Tutorial
AISC 360-10 & Eurocode3

10 Dec 2020
version 2020.0.2

Content

▸ In this tutorial, AISC 360-10 & Eurocode3 Member Check 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.

▸ Report was automatically generated in SDC Verifier Report Tool to represent beam
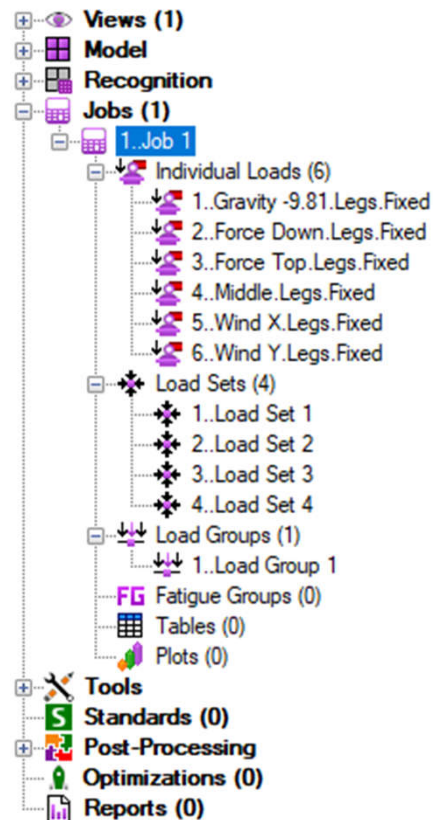checks results according AISC 360-10 and Eurocode3 standards.
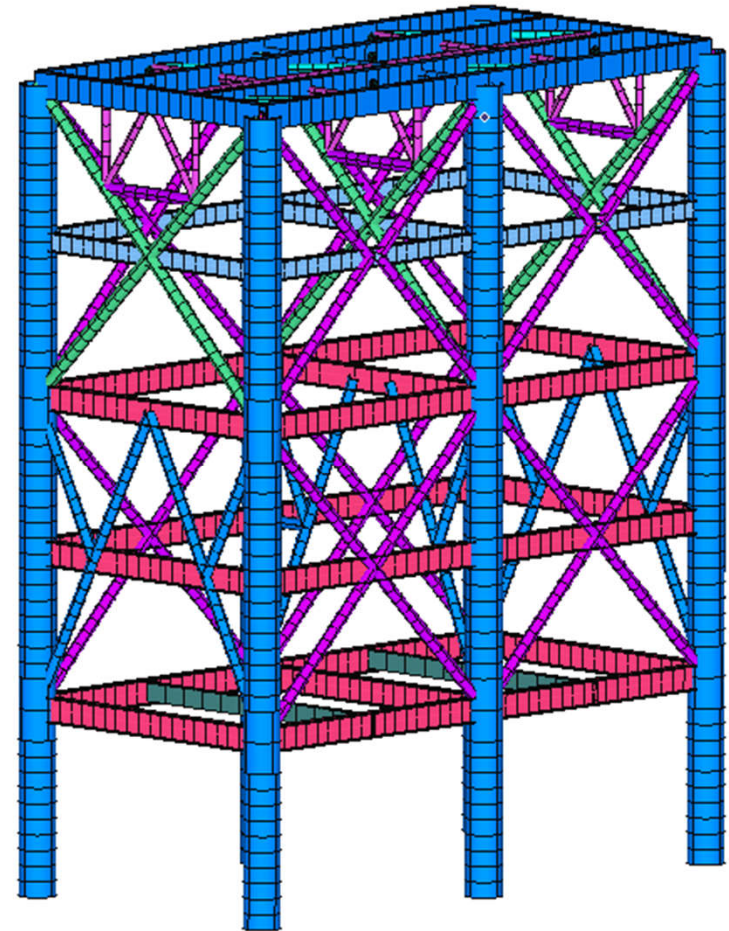
Open Project

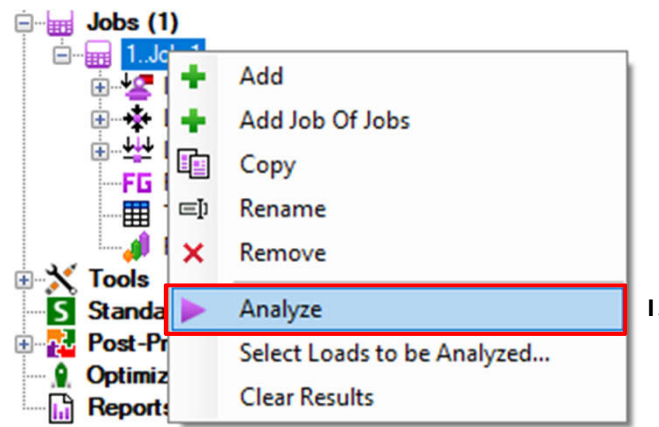| 1 | Launch **SDC Verifier** ✅ |
| 2 | Execute *File - Open Project.* |
| 3 | Project: **AISC 360-10 & Eurocode3.sdcv** |
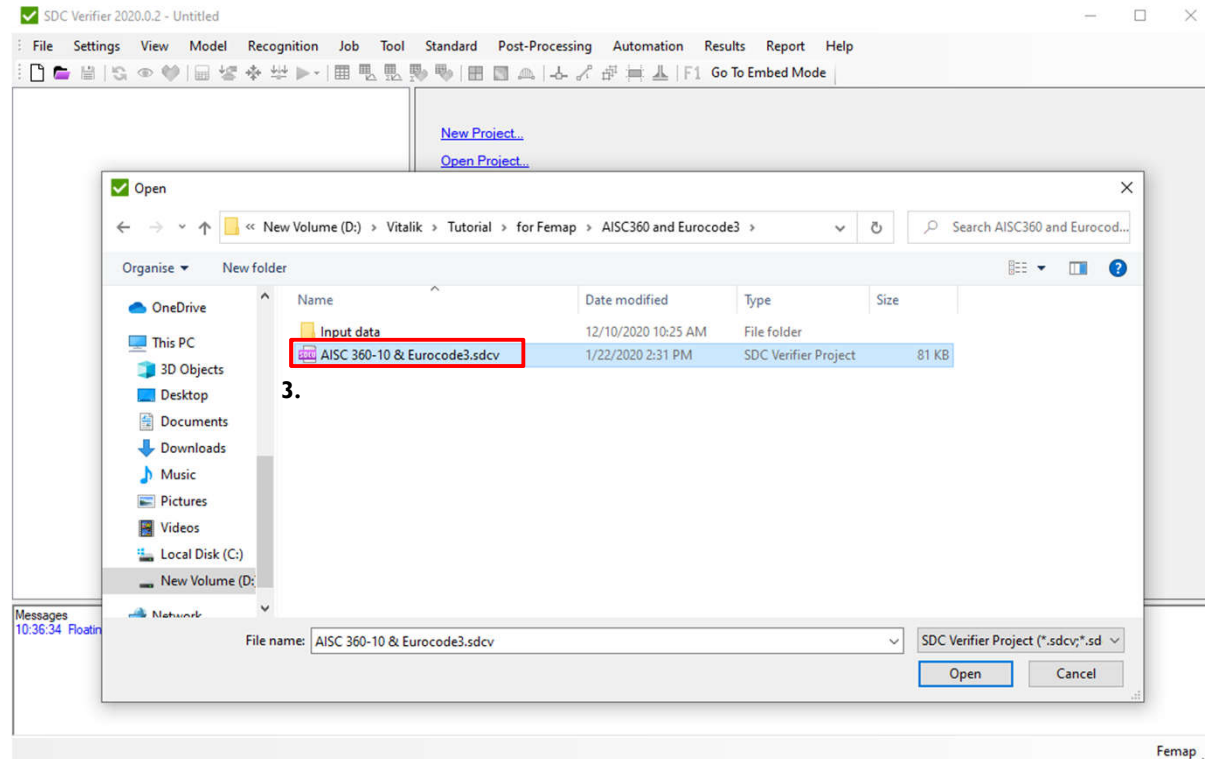
Predefined Project

This tutorial uses project with predefined boundary condition, load combinations and load group.
The model contains only beam elements of the following types: I-Beam, Circular and Rectangular Tubes

Analyze Job

1 Execute ▶ **Analyze** from *Job1* context menu

Joints

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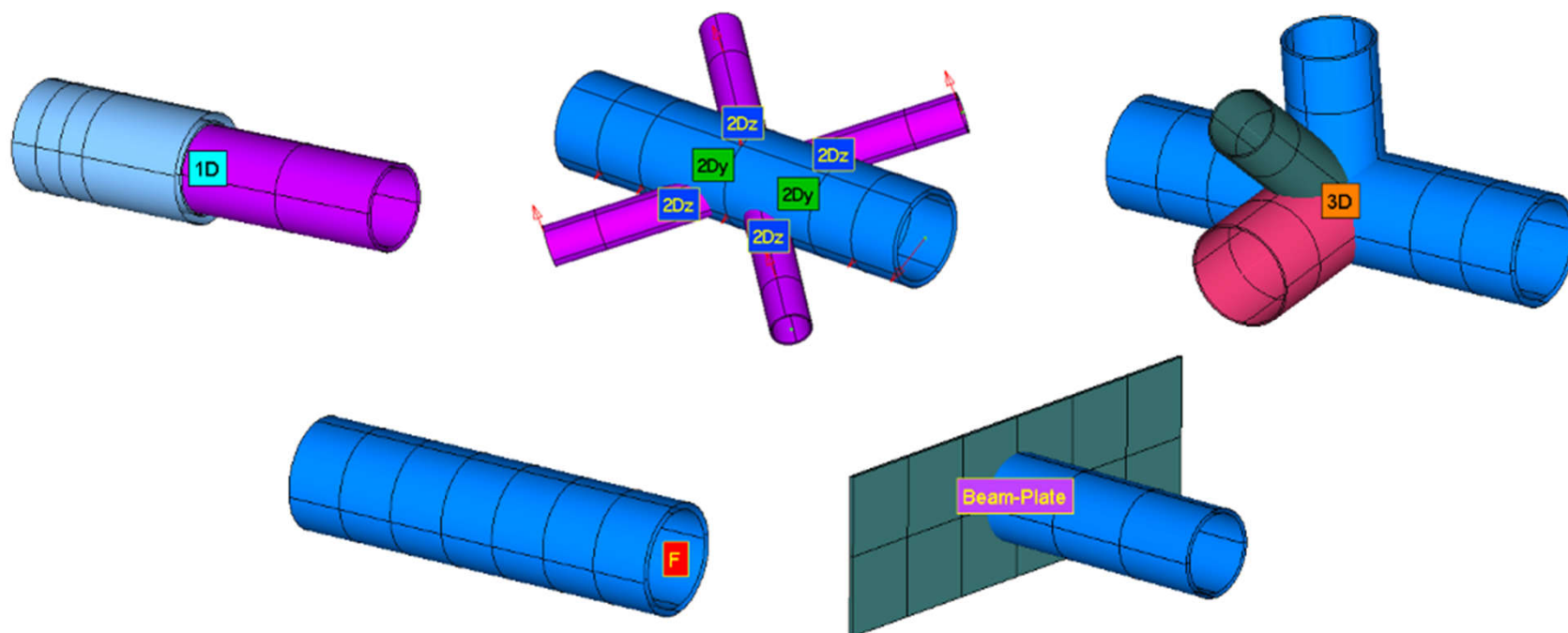1D Joint – 2 beam members that lie on the curve but with different properties;
2D Joint – beam members connected in one plane;
3D Joint – beam members connected in space;
Free Joint – node which belongs only to one element (free);
Beam-Plate Joint – beam member connected to plates (perpendicularly);
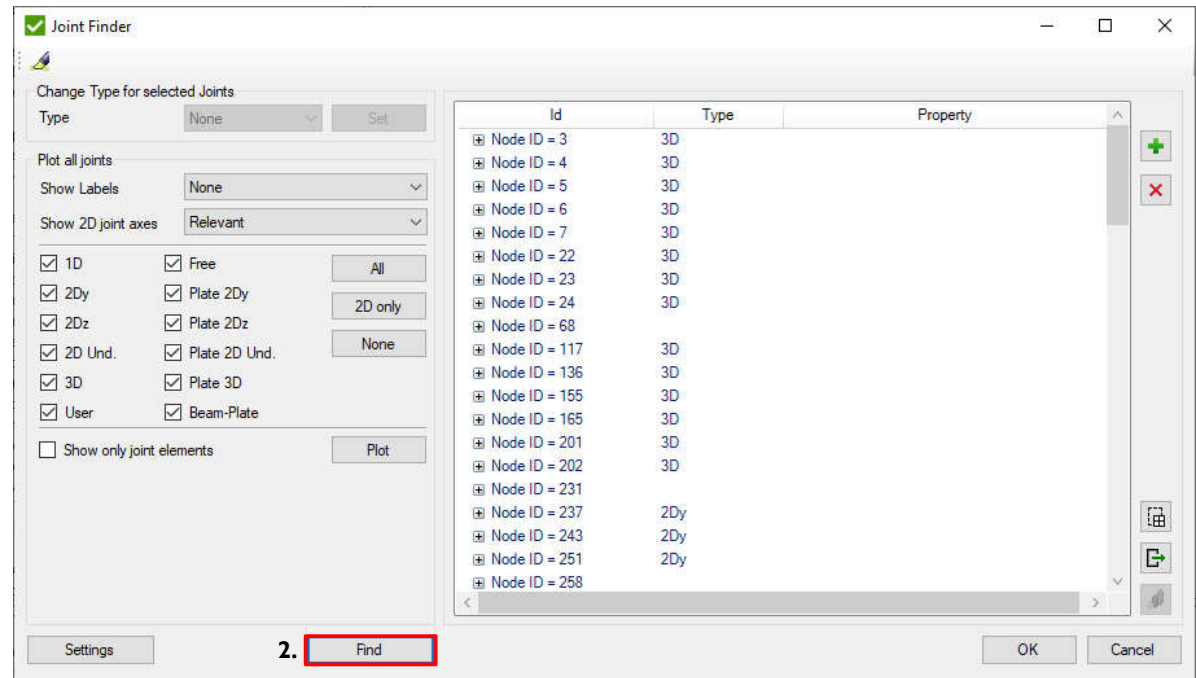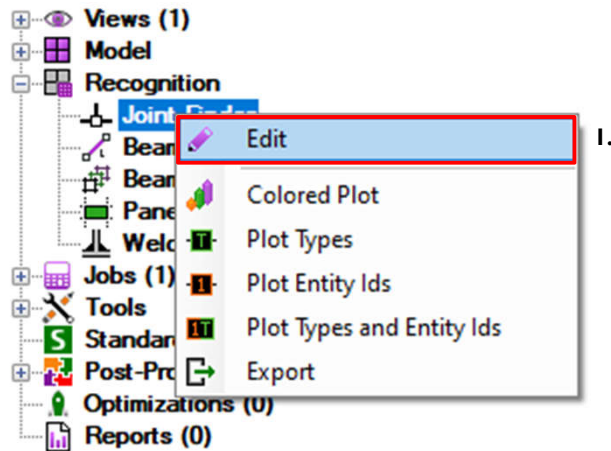User Defined;

Joint Recognition
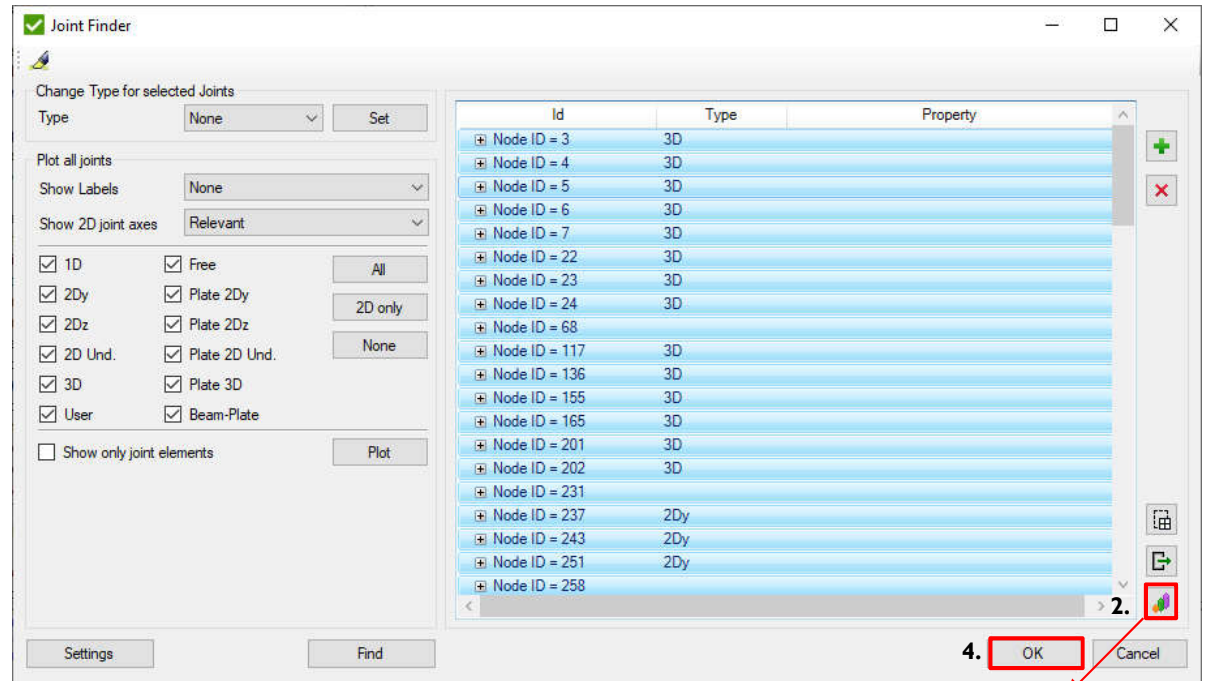
1	Execute *Edit* from *Joint Finder* context menu

2	Press *Find*.

1	Select All Joints (Ctrl+A).
2	Press 📊
3	Press 🅣 Plot Joint Type Labels
4	Press *OK*
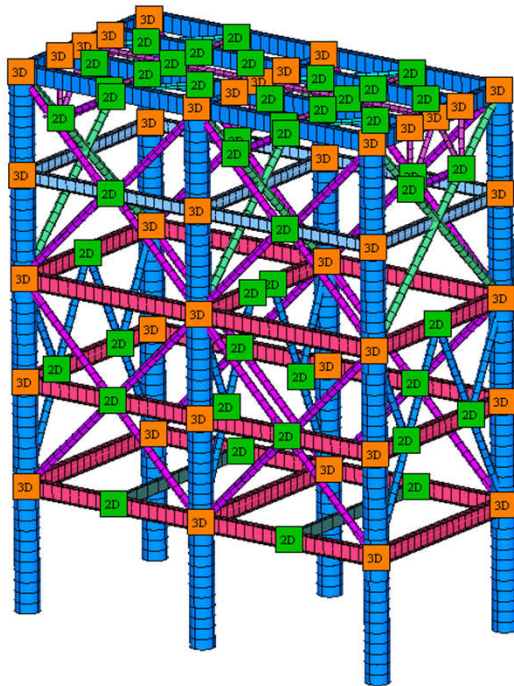
Plot Joints of specific type:
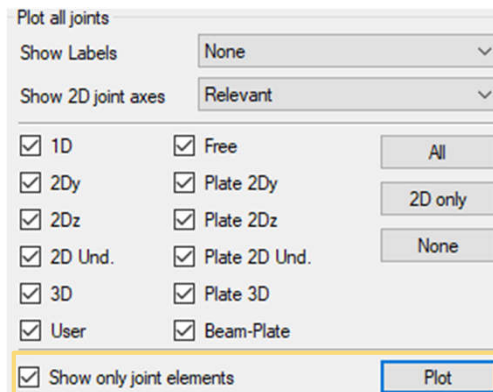
Modify Joint Type:

3. 🅣 Plot Joint Type Labels
   📊 Plot Joint Type in colors
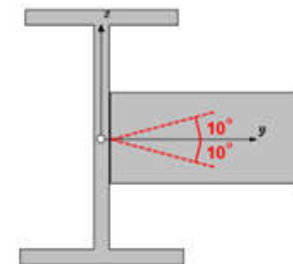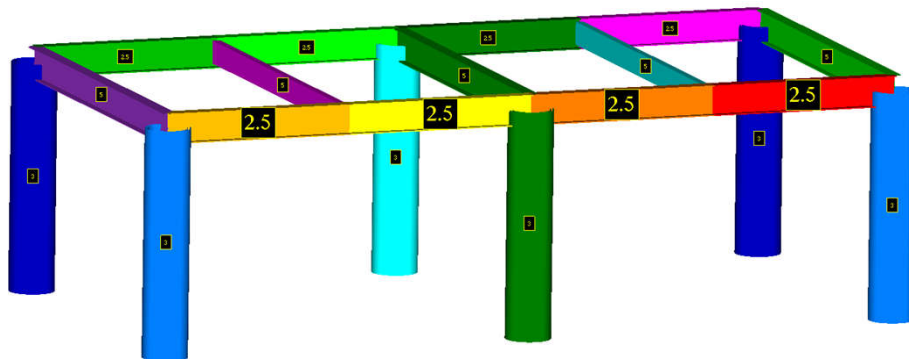
Beam Member Finder recognizes beam members and (buckling) lengths for different directions (Y, Z and Torsional).
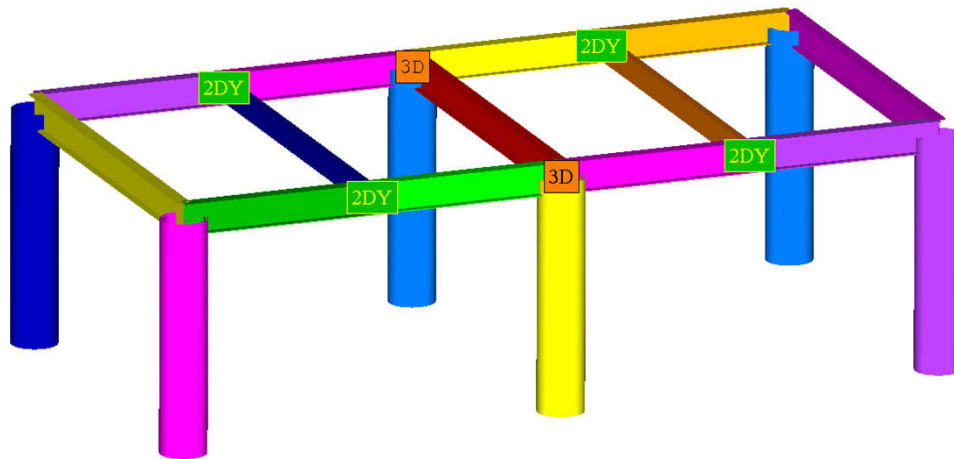
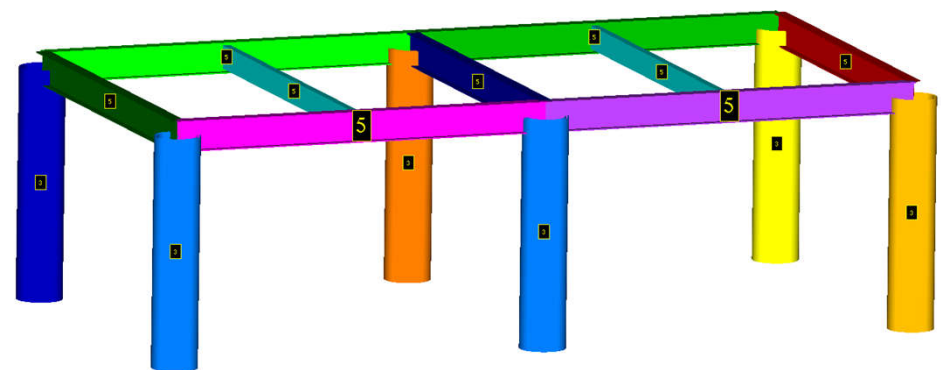**Length Y – 4 Beam Members with L = 2.5**
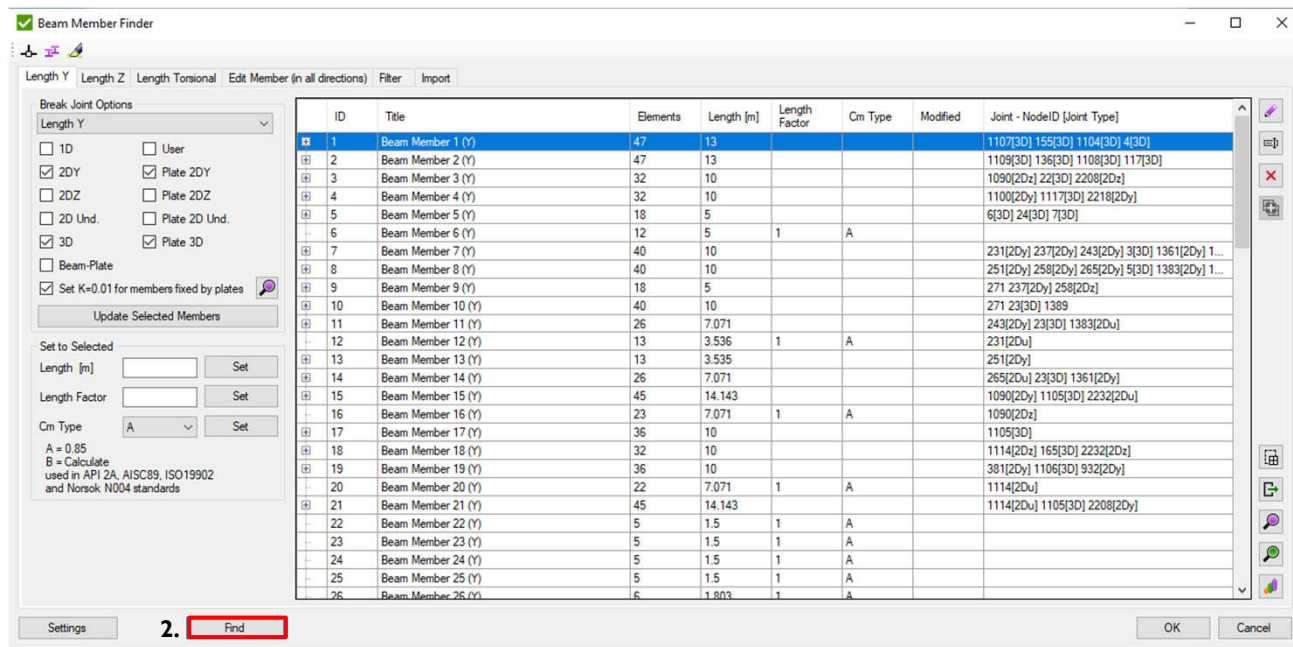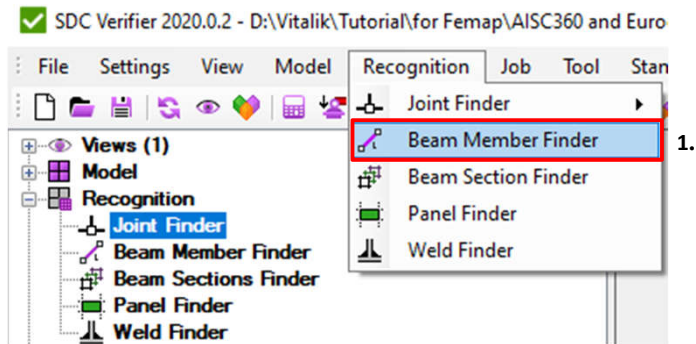
Length Z – 2 Beam Members with L = 5

Recognize Length Y

	Steps
1	Execute *Recognition – Beam Member Finder*
2	Press *Find*

Beam Member Finder Explanation

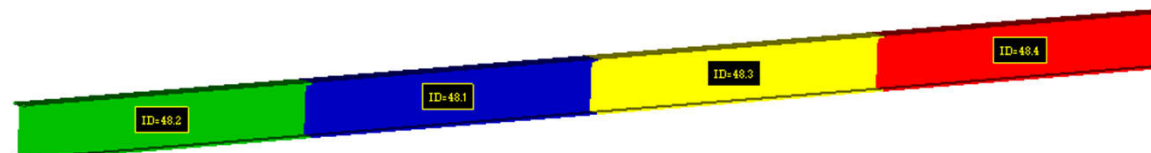Break Options define what joints are used to split beam members

Change Length/Factor for selected beam members

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

Colored Plot of members with labels (ID, Length, Factor or Cm Type).

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

Beam Member Finder Plots

1 Select All Beam Members (Ctrl+A)

2 Press 🎨 and Execute 📗 **Plot Length labels** to display members Length.

3 Press 🎨 and Execute 📒 **Plot Members ID labels** to display beam members IDs.

Also it is possible to display beam members IDs by pressing 📙

ANSI/AISC 360-10 - 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
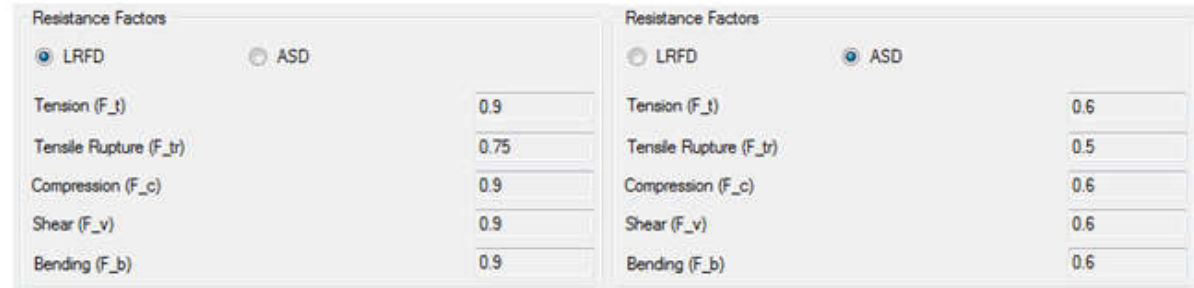
AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.
One East Wacker Drive, Suite 700
Chicago, Illinois 60601-1802

STEEL CONSTRUCTION

MANUAL

AMERICAN INSTITUTE OF STEEL CONSTRUCTION INC.

THIRTEENTH EDITION

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:

Resistance Factors

	LRFD	ASD	
Tension (F_t)	0.9		
Tensile Rupture (F_tr)	0.75		
Compression (F_c)	0.9		
Shear (F_v)	0.9		
Bending (F_b)	0.9		

Resistance Factors

	LRFD	ASD	
Tension (F_t)		0.6	
Tensile Rupture (F_tr)		0.5	
Compression (F_c)		0.6	
Shear (F_v)		0.6	
Bending (F_b)		0.6	

Design for Strength Using Load and Resistance Factor Design (LRFD)
Design will be performed in accordance with Equation B3-1:
Ru ≤ φRn (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 ≤ Rn/Ω (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:

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

$$\phi_t = 0.90 \text{ (LRFD)} \qquad \Omega_t = 1.67 \text{ (ASD)}$$

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

1	Execute *Standards-Add-AISC-AISC 360-10 Members (14th, 2010)*.
2	Resistance Factors: **LRFD**
3	Press ⚏ to set *Section Build Type*
4	Execute - **Rolled**
5	Press *To All*
6	Press *Ok*
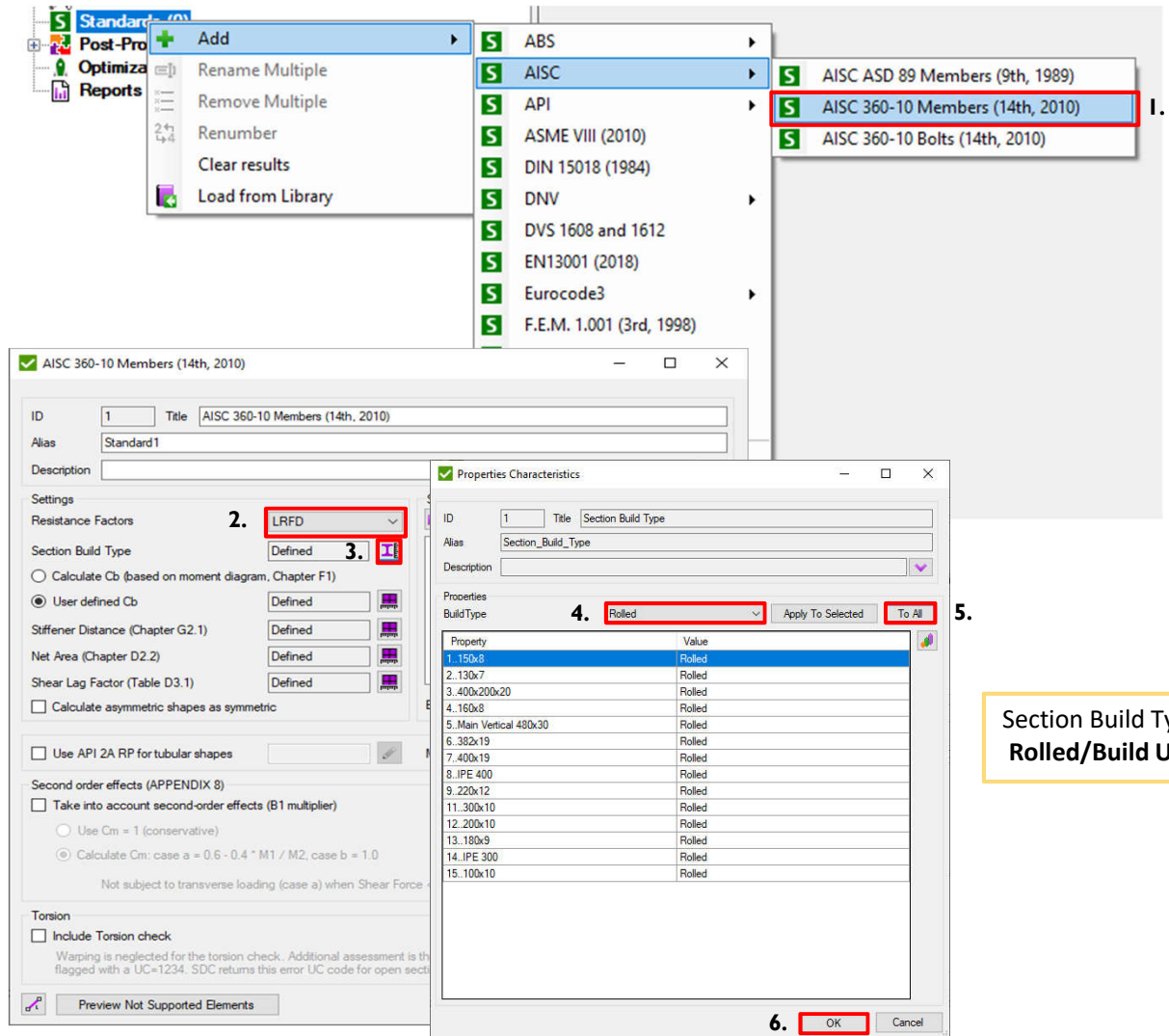
Go to the next slide to Continue

Section Build Type: **Rolled/Build Up**

Lateral-torsional buckling modification factor (Cb)

SDC
VERIFIER

1	Select – *Calculate Cb*

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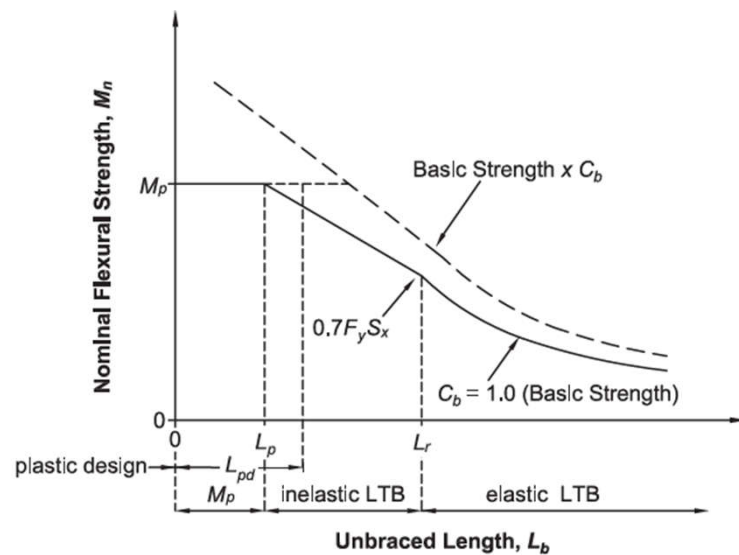
SDC Verifier follows conservative approach and uses Cb = 1.0. Cb is implemented as a characteristic which can be modified. For the details see Chapter F "Design of members for Flexure", F1 General Provisions

Standard is created

It is possible to modify Safety Factors in Constants section.

Standard contains 16 checks:
1 - Beam member characteristics;
2-6 - calculation dimensions and factors for 5 different shapes;
7-11 – strength for different shapes ;
12 – tension and compression check;
13 – additional shear check;
14 – additional bending check;
15 – torsion check;
16 - All Checks together with combined.

www.sdcverifier.com

Preview Table Results
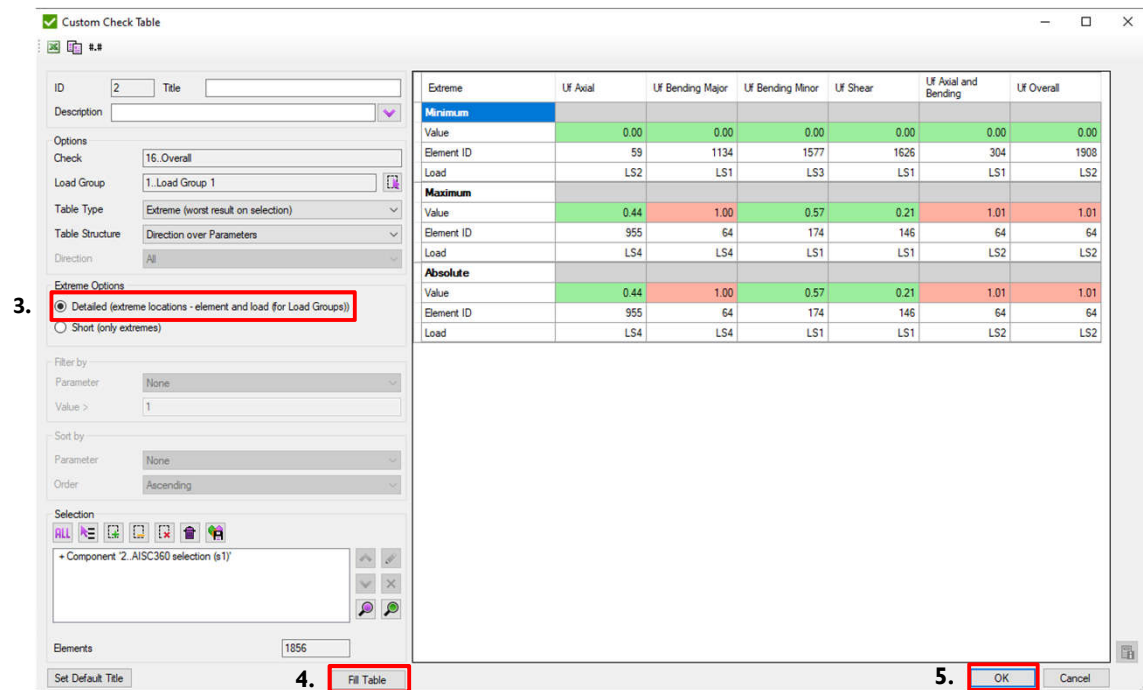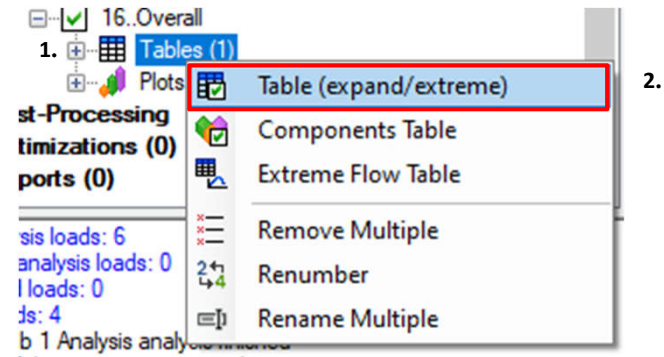
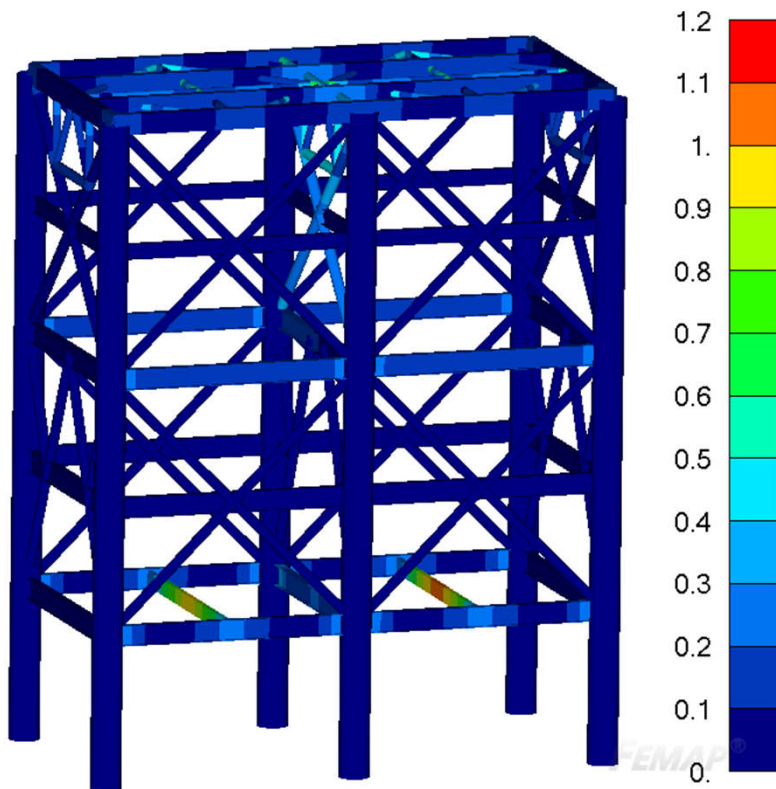|	
1	Select *Tables*
2	Execute *Table (expand/extreme)* in context menu
3	Select Extreme Options - *Detailed*
4	Press *Fill Table*
5	Press *Ok*

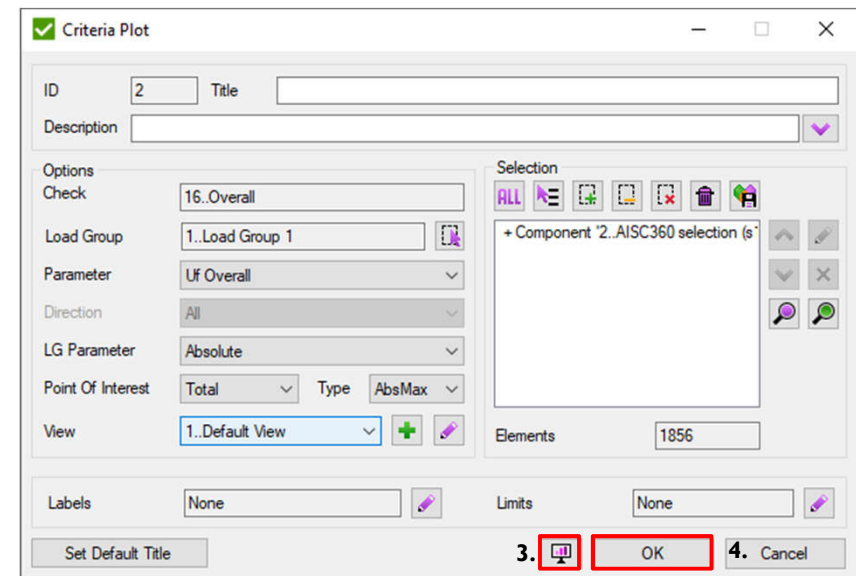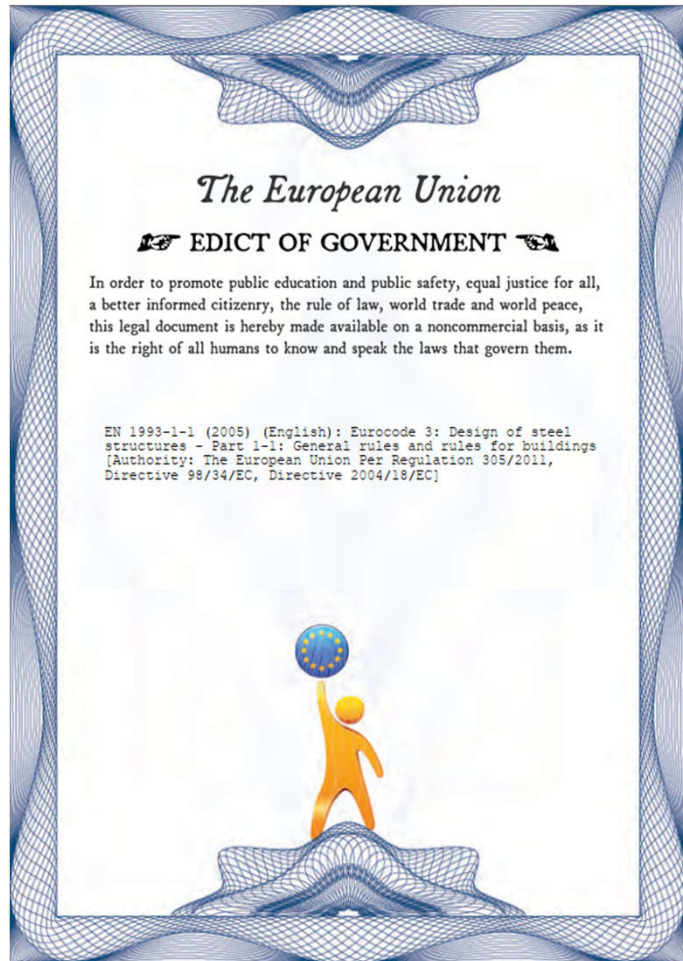Utilization Factor on element ID = 64 doesn't pass the check 1.01 > 1.

Utilization Factor Plot

SDC☑
VERIFIER

1	Select *Plots*	**3**	Press 🖥 to preview Plot
2	Execute *Criteria Plot* in context menu	**4**	Press *Ok*

2.

Plots (1)

Criteria Plot
Contour Plot
Rename Multiple
Remove Multiple
Renumber

Post-Processing
Optimizations (0)
Reports (0)

1.

SDC Verifier uses legend from 0 to 1.2 for Utilization factor. Elements in orange and red do not pass the check

ate [S1] Check
ate [S1] Check 9..Bending Strength Bars - L54..Load Set 4 fir

Legend values:
1.2
1.1
1.
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.

Criteria Plot — □ ✕

ID 2   Title _____
Description _____ ▼

Options
Check   16..Overall
Load Group   1..Load Group 1
Parameter   Uf Overall
Direction   All
LG Parameter Absolute
Point Of Interest Total   Type AbsMax
View   1..Default View ➕ ✏

Selection
ALL ▤ ▦ ▦ ▦ 🗑 📂
+ Component '2..AISC360 selection (s
🔍 🔍
Elements 1856

Labels None ✏   Limits None ✏
Set Default Title   **3.** 🖥   OK   **4.** Cancel

Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings
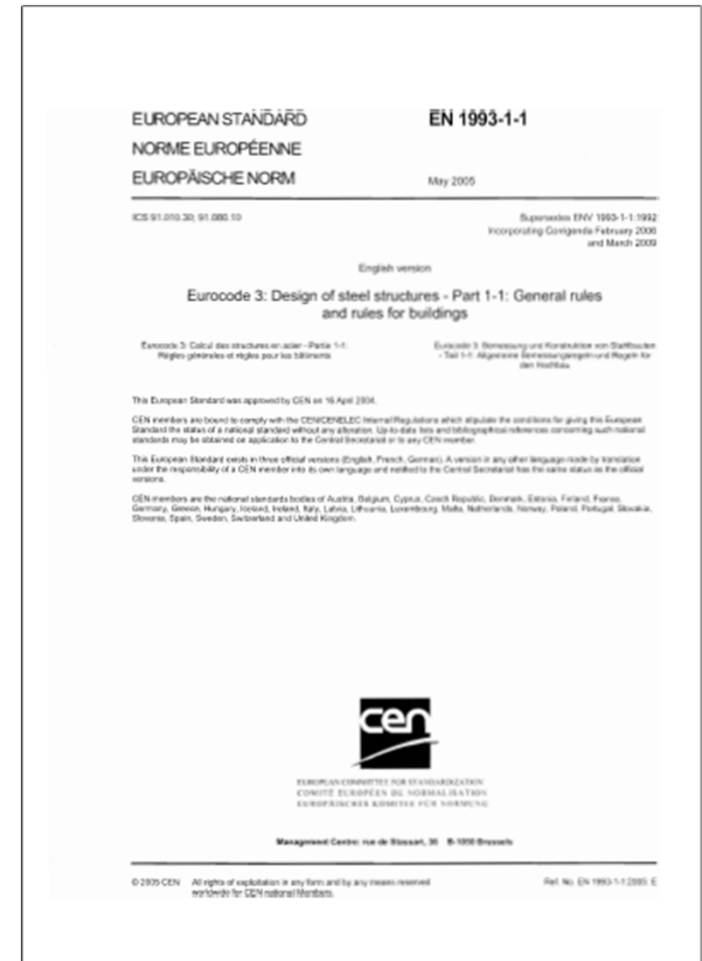
Gm0 - resistance of cross-sections whatever the class is;
Gm1 - resistance of members to instability assessed by member checks;
Gm2 - resistance of cross-sections in tension to fracture.
λLT,0 – plateau length of the lateral torsional buckling curves for rolled sections;
β - correction factor for the 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):
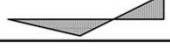
A correction Factor Kc can be calculated using the Cm Tool for each member. Also it is possible to set the Kc equal to 1.

Table 6.6: The Correction Factor:

Moment distribution	k_c
$\psi = 1$	1,0
$-1 \leq \psi \leq 1$	$\dfrac{1}{1,33 - 0,33\psi}$
	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 user.

Eurocode3. Fabrication Type

1 Execute *Standards-Add-Eurocode3-Eurocode3 Members*

2 Press [icon] to set *Fabrication Type*
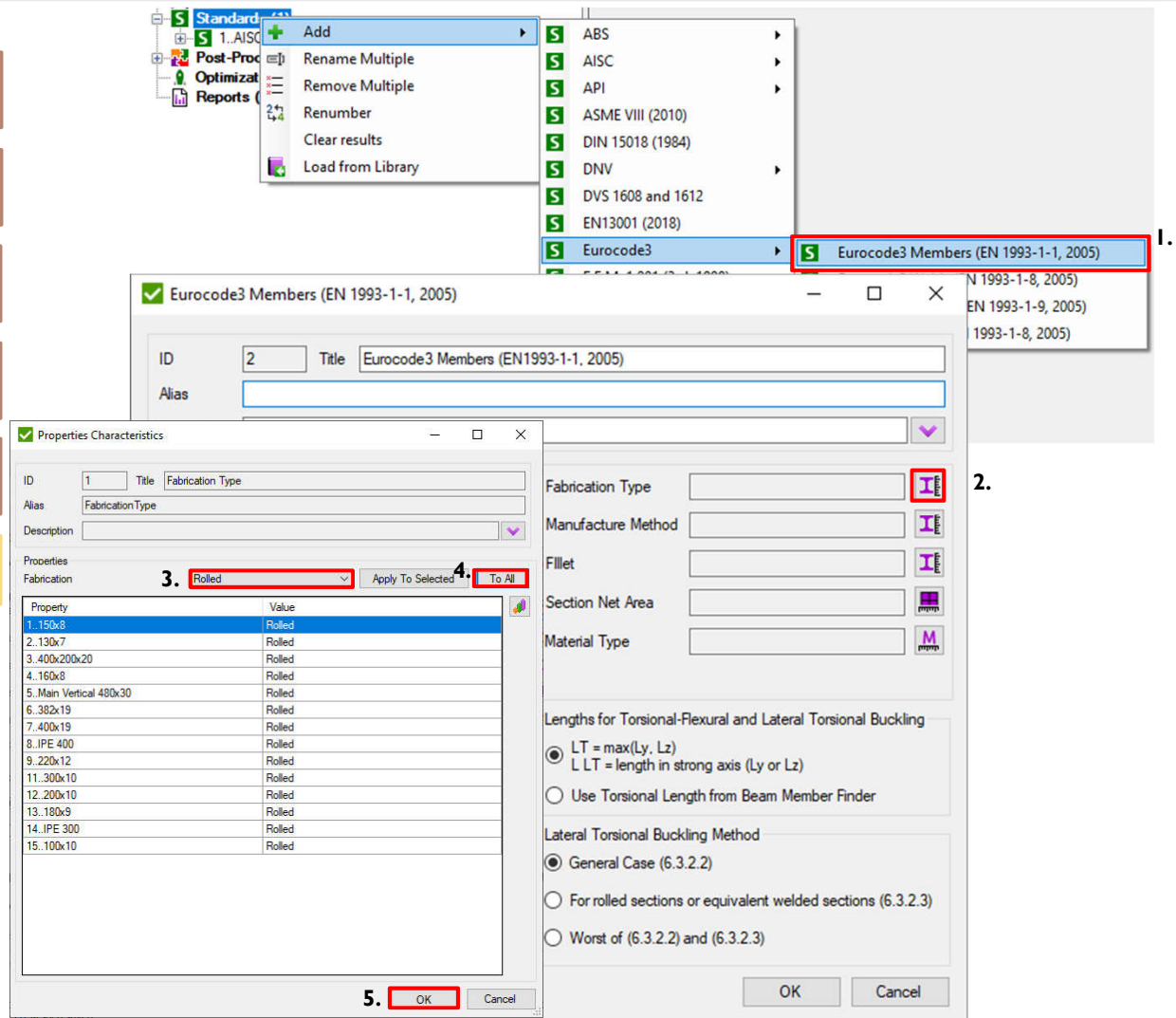
3 Execute - **Rolled**

4 Press *To All*

5 Press *Ok*

Go to the next slide to Continue

Eurocode3. Manufacture Method

1 — Press ▮ to set *Manufacture Method*
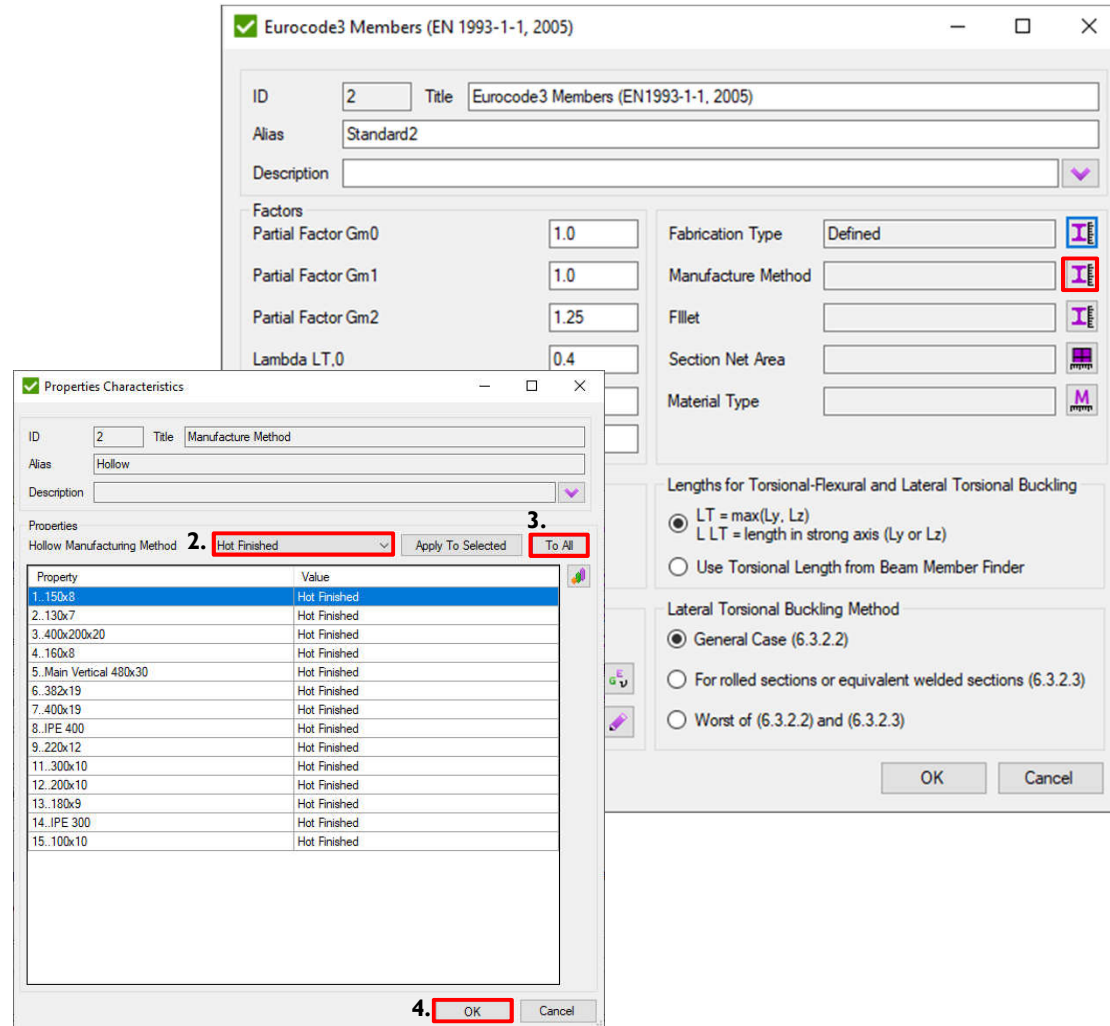
2 — Execute – **Hot Finished**

3 — Press *To All*

4 — Press *Ok*

Go to the next slide to Continue

Eurocode3 Members (EN 1993-1-1, 2005)

ID | 2 | Title | Eurocode3 Members (EN1993-1-1, 2005)

Alias | Standard2

Description

Factors
Partial Factor Gm0 | 1.0
Partial Factor Gm1 | 1.0
Partial Factor Gm2 | 1.25
Lambda LT,0 | 0.4

Fabrication Type | Defined
Manufacture Method | **I.**
Fillet
Section Net Area
Material Type

Lengths for Torsional-Flexural and Lateral Torsional Buckling
- LT = max(Ly, Lz)
  L LT = length in strong axis (Ly or Lz)
- Use Torsional Length from Beam Member Finder

Lateral Torsional Buckling Method
- General Case (6.3.2.2)
- For rolled sections or equivalent welded sections (6.3.2.3)
- Worst of (6.3.2.2) and (6.3.2.3)

OK | Cancel

Properties Characteristics

ID | 2 | Title | Manufacture Method
Alias | Hollow
Description

Properties
Hollow Manufacturing Method | **2.** Hot Finished | Apply To Selected | **3.** To All

Property	Value
1..150x8	Hot Finished
2..130x7	Hot Finished
3..400x200x20	Hot Finished
4..160x8	Hot Finished
5..Main Vertical 480x30	Hot Finished
6..382x19	Hot Finished
7..400x19	Hot Finished
8..IPE 400	Hot Finished
9..220x12	Hot Finished
11..300x10	Hot Finished
12..200x10	Hot Finished
13..180x9	Hot Finished
14..IPE 300	Hot Finished
15..100x10	Hot Finished

4. OK | Cancel

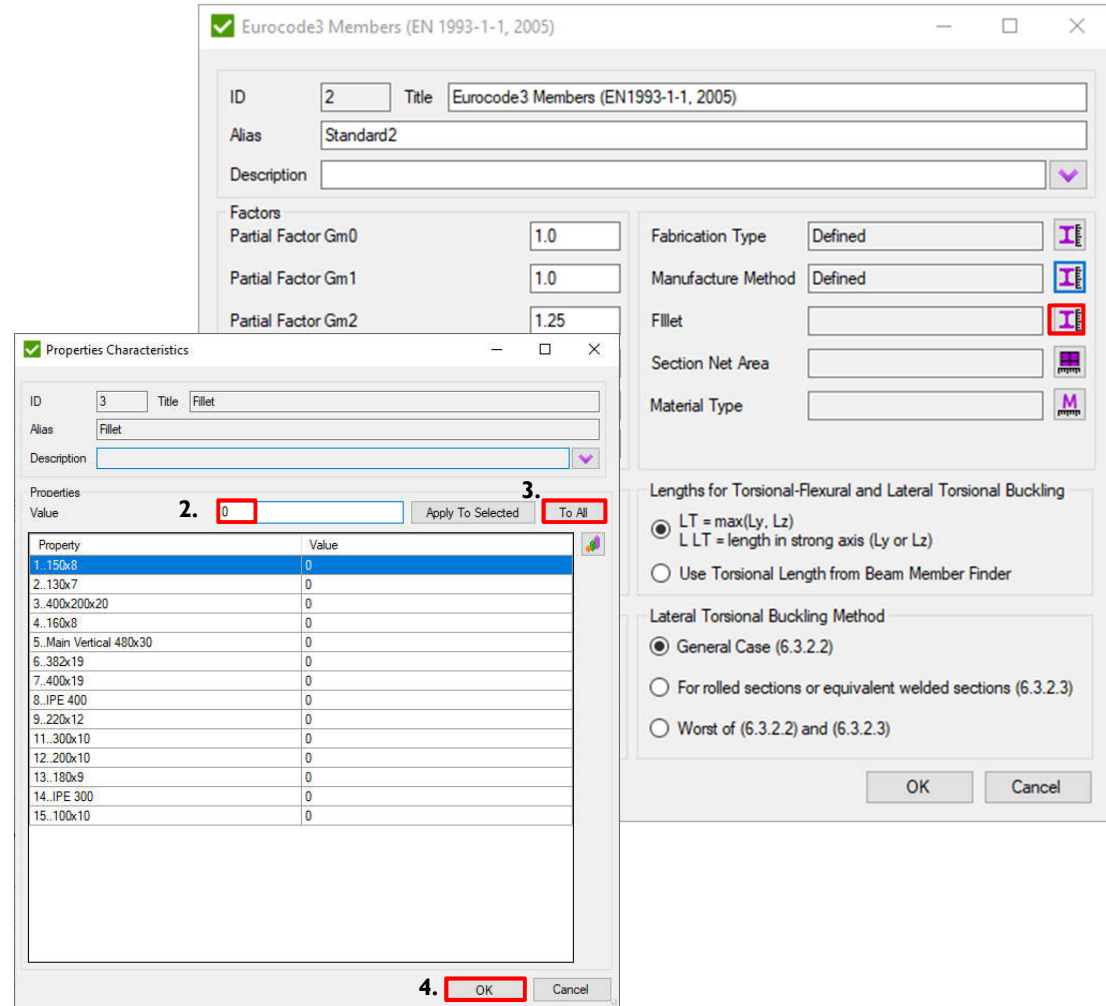# Eurocode3. Fillet

1 Press ∐ to set *Fillet*

2 Properties Value - *0*

3 Press *To All*

4 Press *Ok*

Repeat Steps 1-4 for *Section Net Area*

Go to the next slide to Continue

Eurocode3. Material Type

1	Press ![M] to set *Material Type*
2	Execute – *S235_S275_S355_S420*
3	Press *To All*
4	Press *Ok*
5	Press *Ok*

Standard is created

Standard contains 19 checks:
1 – Beam Characteristics
2-7 - calculation dimensions and factors for 5 different shapes;
8 – cross section resistance;
9 – shear strength check;
10 – tension and compression strength check;
11 – bending strength check;
12 – bending, tension and compression strength check;
13-15 – buckling strength checks ;
16 – additional buckling compression and bending check;
17 – forces;
18 - cross section overall strength check;
19 – buckling and overall strength check.

Preview Table Results

1 Select *Tables*

2 Execute *Table (expand/extreme)* in context menu

3 Select Extreme Options - *Detailed*

4 Press *Fill Table*

5 Press *Ok*

Utilization Factor Plot

1	Select *Plots*

3	Press 🖥 to preview Plot

2	Execute *Criteria Plot* in context menu

4	Press *Ok*

- 12..Bending and Axial
- ☑ 13..Buckling Compression
- ☑ 14..Buckling Torsional
- ☑ 15..Lateral torsional buckling
- ⊞ ☑ 16..Buckling Compression and Bending
- ☑ 17..Forces
- ⊟ ☑ 18..Cross Section Overall
  - ⊟ 🔳 Tables (2)
    - 1..Over Load Groups
    - 2..All (LG1, Component '3..Eurocode3 St
  - **1.** ⊞ Plots (1)
  - ⊞ ☑ 19..Bucklin

Post-Processing
Optimizations (0)
Reports (0)

Criteria Plot **2.**

Contour Plot

Rename Multiple

SDC Verifier uses legend from 0 to 1.2 for Utilization factor. Elements in orange and red do not pass the check

Criteria Plot

ID: 2   Title:

Description:

Options
Check: 18..Cross Section Overall
Load Group: 1..Load Group 1
Parameter: Uf Section
Direction: All
LG Parameter: Absolute
Point Of Interest: Total   Type: AbsMax
View: 1..Default View

Labels: None

Selection
+ Component '3..Eurocode3 Shapes (s
Elements: 1856
Limits: None

Set Default Title   **3.** 🖥   OK   **4.** Cancel

Create Predefined Report

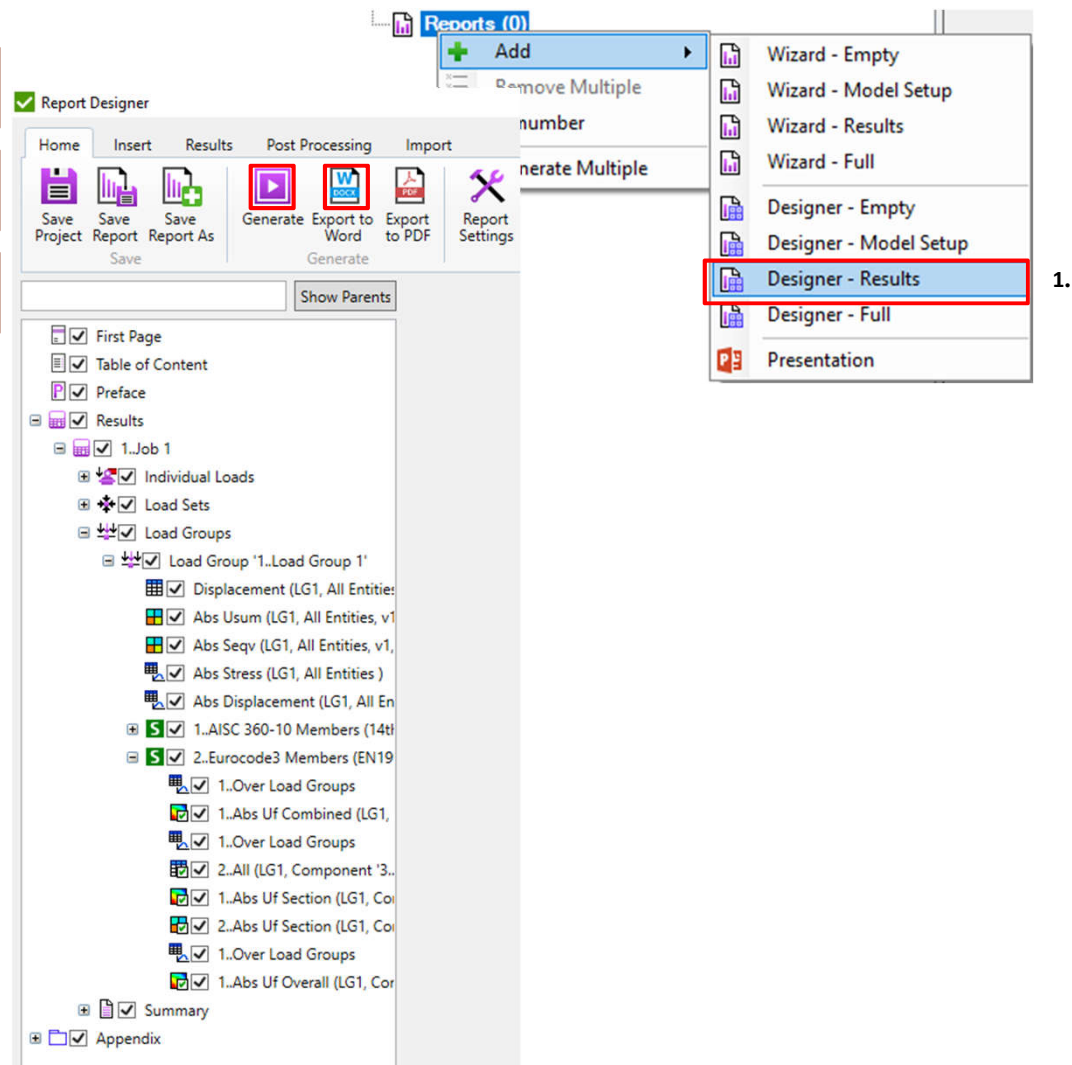**1** Execute *Reports - Add - Designer-Results.*

2 Press ▶ to generate report

3 When report is generated press 📄

Results report includes an overview of the displacements and stresses for all loads and standards with all predefined tables and plots

Generated Report

AISC 360 - 10

Eurocode3