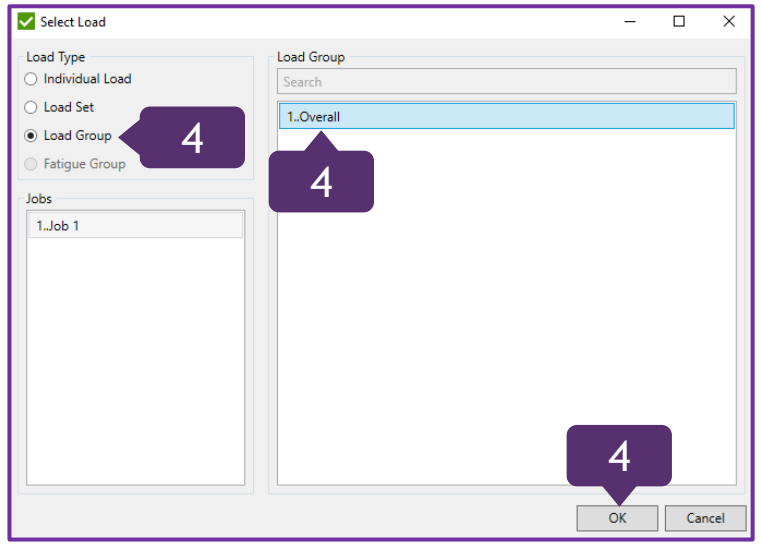
Utilization Factor on element ID=1854 does not pass the check: 1.82 > 1

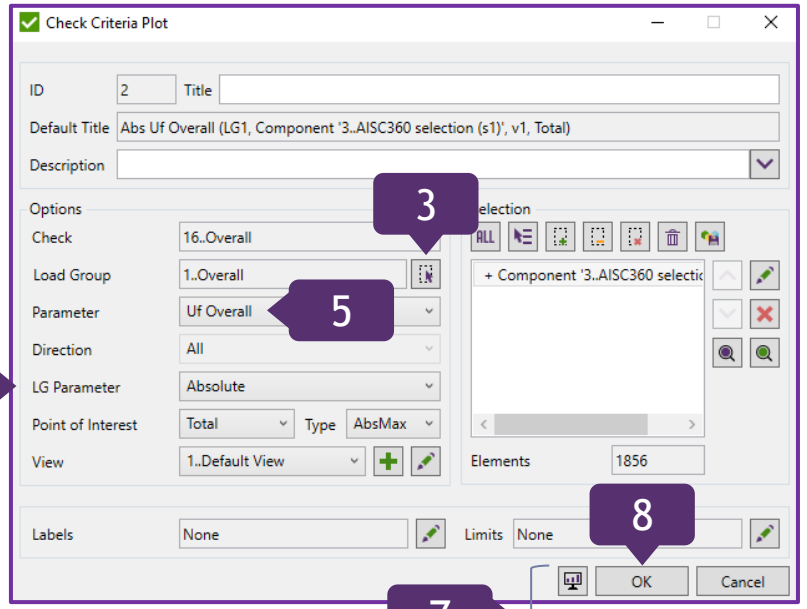
Utilization Factor Plot

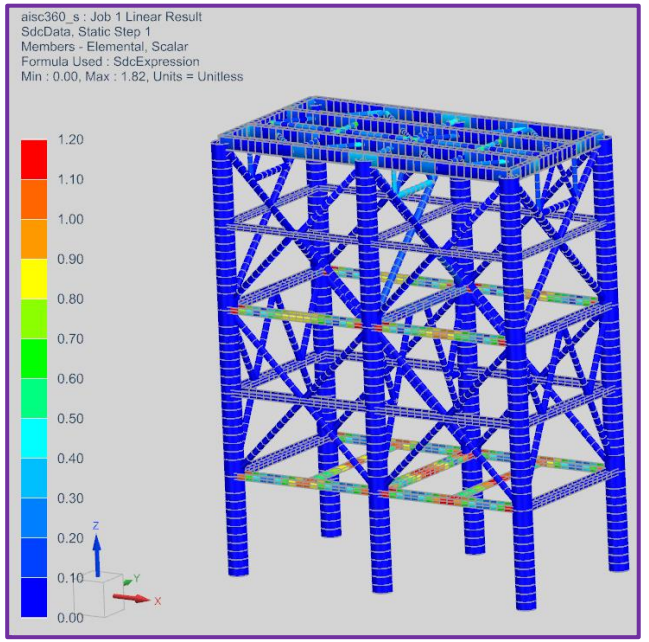
1. In Checks section, **expand 16..Overall and select *Plots***
2. Execute right click on *Plots* and select *Criteria Plot*
3. In Load Group, press
4. Select *Load Group => 1..Overall* and press *OK*
5. Parameter: *Uf Overall*
6. LG Parameter: Absolute
7. Press , and then *Preview*
8. Press *OK*

SDC Verifier uses Legend from 0.00 to 1.20 for Utilization Factor. Elements in orange and red do not pass the check.







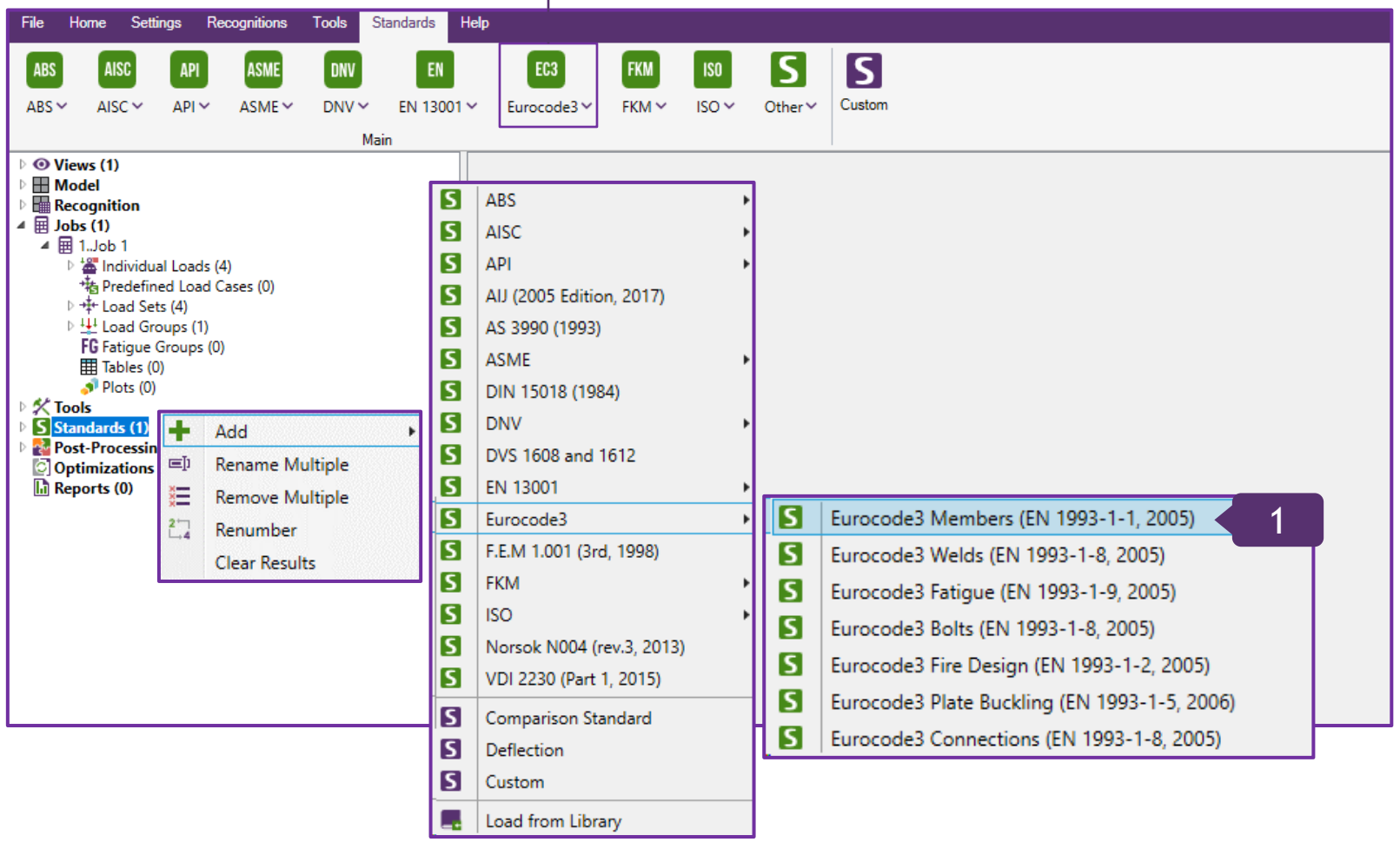


Add Eurocode3 Members (EN1993-1-1, 2005) Standard

1

Execute right click on *Standards* and select *Add => Eurocode3 => Eurocode3 Members (EN 1993-1-1, 2005)*

An alternative method of adding Standards is to select Eurocode3 (in this case) in the Standards section of the Toolbar.

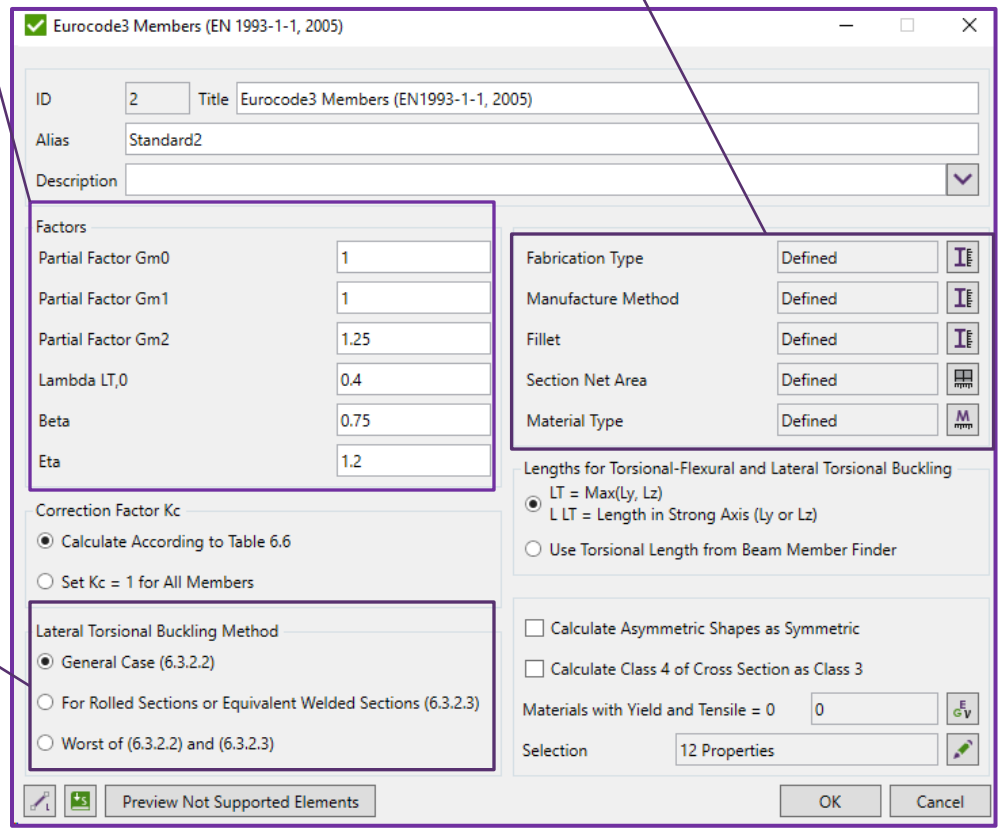


Description of Eurocode3 Members (EN1993-1-1, 2005) Standard

Gm0 - resistance of cross-sections whatever the class is;
Gm1 - resistance of members to instability assessed by member checks;
Gm2 - resistance of cross-sections in tension to fracture;
λLT,0 - plateau length of the lateral torsional buckling curves for rolled sections;
β - correction factor for the lateral torsional buckling curves for rolled sections;
η - is used in the shear area calculations.

Note: All parameters may be taken from the National Annex.

Fabrication Type: Rolled/Welded;
Manufacture Type: Hot Finished/Cold Formed;
Fillets has to be defined in the characteristic (they are missing in the model);
Section Net Area - for fasteners with holes net area has to be defined;
Material Type - the buckling curve (Table 6.2) depends on the material type.

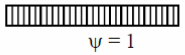
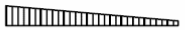


It is possible to choose the calculation method for Lateral Torsional Buckling: General Case (chapter 6.3.2.2), For rolled sections or equivalent welded sections (chapter 6.3.2.3) or the worst of two (min reduction factor is used from 2 methods).

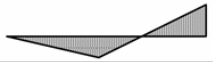
Description of Eurocode3 Members (EN1993-1-1, 2005) (Continuation)

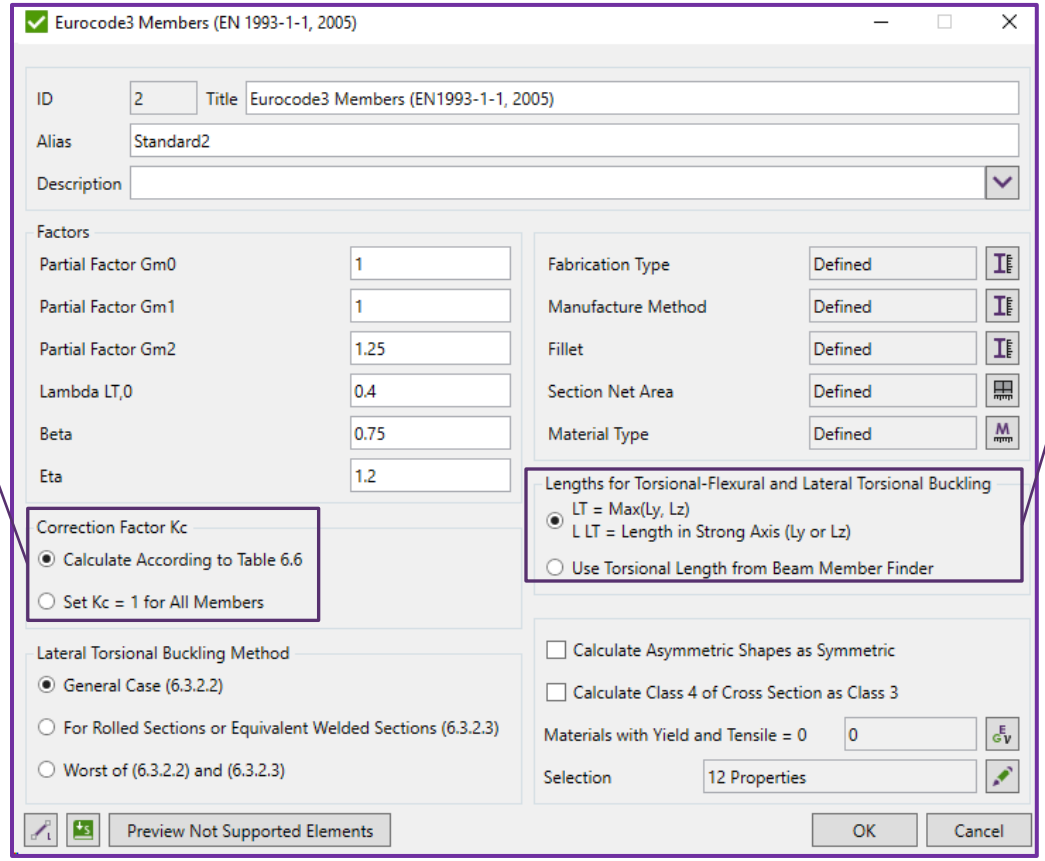
A correction Factor Kc can be calculated, using the Cm Tool for each member. Also it is possible to set the Kc equal to 1.

Table 6.6: The Correction Factor:

Moment distribution	k_c
 $\psi = 1$	1,0
 $-1 \le \psi \le 1$	$\frac{1}{1,33 - 0,33\psi}$
	0,94
	0,90
	0,91

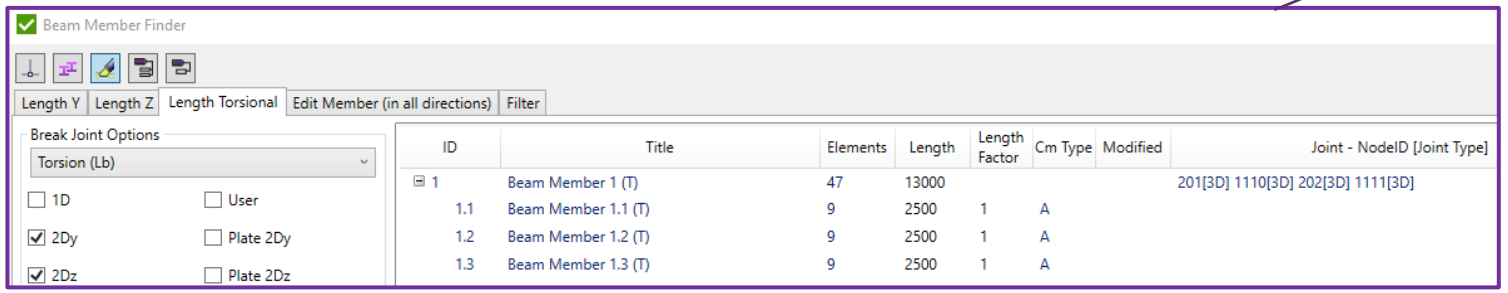
The following cases are NOT recognized and are skipped:

	0,86
	0,77
	0,82



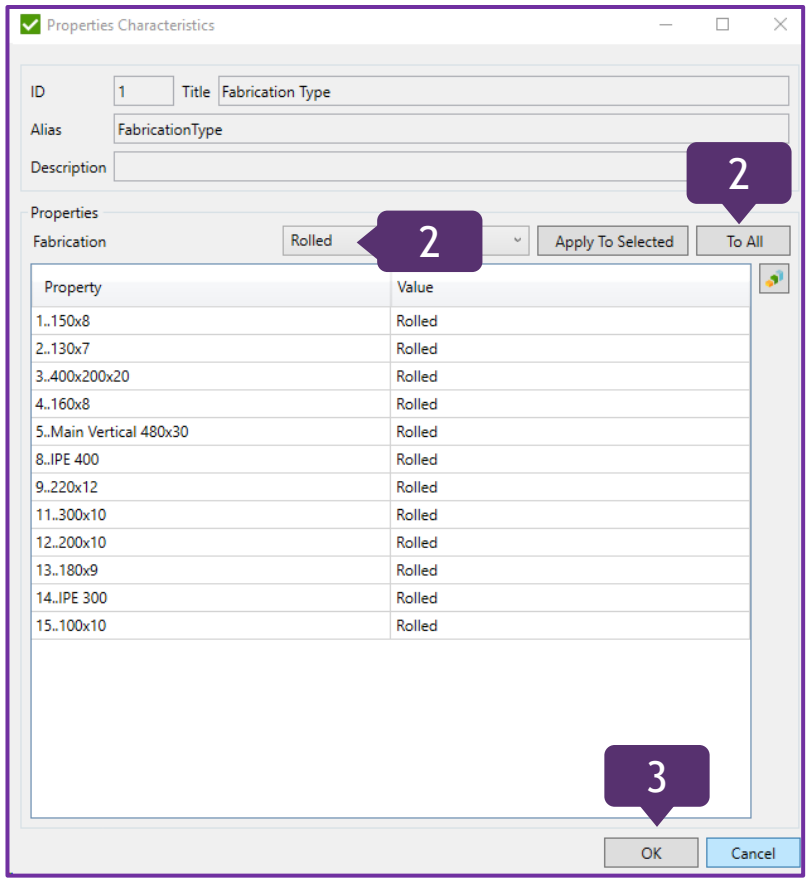
Member Length for Torsional and Torsional-Flexural Buckling Check (LT) by default is max among Ly and Lz lengths. For lateral torsional buckling (L LT) is length in strong axis.

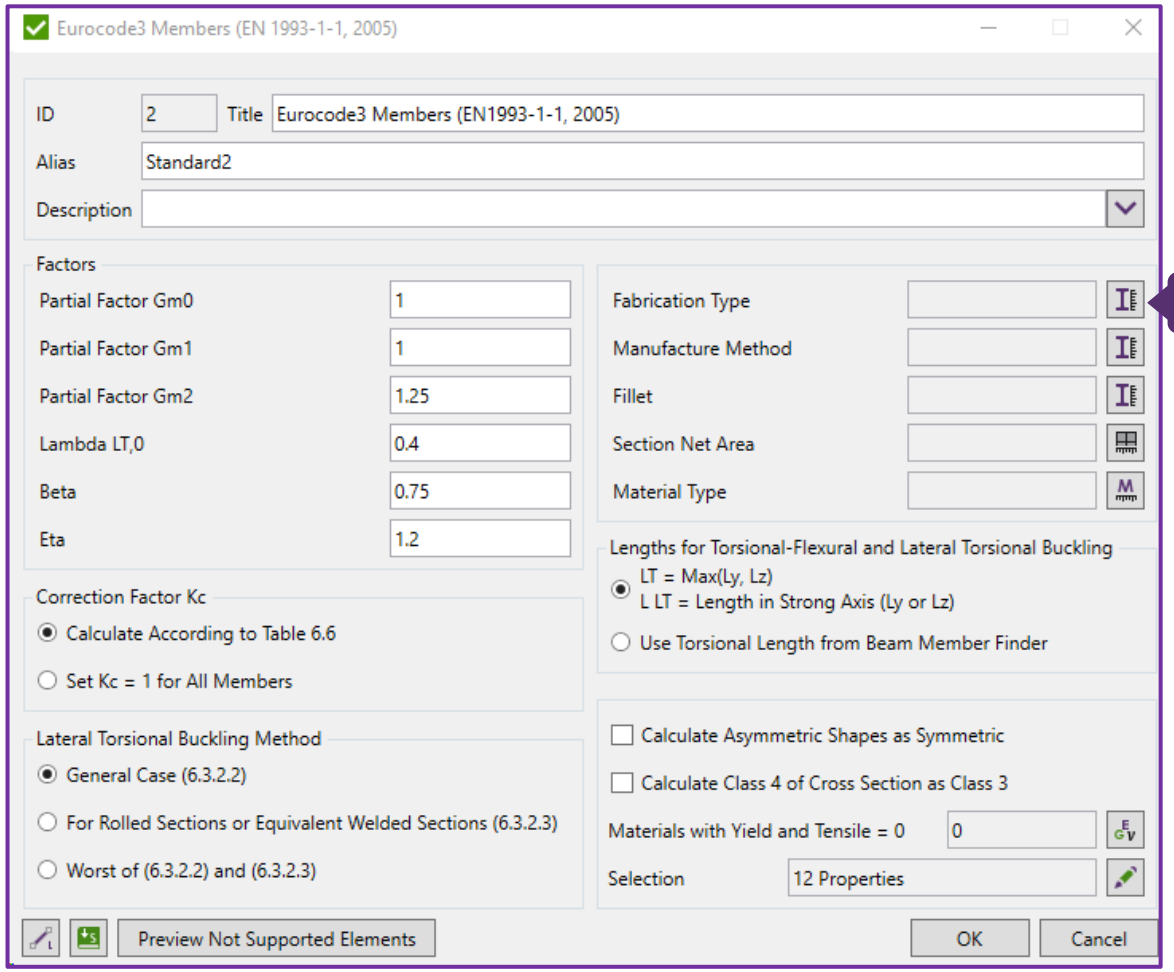
It is possible to use Torsional Length from Beam Member Finder. In this case, it can be modified manually by a user.



Define Fabrication Type

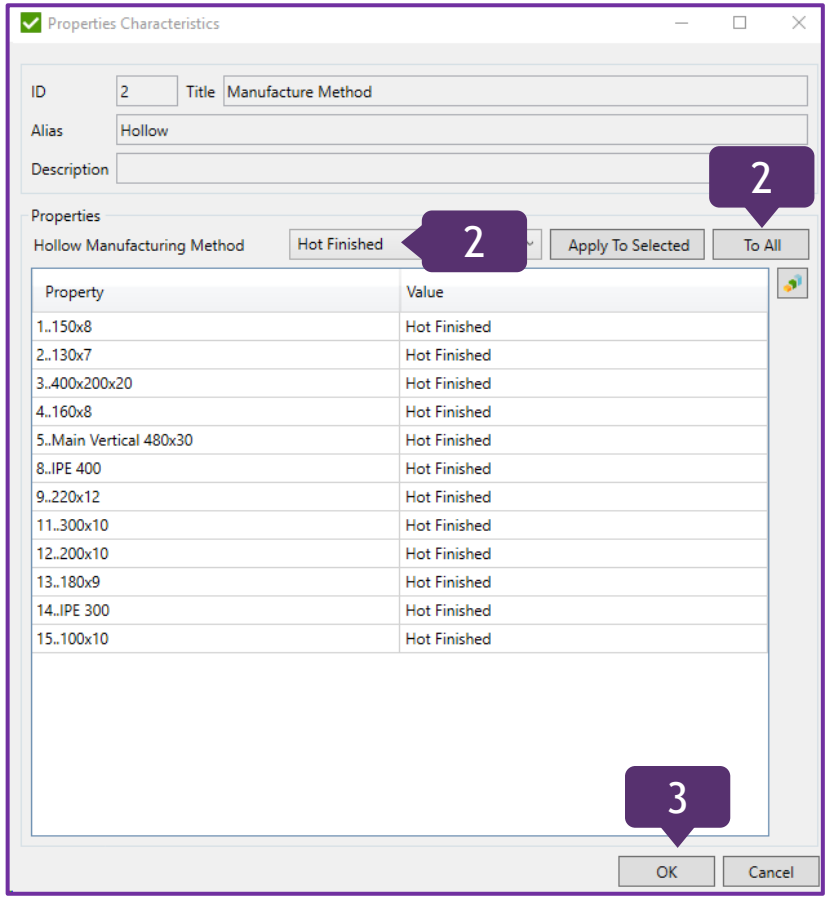
1. Press in *Fabrication Type*
2. Fabrication: *Rolled* and press *To All*
3. Press *OK*

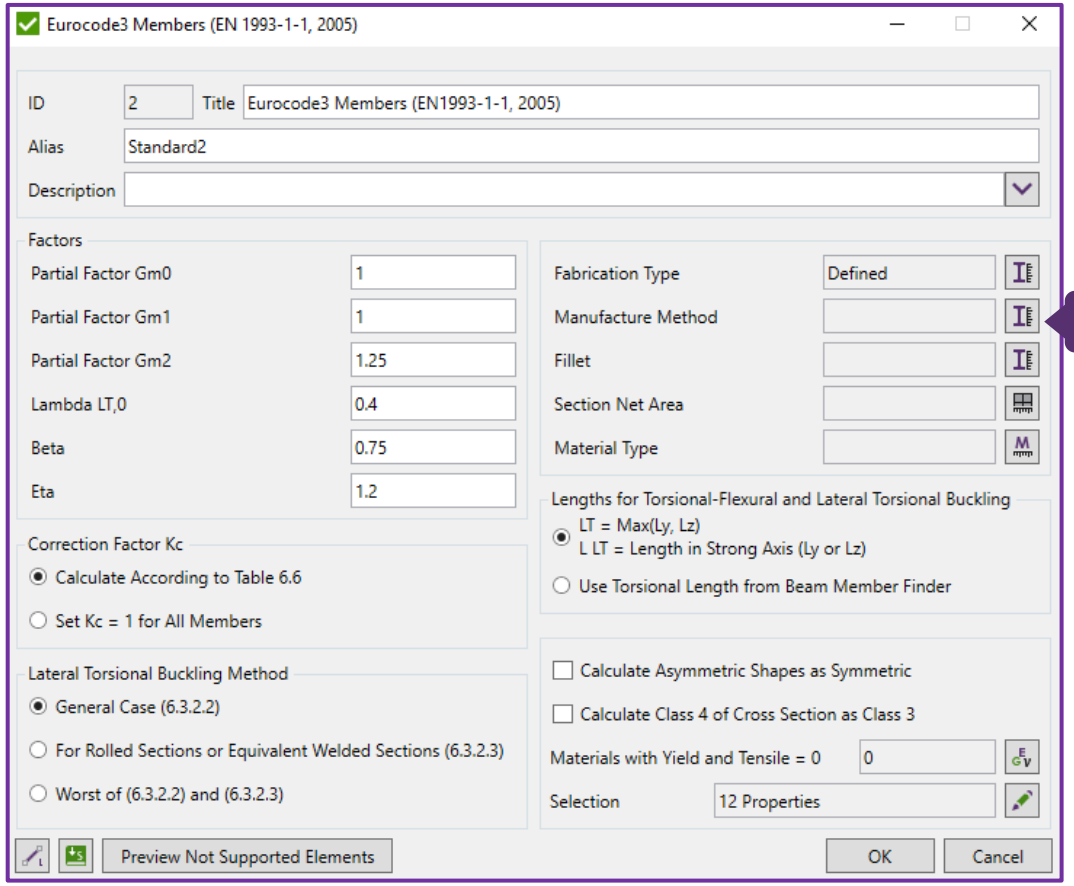




Define Manufacture Method

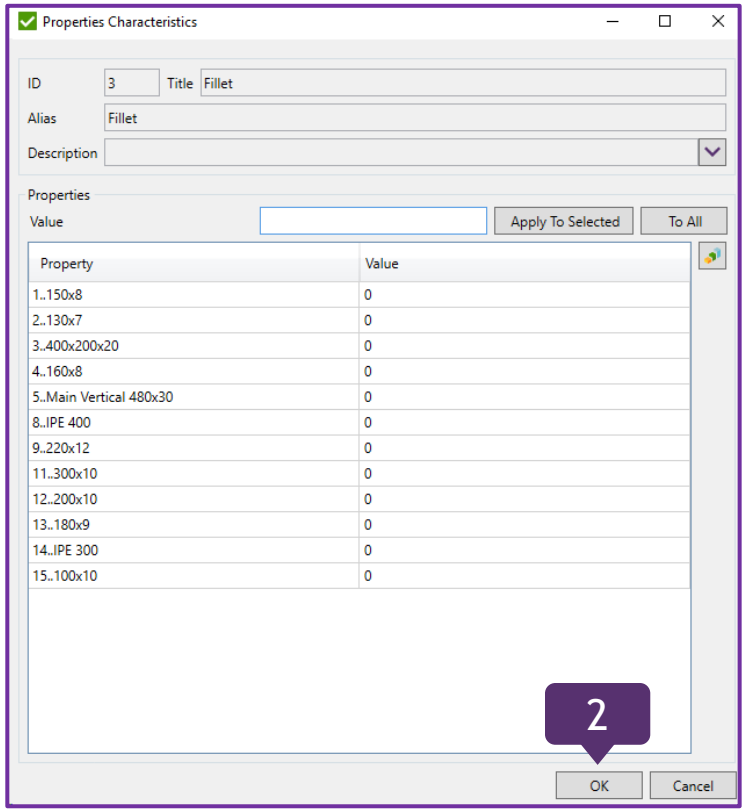
1. Press in *Manufacture Method*
2. Hollow Manufacturing Method: *Hot Finished* and press *To All*
3. Press *OK*

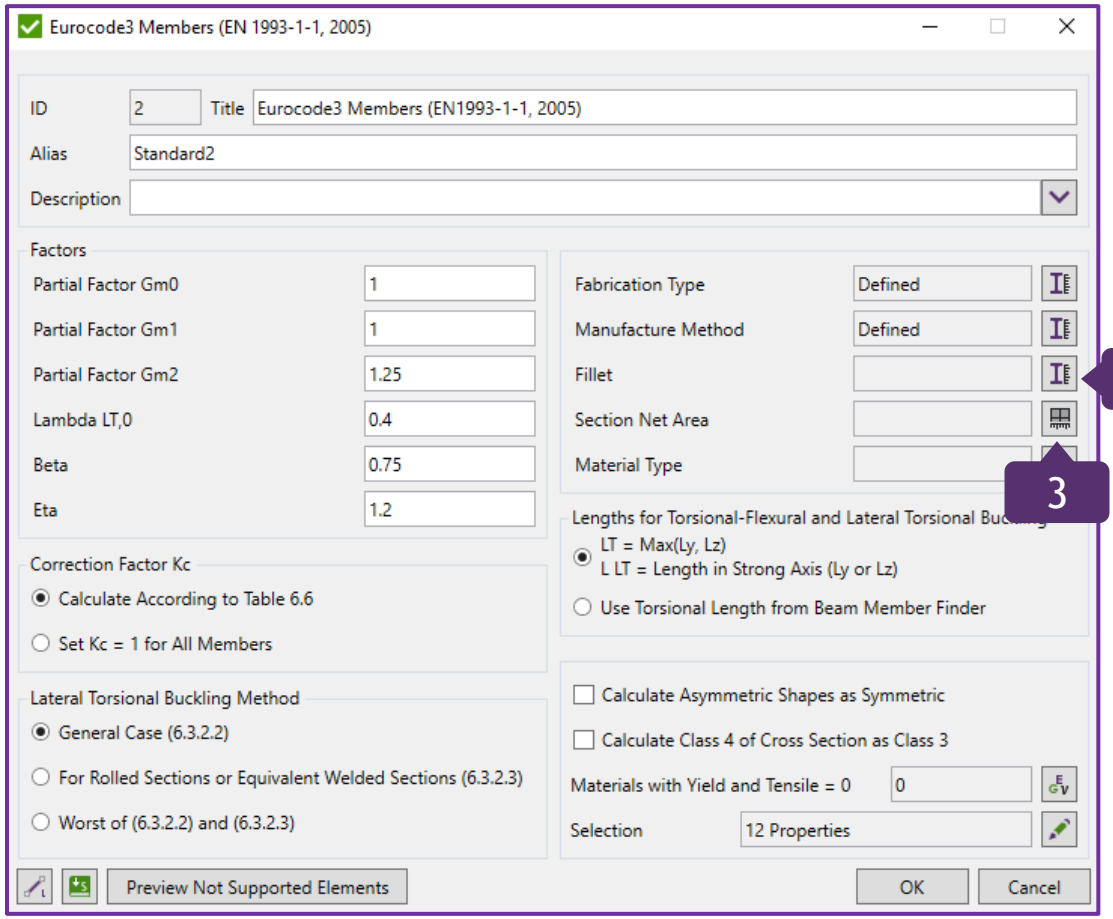




Define Fillet

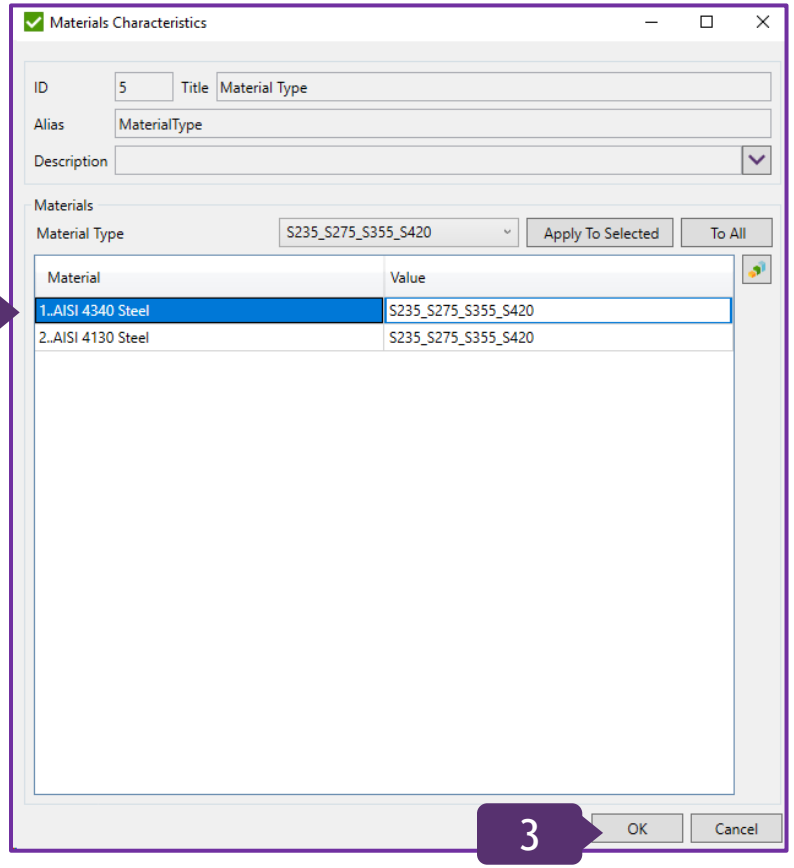
1. Press in *Fillet*
2. Press *OK*
3. Repeat steps 1-2 for *Section Net Area*

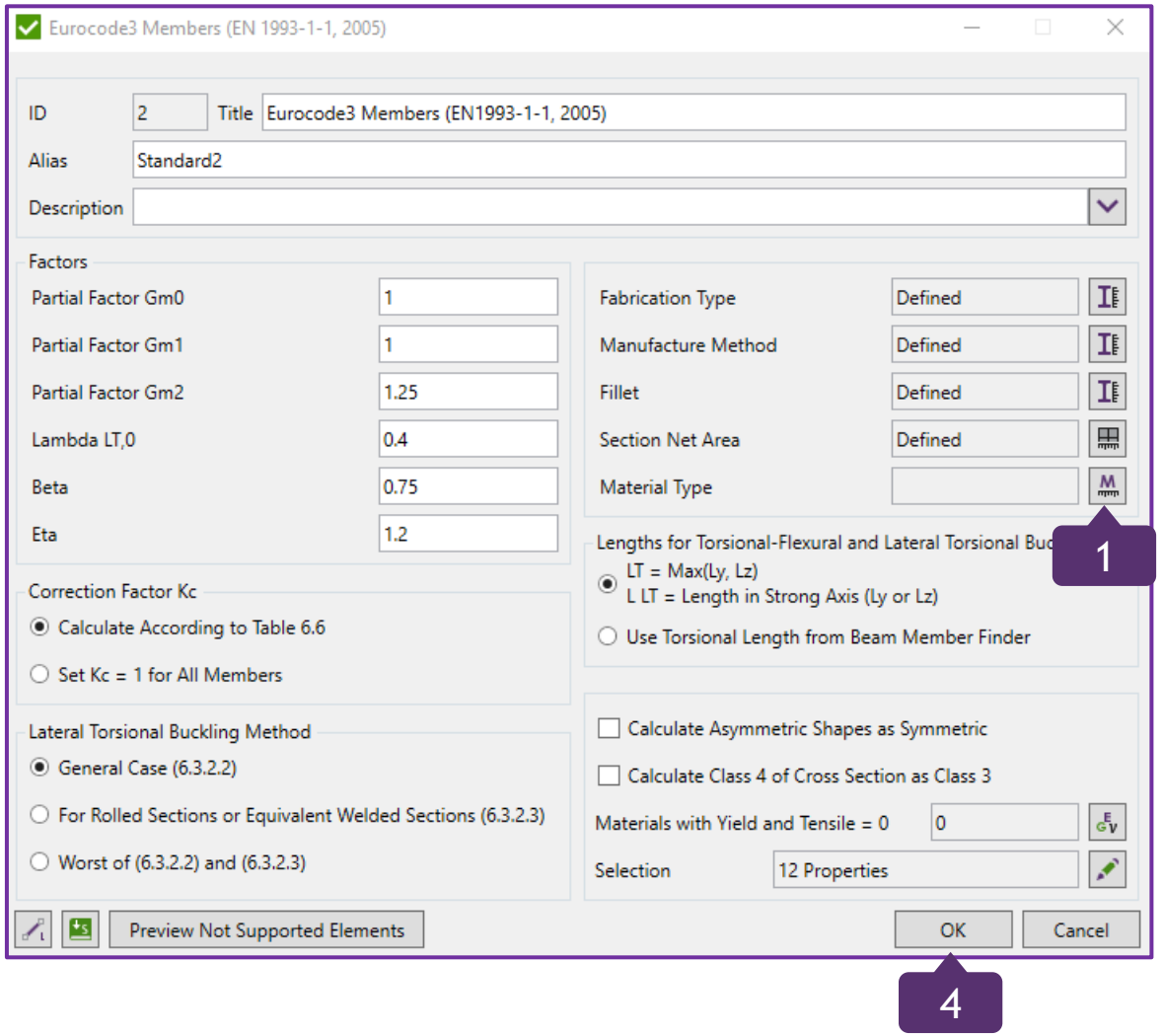




Define Material Type

1. Press *Material Type*
2. Select *1..AISI 4340 Steel* with *Value: S235_S275_S355_S420*
3. Press *OK*
4. Press *OK*

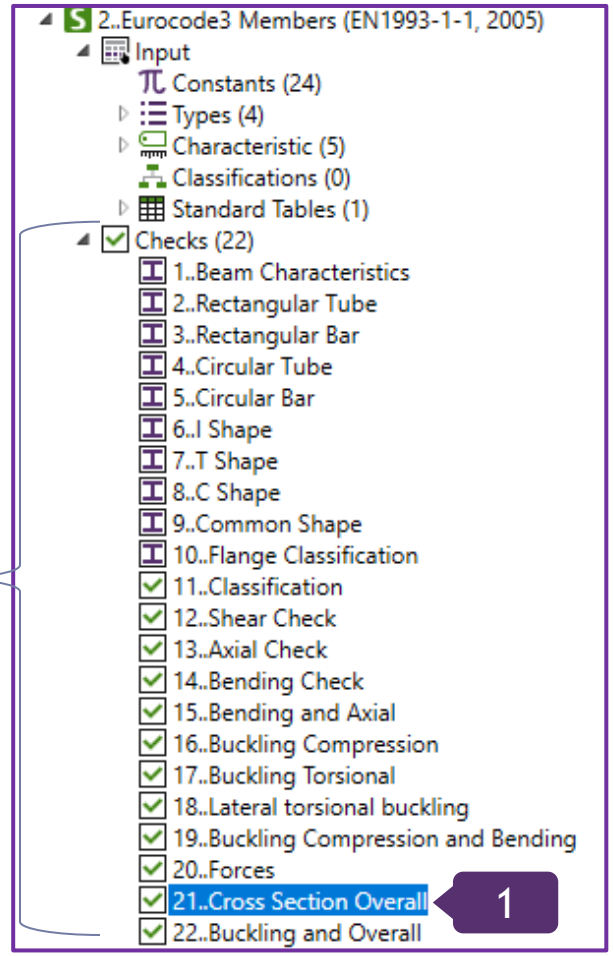


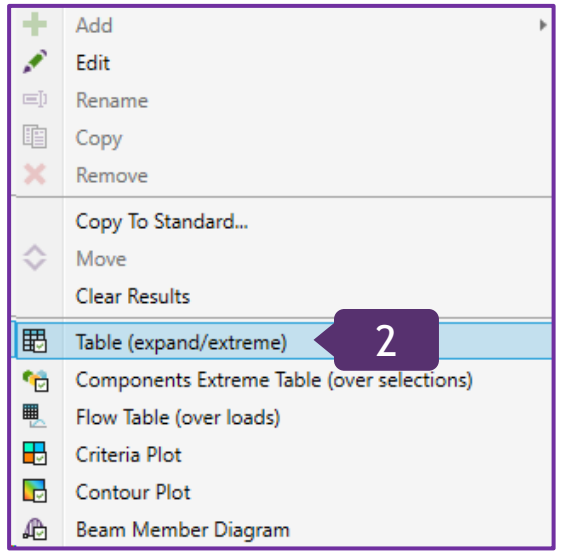


Preview Table Results

1. In *Checks* section of 2..Eurocode3 Members, execute right click on *21..Cross Section Overall*
2. Select *Table (expand/extreme)*

22 Checks have been created.





Preview Table Results (Continuation)

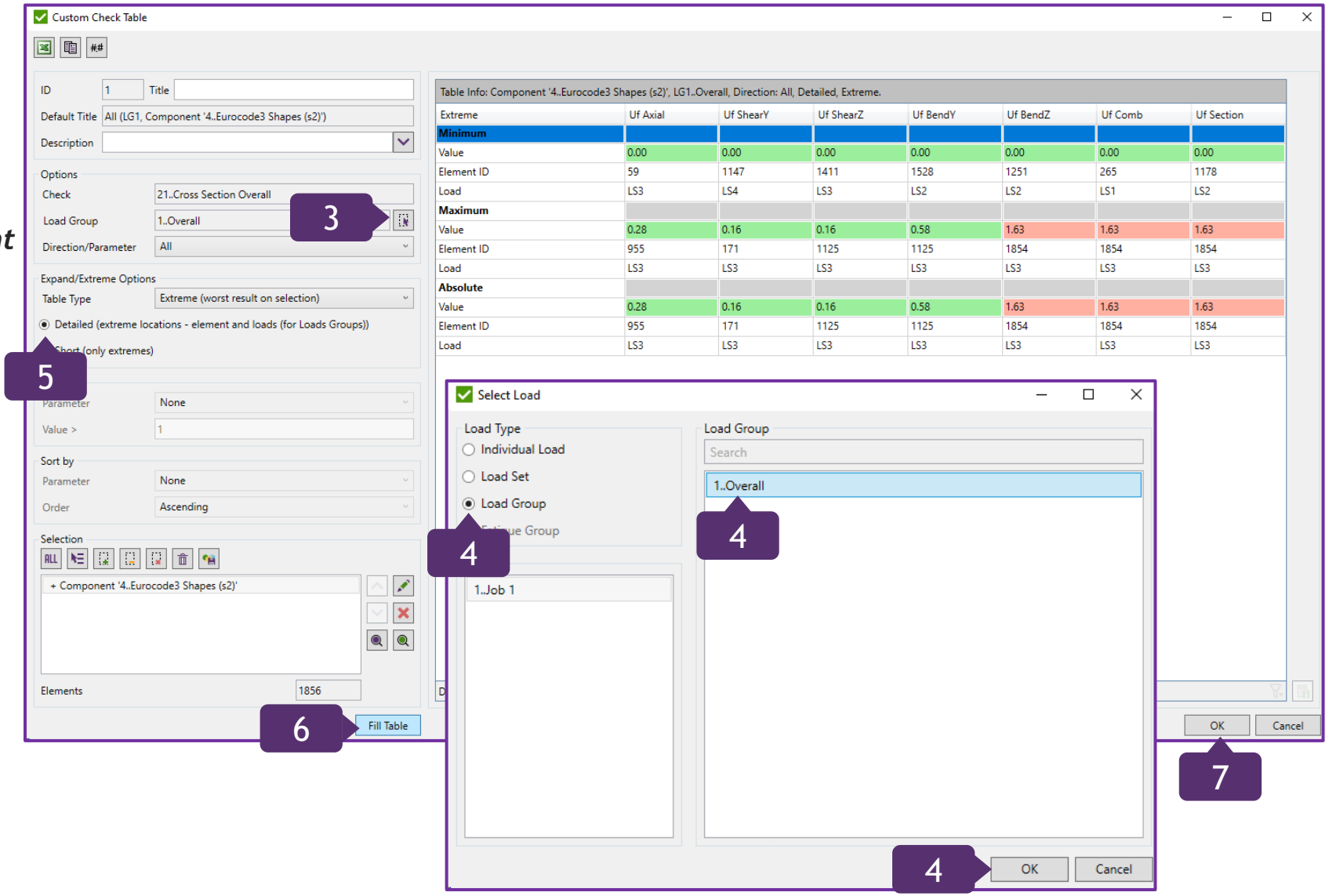
3. Press to select *Load*

4. Select *Load Group => 1..Overall*;
   Press *OK*

5. *Detailed (extreme locations - element and loads (for Loads Groups))* is *ON*

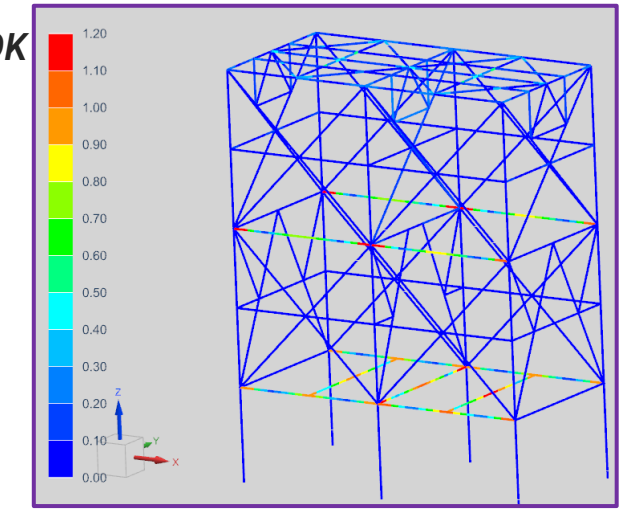
6. Press *Fill Table*

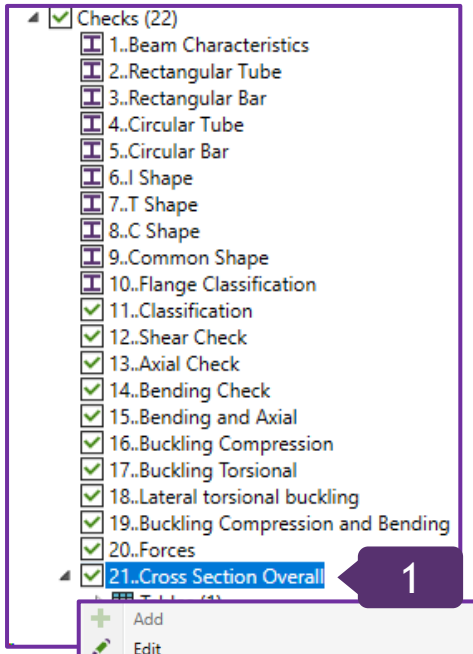
7. Press *OK*

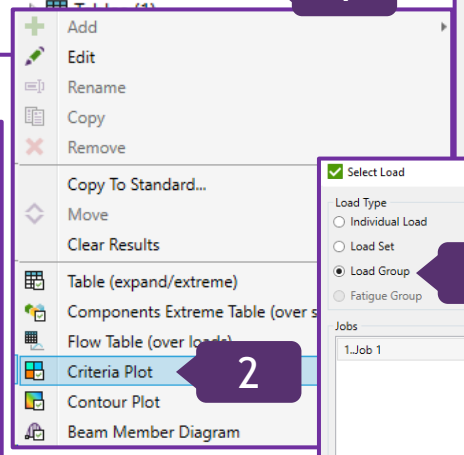


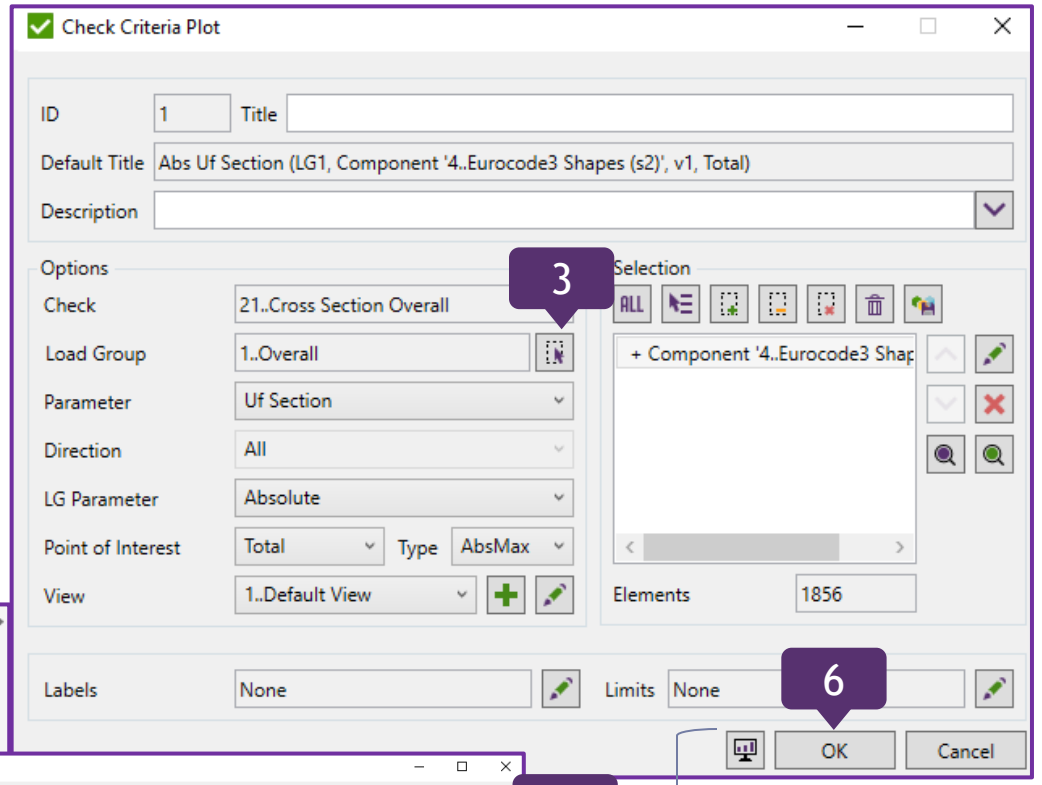
Utilization Factor Plot

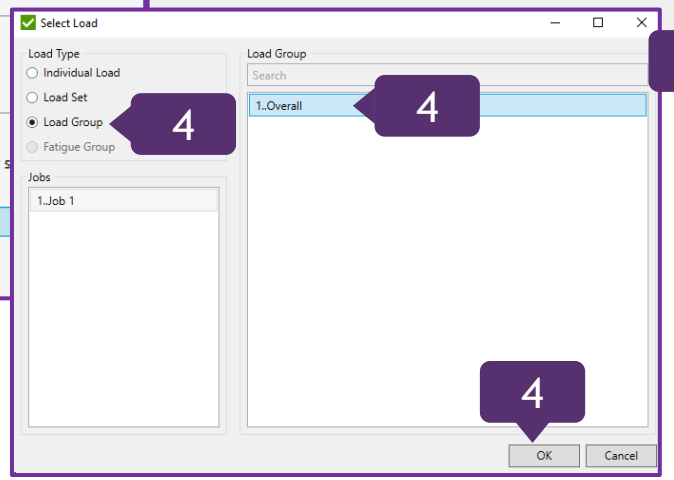
1. In *Checks* section of 2..Eurocode3 Members, execute right click on *21..Cross Section Overall*
2. Select *Criteria Plot*
3. Press to select *Load*
4. Select *Load Group => 1..Overall*; Press *OK*
5. Press , and then *Preview*
6. Press *OK*

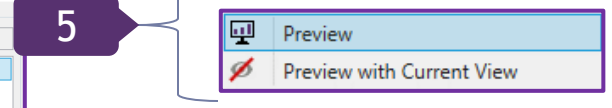












Create Reports in Report Designer

To learn how to obtain reports, please check a separate Tutorial that depicts the functionality of SDC Verifier Report Designer. It may be downloaded via this link:

https://sdcverifier.com/tutorials/report-designer/