SDC VERIFIER

Tutorial

Eurocode3 and F.E.M. 1.001 Fatigue

Updated on: 20 June 2023

Tested with: 2023 R1.1

Version 2022.1

Content

- This step-by-step tutorial demonstrates how to implement the fatigue check according F.E.M. 1.001 and Eurocode 3 in SDC Verifier.
- FEM 1.001 Fatigue and Eurocode 3 detailed review;
- Implementation in SDC Verifier;
- Weld Finder Tool overview;
- Fatigue tables and plots;
- Report preparation and results.

Allowable Stress Design method

The following formulae give for all values of κ the permissible stresses for fatigue

a) $\kappa \leq 0$

- for tension : $\sigma_t = 5 . \sigma_w / (3 - 2 . \kappa)$ (1)
- for compression : $\sigma_c = 2 . \sigma_w / (1 - \kappa)$ (2)

σ_w is given in table above.

b) $\kappa > o$

- for tension $\sigma_t = \sigma_O / [1 - \kappa . (1 - \sigma_O / \sigma_{+1})]$ (3)
- for compression $\sigma_c = 1,2 . \sigma_t$ (4)

where σ_O = tensile stress for $\kappa = 0$ is given by the formula (1) that is :
$\sigma_O = 1,66 . \sigma_w$

σ_{+1} = tensile stress for $\kappa = + 1$ that is the ultimate strength σ_R divided by the coefficient of safety 4/3 : $\sigma_{+1} = 0,75 . \sigma_R$

σ_t is limited in every case to $0,75 . \sigma_R$.

By way of illustration, fig. A.3.6.1. shows curves giving the permissible stress as a function of the ratio κ for the following cases :

- steel A.52 ;
- predominant tensile stress ;
- group E6 ;
- construction cases W_0, W_1, W_2 for unwelded components and cases of construction for joints K_0 to K_4.

The permissible stresses have been limited to 240 N/mm², i.e. to the permissible stress adopted for checking for ultimate strength.

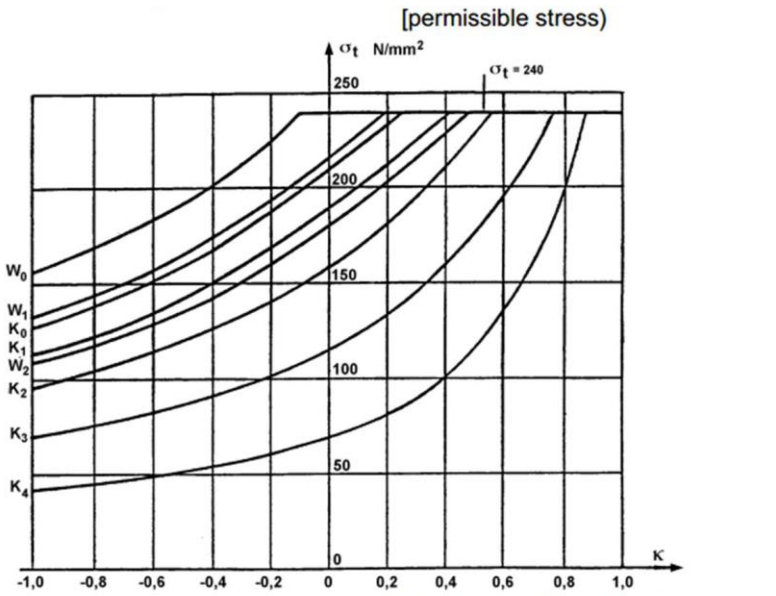


Figure A.3.6.1. - (A 52; tension; group E6)

Fatigue in SDC Verifier

Kappa Factor

$\kappa_x = \sigma_{x\,min} / \sigma_{x\,max}$

$\kappa_y = \sigma_{y\,min} / \sigma_{y\,max}$

$\kappa_{xy} = \tau_{xy\,min} / \tau_{xy\,max}$

Allowable Stress

a) $\kappa \leq 0$

- for tension : $\sigma_t = 5 \,.\, \sigma_w / (3 - 2 \,.\, \kappa)$ (1)
- for compression : $\sigma_c = 2 \,.\, \sigma_w / (1 - \kappa)$ (2)

σ_w is given in table above.

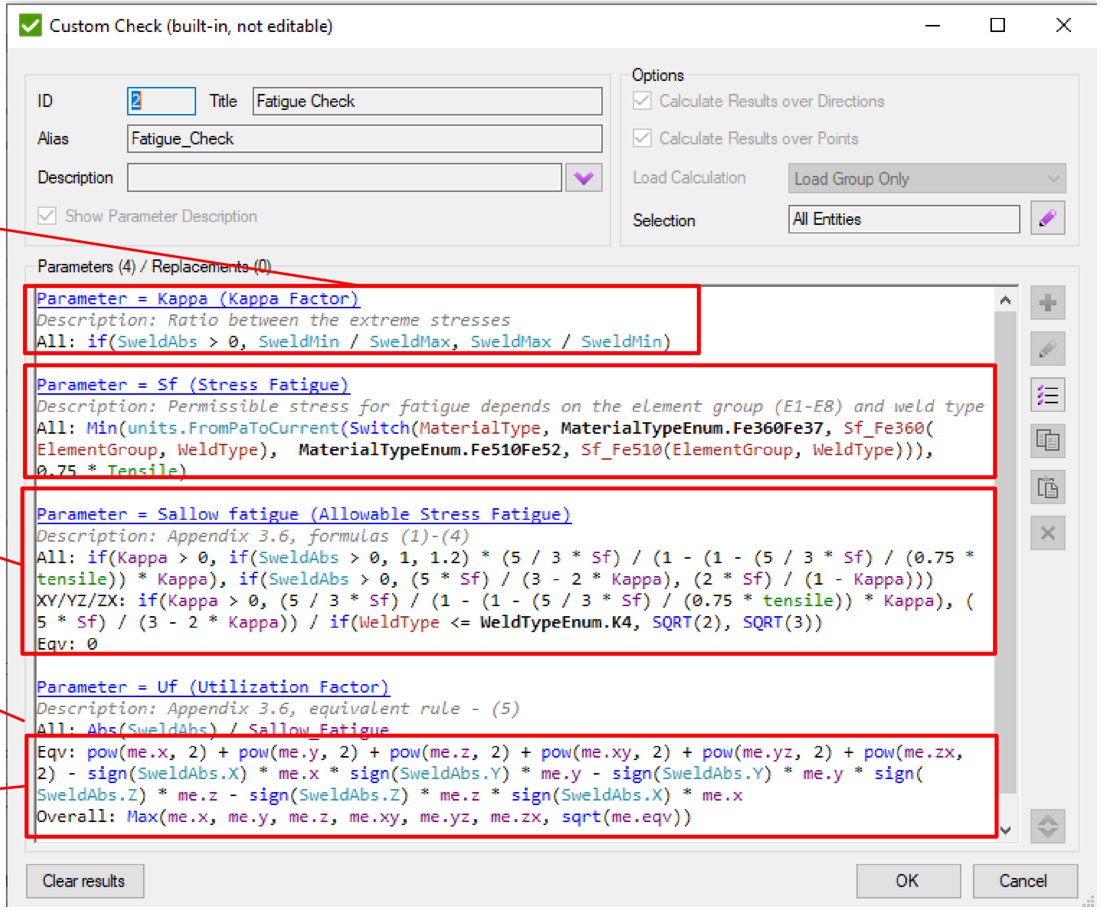
b) $\kappa > o$

- for tension $\sigma_t = \sigma_O / [1 - \kappa \,.\, (1 - \sigma_O / \sigma_{+1})]$ (3)
- for compression $\sigma_c = 1{,}2 \,.\, \sigma_t$ (4)

Utilization Factor Combined

$$(\sigma_{x\,max} / \sigma_{xa})^2 + (\sigma_{y\,max} / \sigma_{ya})^2 - \sigma_{x\,max} \,.\, \sigma_{y\,max} / (|\sigma_{xa}| \,.\, |\sigma_{ya}|) + (\tau_{xy\,max} / \tau_{xya})^2 \leq 1$$

where the stress values σ_{xa}, σ_{ya} and τ_{xya} are those resulting from the application of formulae (1), (2), (3) and (4) limited to 0,75 . σ_R.



Stress Fatigue

Stress Fatigue is used in Fatigue Allowable Stress calculations.

Stress Fatigue depends on:
- Weld Type (W0-W2, K0-K4);
- Element Group / Loading Group (B1-B6);
- Material Type (St360/St37, St510/St52).

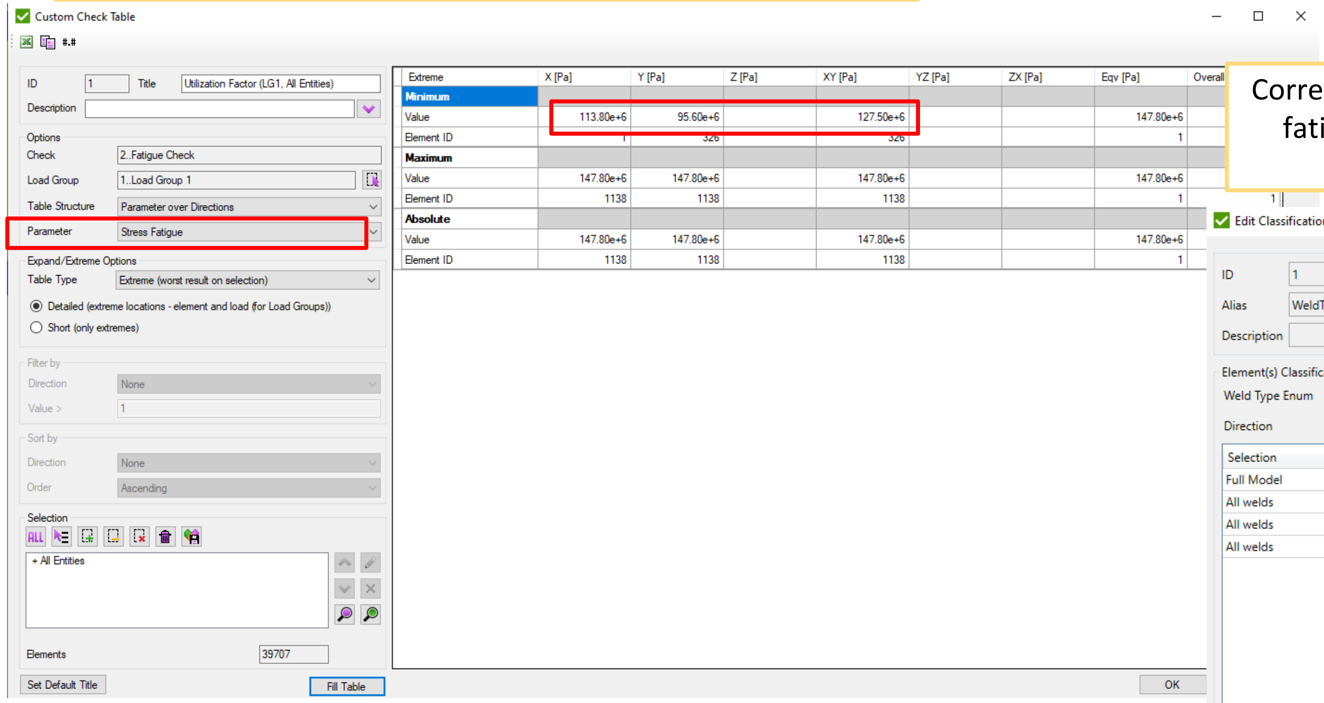
$\kappa \leq 0$

- for tension : $\sigma_t = 5 \,.\, \sigma_w / (3 - 2 \,.\, \kappa)$ (1)
- for compression : $\sigma_c = 2 \,.\, \sigma_w / (1 - \kappa)$ (2)

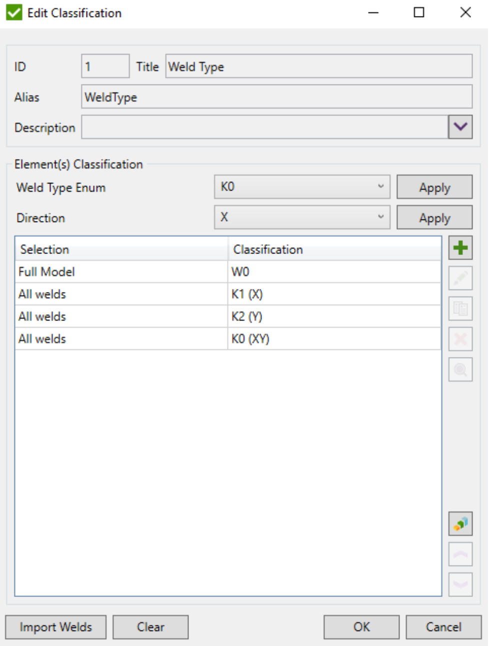
Table T.A.3.6.1.
Values of σ_W depending on the component group and construction case (N/mm²)

Com-ponent group	Unwelded components Construction cases						Welded components Construction cases (Steels St 37 to St 52, Fe 360 to Fe 510)				
	W_0		W_1		W_2						
	Fe 360 St 37 St 44	St 52 Fe 510	Fe 360 St 37 St 44	St 52 Fe 510	Fe 360 St 37 St 44	St 52 Fe 510	K_0	K_1	K_2	K_3	K_4
E1	249,1	298,0	211,7	253,3	174,4	208,6	(361,9)	(323,1)	(271,4)	193,9	116,3
E2	224,4	261,7	190,7	222,4	157,1	183,2	(293,8)	262,3	220,3	157,4	94,4
E3	202,2	229,8	171,8	195,3	141,5	160,8	238,4	212,9	178,8	127,7	76,6
E4	182,1	201,8	154,8	171,5	127,5	141,2	193,5	172,8	145,1	103,7	62,2
E5	164,1	177,2	139,5	150,6	114,9	124,0	157,1	140,3	117,8	84,2	50,5
E6	147,8	155,6	125,7	132,3	103,5	108,9	127,5	113,8	95,6	68,3	41,0
E7	133,2	136,6	113,2	116,2	93,2	95,7	103,5	92,4	77,6	55,4	33,3
E8	120,0	120,0	102,0	102,0	84,0	84,0	84,0	75,0	63,0	45,0	27,0

Corresponding values of Stress fatigue in SDC Verifier:



Corresponding values of Stress fatigue in SDC Verifier for classification below



Weld Type

Weld Type – also called Notch Case, defines which elements belong to what weld type (K0-K4 – joints affected by welding, W0-W2 – elements and joints, not affected by welding). Weld Type depends on shape, structural design, whole pattern or type and quality of welds.

Case W_O

Reference	Description	Figure	Symbol
W_O	Parent metal, homogeneous surface. Part without joints or breaks in continuity (solid bars) and without notch effects unless the latter can be calculated.		

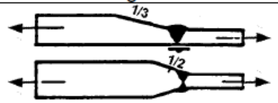
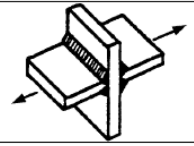
Case K_0 - Slight stress concentration

Reference	Description	Figure	Symbol
0,1	Parts butt-welded (S.Q.) at right angles to direction of forces		P 100

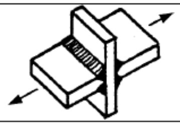
Case K_1 - Moderate stress concentration

Reference	Description	Figure	Symbol
1,1	Parts joined by butt welding (O.Q.) at right angles to the direction of the forces		P 100 or P10

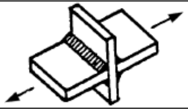
Case K2 - Medium stress concentration

Reference	Description	Figure	Symbol
2,1	Parts of different thickness butt welded (O.Q.) at right angles to the direction of the forces. Asymmetrical slope : 1 in 3 (or symmetrical slopes : 1 in 2)		
2,4	Cruciform joint made with K-welds (S.Q.) perpendicular to the direction of the forces		D

Case K_3 - Severe stress concentration

Reference	Description	Figure	Symbol
3,11	Butt weld with backing strip and no backing run. Backing strip secured by intermittent tack welds		
3,4	Cruciform joint made with K-weld (O.Q.) at right angles to the direction of the forces		D

Case K_4 - Very severe stress concentration

Reference	Description	Figure	Symbol
4,1	Parts of different thickness butt welded (O.Q.) at right angles to the direction of the forces. Asymmetrical position without blend slope		
4,4	Cruciform joint made with fillet weld (O.Q.) at right angles to the direction of the forces		D

Element Group also called Loading Group depends on: Class of Utilization, Load Spectrum.

Example of Load Cycles:

Load Cycles	Number	Total
Moves per hour	30	
Hours per day	10	300
Days per year	300	90000
Number of Years	20	1800000
Total	Million:	1.8

Class of Utilization **B7** (1.8 million < 2 x 10^6)

Table T.2.1.4.2. - Classes of utilization

Symbol	Total duration of use (number n of stress cycles)				
B0			n	≤	16 000
B1	16 000	<	n	≤	32 000
B2	32 000	<	n	≤	63 000
B3	63 000	<	n	≤	125 000
B4	125 000	<	n	≤	250 000
B5	250 000	<	n	≤	500 000
B6	500 000	<	n	≤	1 000 000
B7	1 000 000	<	n	≤	2 000 000
B8	2 000 000	<	n	≤	4 000 000
B9	4 000 000	<	n	≤	8 000 000
B10	8 000 000	<	n		

Load Spectrum

Table T.2.1.4.3. - Spectrum classes

Symbol	Spectrum factor k_{sp}				
P1			k_{sp}	≤	0,125
P2	0,125	<	k_{sp}	≤	0,250
P3	0,250	<	k_{sp}	≤	0,500
P4	0,500	<	k_{sp}	≤	1,000

$$k_{sp} = (\sigma_1/\sigma_{max})^c (n_1/n) + (\sigma_2/\sigma_{max})^c (n_2/n) + \ldots + (\sigma_r/\sigma_{max})^c (n_r/n) = \sum_{i=1}^{r} [(\sigma_i/\sigma_{max})^c (n_i/n)]$$

$$n_1 + n_2 + \ldots + n_r = \sum_{i=1}^{r} n_i = n$$

Element Group

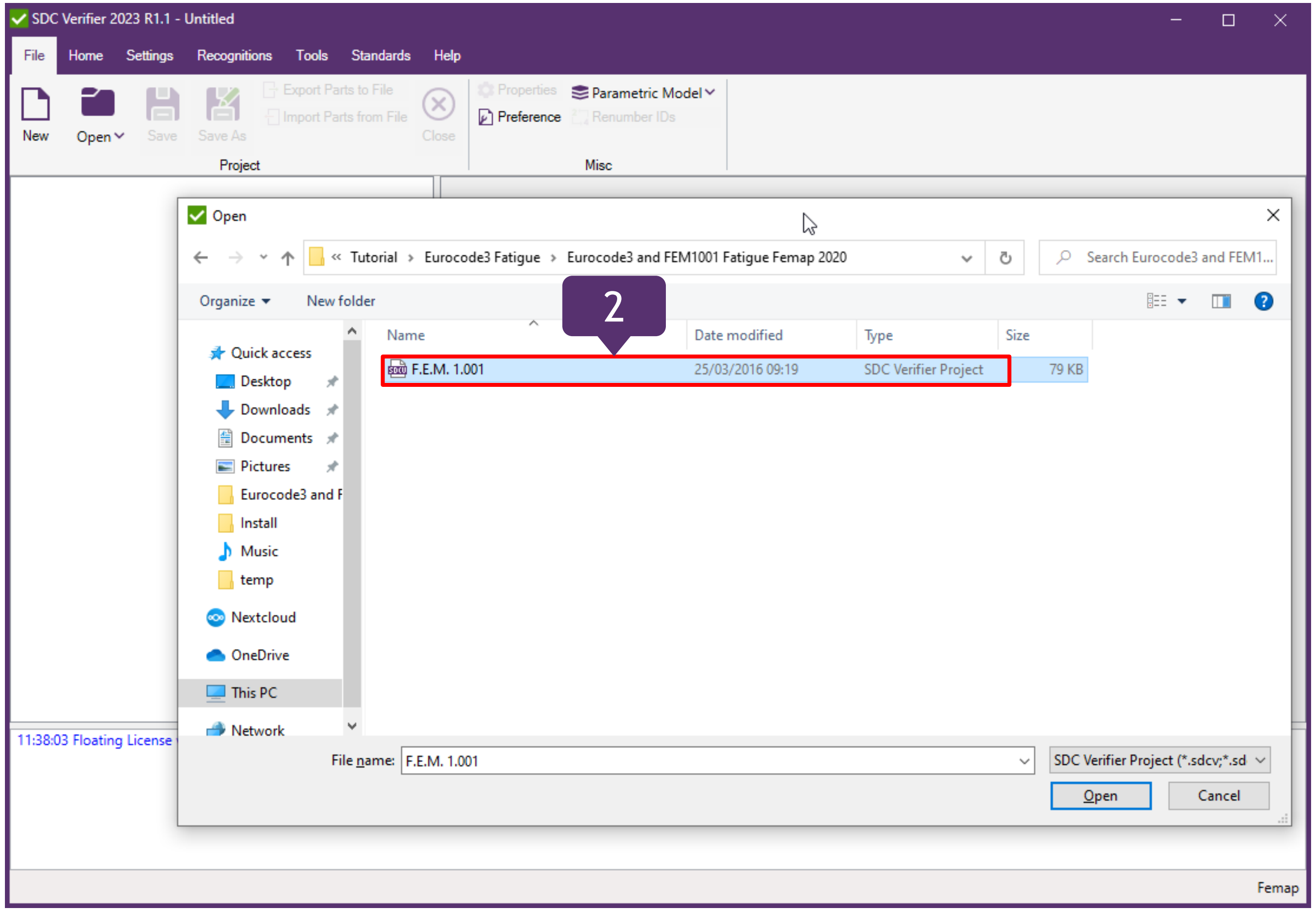
Table T.2.1.4.4. - Component groups

Stress Spectrum class	Class of utilization										
	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
P1	E1	E1	E1	E1	E2	E3	E4	E5	E6	E7	E8
P2	E1	E1	E1	E2	E3	E4	E5	E6	E7	E8	E8
P3	E1	E1	E2	E3	E4	E5	E6	E7	E8	E8	E8
P4	E1	E2	E2	E4	E5	E6	E7	E8	E8	E8	E8

Open the starter model

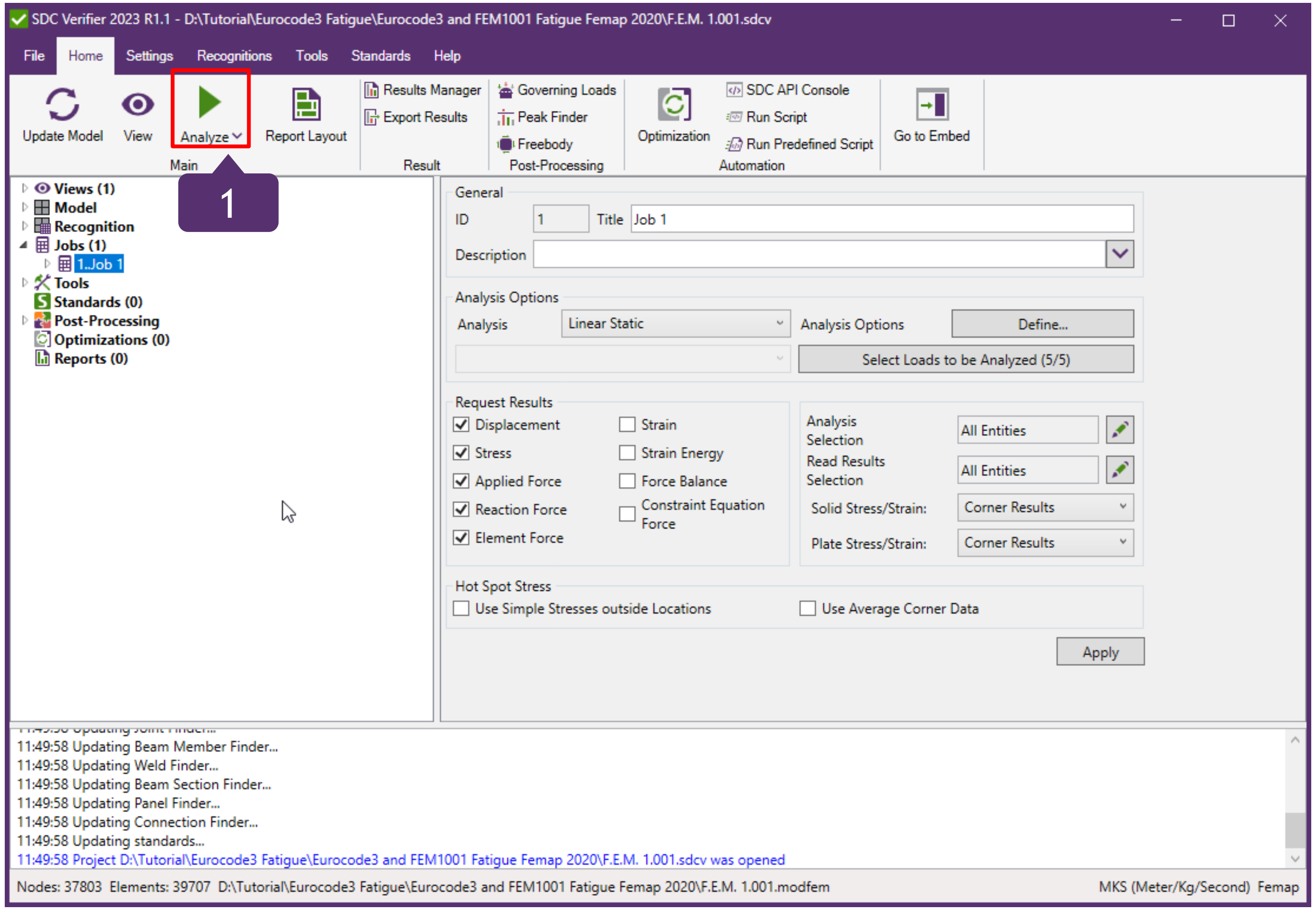
1 Launch **SDC Verifier**

2 Open project ***F.E.M. 1.001***



Run Analysis

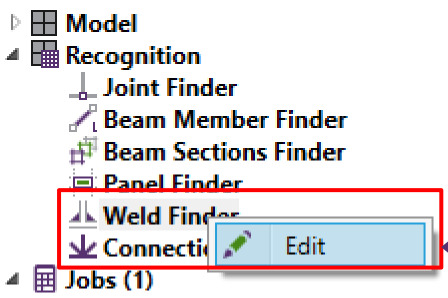
1 Press to start Analysis in Femap



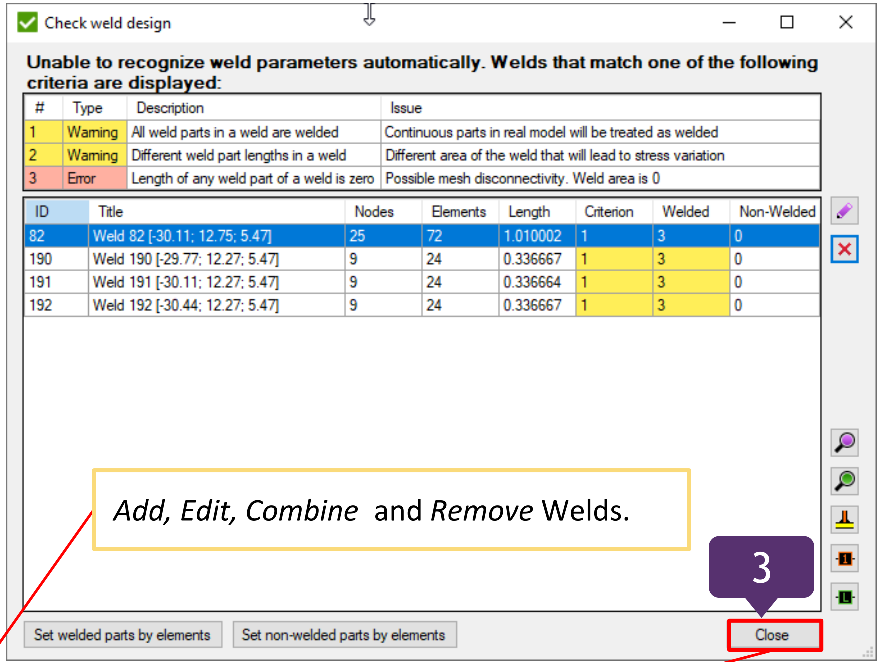
Weld Finder

SDC VERIFIER

1. Execute Recognition =>**Weld Finder => Edit…**
2. Press *Find.*
3. Press *Close.*
4. Press [export icon] to Export selected sections *to* components



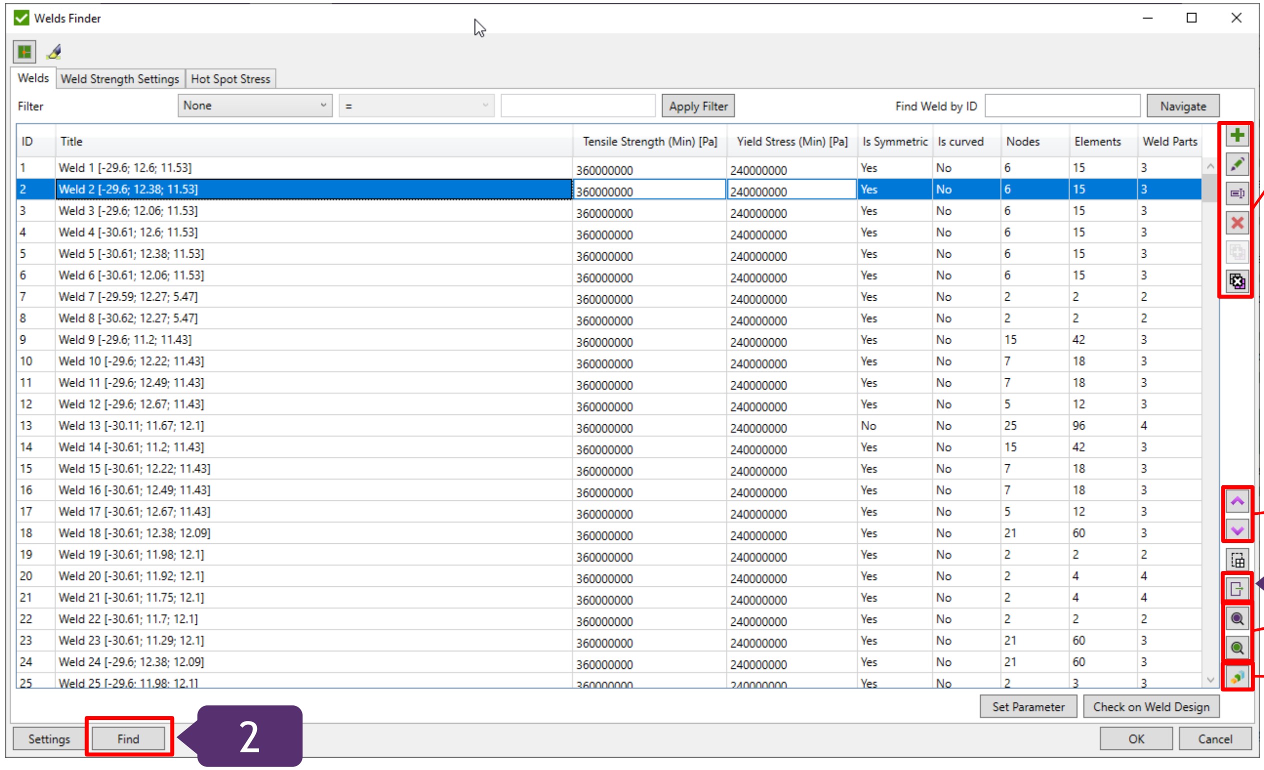
1



Add, Edit, Combine and *Remove* Welds.

3

There were found some Welds with all welded Parts; click to close this message



2

4

Move Welds. Order is important when one element belongs to 2 welds.

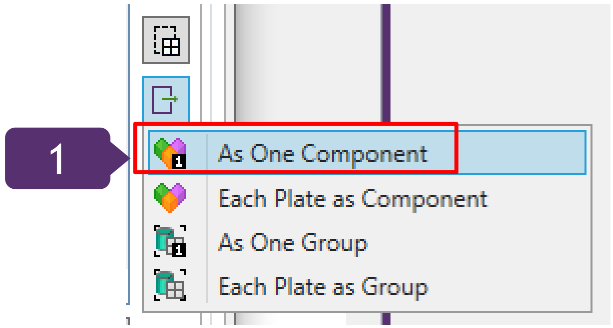
Preview selected welds

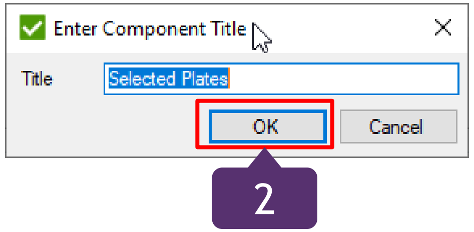
Plot of selected welds in colors and with labels of IDs

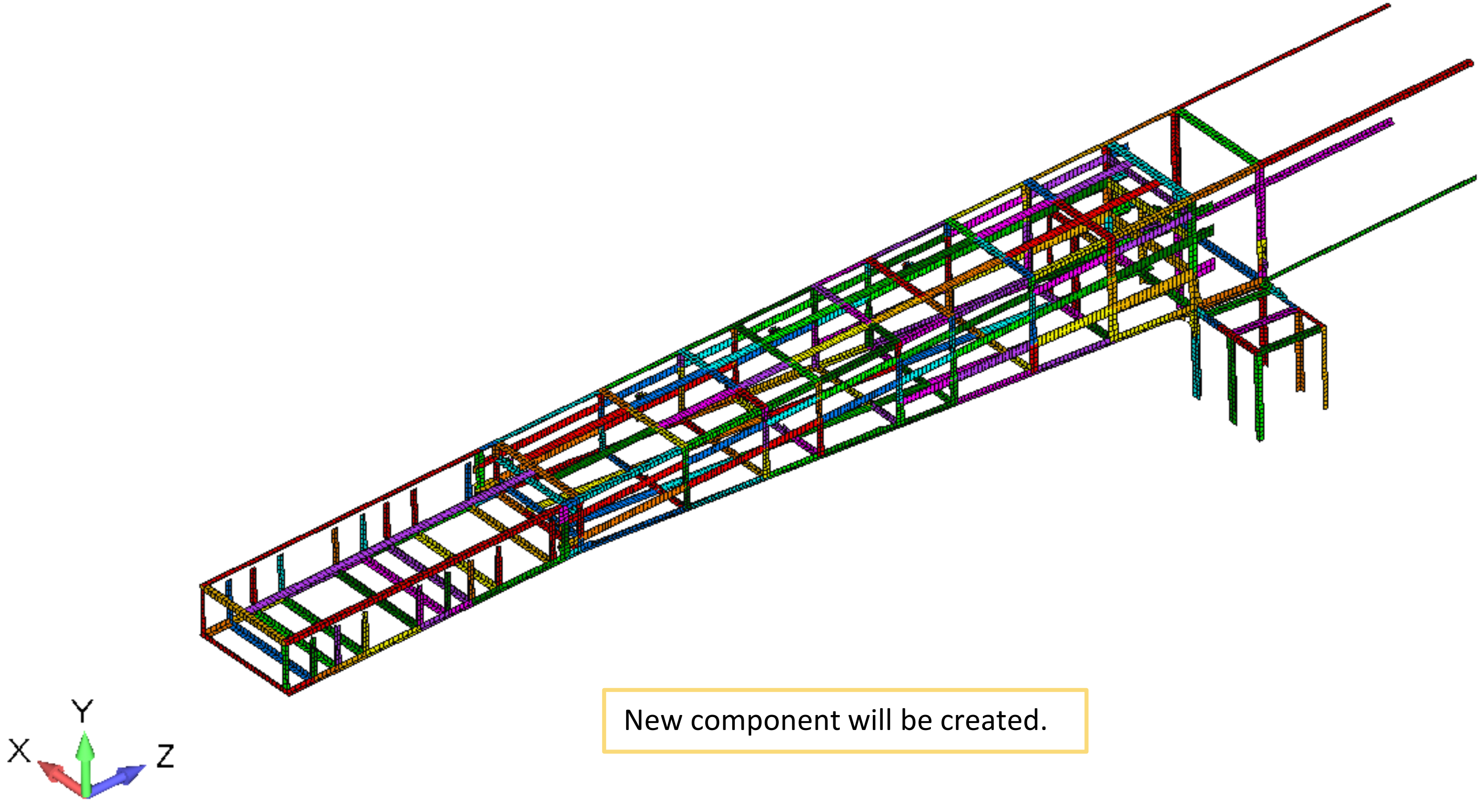
https://sdcverifier.com

Weld Finder. Export

1. Click *As One Component*
2. Press *OK.*



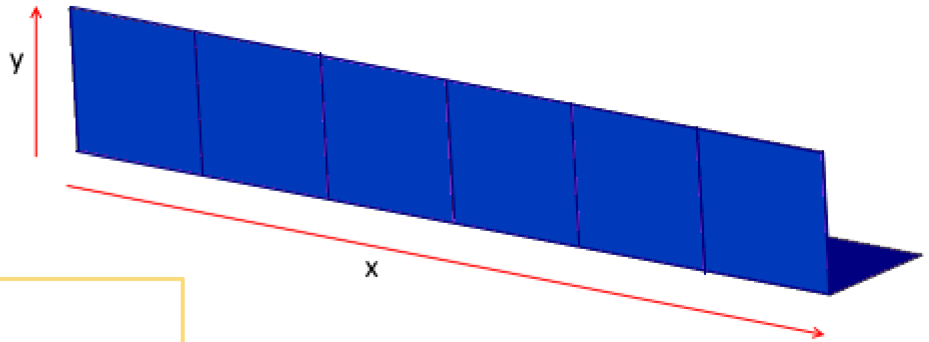




New component will be created.

Stress Transformation

Stresses for weld elements are automatically transformed in the direction of the corresponding weld from Weld Finder Tool using the wedge method. Stresses are transformed only for plate type elements.



$$\sigma_{nn} = \frac{(\sigma_{xx}+\sigma_{yy})}{2} + \frac{(\sigma_{xx}-\sigma_{yy})}{2} * \cos 2\theta + \tau_{xy} * \sin 2\theta$$

$$\tau_{nt} = -\frac{(\sigma_{xx}-\sigma_{yy})}{2} * \sin 2\theta + \tau_{xy} * \cos 2\theta$$

$$\sigma_{tt} = \frac{(\sigma_{xx}+\sigma_{yy})}{2} - \frac{(\sigma_{xx}-\sigma_{yy})}{2} * \cos 2\theta - \tau_{xy} * sin\, 2\theta$$

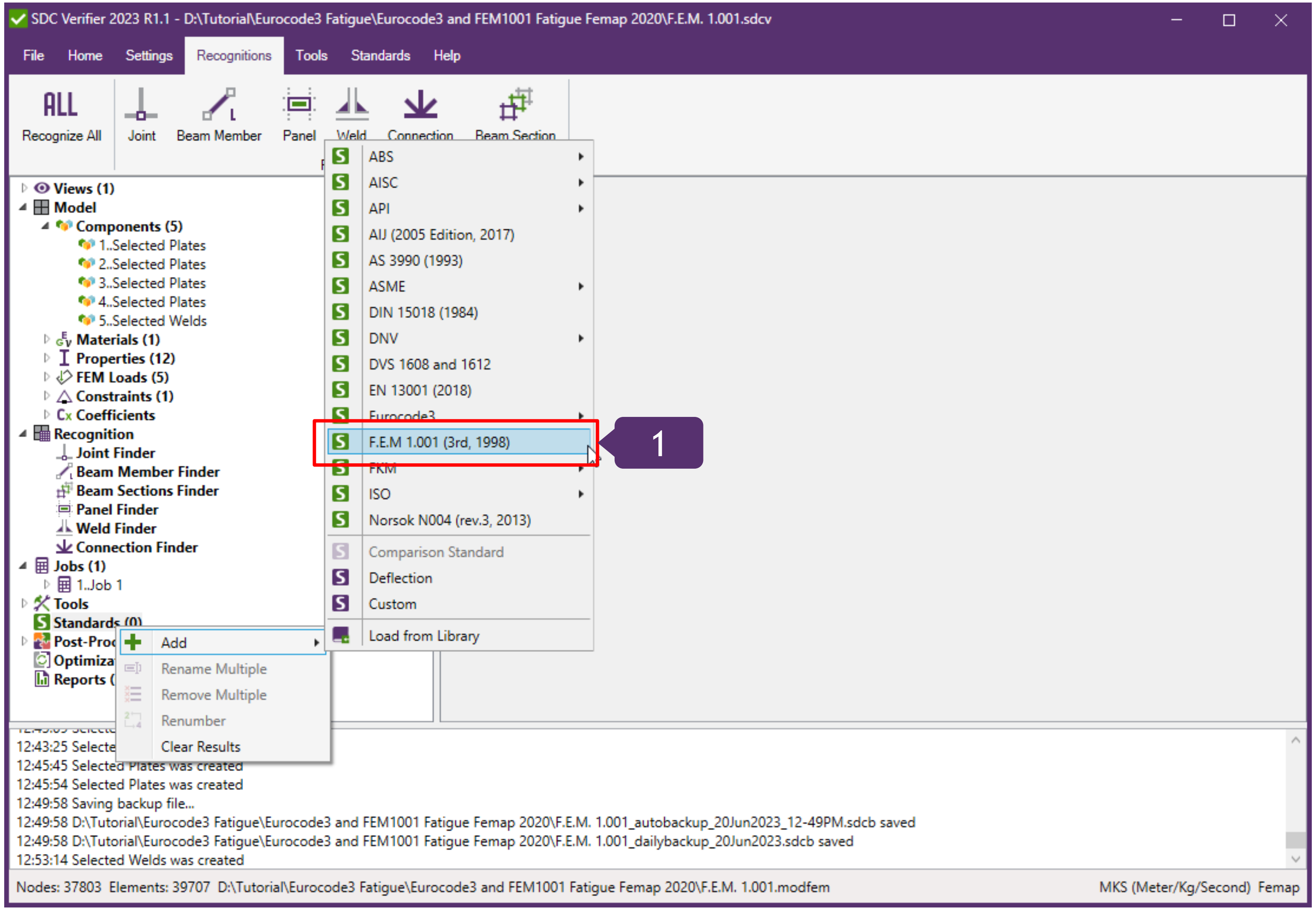
$\sigma_{xx}, \sigma_{yy}, \tau_{xy}$ – original x, y and shear stress in local element x, y and shear directions
$\sigma_{tt}, \sigma_{nn}, \tau_{nt}$ – transformed x, y and shear stress in weld x, y and shear directions
θ – angle between the element and weld x directions.

Add FEM 1.001 standard

1

Execute *Add* => **F.E.M. 1.001** in Standards context menu.

F.E.M. 1.001 - performs static stress check and fatigue check for steel structures of crane and crane equipment. Fatigue calculations are performed according to Allowable Stress Design method (ASD).



1 Selection: **All Entities**

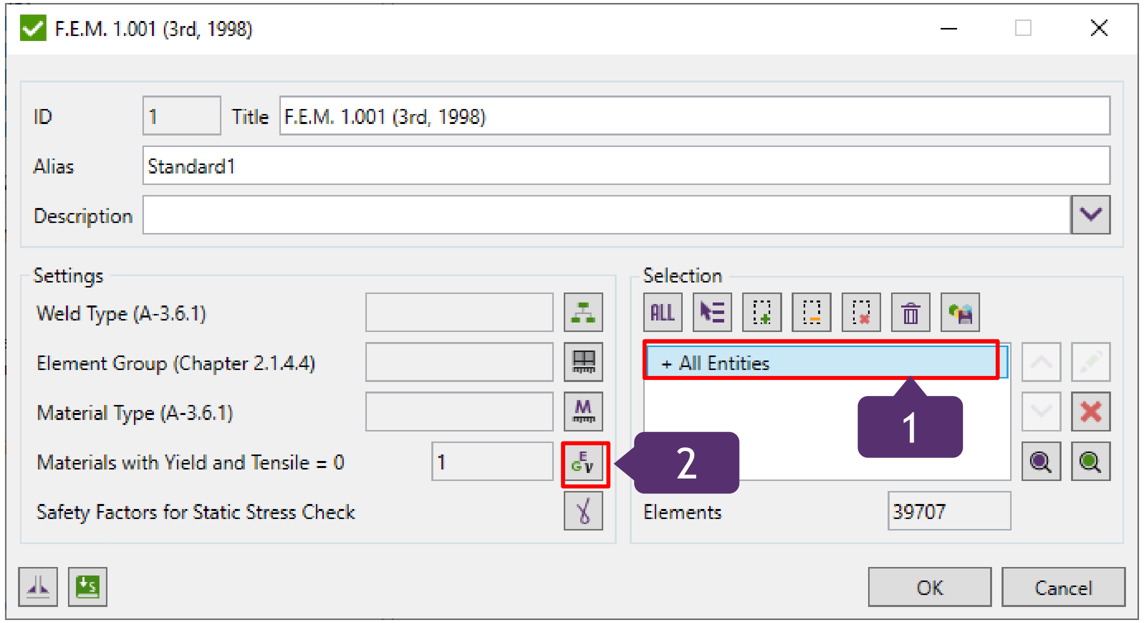
2 Press to edit material properties.

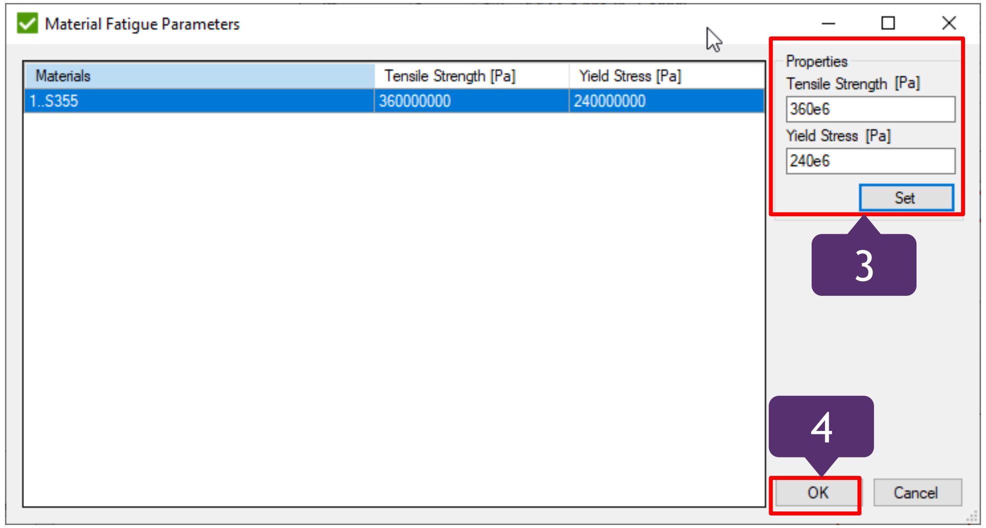
Amount of materials with not defined Tensile or Yield are displayed in the field

3 Tensile Strength: **360e6**
Yield Stress: **240e6** and Press *Set.*

4 Press *OK*.

Unit System. Stress Fatigue values are constant for specified material and are measured in Pa. Changing unit system enables to convert Pa into Mpa, for example.





Definition of weld categories

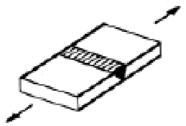
- Weld/notch category determines fatigue resistance
- Division in welds / non welds for FEM 1.001:
  - W category is for non welded parts
  - K category is for welded parts
- Fatigue resistance is further specified by adding classes
  - W0-W2 for non-welded parts
  - K0-K4 for welded parts
- Better fatigue resistance results in lower class number

Weld Classes depends on Weld Type

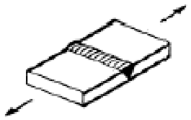
Non-weld group W0

nr.	description of the main types		symbol
W01	Part without hole and without joint, with a normal state of the surface, without notch behaviour.		—

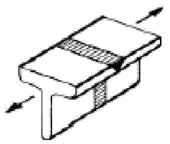
Slight notch behavior group K0

nr.	description of the main types		symbol
011	Parts, jointed by a butt weld of special quality, perpendicular to the direction of force.		P 100 P 100

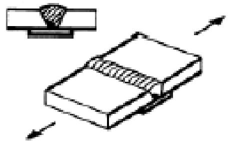
Moderate notch behavior group K1

nr.	description of the main types		symbol
111	Parts, jointed by a butt weld of ordinary quality, perpendicular to the direction of force.		P or P 100 P or P 100

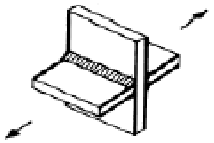
Medium notch behavior group K2

nr.	description of the main types		symbol
211	Profiles, jointed by butt welds of special quality, perpendicular to the direction of force.		P 100 P 100

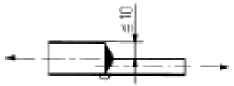
Great notch behavior group K3

311	Parts jointed by a butt weld with a backing strap, without sealing run and perpendicular to the direction of force. Backing strap fixed by tack welding.		>

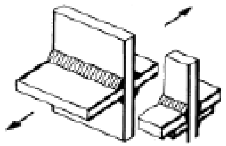
and a different connection type 351

nr.	description of the main types		symbol
351	Double bevel weld of ordinary quality, perpendicular to the direction of force, between crossing parts.		V D

Very great notch behavior group K4

nr.	description of the main types		symbol
412	Parts of different thickness, jointed by a butt weld of ordinary quality, perpendicular to the direction of force. Asymmetrical joint without slope.		P P

and a different connection type 451

451	Fillet welds of normal quality or single bevel weld (included fillet weld) with backing, perpendicular to the direction of force, between crossing parts.		D D

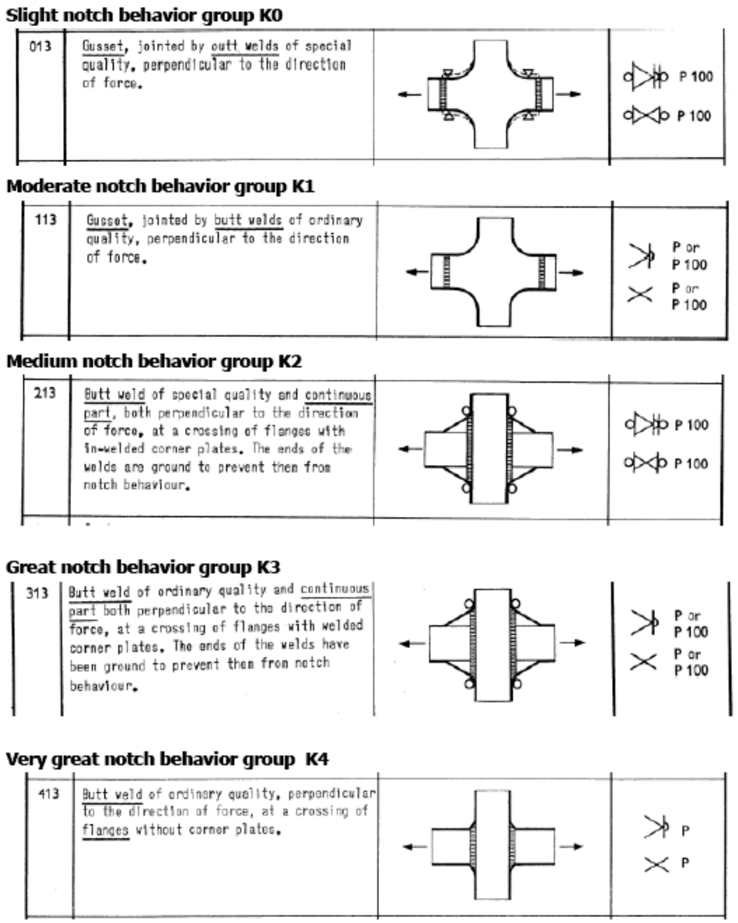
Welt Type - stress direction

	Parallel with weld	Perpendicular to weld	Shear
Weld	K1	K2	K0
No weld	W0		$\tau_D(-1) = \sigma_D(-1) / sqrt(3)$

Steel Grade	$\sigma_D(-1)$ for κ=-1 element group 5 St 52-3							
Notch group	W0	W1	W2	K0	K1	K2	K3	K4
Stress amplitude	163.8	130.3	104.2	118.8	106.1	89.1	63.6	38.2

For beams SCF of connections can be included in the classification

Depends on Stress concentrations:



Slight notch behavior group K0

013	Gusset, jointed by butt welds of special quality, perpendicular to the direction of force.	P 100 P 100

Moderate notch behavior group K1

113	Gusset, jointed by butt welds of ordinary quality, perpendicular to the direction of force.	P or P 100 P or P 100

Medium notch behavior group K2

213	Butt weld of special quality and continuous part, both perpendicular to the direction of force, at a crossing of flanges with in-welded corner plates. The ends of the welds are ground to prevent them from notch behaviour.	P 100 P 100

Great notch behavior group K3

313	Butt weld of ordinary quality and continuous part both perpendicular to the direction of force, at a crossing of flanges with welded corner plates. The ends of the welds have been ground to prevent them from notch behaviour.	P or P 100 P or P 100

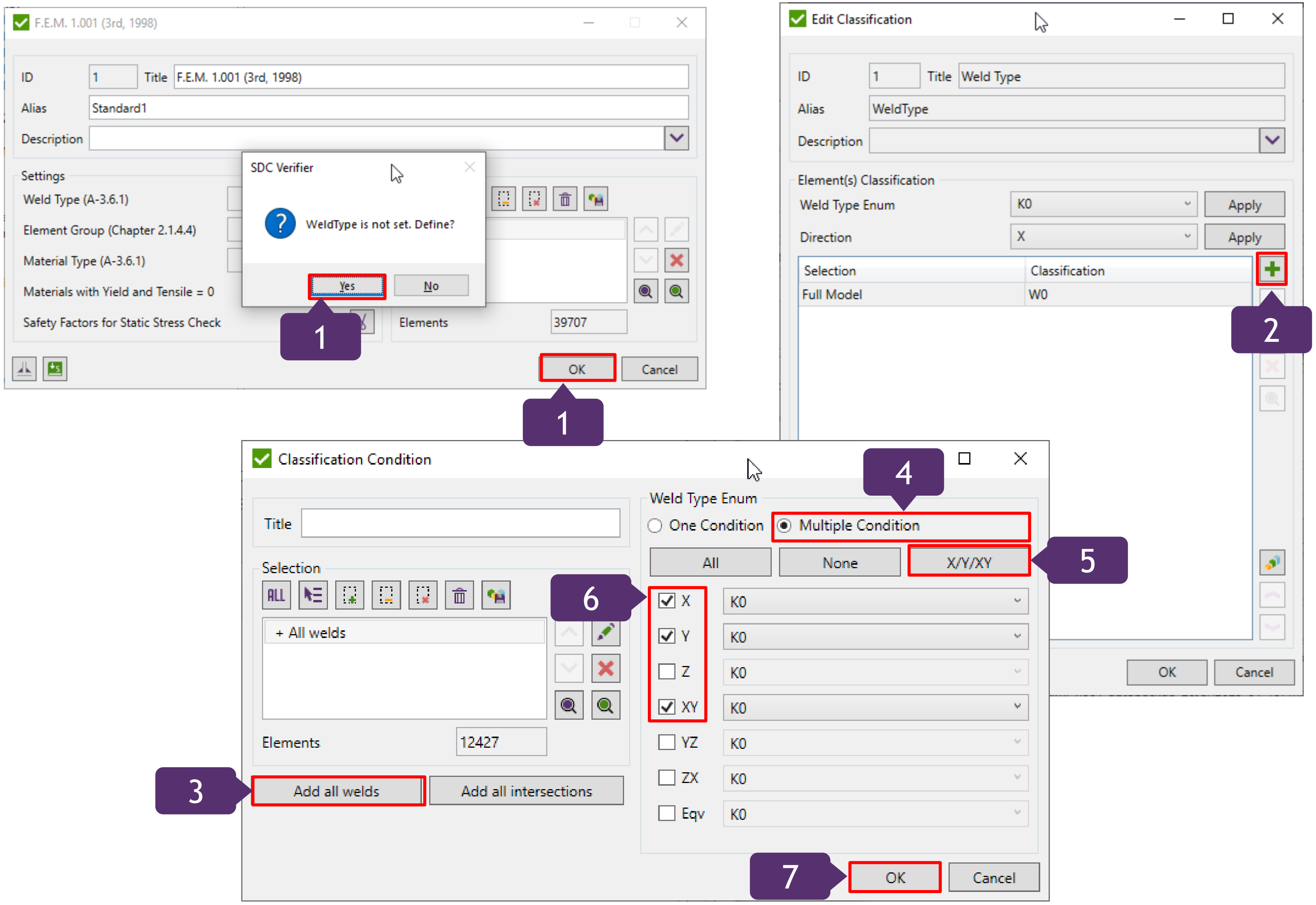
Very great notch behavior group K4

413	Butt weld of ordinary quality, perpendicular to the direction of force, at a crossing of flanges without corner plates.	P P

(not included in this tutorial)

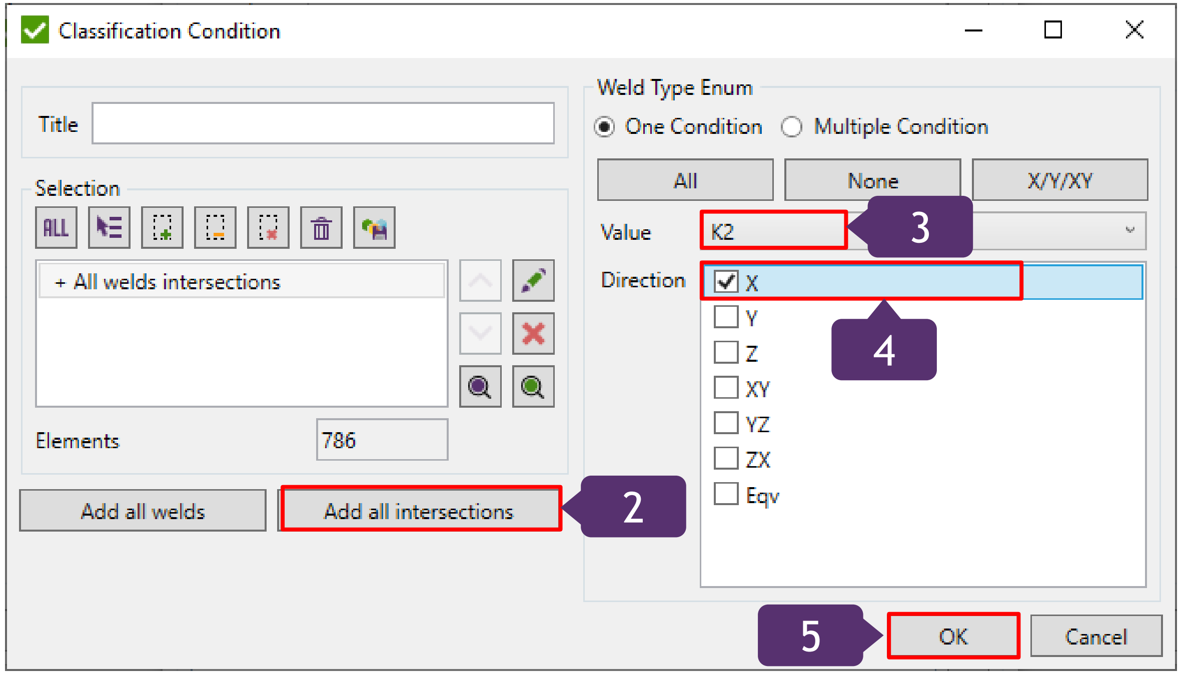
Weld Type Classification

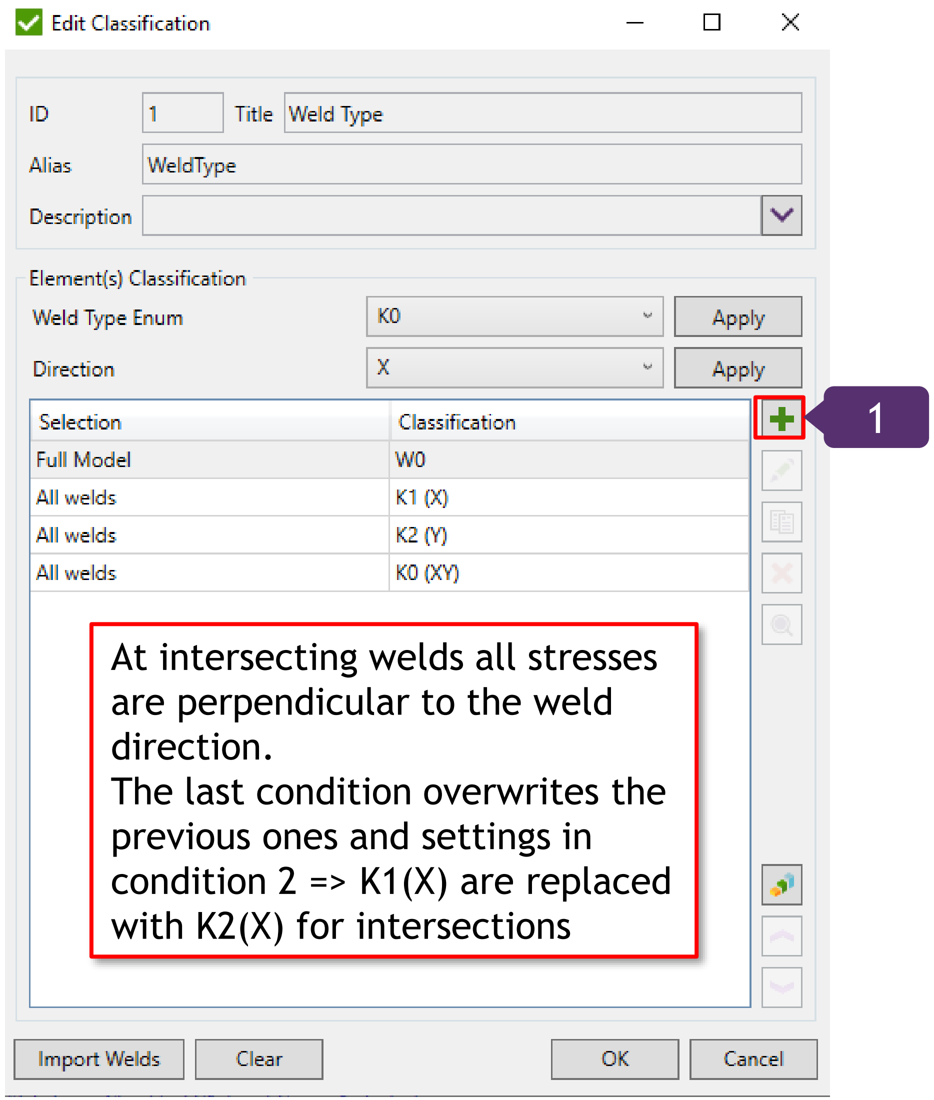
1. Press Ok-->Yes (*Define* for the Weld Type).
2. Press ➕ to *Add Condition*.
3. Press *Add all Welds*
4. Select *Multiple Conditions* options
5. Press *X/Y/XY*
6. X: **K1** Y: **K2** XY: **K0**
7. Press *OK*



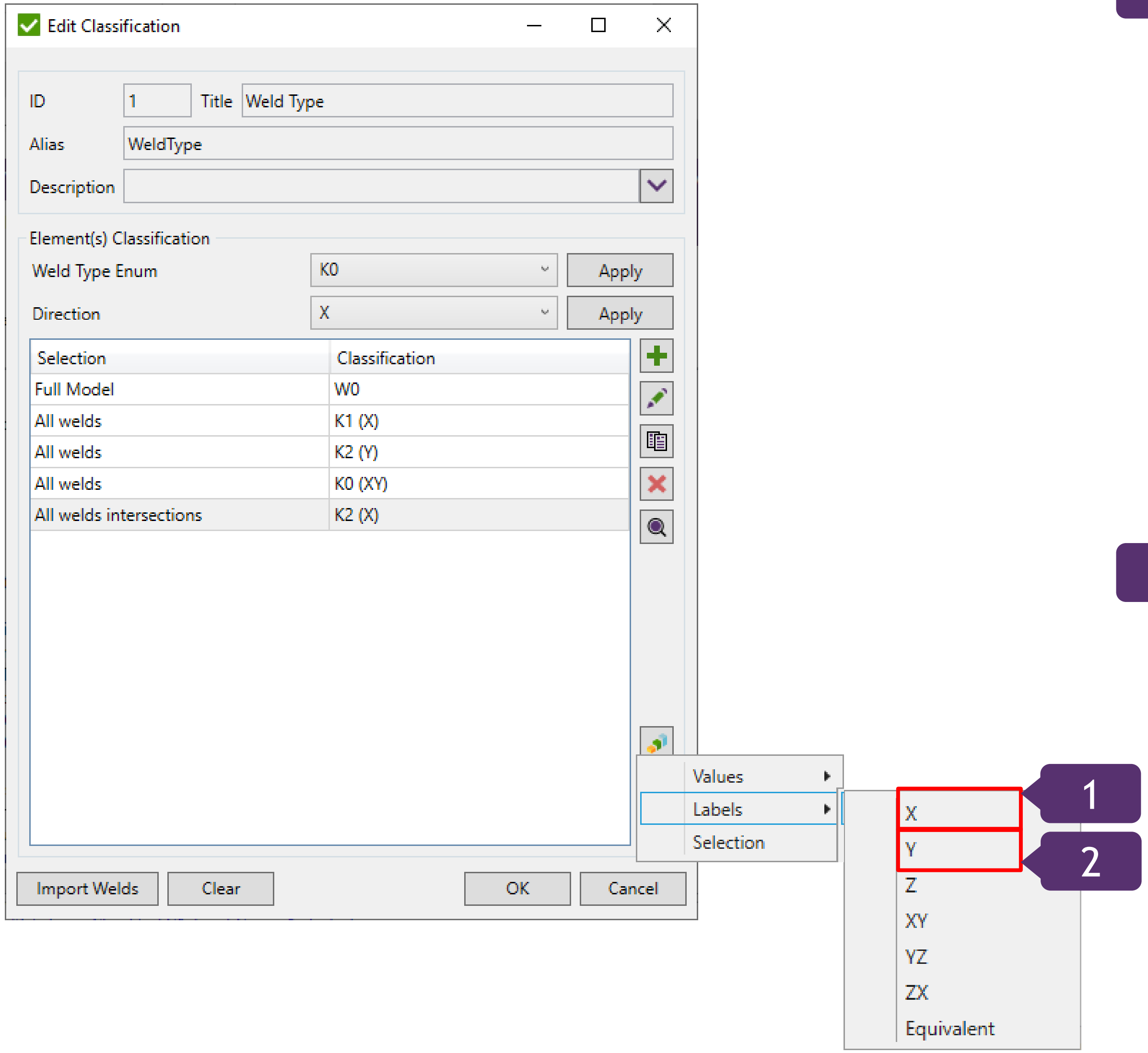
Weld Type classification intersecting welds

1. Press [+] to *Add Condition*.
2. Click *All welds intersections*
3. Value: **K2**
4. Directions: **X**
5. Press *OK*

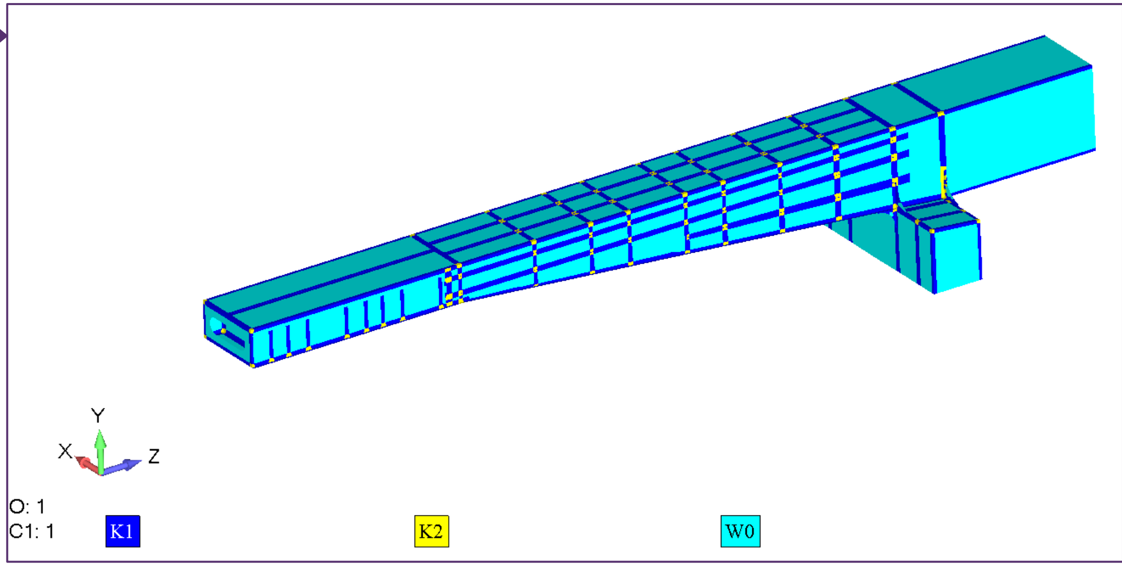




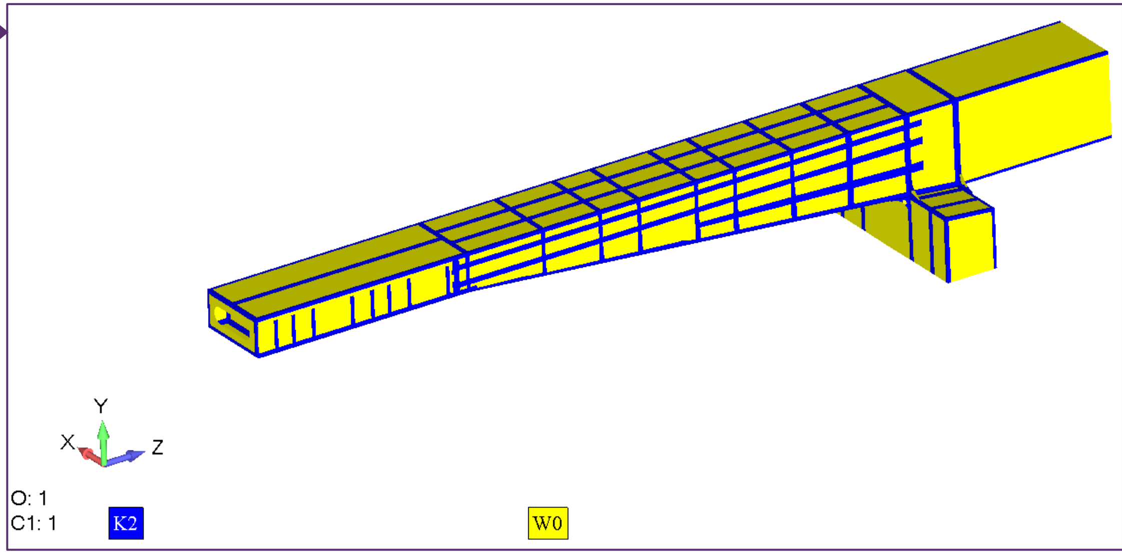
Check classification



1



2

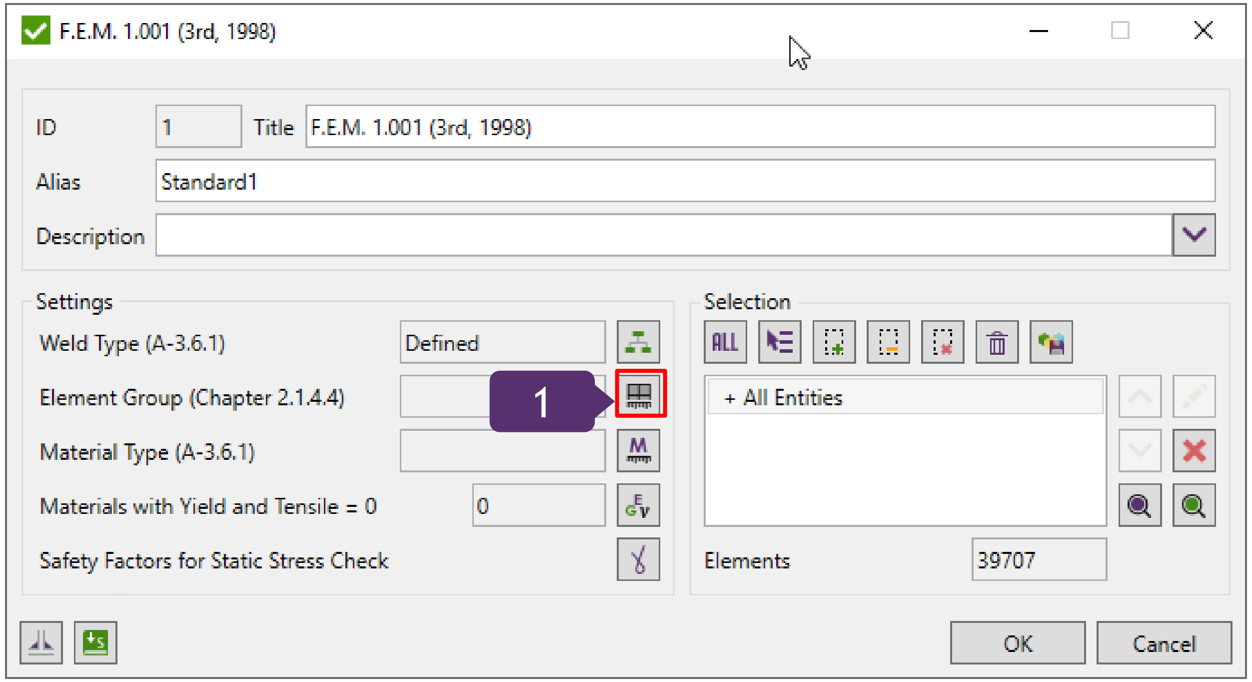


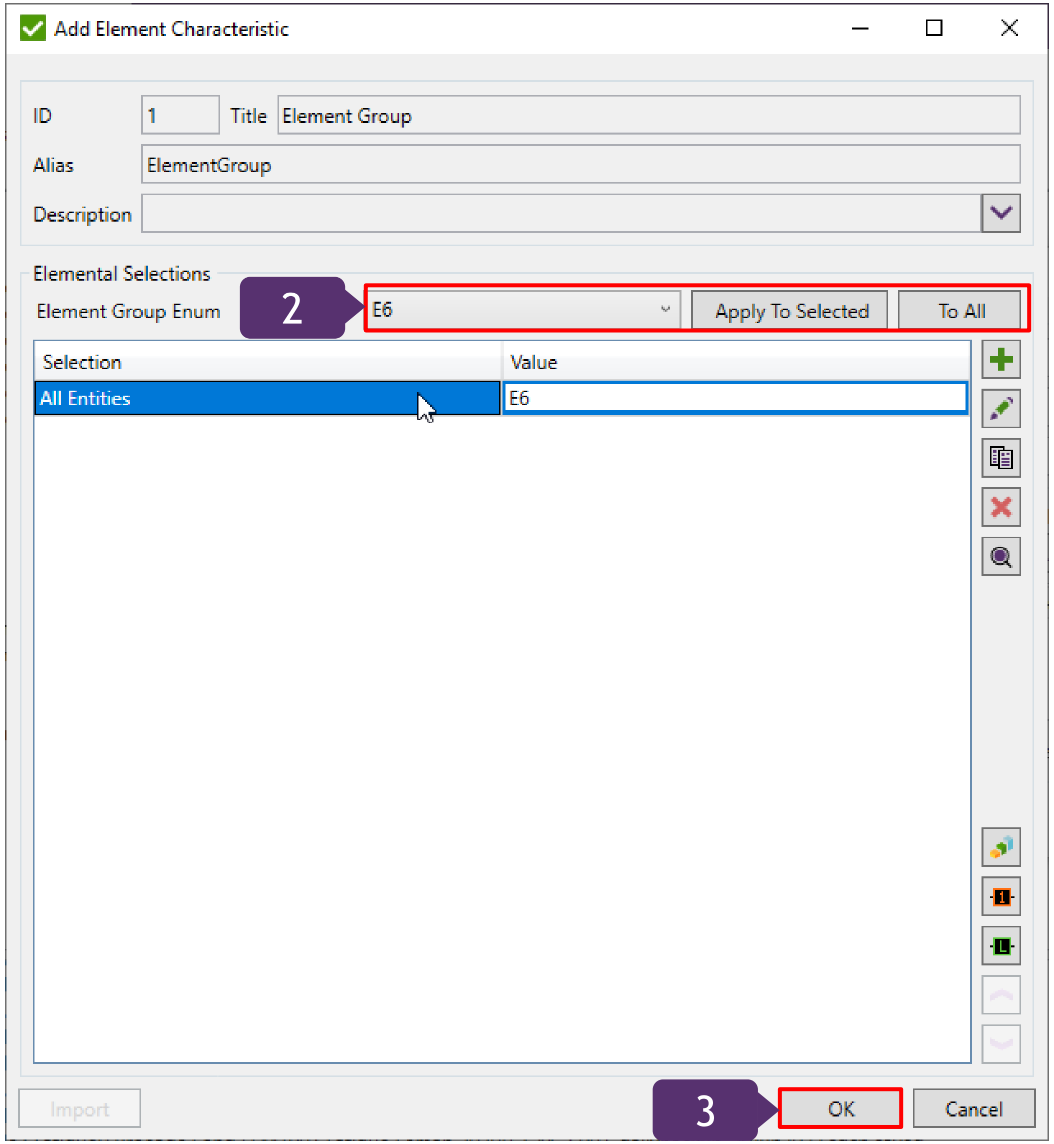
Element Group classification

1 Press [icon] for the Element Group.

2 Select Element Group: **E6.** Press *To All*.

3 Press *OK.*





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Material Type classification

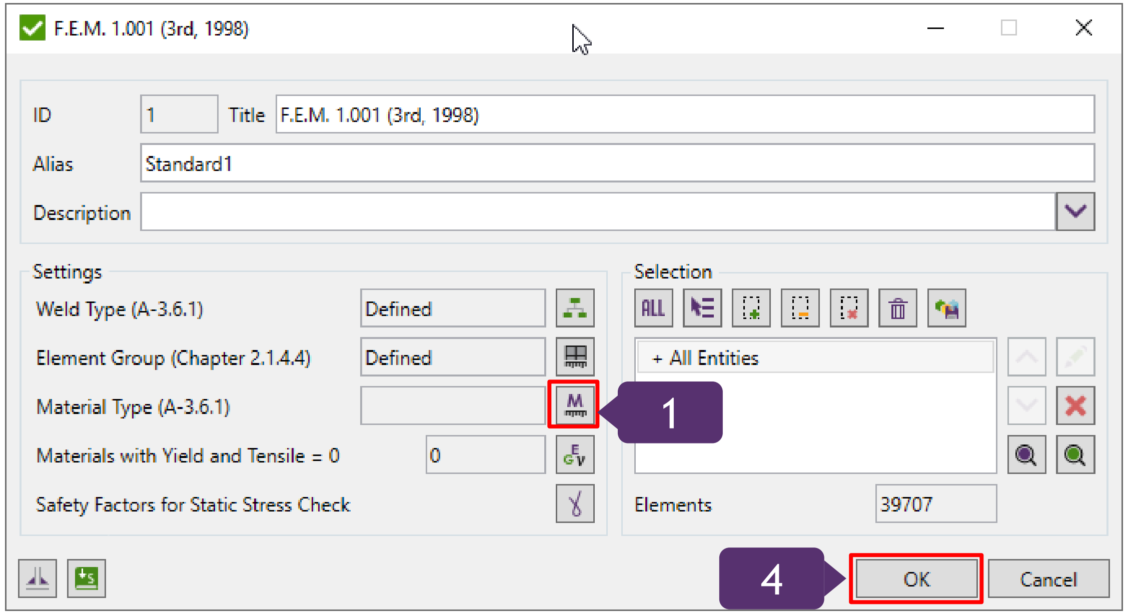
1. Press [M] for the Material Type.

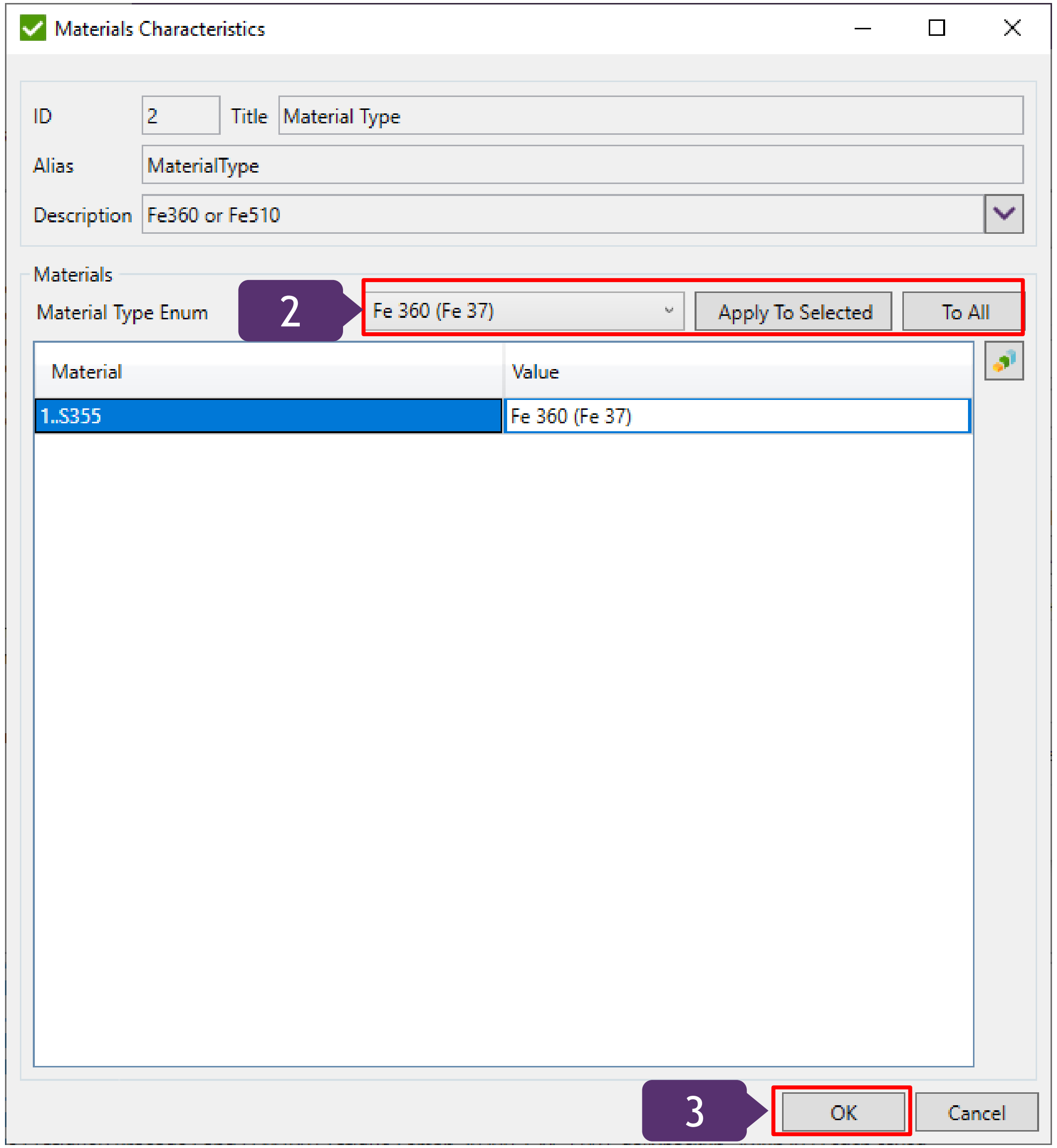
2. Select Material Type: **Fe360 (Fe 37)**. Press *To All*.

3. Press *OK*.

4. Press *OK* to create Standard.

Material Type defines which steel is used: St37 or St52. Stress Fatigue values are different for different materials.





Create extreme table

1. Execute *Table (expand/extreme)* in **Fatigue Check** context menu.

2. Load: **1..Load Group1**.

> Fatigue check supports only Load Groups. If only one load group exist in the project it will be selected automatically.

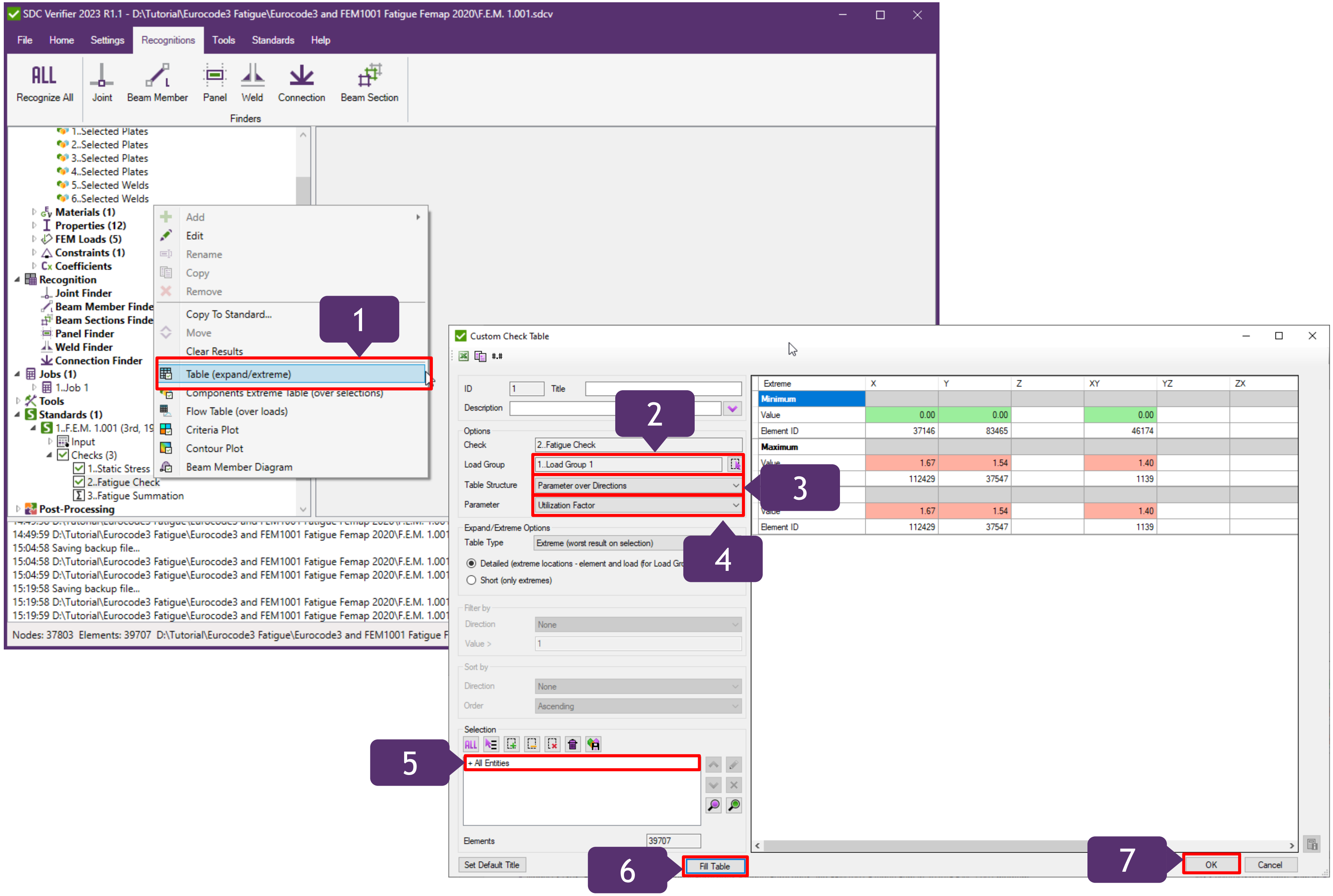
3. Table Type: **Parameter over Directions.**

4. Parameter: **Utilization Factor.**

5. Selection: ***All Entities.***

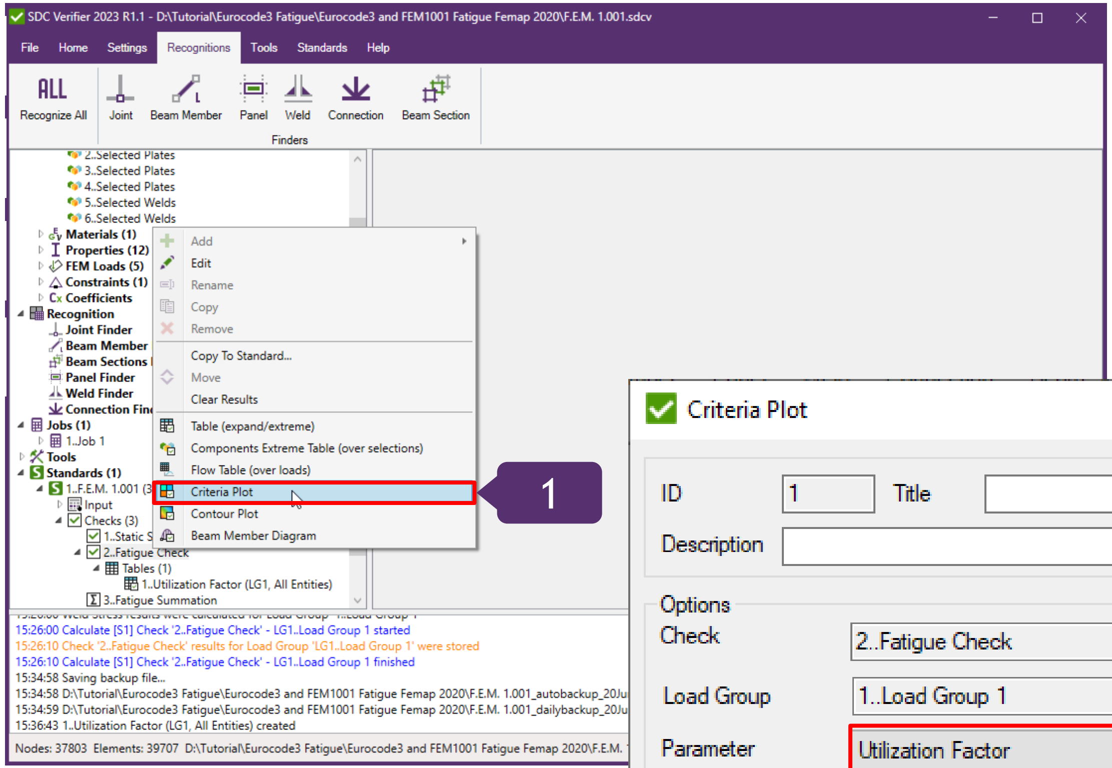
6. Press *Fill Table.*

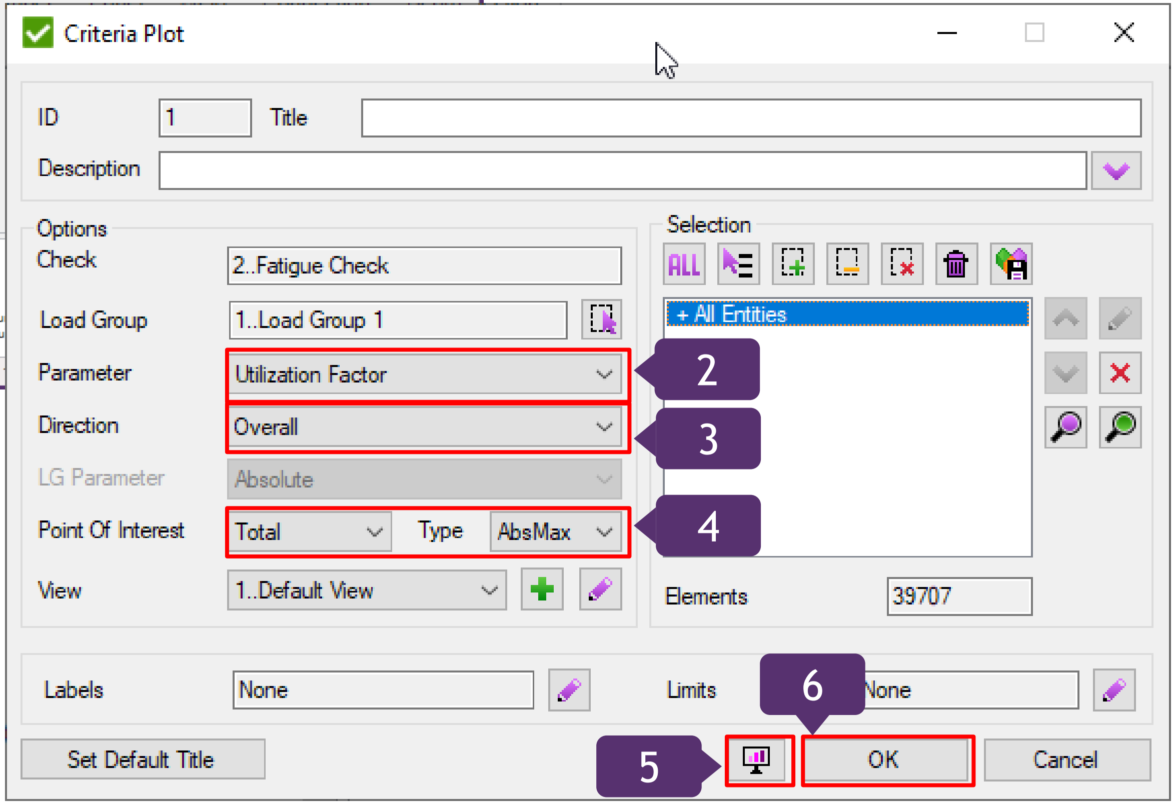
7. Press *OK.*



Create criteria plot

1. Execute *Criteria Plot* in **Fatigue Check** context menu
2. Parameter: **Utilization Factor**
3. Direction: **Overall**
4. Point of interest: **Total** Type: **AbsMax**
5. Press *Preview*
6. Press *OK*

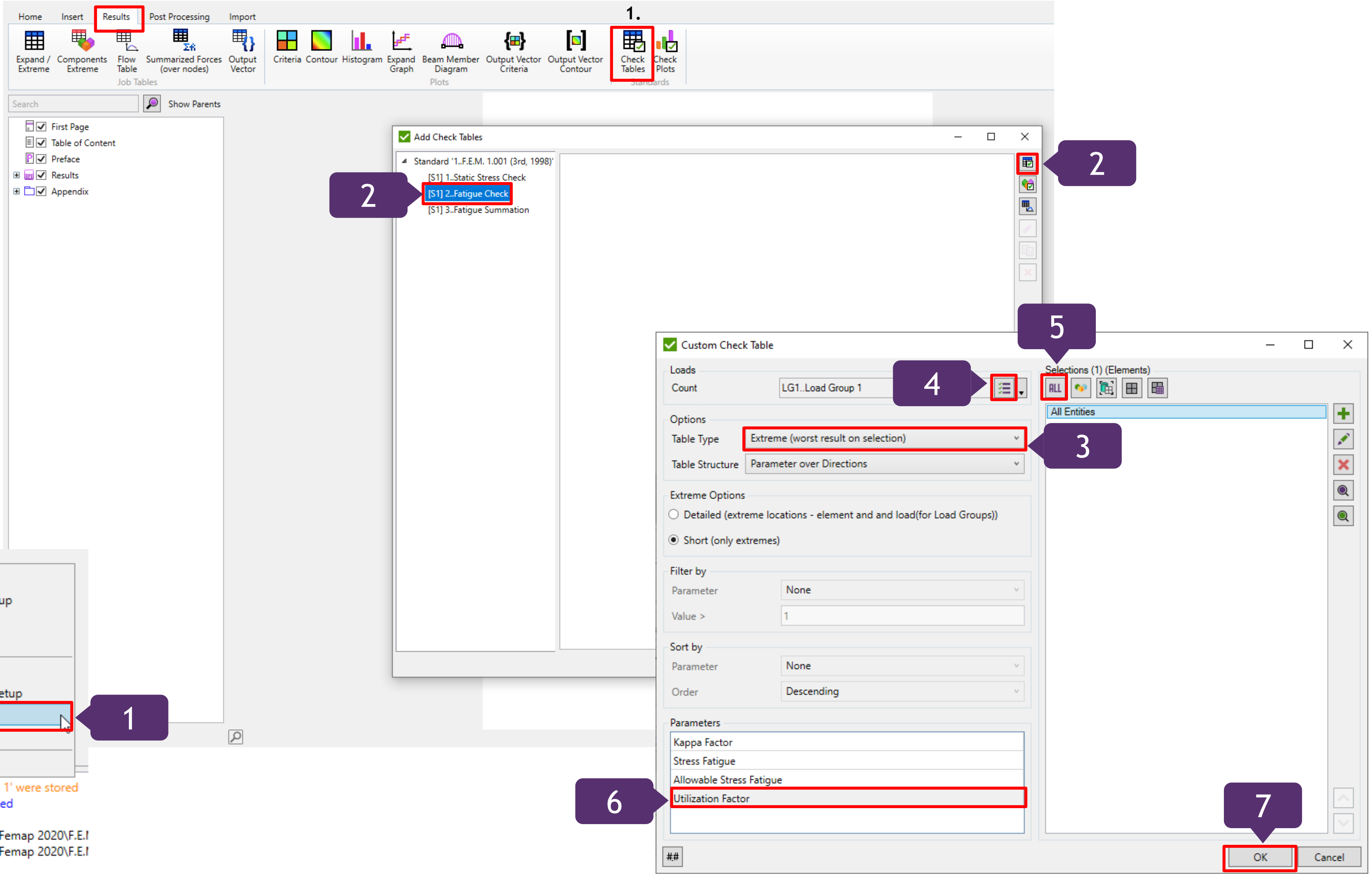


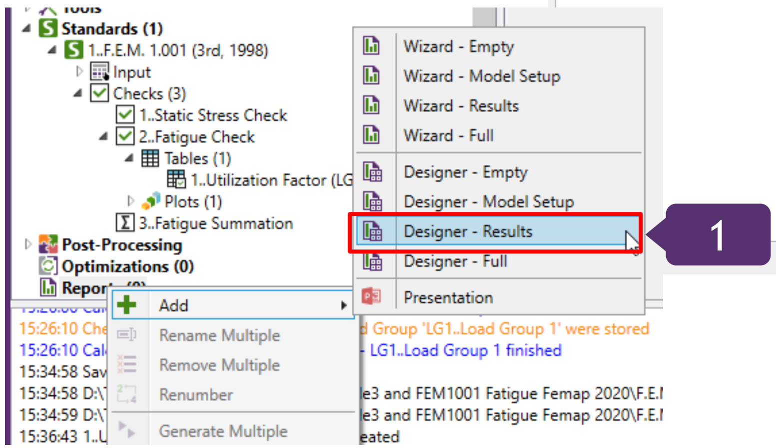


Point of interest = AbsMax Total is absolute maximum utilization factors among all point of interest.

Report. Tables and plots

1. Results => *Check Tables*
2. *Press => Check '2..Fatigue Check'* =>
3. Table Type: **Extreme.**
4. Load Group: ***1..Load Group***
5. Selection: ***All Entities.***
6. Parameter: ***Utilization Factor.***
7. Press *OK.*





Report. Tables and plots

1 Results => *Check Plots*

2 *Press => Check '2..Fatigue Check' =>*

3 Load Group: ***1..Load Group***

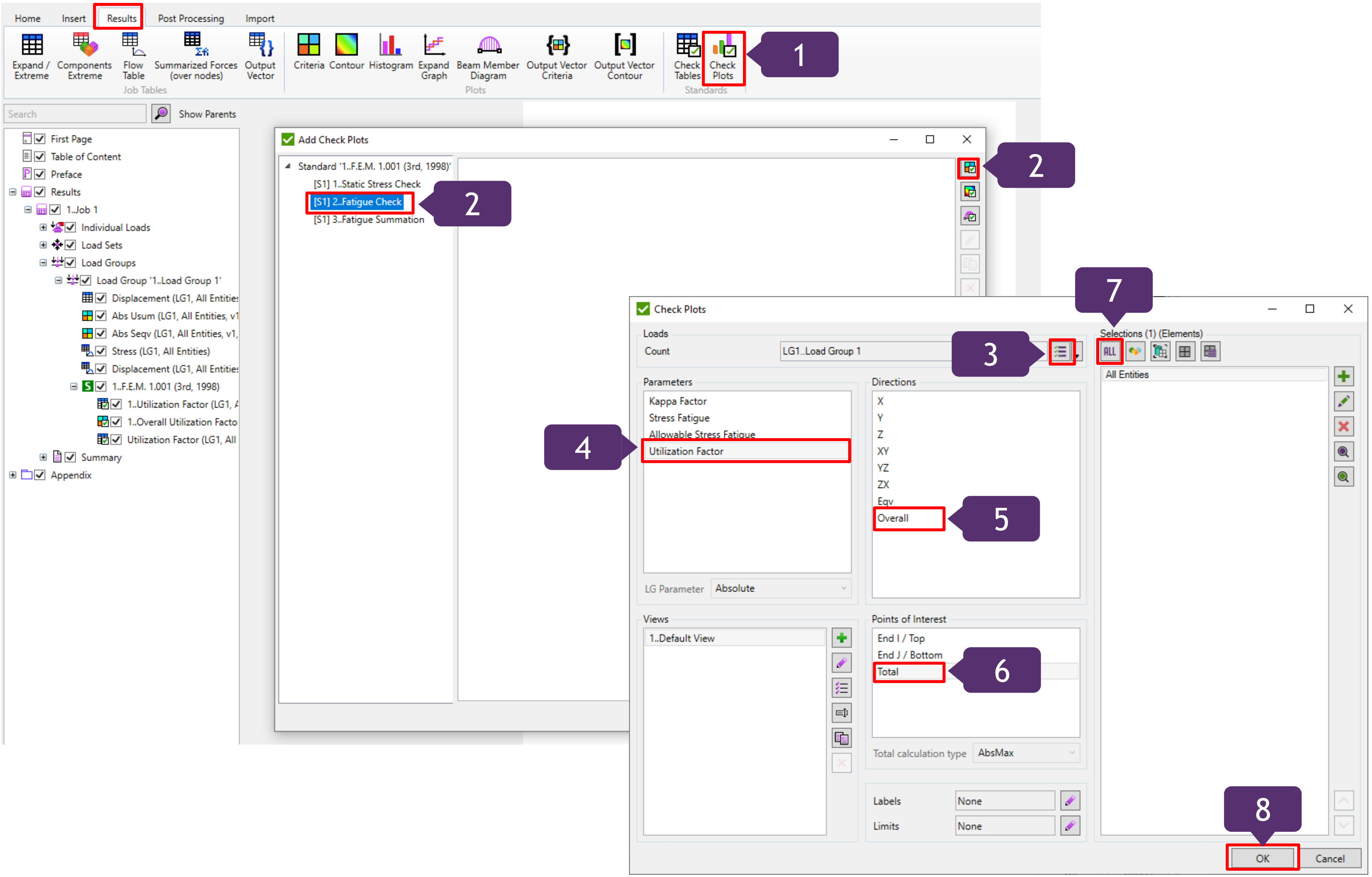
4 Parameters: **Utilization Factor**

5 Direction: **Overall**

6 Point of Interest: **Total**.

7 Selection: ***All Entities.***

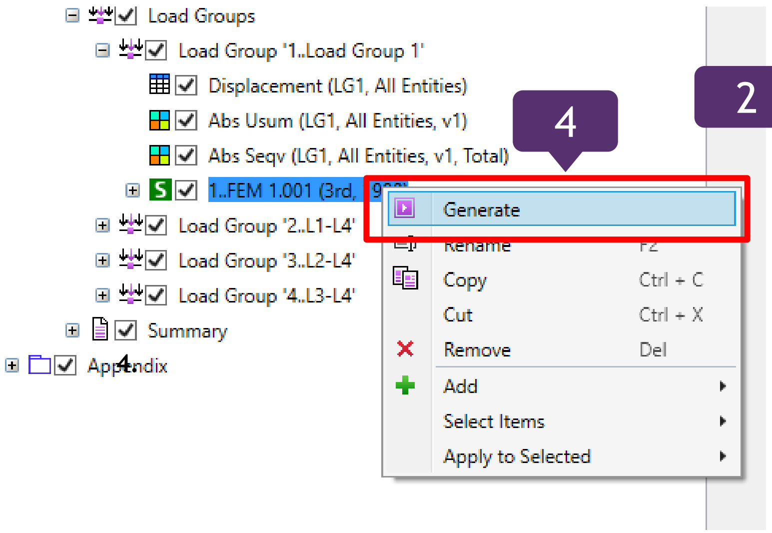
8 Press *OK.*

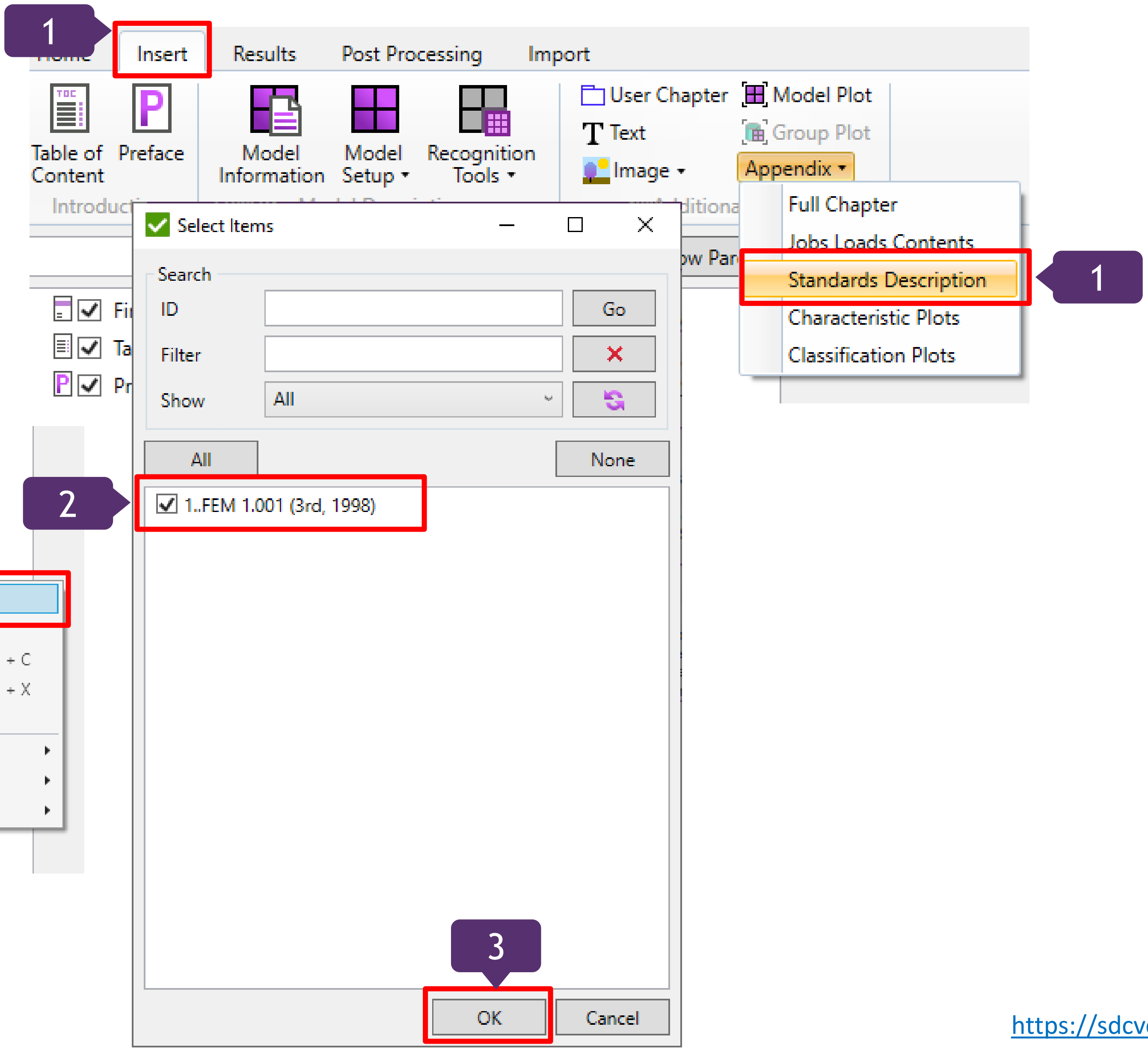


Report. Fatigue Check

SDC VERIFIER

1. Insert => *Appendix* => *Standards Description*
2. *Choose 1..FEM 1.001*
3. Press *OK.*
4. Expand standard 1..FEM 1.001 => *Generate* .





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1..F.E.M. 1.001 (3rd, 1998)

Unit System

Current Unit System = MKS (Meter/Kg/Second). It is used in calculations for the following standards: API RP 2A, ISO 19902, Norsok N004, DIN 15018, FEM 1.001 and Eurocode3.

1..Utilization Factor (LG1, All Entities)

Standard	1..F.E.M. 1.001 (3rd, 1998)	Check	[S1] 2..Fatigue Check
Load Group	LG1..Load Group 1	Parameter	Utilization Factor
Selection	All Entities		

Extreme	X	Y	Z	XY	YZ	ZX	Eqv	Overall
Minimum								
Value	0.00	0.00		0.00			0.00	0.00
Element ID	37146	83465		46174			83624	22151
Maximum								
Value	1.67	1.90		1.40			4.04	2.01
Element ID	112429	37547		1139			37547	37547
Absolute								
Value	1.67	1.90		1.40			4.04	2.01
Element ID	112429	37547		1139			37547	37547

Utilization Factor (LG1, 9 Selections)

Check	[S1] 2..Fatigue Check	Load Group	LG1..Load Group 1
Parameter	Utilization Factor	Selection	9 Selections

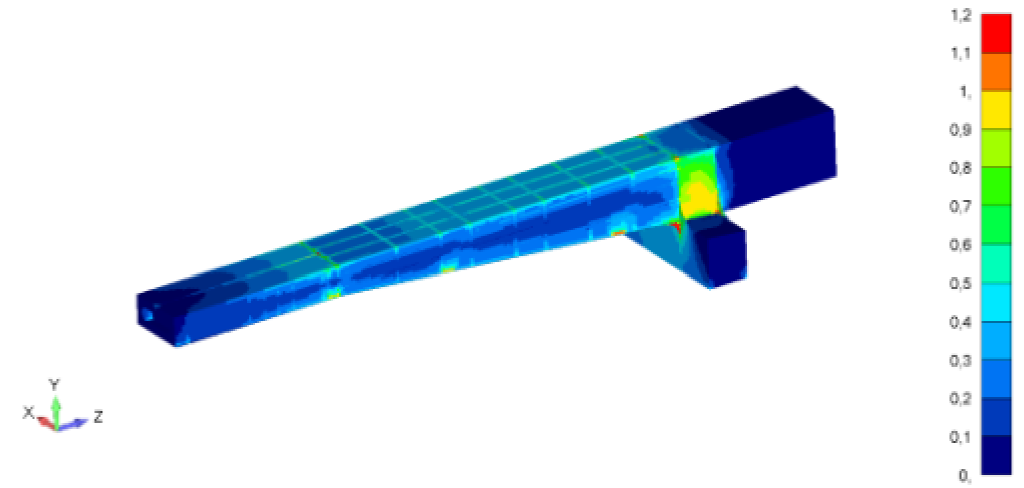
Components	X	Y	Z	XY	YZ	ZX	Eqv	Overall
Plate '4..stl plt 10 mm thks'	0.73	1.11		0.24			1.09	1.11
Plate '5..stl plt 8 mm thks'	0.37	0.56		0.14			0.33	0.58
Plate '8..stl plt 25 mm thks'								
Plate '10..stl plt 4 mm thks'	0.40	0.49		0.04			0.23	0.49
Plate '11..stl plt 12 mm thks'	1.05	1.90		1.01			4.04	2.01
Plate '12..stl plt 24 mm thks'								
Beam '13..stl L-bar 100x65x8 mm'	0.96						0.93	0.96
Beam '14..stl L-bar 100x65x8 mm (top)'	0.67						0.45	0.67
Beam '15..stl L-bar 100x65x8 mm (side)'	0.94						0.89	0.94

Utilization Factor (LG1, All Entities)

Standard	1..F.E.M. 1.001 (3rd, 1998)	Check	[S1] 2..Fatigue Check
Load Group	LG1..Load Group 1	Parameter	Utilization Factor
Selection	All Entities		

Extreme	X	Y	Z	XY	YZ	ZX	Eqv	Overall
Minimum	0.00	0.00		0.00			0.00	0.00
Maximum	1.67	1.90		1.40			4.04	2.01
Absolute	1.67	1.90		1.40			4.04	2.01

Overall Utilization Factor (LG1, All Entities, v1, Total)

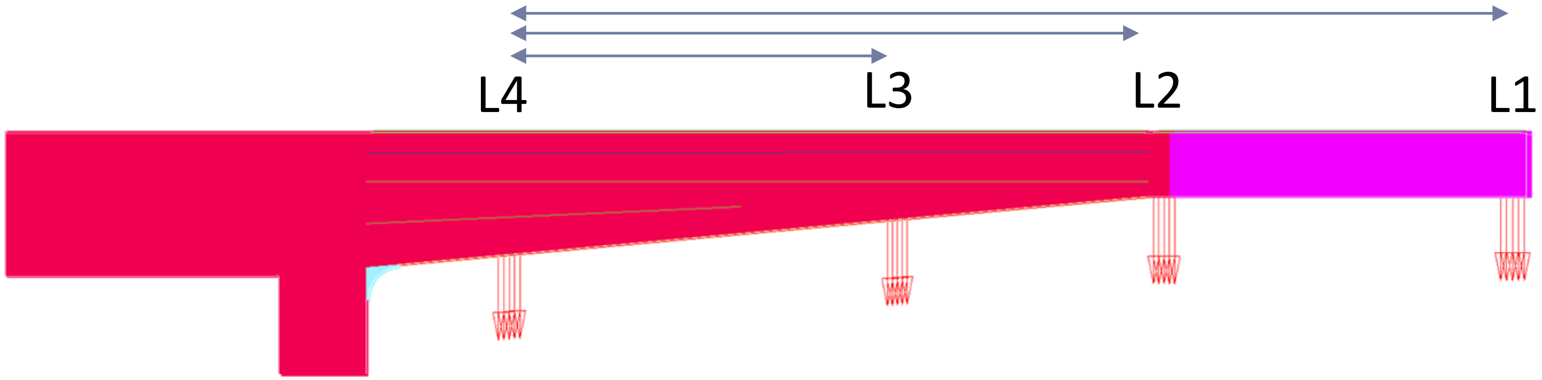


Check	[S1] 2..Fatigue Check	Point	Total
Load Group	LG1..Load Group 1	Parameter	Overall Utilization Factor
Selection	All Entities	View	1..Default View

Eurocode3 Stress history

- A better fatigue damage can be made if load cycles are specified more accurately.
- Instead of 2 million load cycles from start to end:

Load cycle	Number of cycles	Content
L4-L1	0,5 e6	LS4, LS3, LS2, LS1, IL1
L4-L2	1,0 e6	LS4, LS3, LS2, IL1
L4-L3	0,5 e6	LS4, LS3, IL1

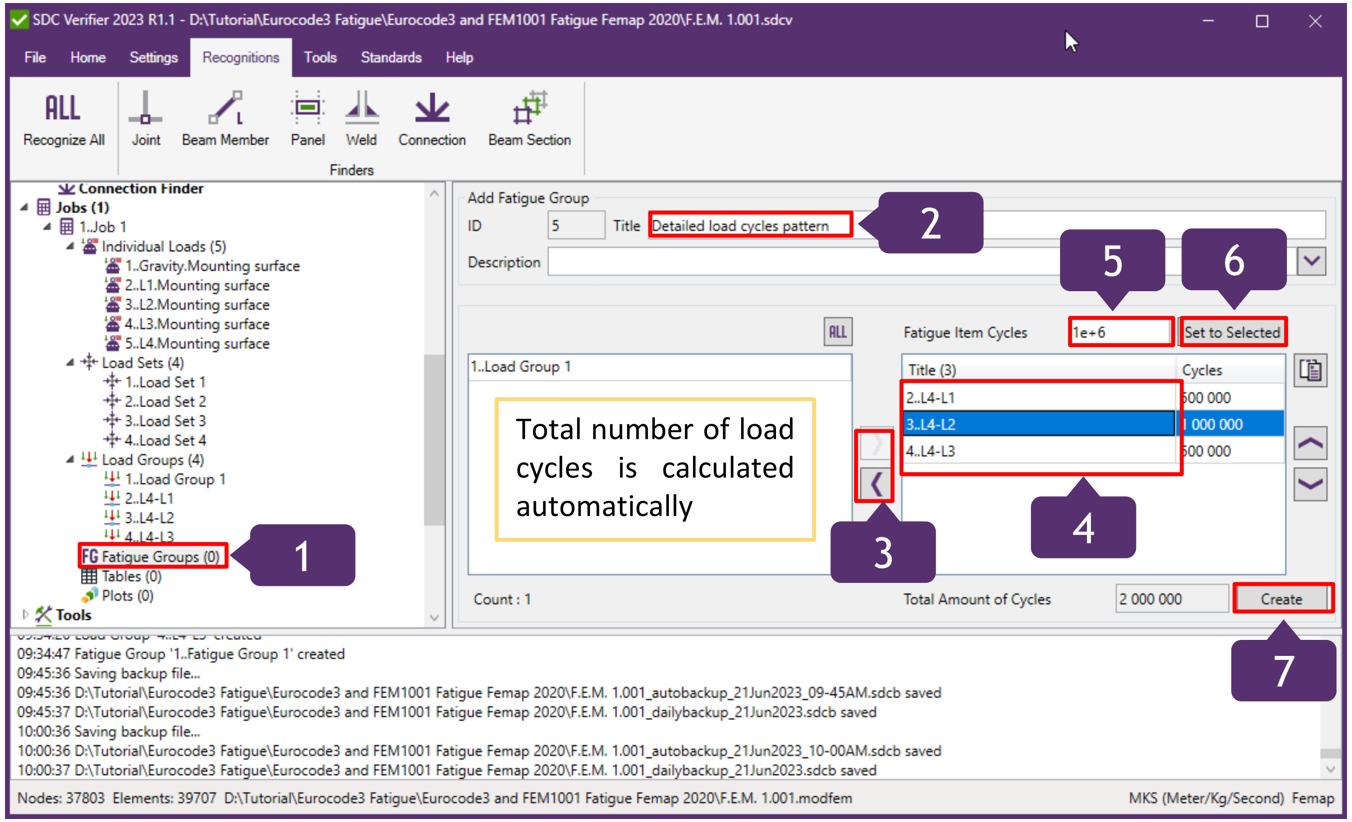


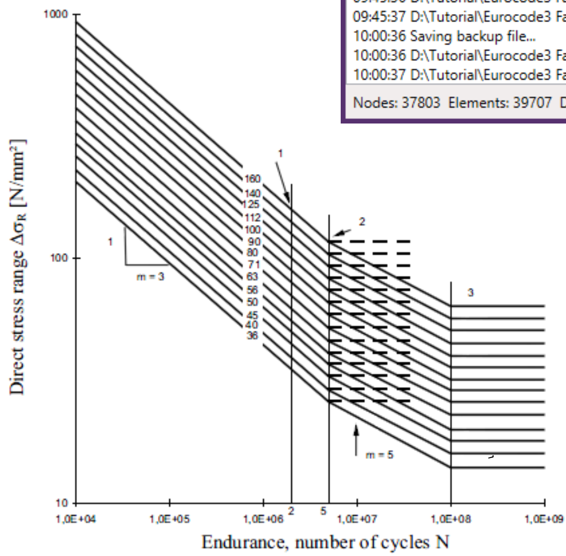
NB gravity load is also included because the stress variation determines the fatigue damage

Add Fatigue Group (stress history)

SDC VERIFIER

1. Select **Fatigue Groups** in Navigation tree
2. Title: **Detailed load cycles pattern**
3. Select all groups and press
4. Select **1..L4-L1** and **3..L4-L3**
5. Fatigue Item Cycles: **0.5e+6** and *Set*.
6. Set **1e+6** cycles for 2..L4-L2
7. Press *Create*



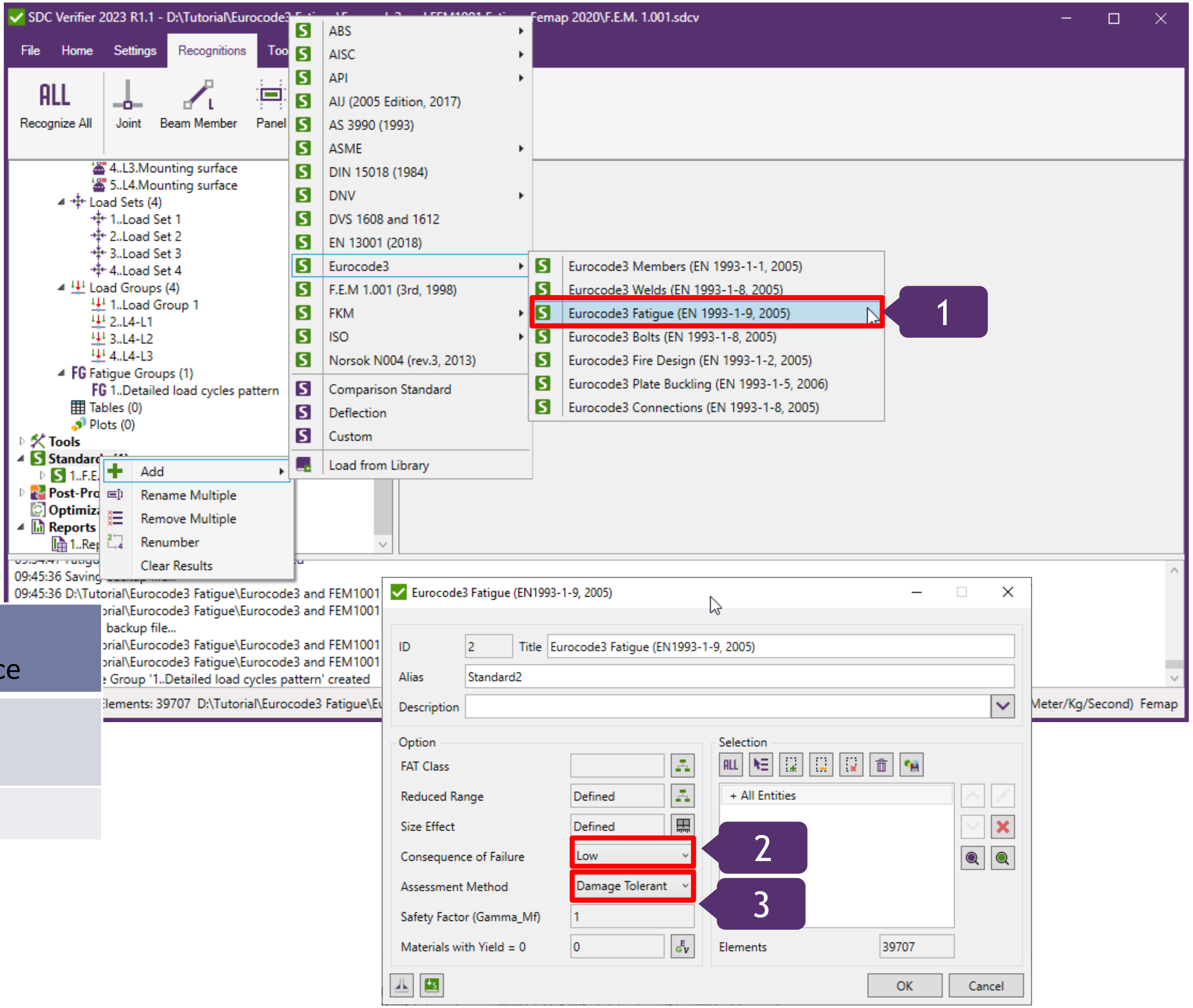


1 Detail category $\Delta\sigma_C$
2 Constant amplitude fatigue limit $\Delta\sigma_D$
3 Cut-off limit $\Delta\sigma_L$

Fatigue calculation with Eurocode 3

1. Execute *Add* => **Eurocode 3 Fatigue (EN 1993-1-9)** in Standards context menu.
2. Consequence of Failure: **Low**
3. Assessment Method: **Damage tolerant**

Safety Factor	Low consequence	High consequence
Damage tolerant	1.0	1.15
Safe life	1.15	1.35



FAT classes Eurocode3

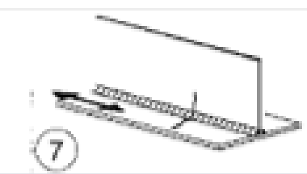
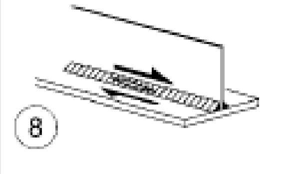
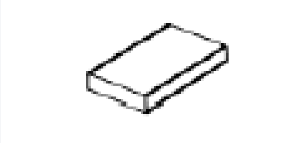
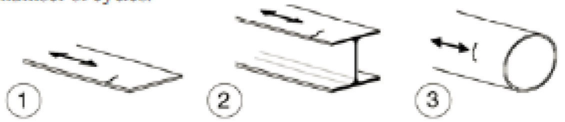
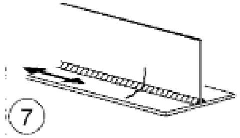
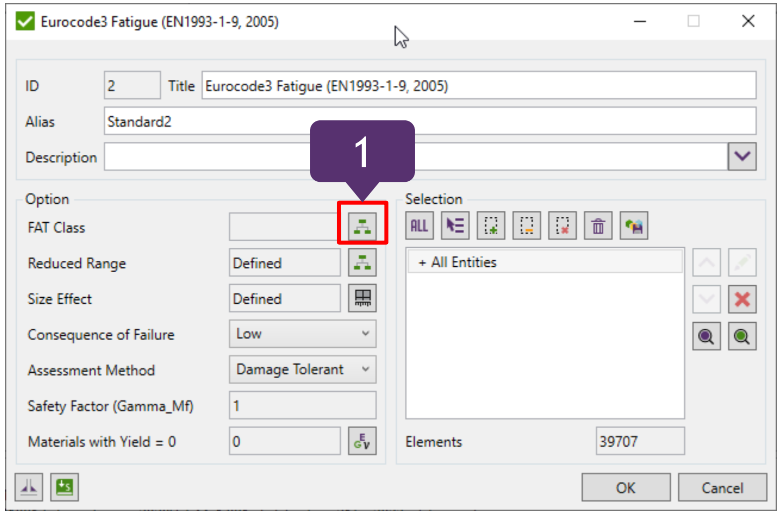
	Perpendicular to weld	Parallel with weld	Shear
Weld	**80** 	**100** 	**80** 
No weld	**160** 		**100** 

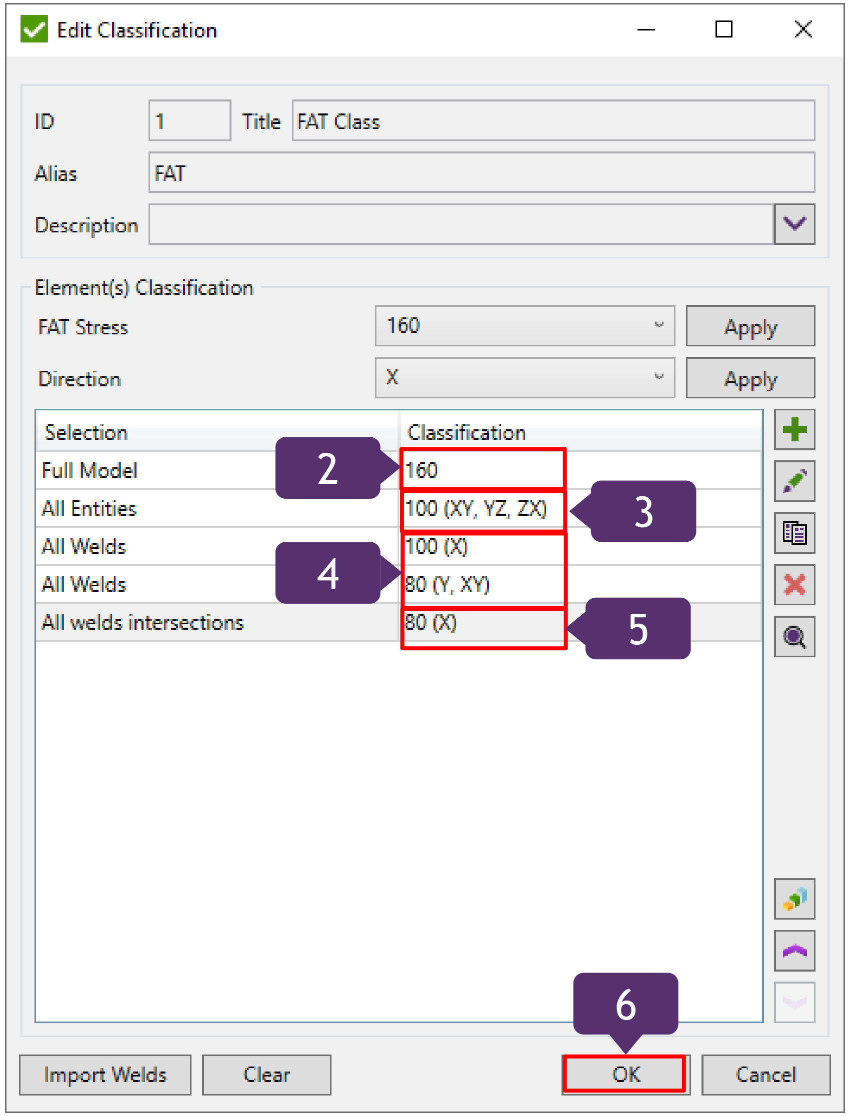
Table 8.1: Plain members and mechanically fastened joints

Detail category	Constructional detail	Description	Requirements
160	**NOTE** The fatigue strength curve associated with category 160 is the highest. No detail can reach a better fatigue strength at any number of cycles. 	Rolled and extruded products: 1) Plates and flats; 2) Rolled sections; 3) Seamless hollow sections, either rectangular or circular.	Details 1) to 3): Sharp edges, surface and rolling flaws to be improved by grinding until removed and smooth transition achieved.
100		7) Repaired automatic or manual fillet or butt welds for categories 1) to 6).	7) Improvement by grinding performed by specialist to remove all visible signs and adequate verification can restore the original category.

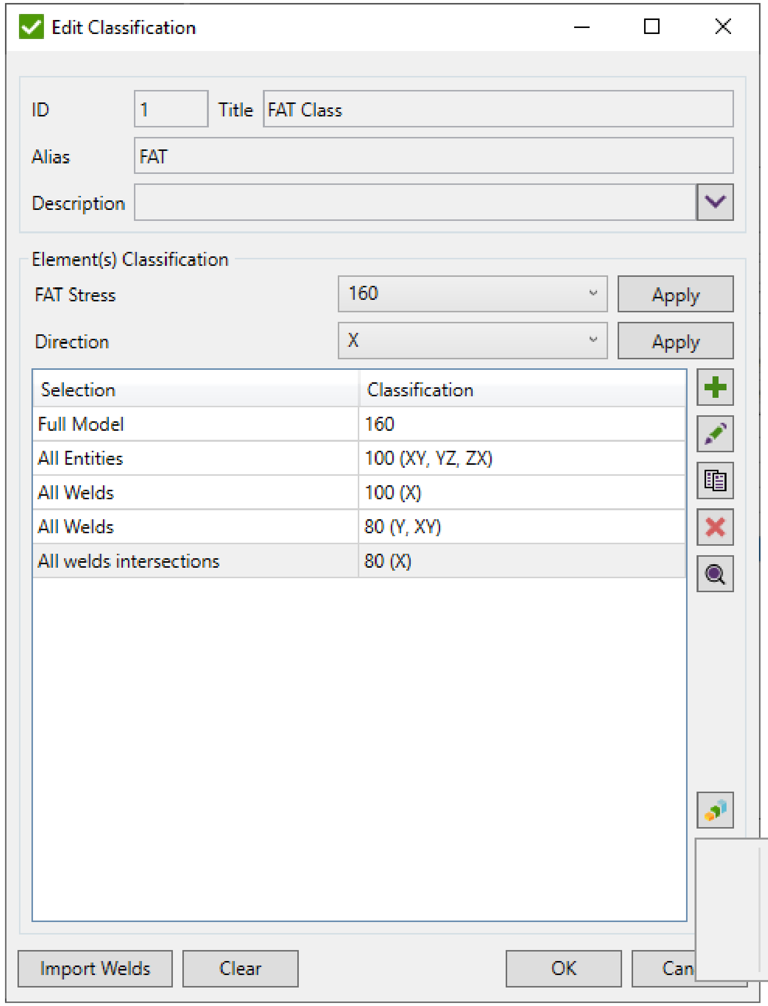
For determination of FAT classes check standard!
In this tutorial only examples are given

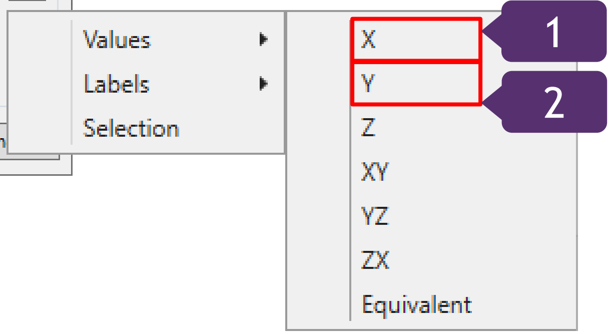
1. Press *Define* for the FAT Class.
2. Full Model: **160**
3. All Entities: **100** (No weld)
4. For welds: X: **100**; Y/XY: **80**
5. For welds intersections: X: **80**
6. Press *OK*



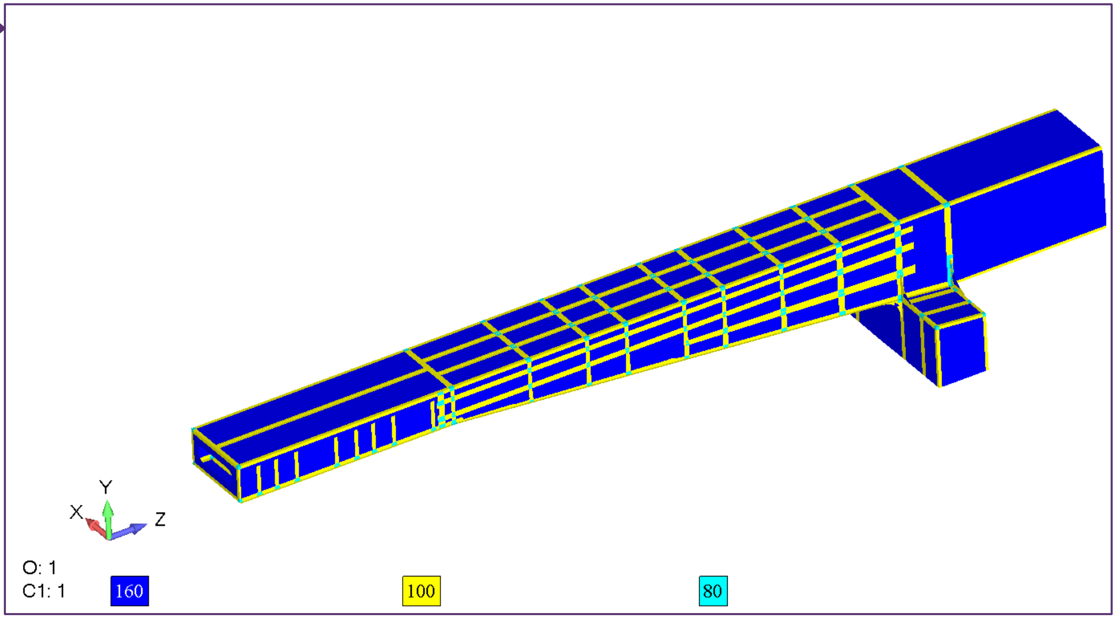


FAT classes plot

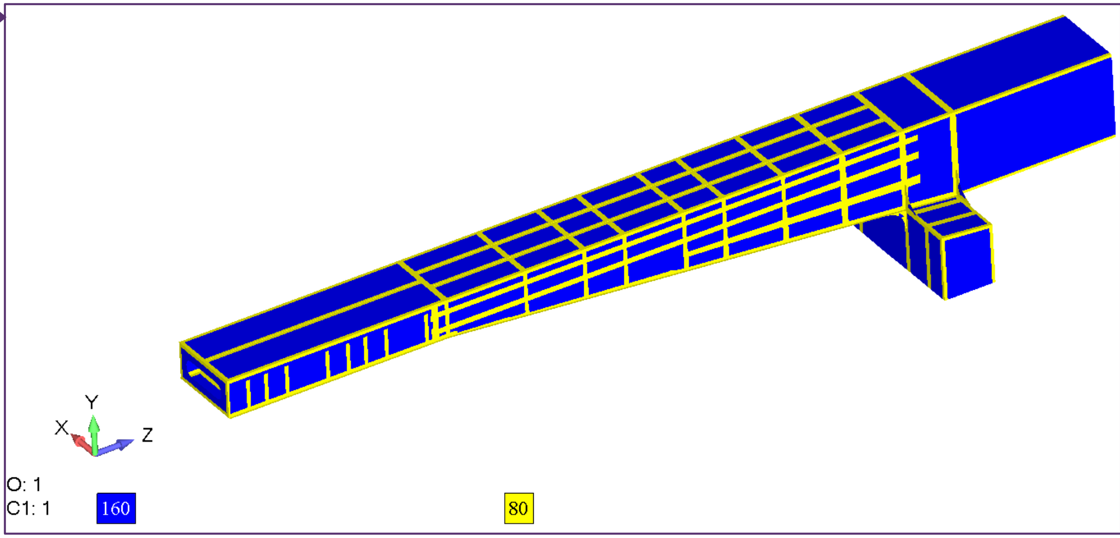




1

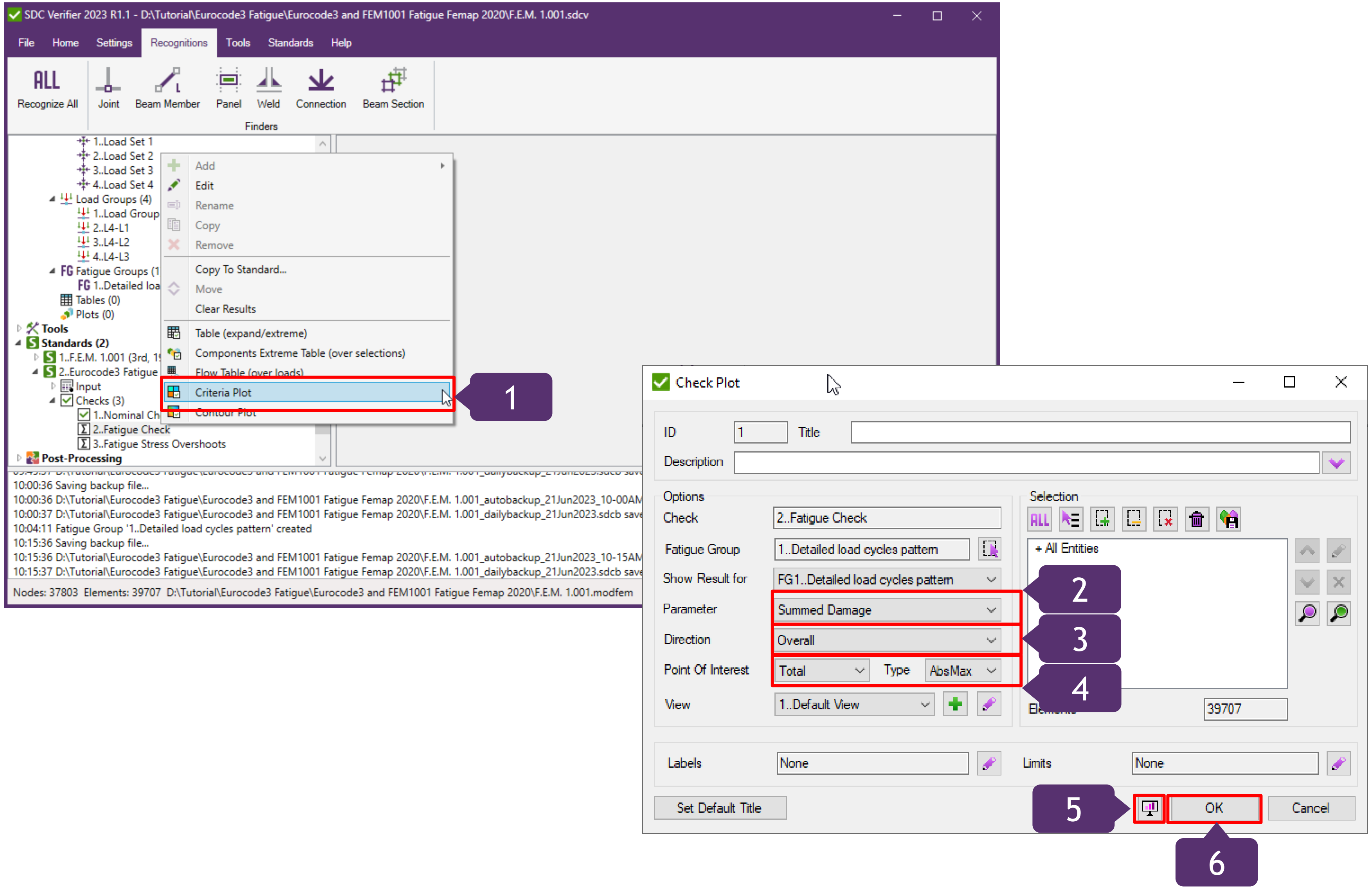


2



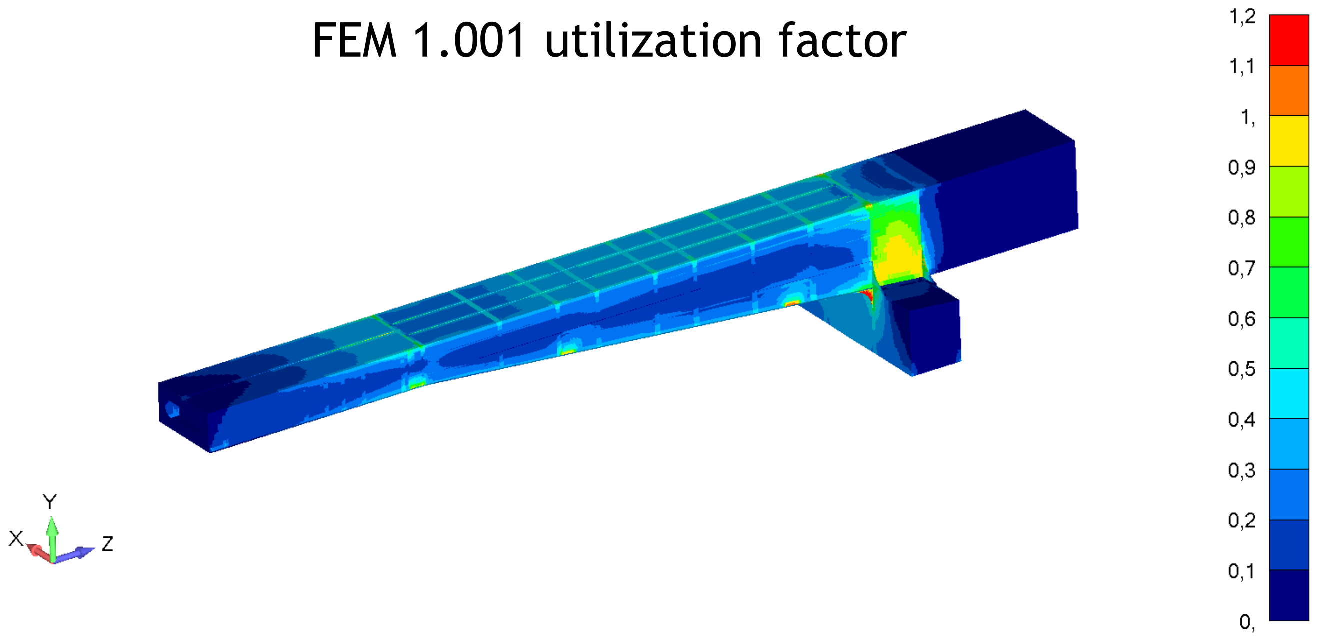
Fatigue Damage Plot

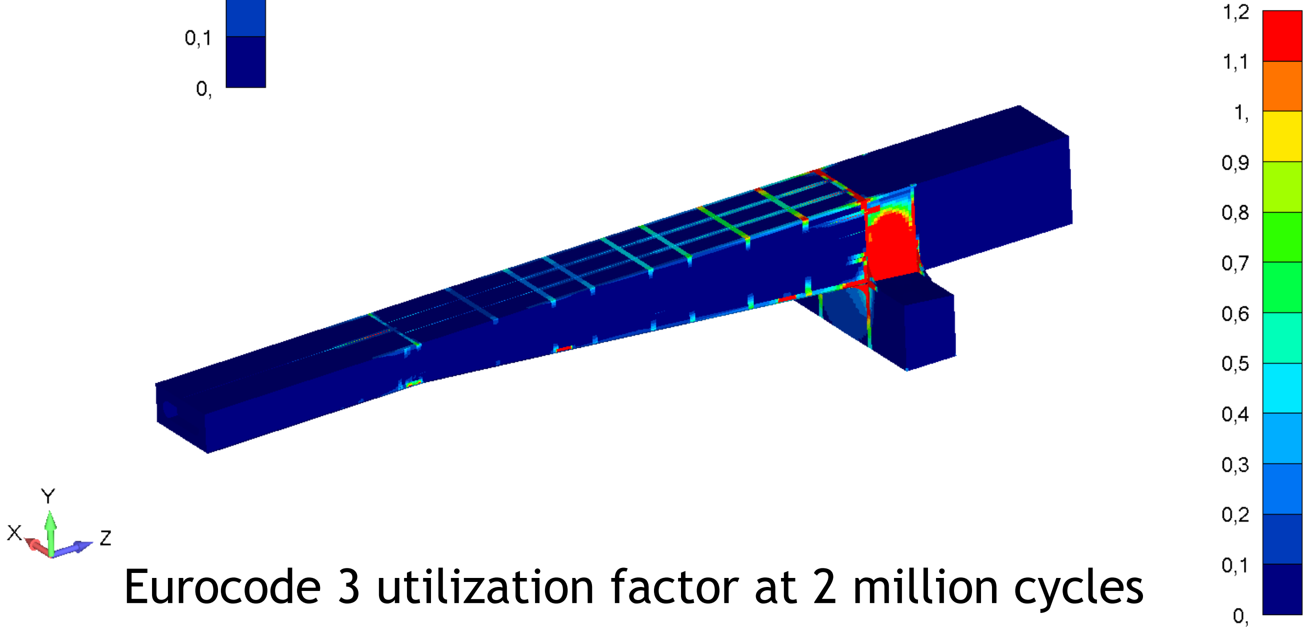
1. Execute *Criteria Plot* in **Fatigue Check** context menu
2. Parameter: **Summed Damage**
3. Direction: **Overall**
4. Point of interest: **Total** Type: **AbsMax**
5. Press *Preview*
6. Press *OK*



Comparison

FEM 1.001 utilization factor





Eurocode 3 utilization factor at 2 million cycles