SDC VERIFIER

Tutorial

Eurocode3 and F.E.M. 1.001 Fatigue

Updated on: January 31st 2024

Tested with: SDC Verifier 2023 R2

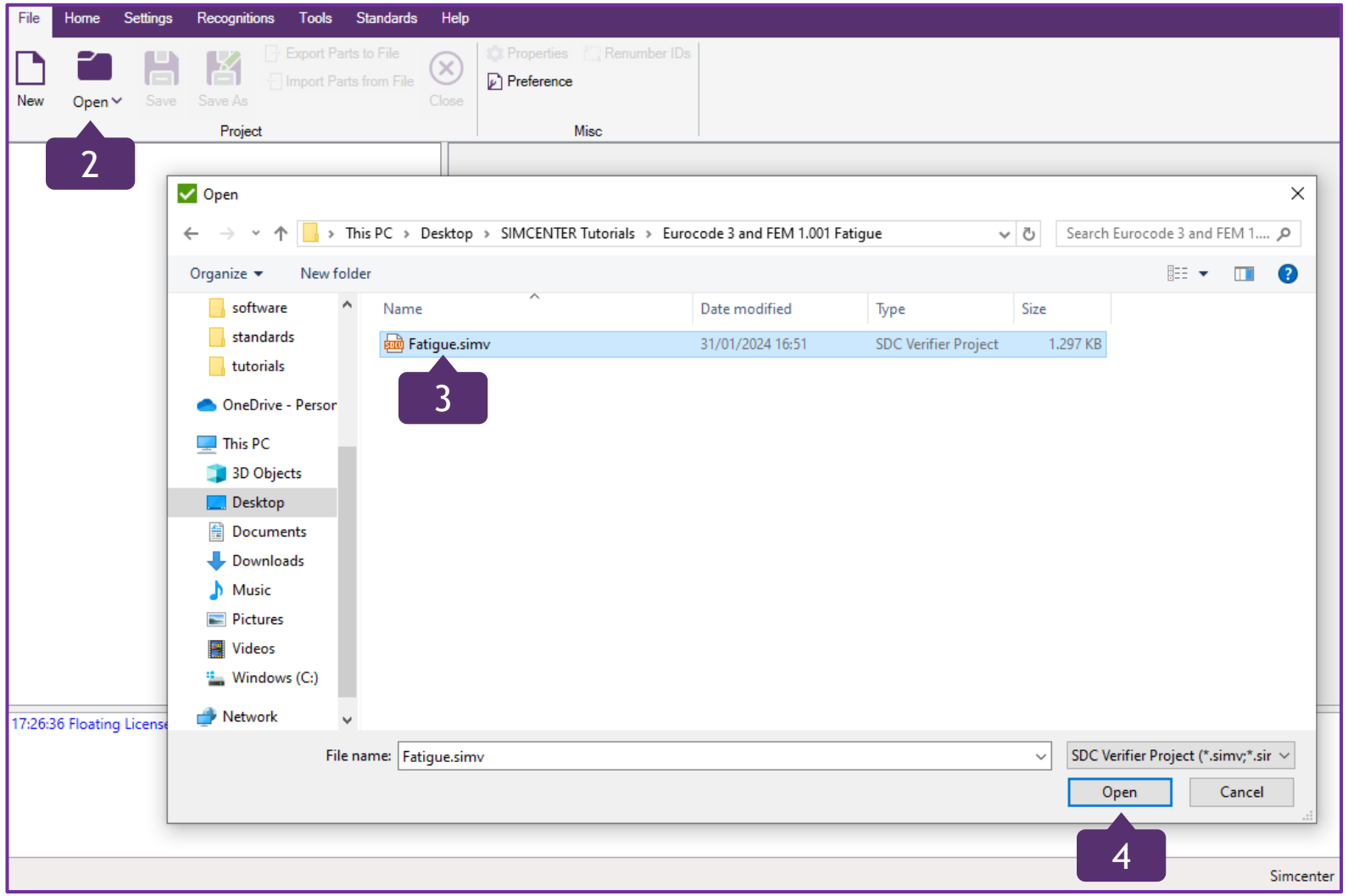
Simcenter3D 2306

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;
- Weld Finder Tool overview;
- Implementation in SDC Verifier;
- Fatigue tables and plots;
- The functionality of SDC Verifier Report Designer can be checked via the link to a separate tutorial (Slide 38).

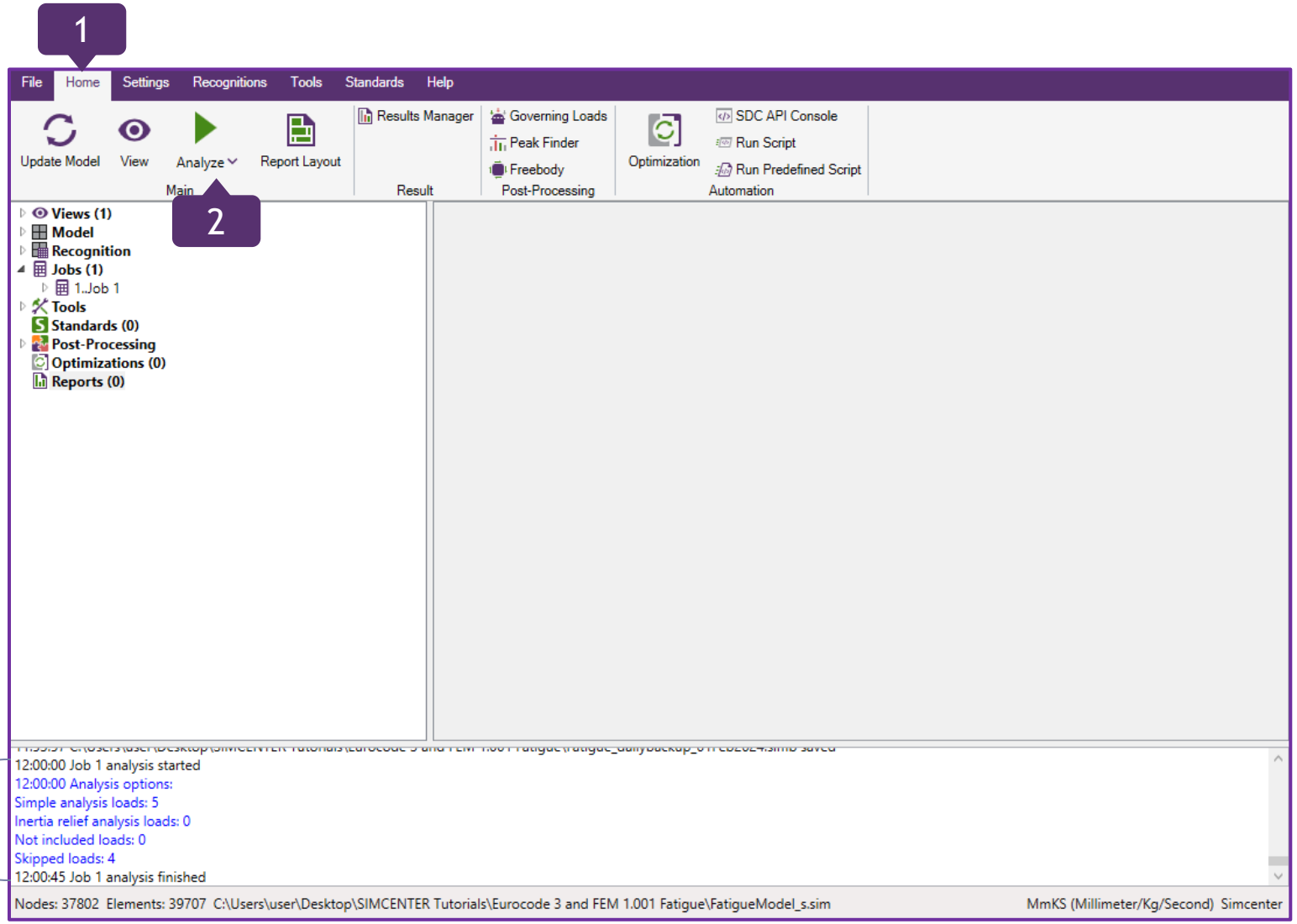
Open the Starter Model

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



Run Analysis

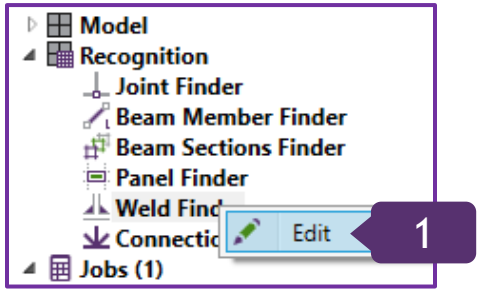
1. Go to *Home* section on the Ribbon
2. Press  on the toolbar to analyze Job

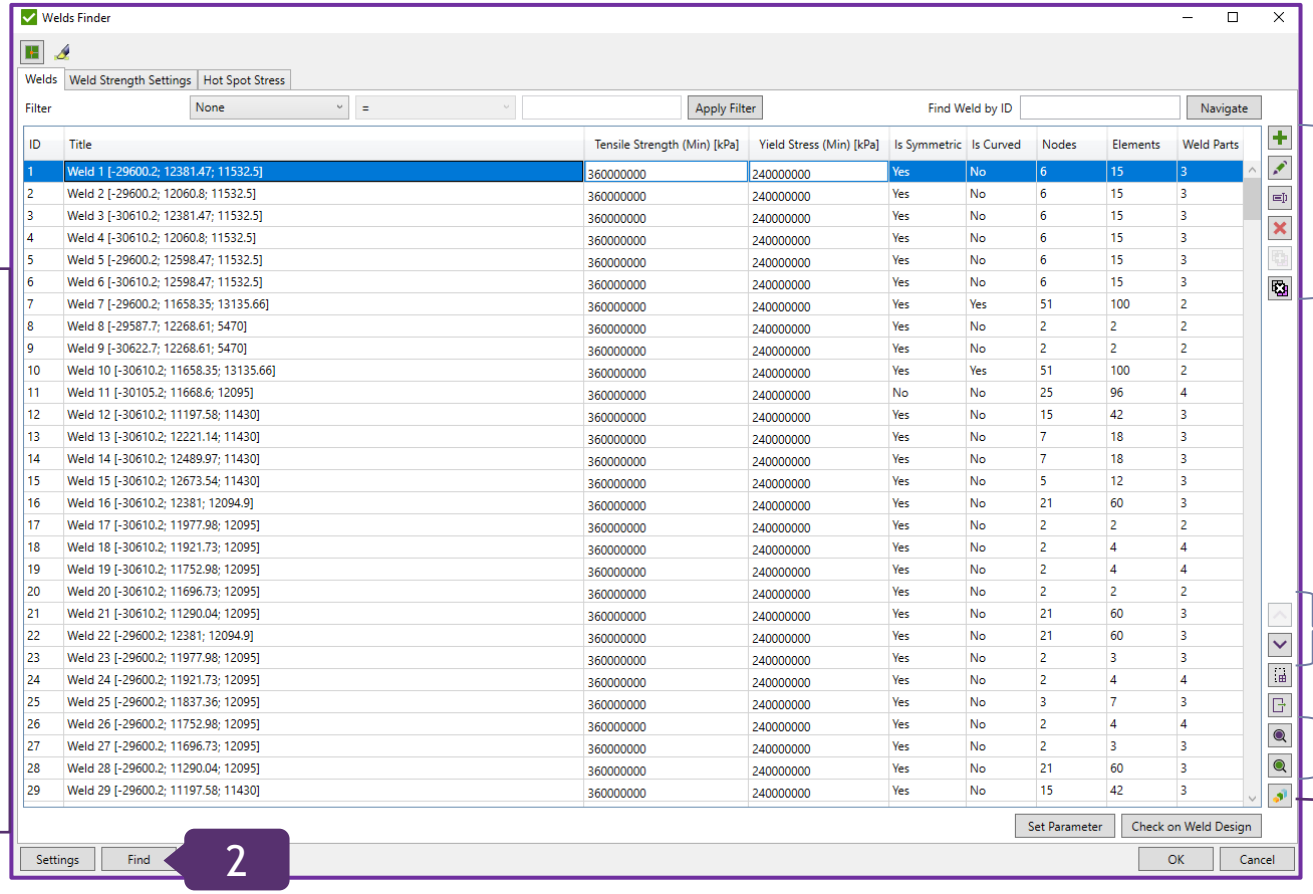


Job 1 analysis started and finished.

Weld Finder

1. **In the Model Tree, execute Recognition =>Weld Finder => Edit…**
2. **Press *Find***





Add, Edit, Combine and Remove Welds

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

Note: All weld nodes should belong to weld elements.

The option is automatically disabled when the weld is in Add mode and enabled when in Edit mode.

Is used to recognize weld elements from nodes. Enabled when the *Pick elements manually* option is turned ON.

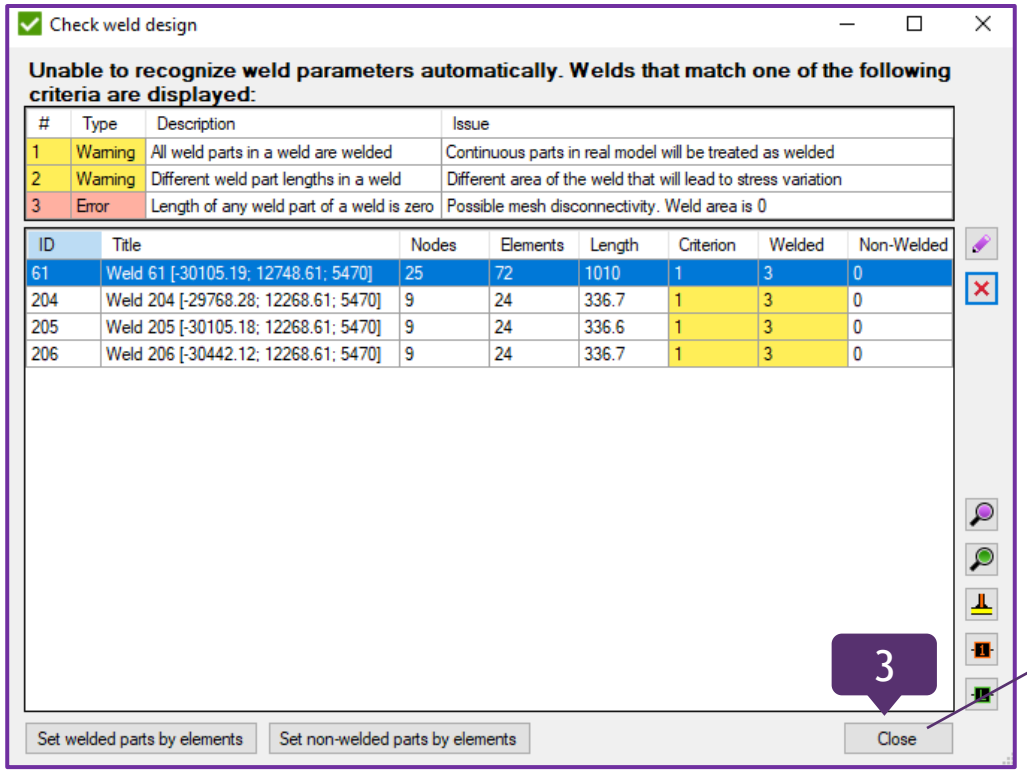
Weld Finder. Additional Information

After the recognition is finished, all welds are checked on the design. If all weld parts of single weld are welded or all weld parts are not-welded, they will be included to the list of welds that are recommended to be checked manually:

3 **Press *Close***

Note: If a weld consists of only 2 parts (e.g. Angle-weld), all parts will be set as welded but weld will not be included to the list;

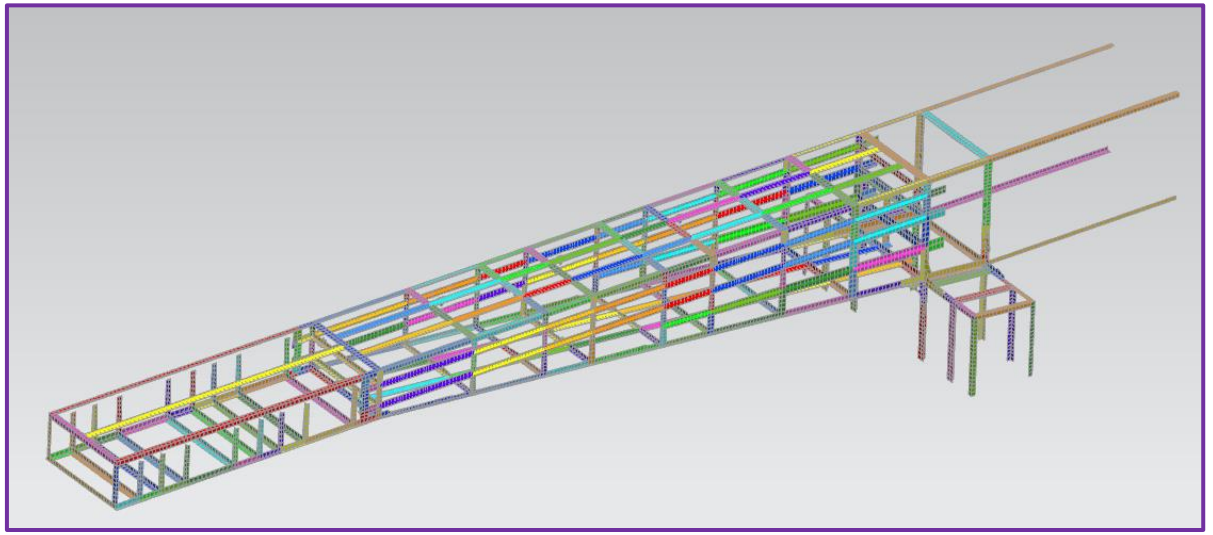
Check weld design is essential for Weld Strength checks. As this tutorial is devoted to Fatigue, the window is to be closed.

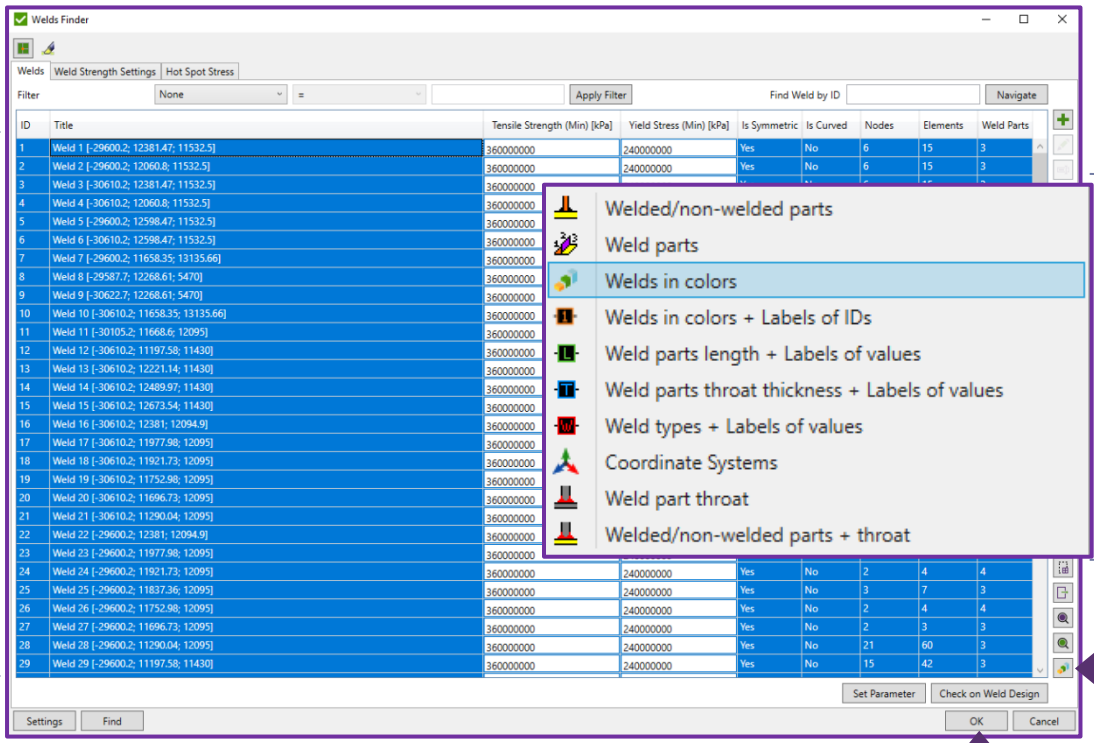


There some Welds with all welded parts were found; this message should be closed

Weld Finder Plotting Functions

1. To plot all welds, in Welds Finder select them by combining Ctrl + A
2. Press  and select *Welds in colors*
3. Press *OK*





The software offers an extensive variety of Plotting options that can be selected according to the user's objectives.

Stress Transformation

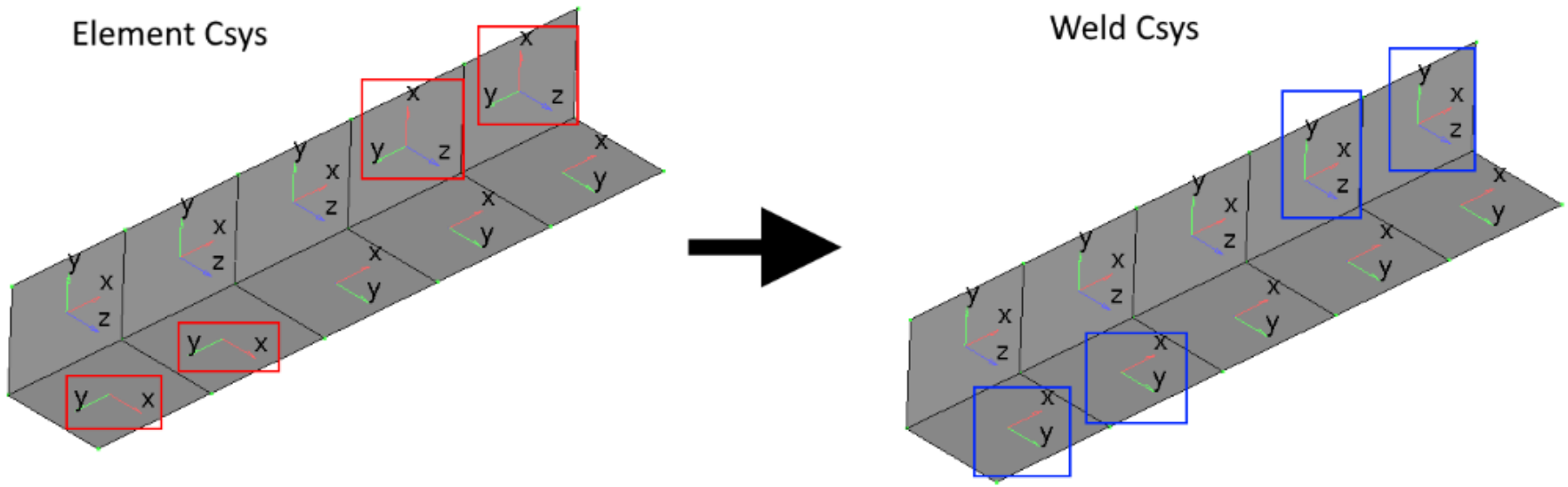
$$\sigma_{nn} = \frac{(\sigma_{xx}+\sigma_{yy})}{2} + \frac{(\sigma_{xx}-\sigma_{yy})}{2} * \cos 2\theta + \tau_{xy} * \sin 2\theta$$

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

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

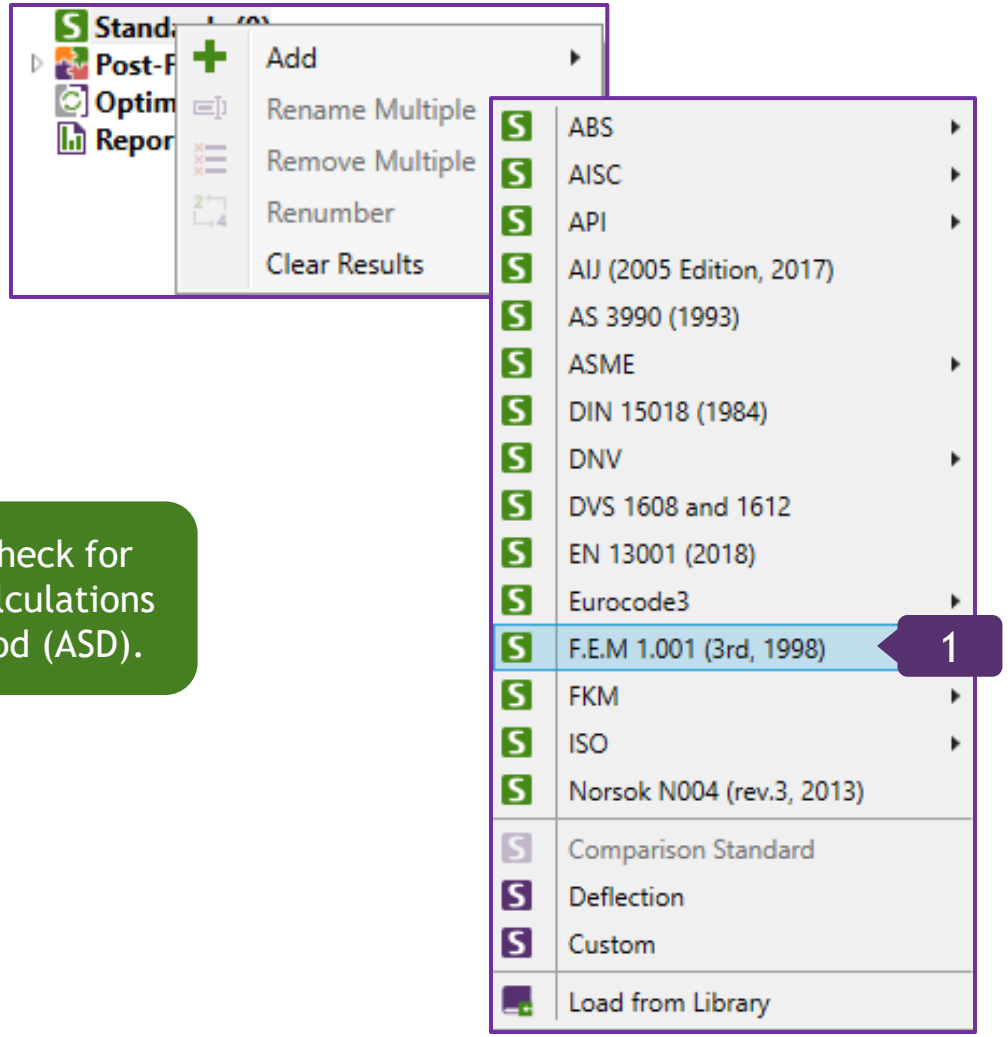
Stresses for Weld elements are automatically transformed in the direction of the corresponding Weld from Weld Finder Tool, using the Wedge Method. Stresses are transformed only for plate type elements.

$\sigma_{xx}, \sigma_{yy}, \tau_{xy}$ – 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 F.E.M. 1.001

1 In the *Model tree*, in Standards execute *Add => F.E.M 1.001 (3rd, 1998)*



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).

Allowable Stress Design method

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

a) $\kappa \leq 0$

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

- for compression : $\sigma_c = 2 \cdot \sigma_w / (1 - \kappa)$ (2)

σ_w is given in table above.

b) $\kappa > o$

- for tension $\sigma_t = \sigma_O / [1 - \kappa \cdot (1 - \sigma_O / \sigma_{+1})]$ (3)

- for compression $\sigma_c = 1,2 \cdot \sigma_t$ (4)

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

$\sigma_O = 1,66 \cdot \sigma_w$

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

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

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/mm^2, i.e. to the permissible stress adopted for checking for ultimate strength.

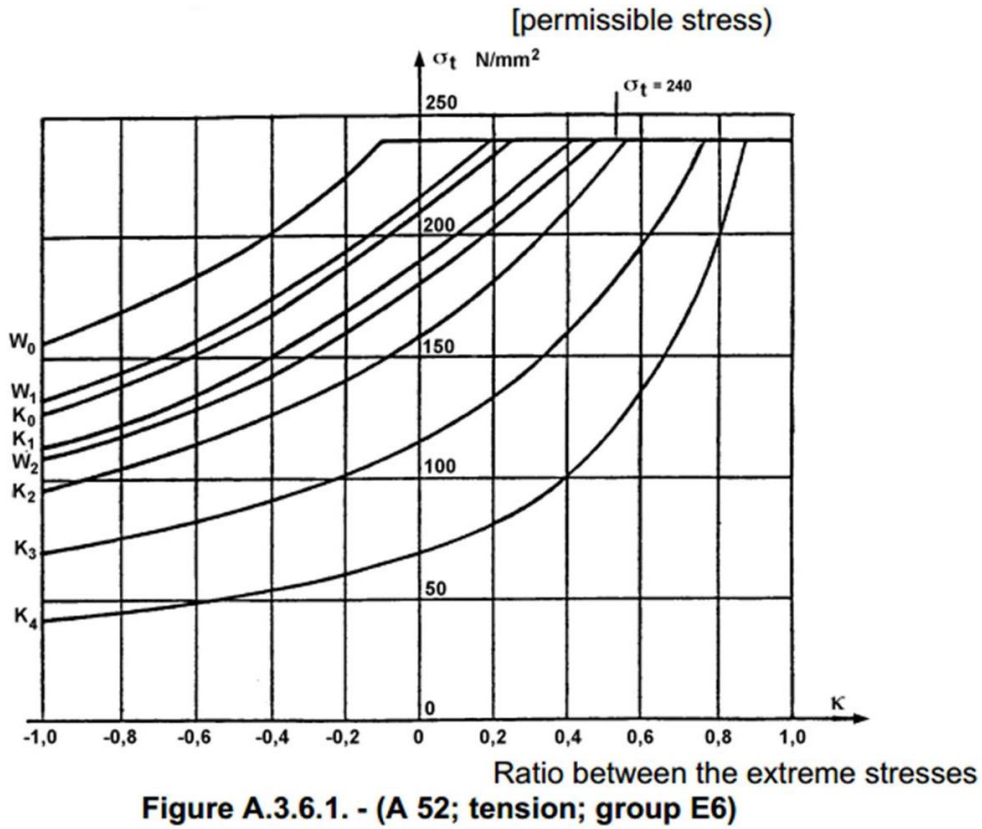


Figure A.3.6.1. - (A 52; tension; group E6)

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

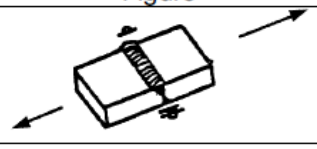
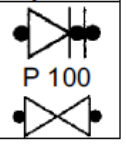
Weld Type

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

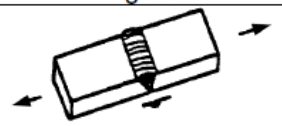
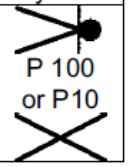
Case W_O

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.		

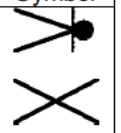
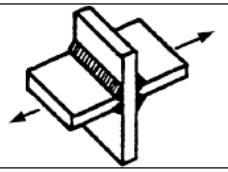
Case K_0 - Slight stress concentration

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

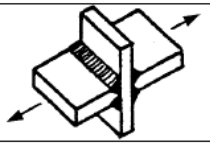
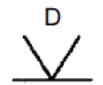
Case K_1 - Moderate stress concentration

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

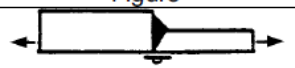
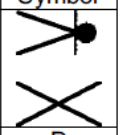
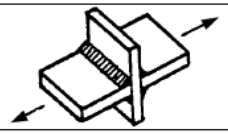
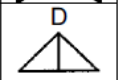
Case K2 - Medium stress concentration

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		

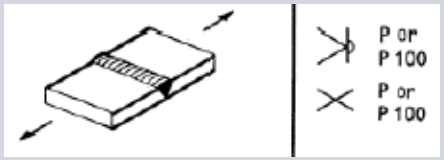
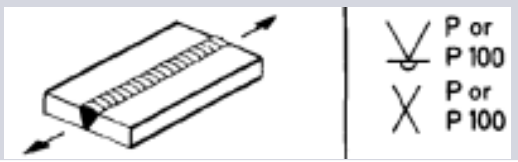
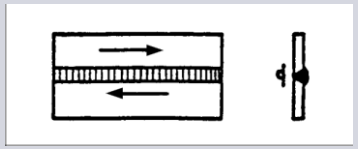
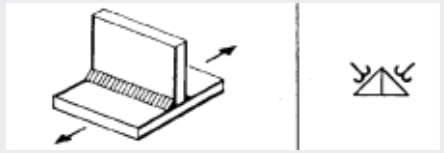
Case K_3 - Severe stress concentration

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		

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		

Fatigue Resistance Depends on Stress Direction

Stress Perpendicular to Weld	Stress Parallel with Weld	Shear
K1 	K0 	K0 
K2 	K1 	

No Weld (All Directions)

W0 

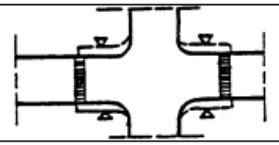
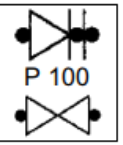
In the software: $\tau_w(-1) = \sigma_w(-1) / sqrt(3)$

	$\sigma_w(-1)$ for κ=-1, Element Group E6, Fe 360							
Notch group	W0	W1	W2	K0	K1	K2	K3	K4
Stress amplitude	147.8	125.7	103.5	127.5	113.8	95.6	68.3	41.0

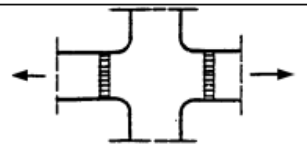
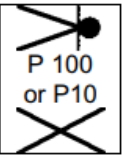
For Beams SCF of Connections Can Be Included in the Classification

Depends on Stress concentrations:

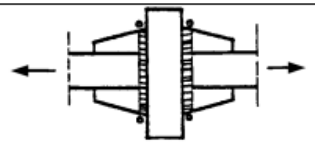
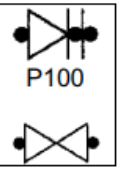
Case K_0 - Slight stress concentration

0,13	Gusset secured by butt-welding (S.Q.) at right angles to the direction of the forces		

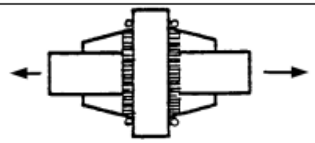
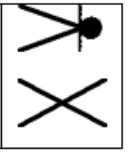
Case K_1 - Moderate stress concentration

1,13	Gusset joined by butt welding (O.Q.) at right angles to the direction of the forces		

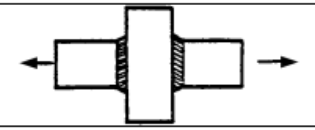
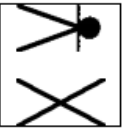
Case K2 - Medium stress concentration

2,13	Butt weld (S.Q.) at right angles to the direction of the forces, made at intersection of flats, with welded auxiliary gussets. The ends of the welds are ground, avoiding notches		

Case K_3 - Severe stress concentration

3,13	Butt weld (O.Q.) at right angles to the direction of the forces at the intersection of flats with welded auxiliary gussets. The ends of the welds are ground, avoiding notches		

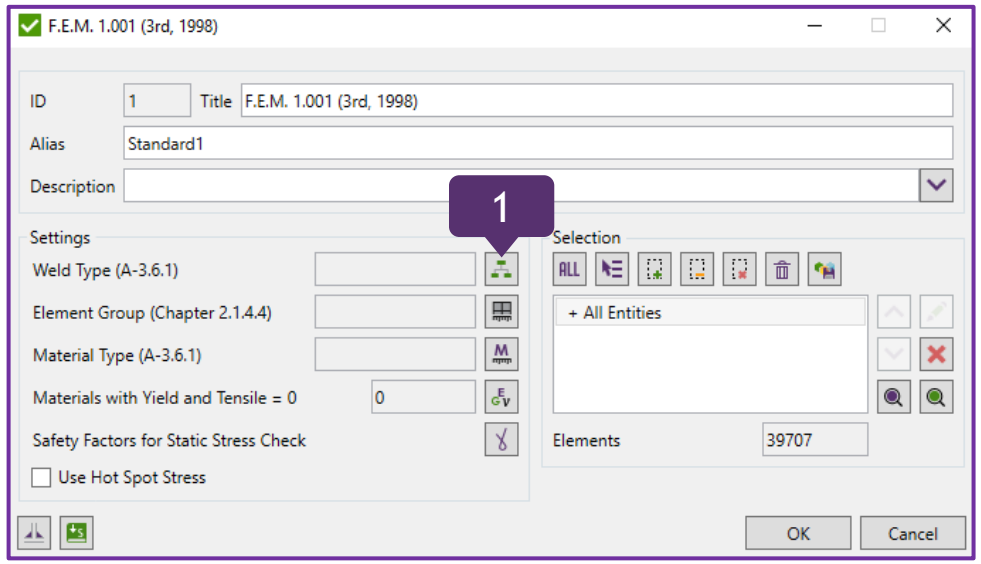
Case K_4 - Very severe stress concentration

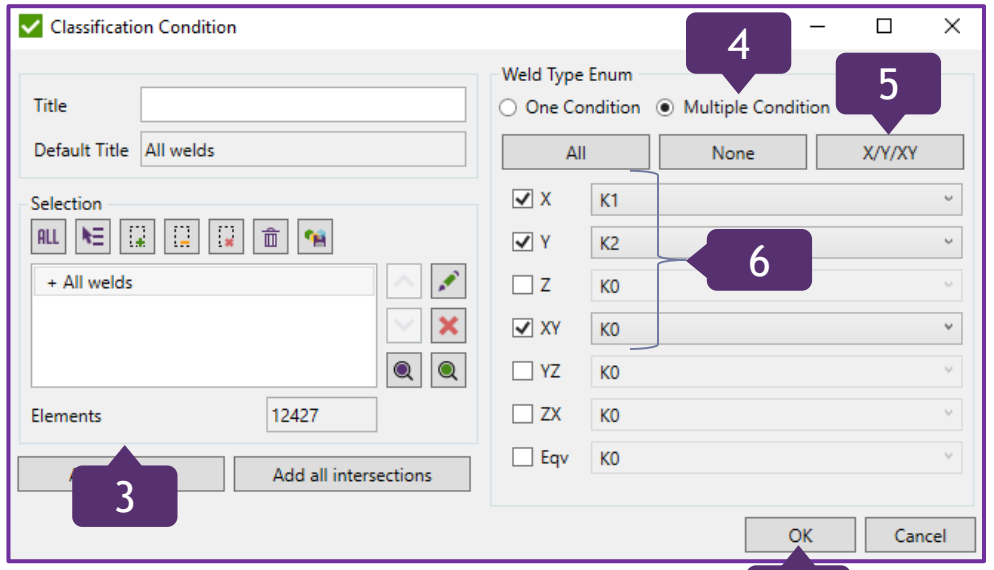
4,11	Butt welds (O.Q.) at right angles to the direction of the forces, at the intersection of flats (no auxiliary gussets)		

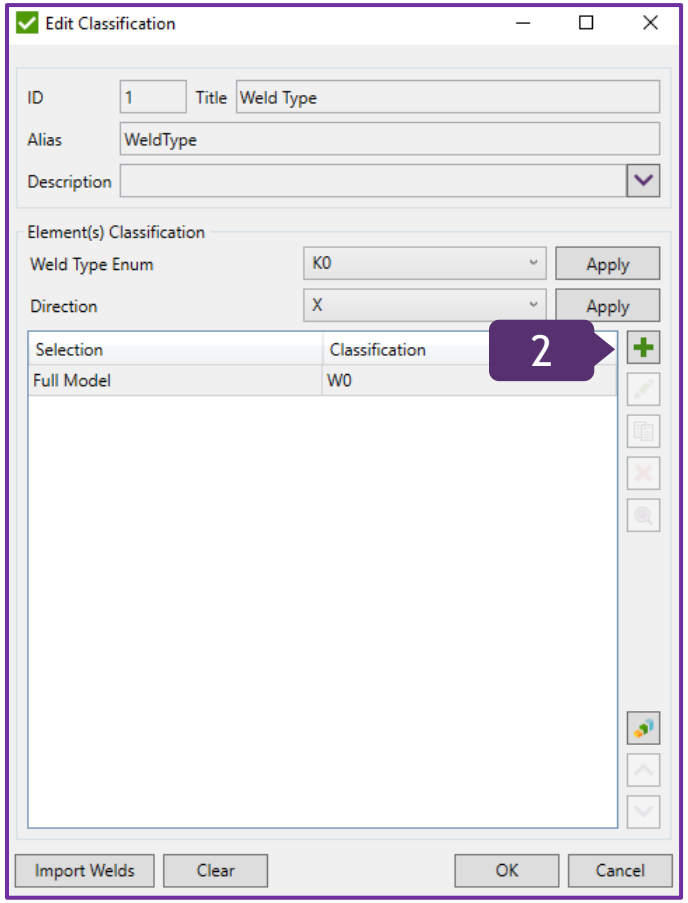
(not included in this tutorial)

Weld Type Classification. All Welds

1. Press  to set Weld Type (A-3.6.1)
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*

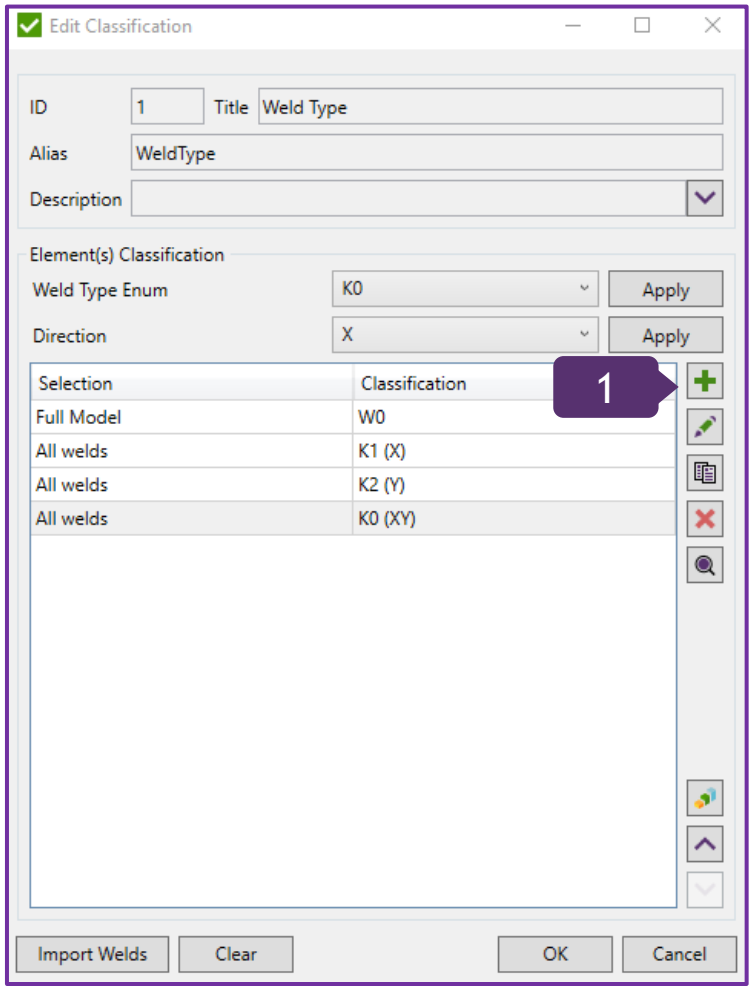


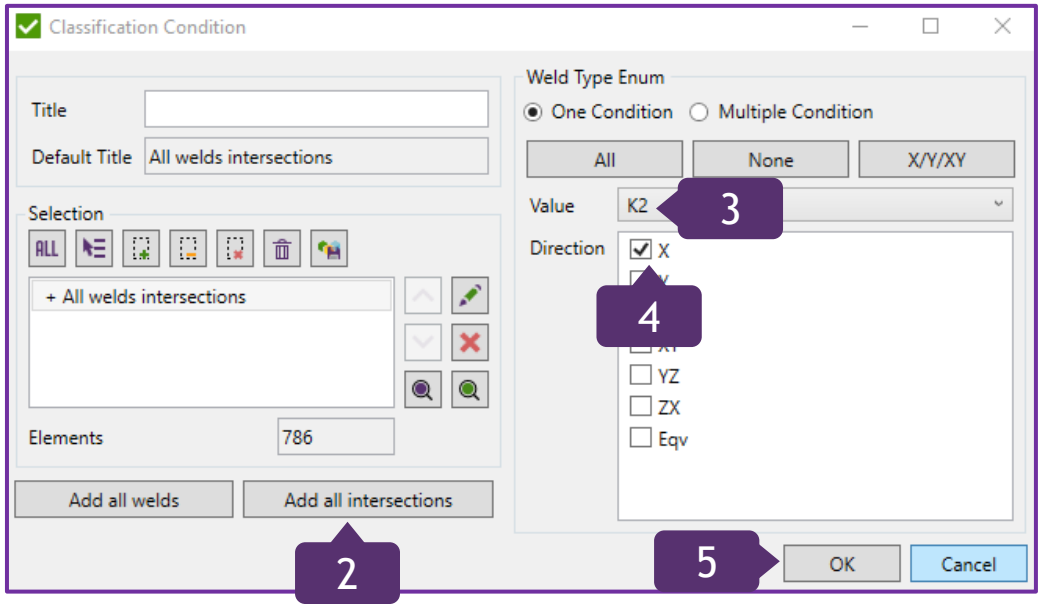




Weld Type Classification. Welds Intersections

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



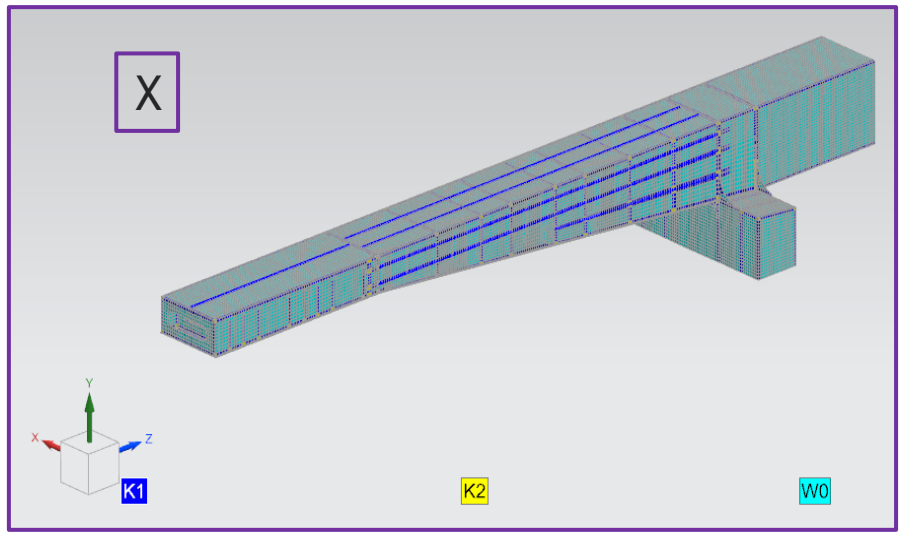


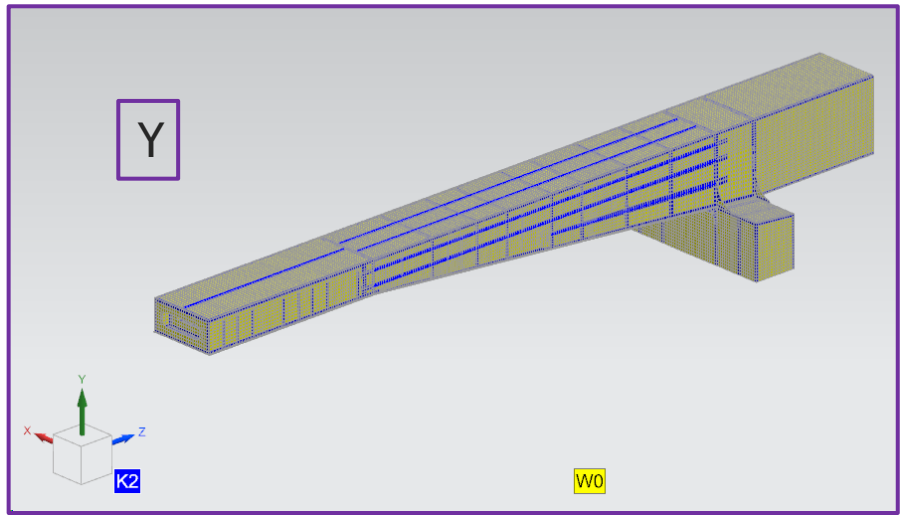
At intersecting Welds all stresses are perpendicular to the weld direction.
The last condition overwrites the previous ones, and settings in condition 2 => K1(X) are replaced with K2(X) for intersections.

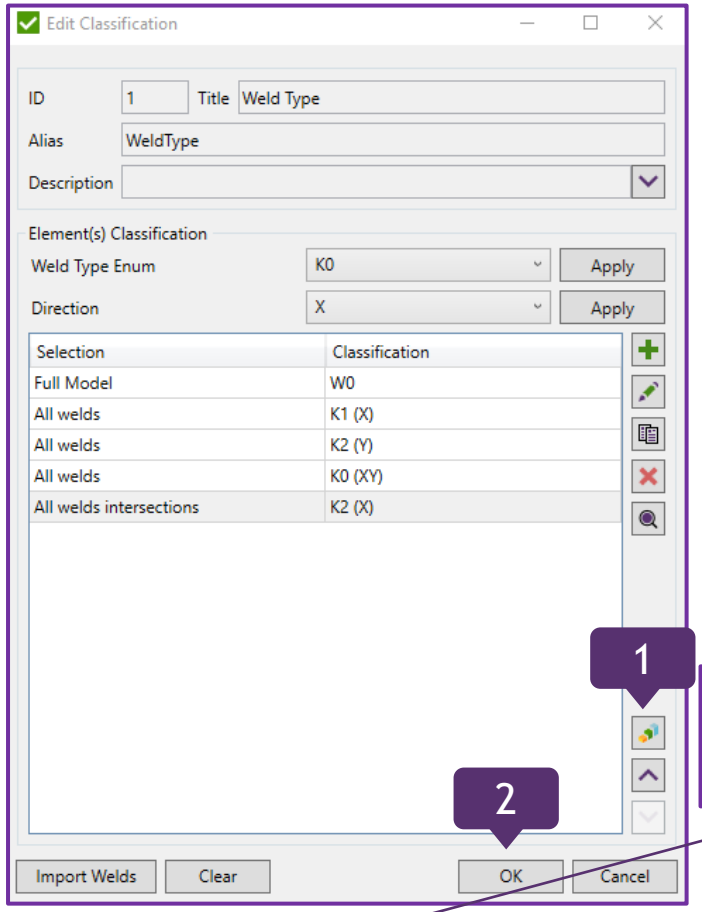
Plot Weld Type Classification

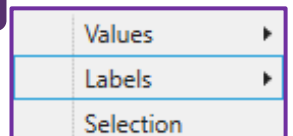
1. Press  => Labels => Direction X, and then Y to make Plots for the full model

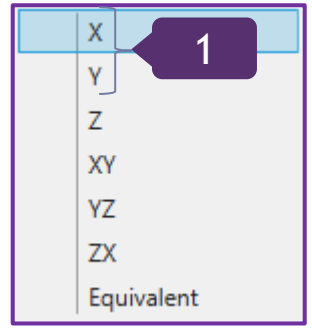
2. Press *OK*











Plots are displayed for the full model by default. In order to limit the displayed part, it is possible to change the Selection.

Element Group

Element Group, also called Loading Group, depends on: Class of Utilization and 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

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

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

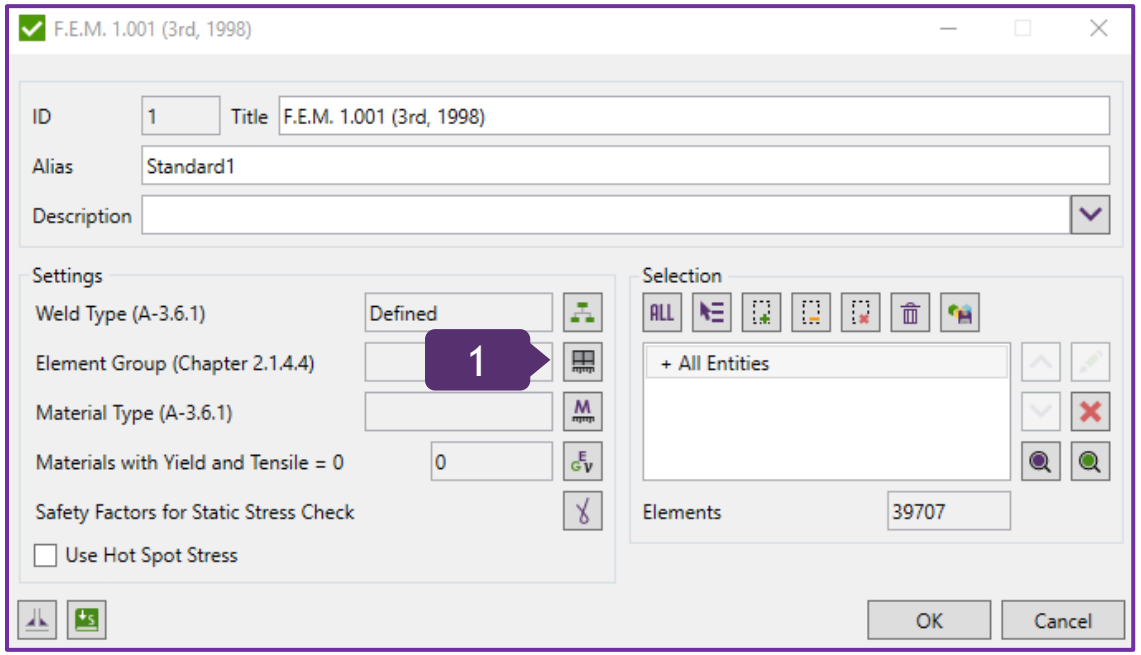
Element Group

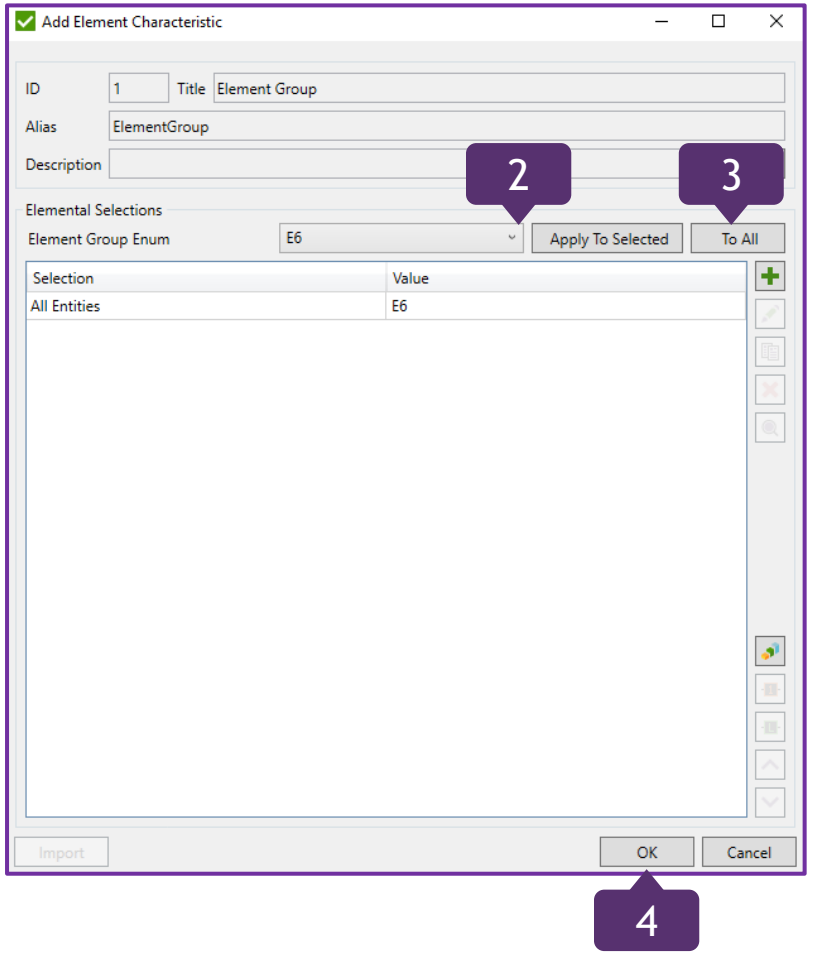
Table T.2.1.4.4. - Component groups

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

Define Element Group

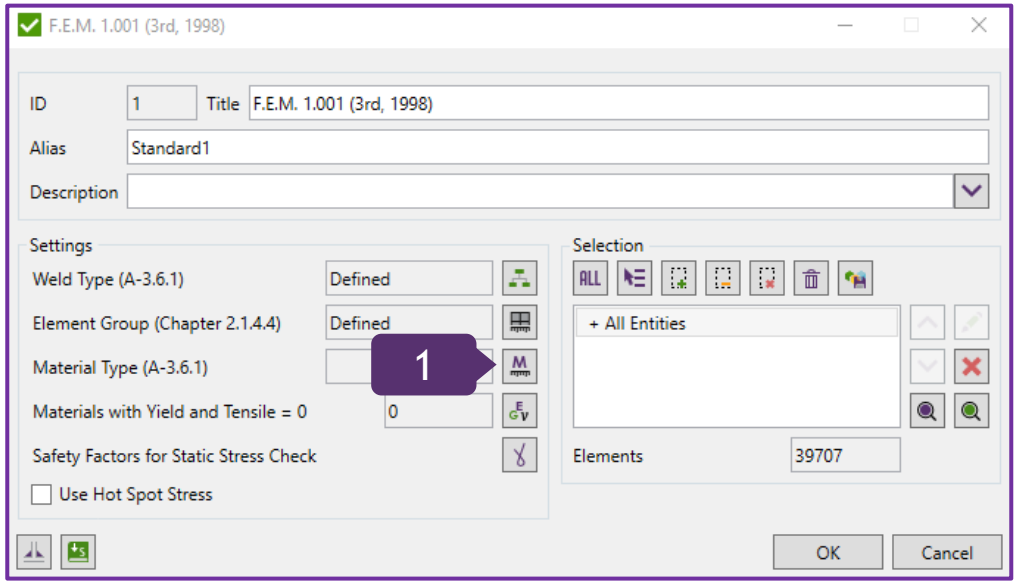
1. In F.E.M. 1.001 (3rd, 1998), press  to define Element Group
2. Select Element Group Enum: E6.
3. Press *To All*
4. Press *OK*

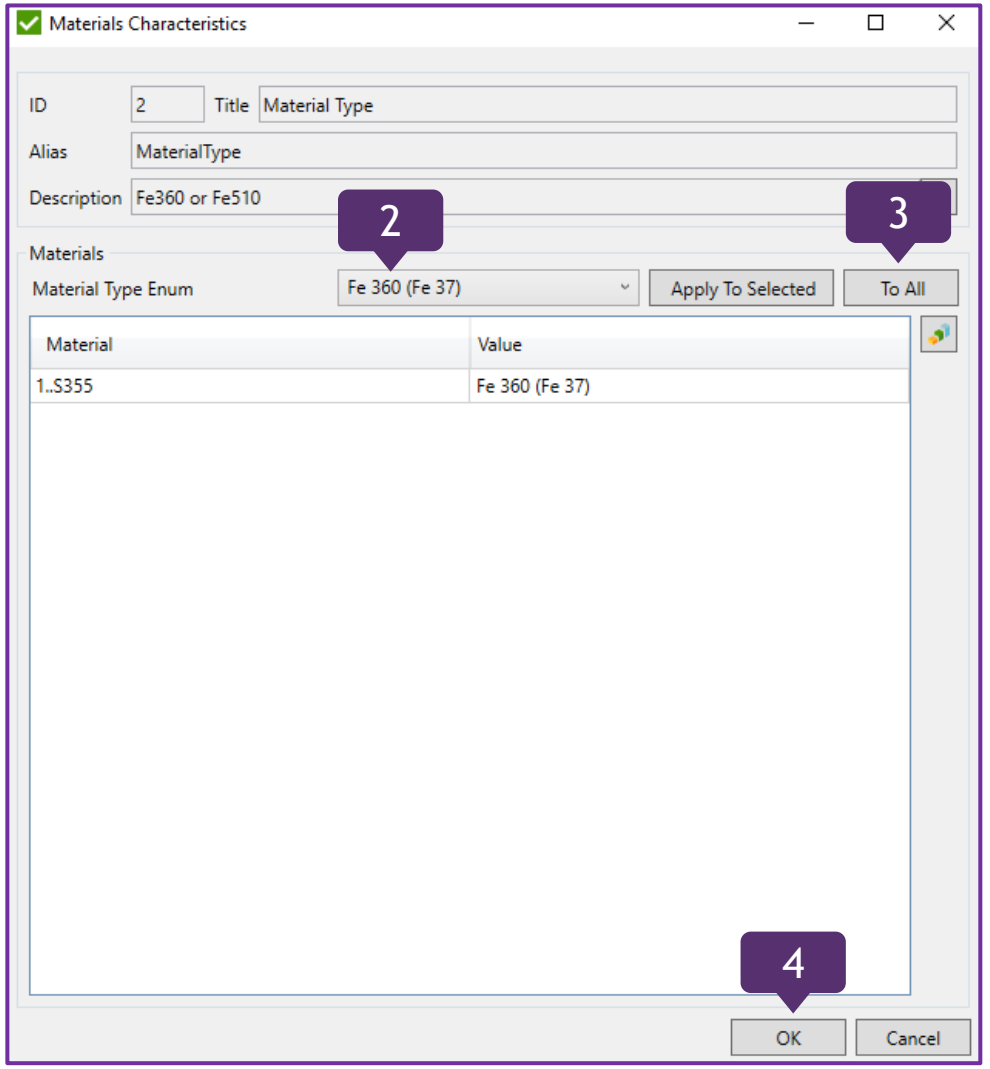




Define Material Type

1. In F.E.M. 1.001 (3rd, 1998), press  to define Material Type
2. In Material Type Enum, select *Fe 360 (Fe 37)*
3. Press To *All*
4. Press *OK*

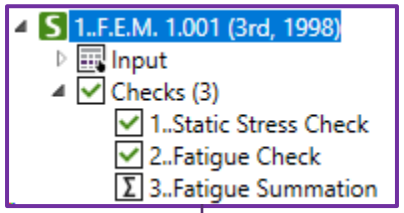




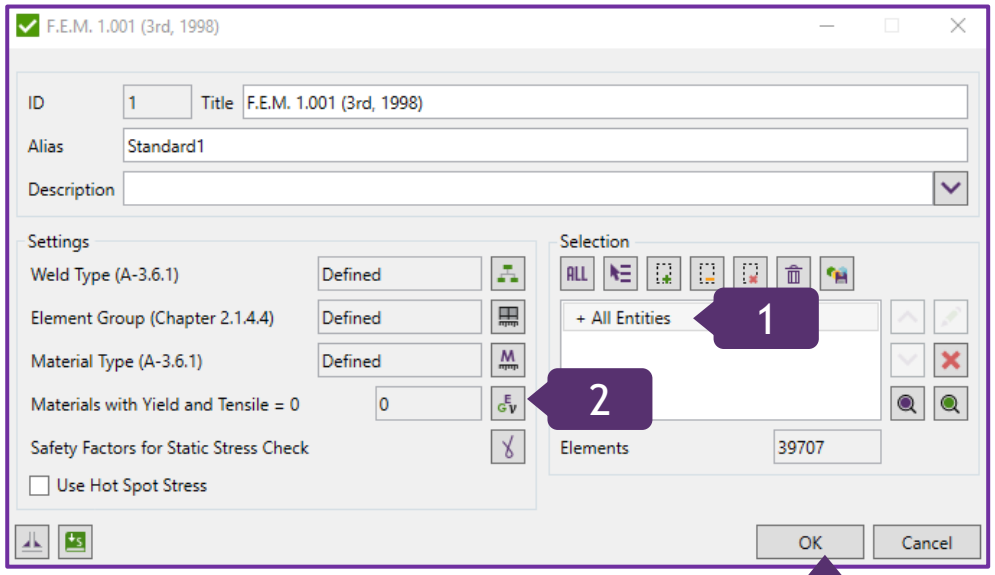
Materials Yield Stress and Tensile Strength

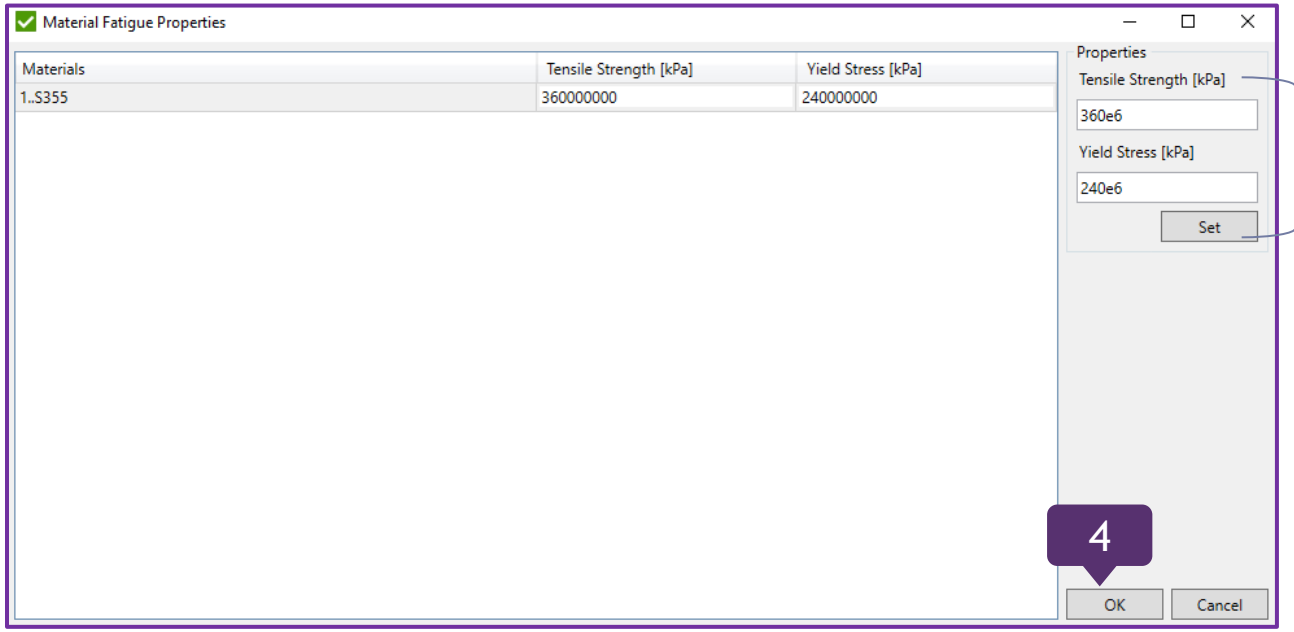
1. Selection: *All Entities*
2. Press  to edit material properties

   The amount of materials with undefined Tensile or Yield is displayed in the field
3. **Tensile Strength: 360e6**
   Yield Stress: 240e6 and Press *Set*
4. Press *OK*
5. Press *OK*



The Standard has ben created.





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) $\kappa \le 0$

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

σ_w is given in table above.

b) $\kappa > o$

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

Utilization Factor Combined

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

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.

Implementation of Formulas in SDC Verifier.

Custom Check (built-in, not editable)

ID: 2 Title: Fatigue Check
Alias: Fatigue_Check
Description:
Show Parameter Description

Options
Calculate Results over Directions
Calculate Results over Points
Load Calculation: Load Group Only
Selection: All Entities

Parameters (4) / Replacements (2)

```
Replacement = Use Hot Spot Stress (Use Hot Spot Stress)
All: if(UseHotSpotStress = yes and Element.IsHotSpotCalculated = yes, yes, no)

Replacement = Stress AbsMax (Absolute Maximum Stress)
Description: Absolute maximum Weld or Hot Spot stress
All: if(Use_Hot_Spot_Stress = yes, S_HotSpotAbs, SWeldAbs)

Parameter = Kappa (Kappa Factor)
Description: Ratio between the extreme stresses. Chapter 3.6.4.
All: if(Stress_AbsMax = 0, 0, if(Use_Hot_Spot_Stress = yes, if(Stress_AbsMax > 0, S_HotSpotMin / S_HotSpotMax, S_HotSpotMax /
S_HotSpotMin), if(Stress_AbsMax > 0, SWeldMin / SWeldMax, SWeldMax / SWeldMin)))

Parameter = Sf (Stress Fatigue)
Description: Permissible stress for fatigue depends on the element group (E1-E8) and weld type
All: Min(units.FromPaToCurrent(Switch(MaterialType, MaterialTypeEnum.Fe360Fe37, Sf_Fe360(ElementGroup, WeldType),
MaterialTypeEnum.Fe510Fe52, Sf_Fe510(ElementGroup, WeldType))), 0.75 * Tensile)

Parameter = Sallow fatigue (Allowable Stress Fatigue)
Description: Appendix 3.6, formulas (1)-(4)
All: if(Kappa > 0, if(Stress_AbsMax > 0, 1, 1.2) * (5 / 3 * Sf) / (1 - (1 - (5 / 3 * Sf) / (0.75 * tensile)) * Kappa), if(
Stress_AbsMax > 0, (5 * Sf) / (3 - 2 * Kappa), (2 * Sf) / (1 - Kappa)))
XY/YZ/ZX: if(Kappa > 0, (5 / 3 * Sf) / (1 - (1 - (5 / 3 * Sf) / (0.75 * tensile)) * Kappa), (5 * Sf) / (3 - 2 * Kappa)) / if(
WeldType <= WeldTypeEnum.K4, SQRT(2), SQRT(3))
Eqv: 0

Parameter = Uf (Utilization Factor)
Description: Appendix 3.6, equivalent rule - (5)
All: Abs(Stress_AbsMax) / Sallow_Fatigue
Eqv: pow(me.x, 2) + pow(me.y, 2) + pow(me.z, 2) + pow(me.xy, 2) + pow(me.yz, 2) + pow(me.zx, 2) - sign(Stress_AbsMax.X) * me.x *
sign(Stress_AbsMax.Y) * me.y - sign(Stress_AbsMax.Y) * me.y * sign(Stress_AbsMax.Z) * me.z - sign(Stress_AbsMax.Z) * me.z * sign(
Stress_AbsMax.X) * me.x
Overall: Max(me.x, me.y, me.z, me.xy, me.yz, me.zx, sqrt(me.eqv))
```

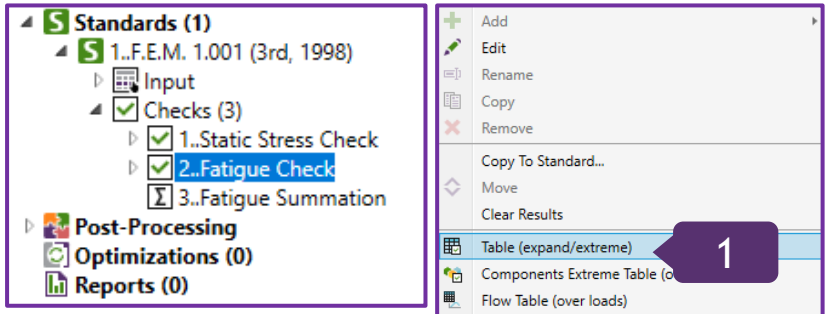
Clear results | OK | Cancel

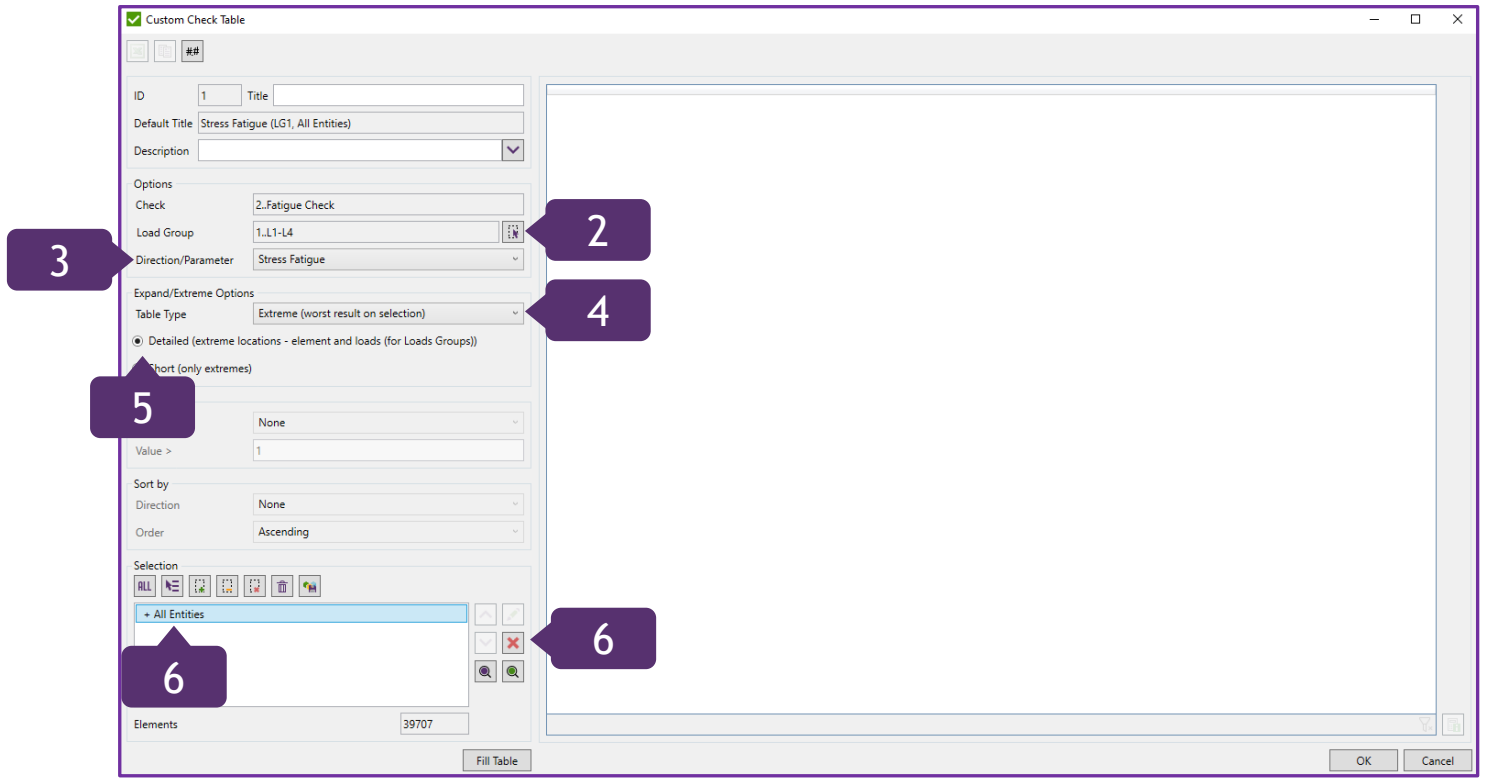
Create Extreme Table

1. Execute *Table (expand/extreme)* in Standards => Fatigue Check context menu
2. Load Group: *1..L1-L4*

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

3. Direction/Parameter: *Stress Fatigue*
4. Table Type: *Extreme (worst result on selection)*
5. *Detailed (extreme locations-element and load (for Loads Groups)) - ON*
6. Select *+All Entities* and press ✕ to remove them



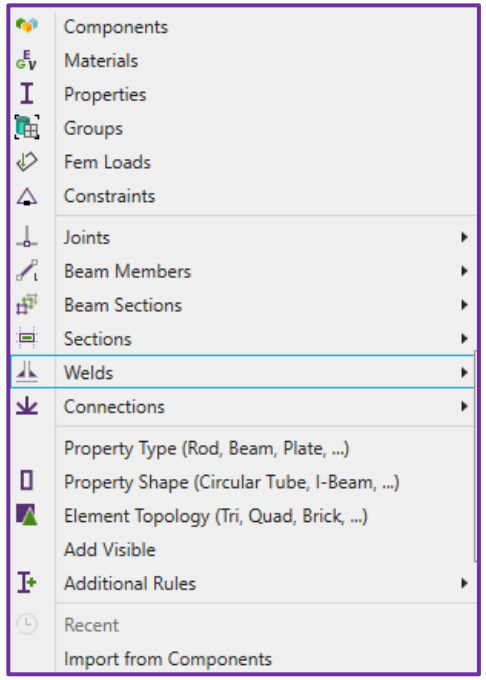


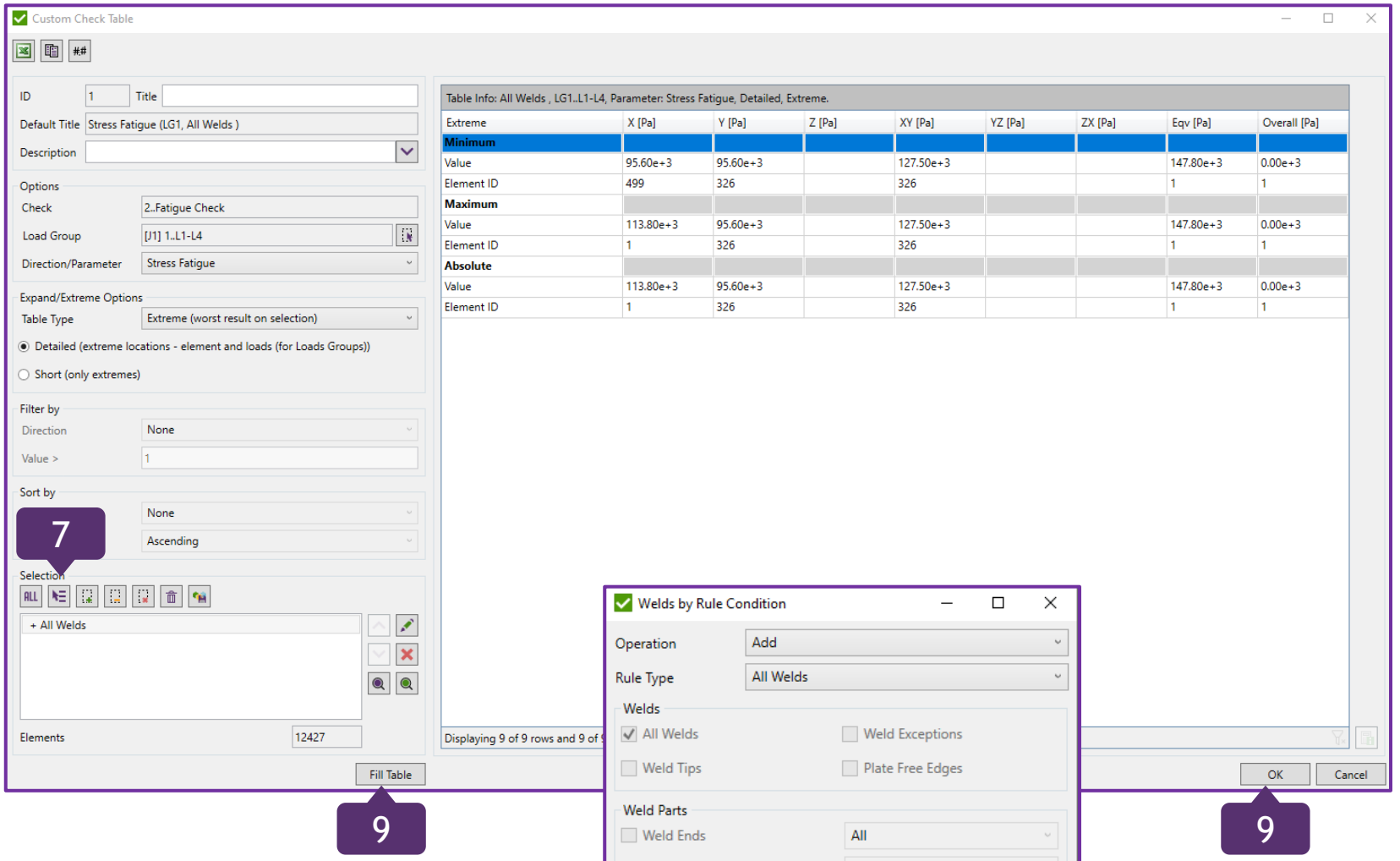
Create Extreme Table (Continuation)

7. In Custom Check Table in *Selection* => press 

8. Select *Welds* => *By Rule* and press *OK*

9. In Selection, press *Fill Table*; Press *OK*





Stress Fatigue

Stress Fatigue is used in fatigue Allowable Stress calculations.

$\kappa \leq 0$

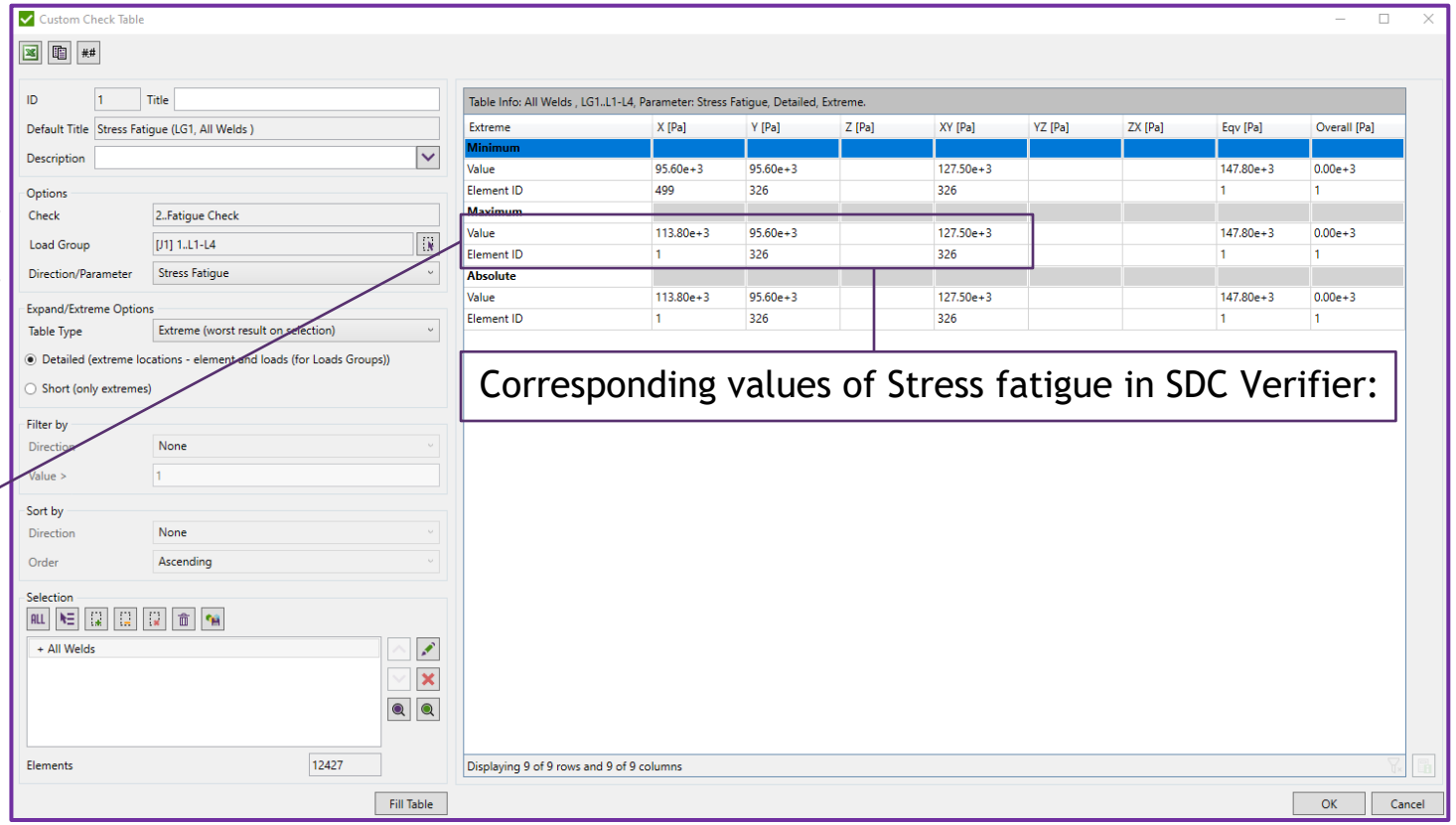
- for tension : $\sigma_t = 5 \cdot \sigma_w / (3 - 2 \cdot \kappa)$ (1)

- for compression : $\sigma_c = 2 \cdot \sigma_w / (1 - \kappa)$ (2)

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

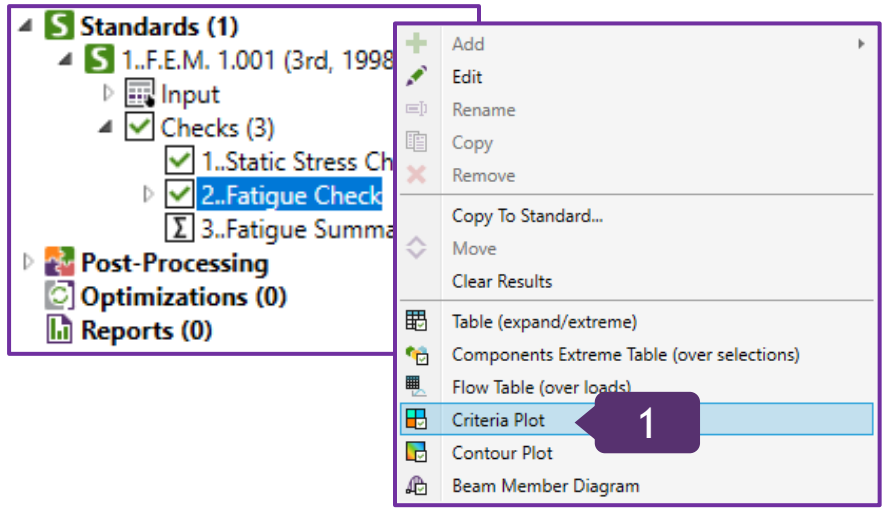
Component group	Unwelded components Construction cases						Welded components Construction cases (Steels St 37 to St 52, Fe 360 to Fe 510)				
	W_0		W_1		W_2						
	Fe 360 St 37 St 44	St 52 Fe 510	Fe 360 St 37 St 44	St 52 Fe 510	Fe 360 St 37 St 44	St 52 Fe 510	K_0	K_1	K_2	K_3	K_4
E1	249,1	298,0	211,7	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

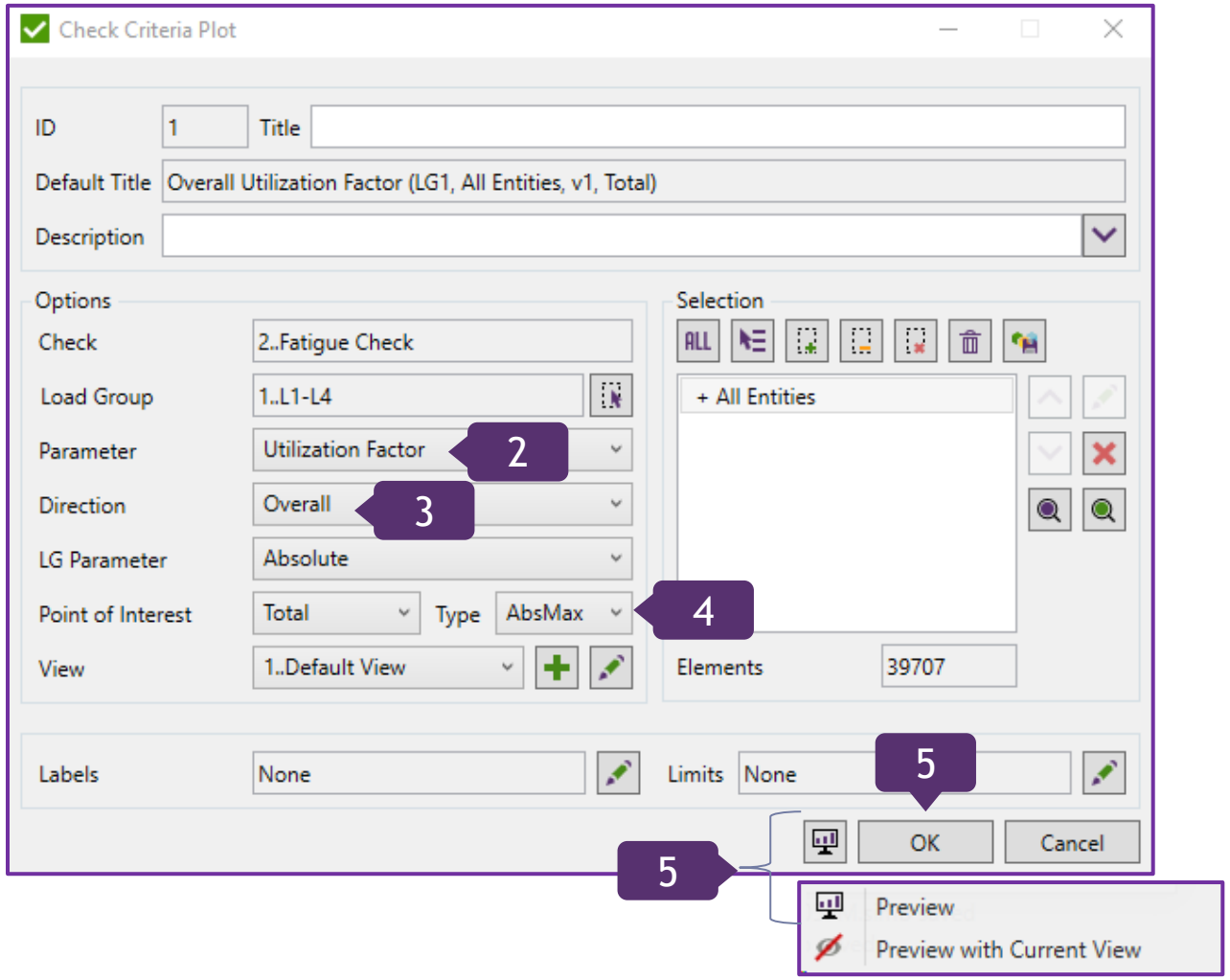
Stress Fatigue depends on:
- Weld Type (W0-W2, K0-K4);
- Element Group / Loading Group (B1-B6);
- Material Type (St360/St37, St510/St52).



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 and then *Preview*; Press *OK*



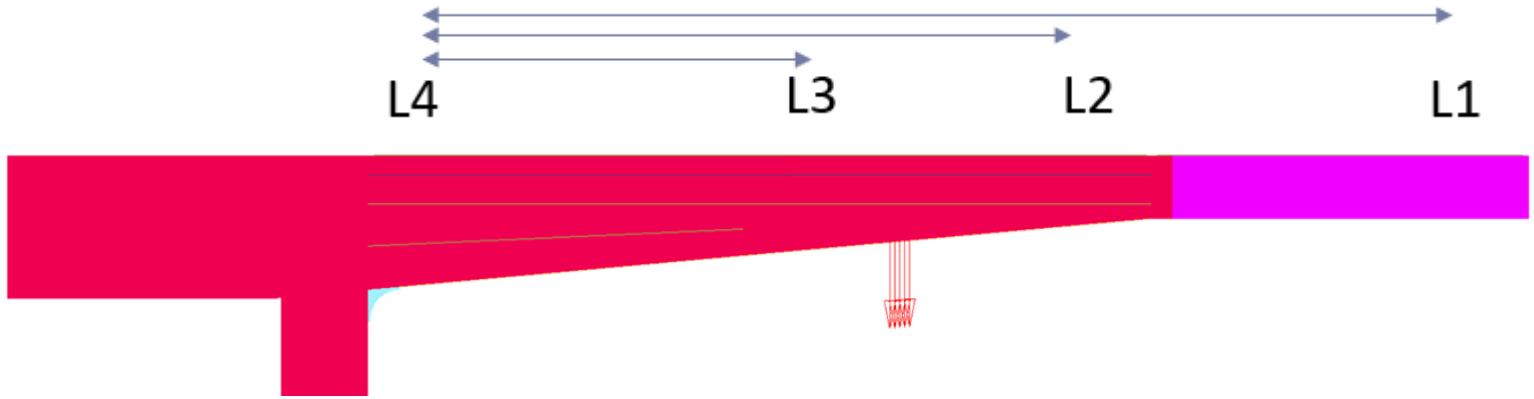


Point of interest = AbsMax Total is an absolute maximum of Utilization Factors among all point of interest.

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:

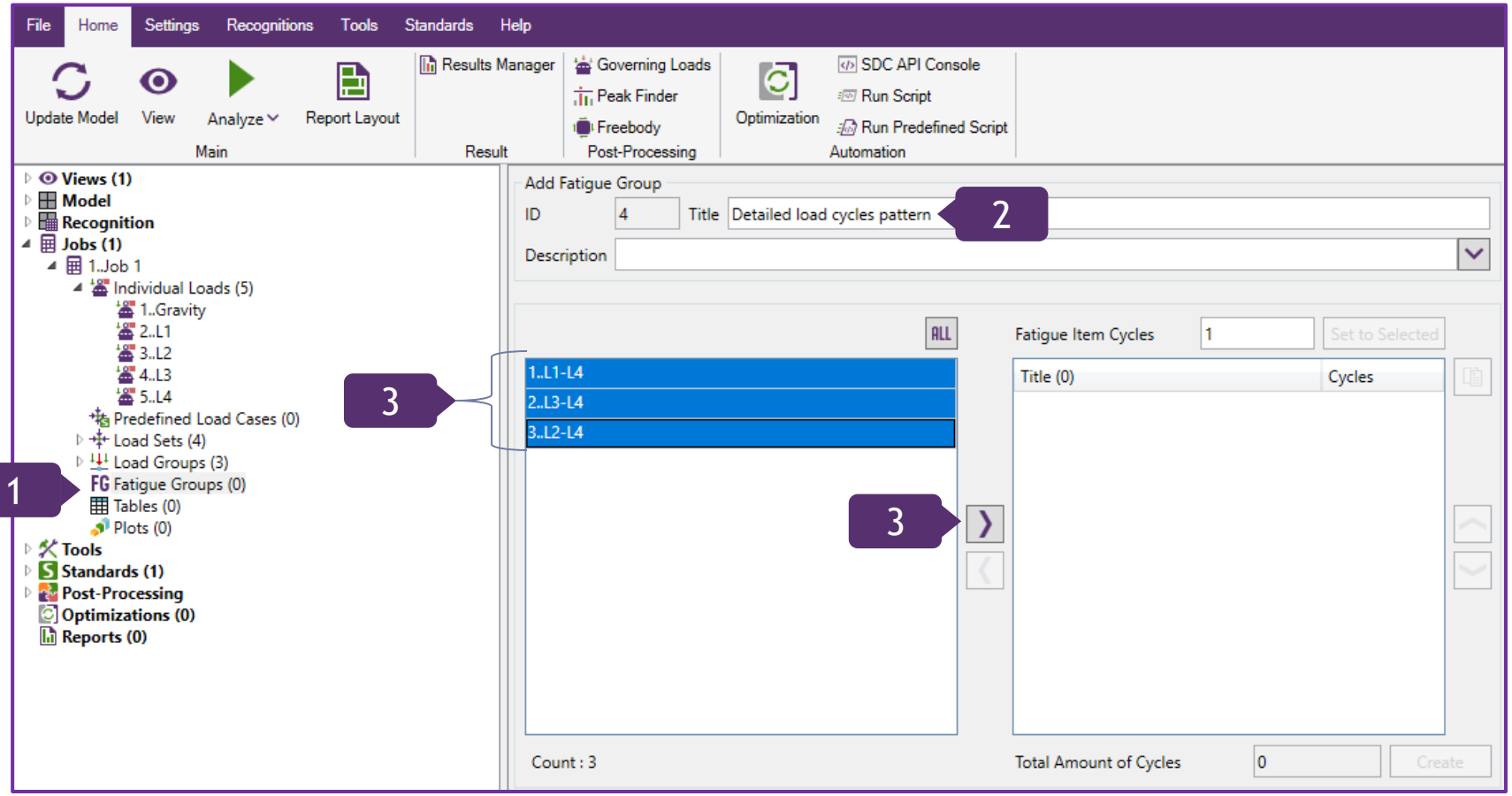
Load cycle	Number of cycles	Content
L4-L1	0,5 e6	LS4, LS3, LS2, LS1, IL1
L4-L2	1,0 e6	LS4, LS3, LS2, IL1
L4-L3	0,5 e6	LS4, LS3, IL1



NB. Gravity load is also included, because the stress variation determines the fatigue damage.

Add Fatigue Group (Stress History)

1. In the *Model tree* in Jobs, select *Fatigue Groups* FG
2. Title: *Detailed load cycles pattern*
3. Select Load Groups 1-3 and press ❯



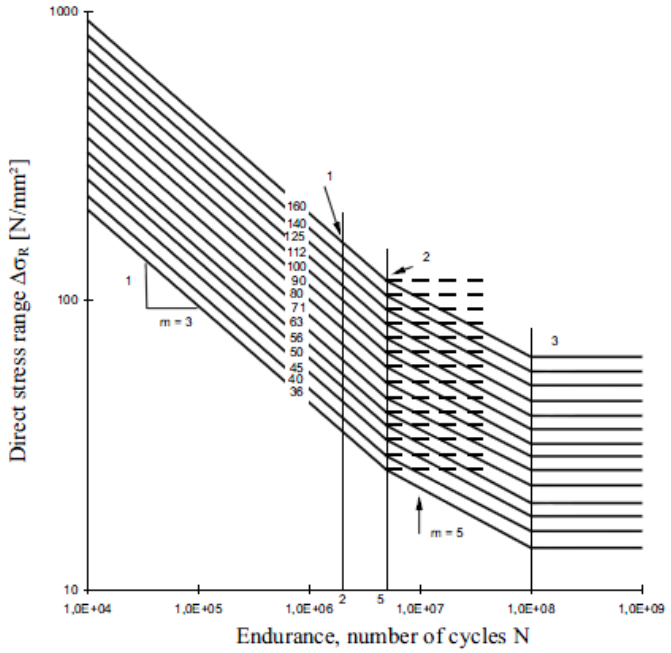
Add Fatigue Group (Stress History) (Continuation)

4 **Select 1..L1-L4 and 3..L3-L4**

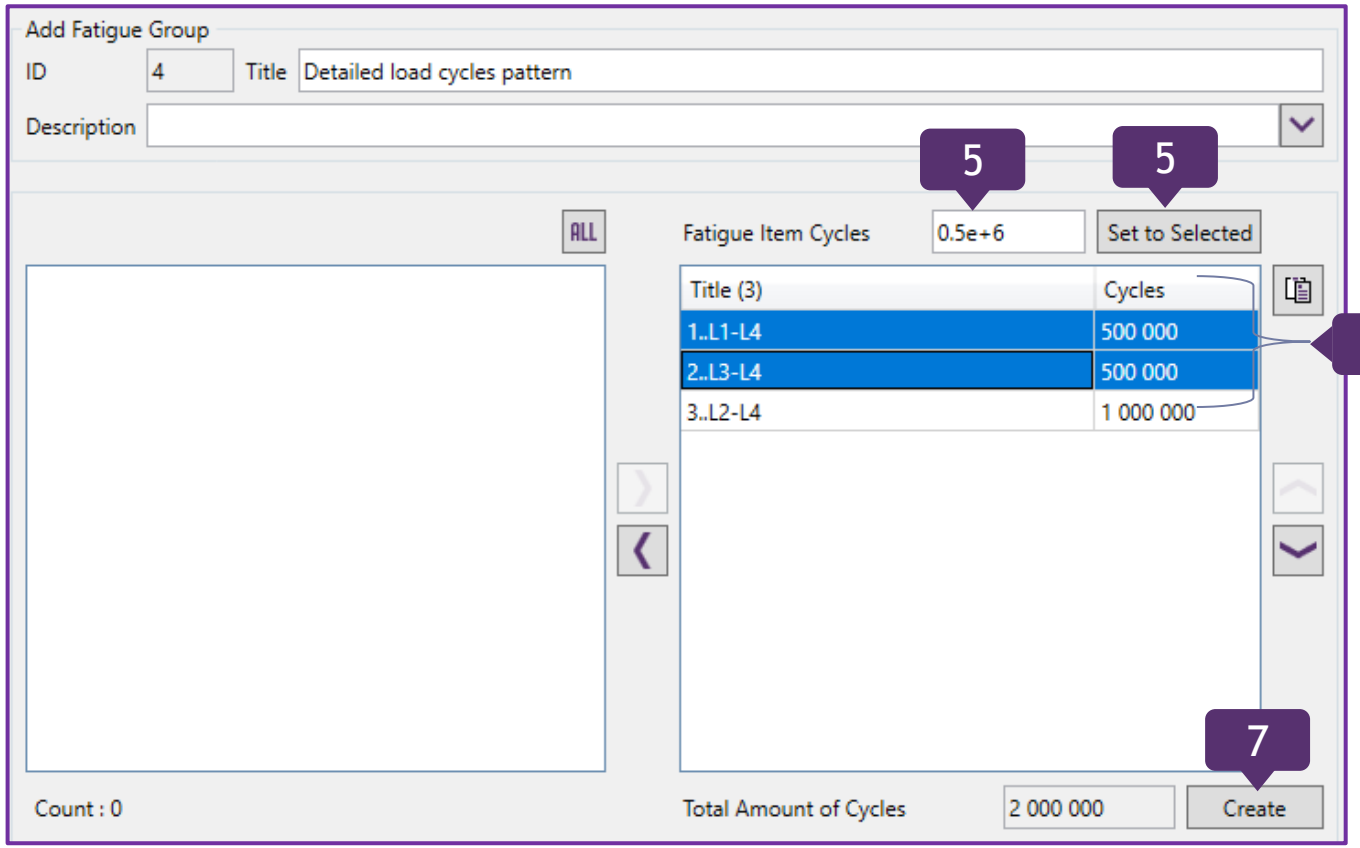
5 **Fatigue Item Cycles: 0.5e+6 and press *Set to Selected***

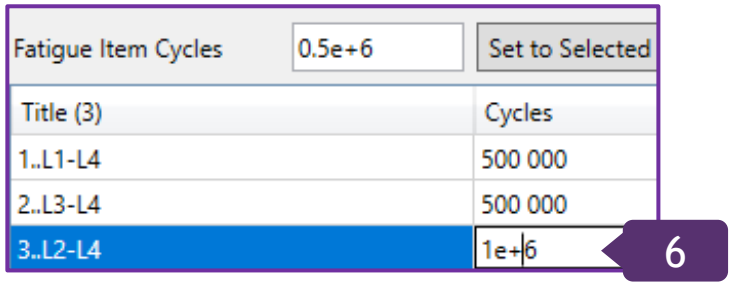
6 **Select 2..L2-L4 and double-click on Cycles cell; Set value 1e+6 and press Enter button**

7 **Press *Create***



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





Total Amount of Cycles is calculated automatically.

FAT Classes Eurocode3

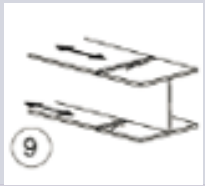
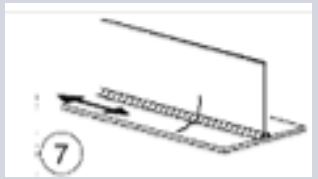
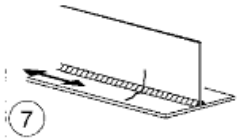
	Perpendicular to weld		Parallel with weld		Shear	
Weld	**80**		**100**		**80**	
No weld	**160**				**100**	

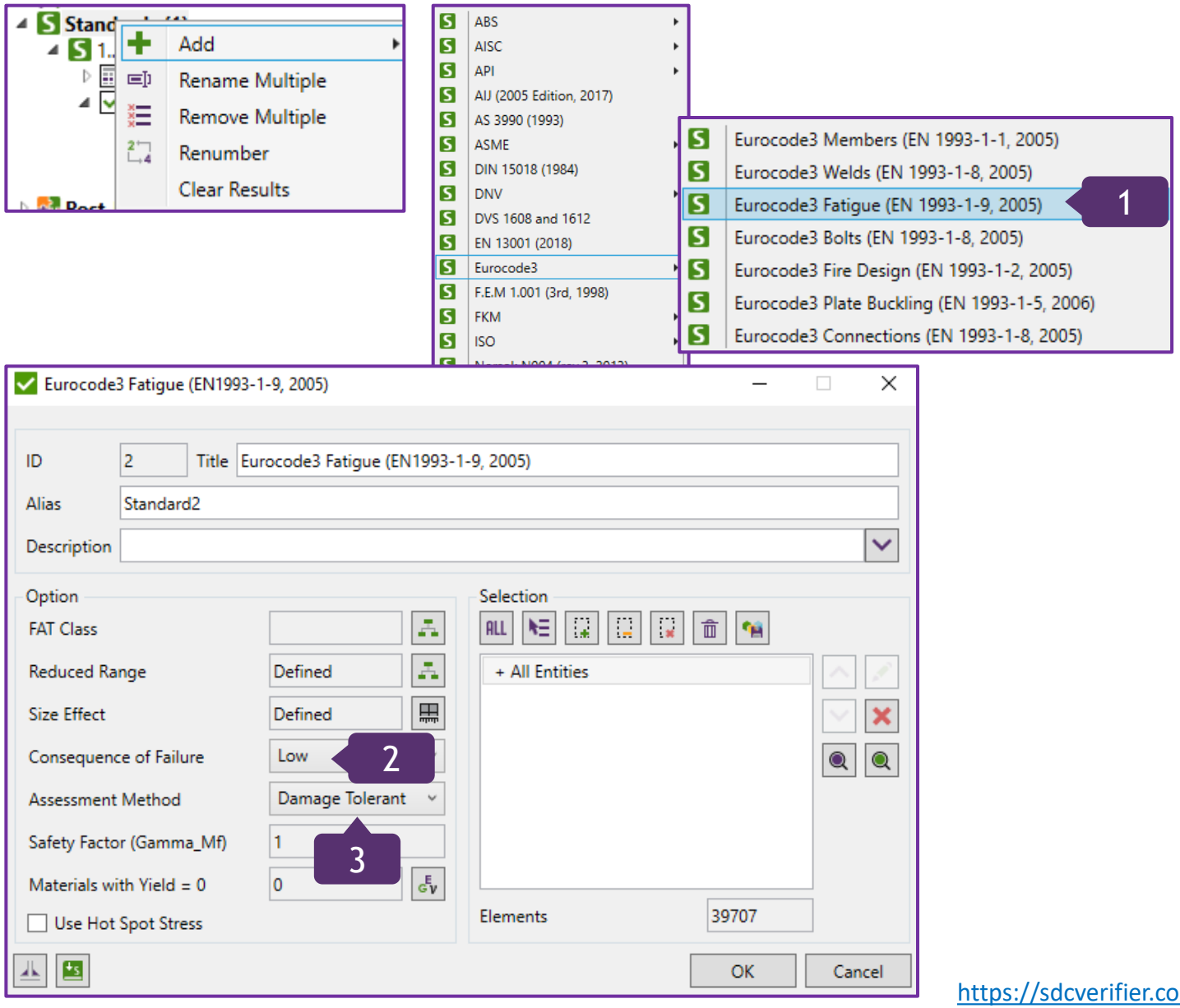
Table 8.1: Plain members and mechanically fastened joints

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.

Fatigue Calculation with Eurocode 3

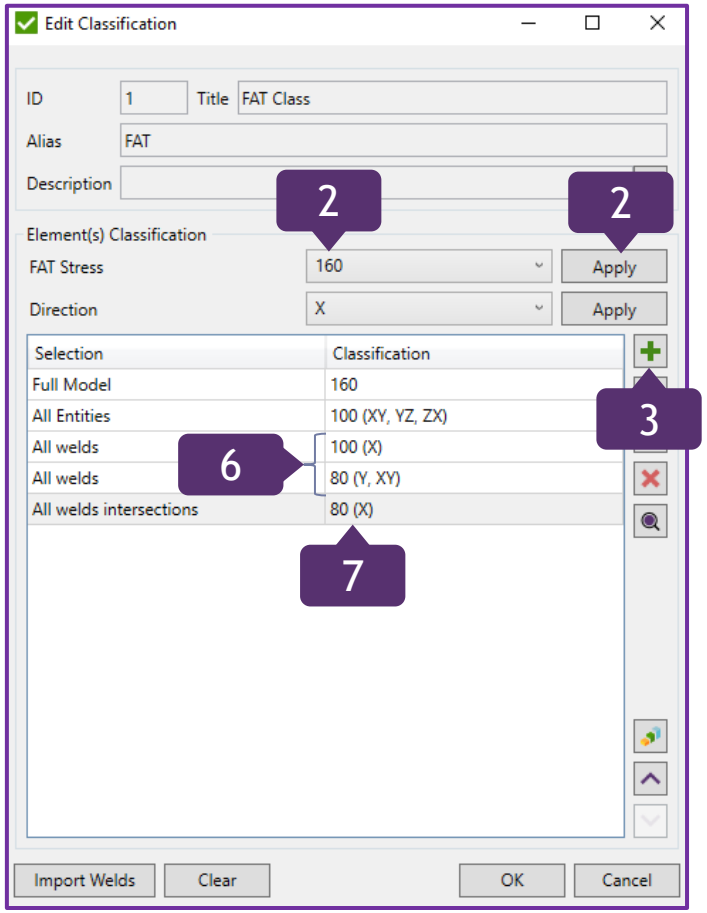
1. In Standards, execute *Add => Eurocode3 => Eurocode3 Fatigue (EN 1993-1-9, 2005)*
2. Consequence of Failure: *Low*
3. Assessment Method: *Damage Tolerant*

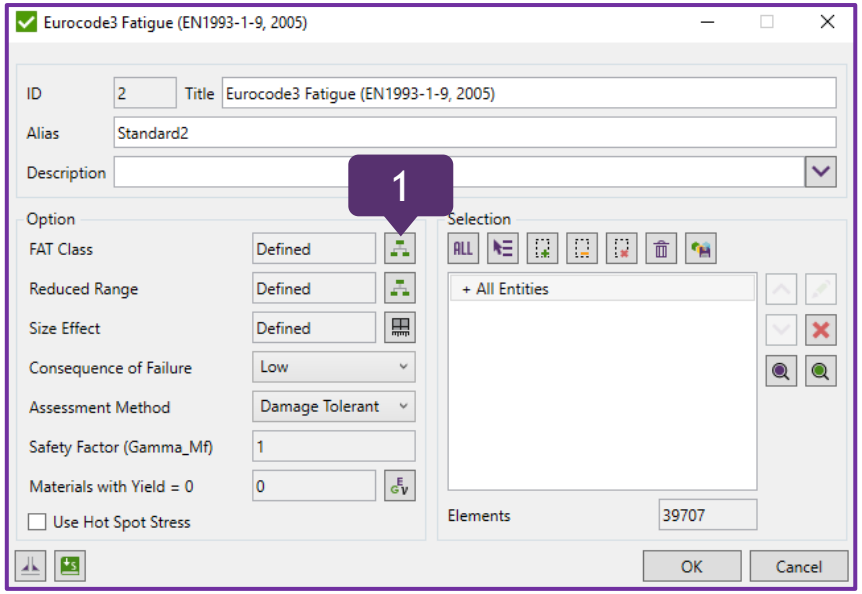


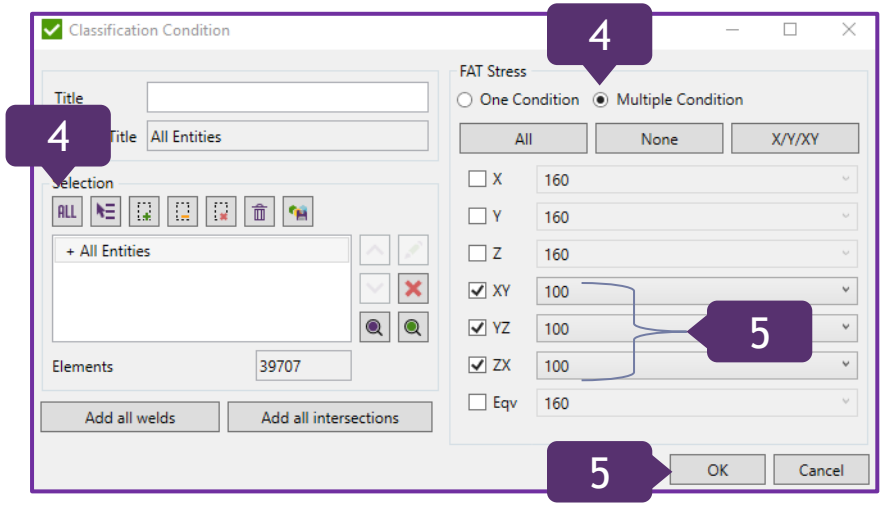
Safety Factor	Low consequence	High consequence
Damage tolerant	1.0	1.15
Safe life	1.15	1.35

Eurocode3 FAT Class

1. Press  to define FAT Class
2. Full Model: 160;
   Press *Apply*
3. Press  to add condition
4. Press  to add *All Entities*;
   Activate *Multiple Condition*
5. XY/YZ/ZX: *100 (No weld)*;
   Press *OK*
6. For all welds: *X: 100; Y/XY: 80*
7. For welds intersections: *X: 80*





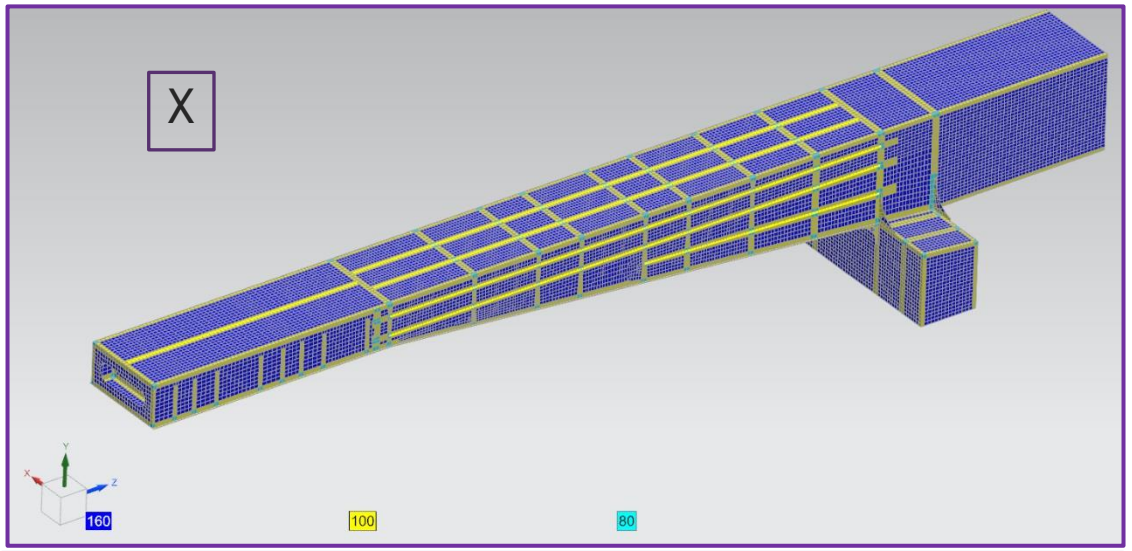


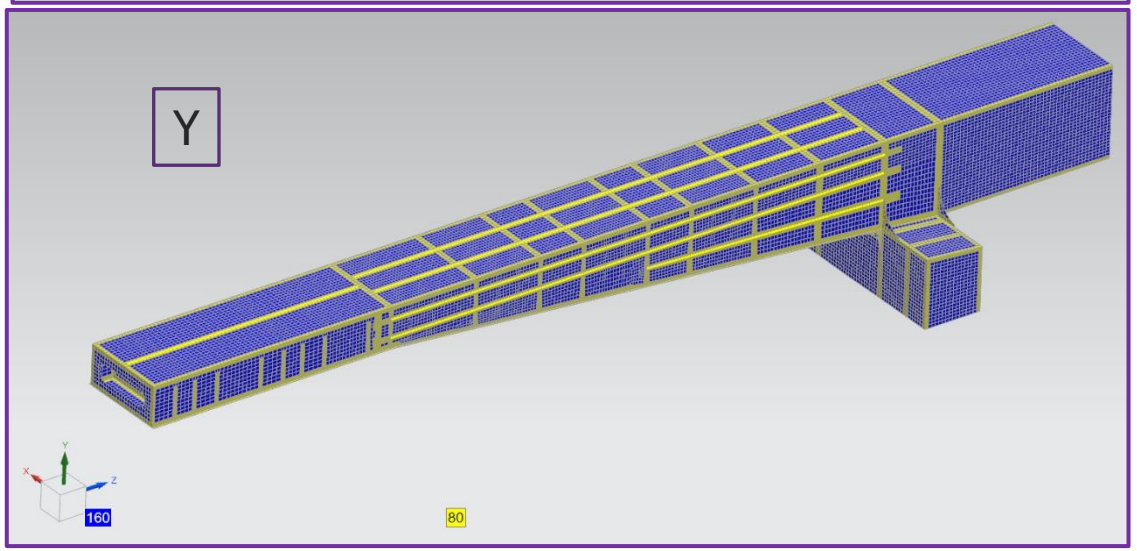
The detailed description of steps can be found on slides 15 and 16.

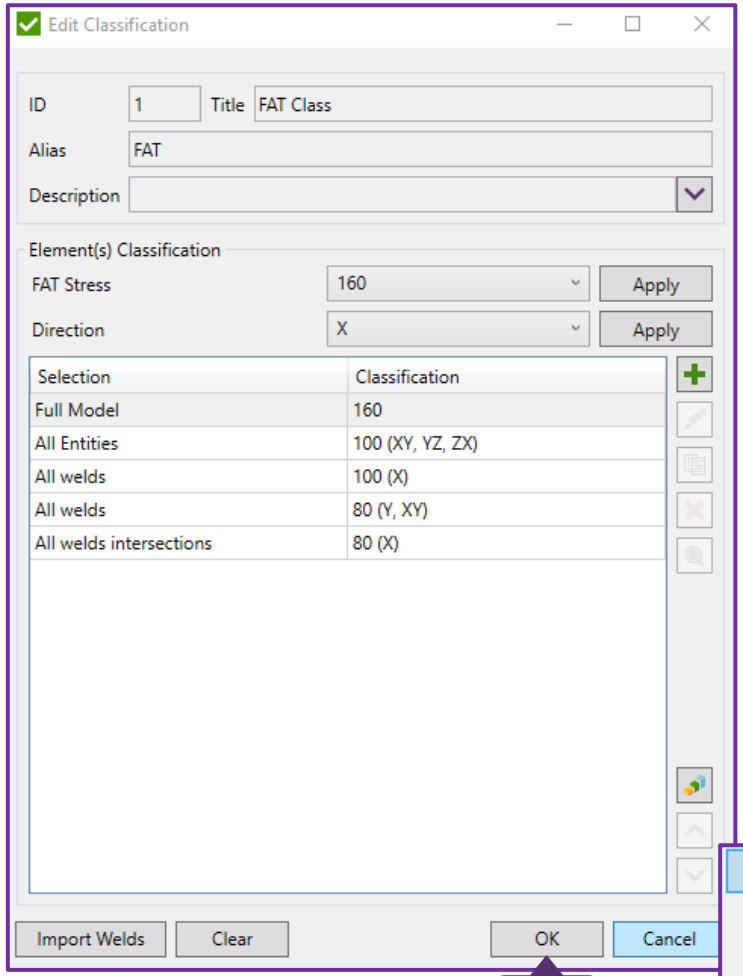
FAT Classes Plot

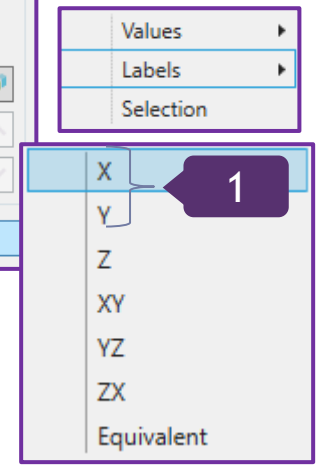
1. Press  => Labels => Direction X, and then Y to make Plots

2. Press *OK*





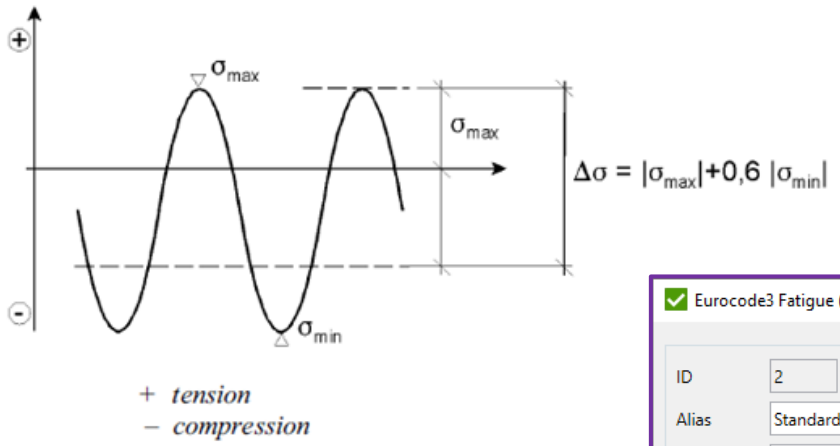




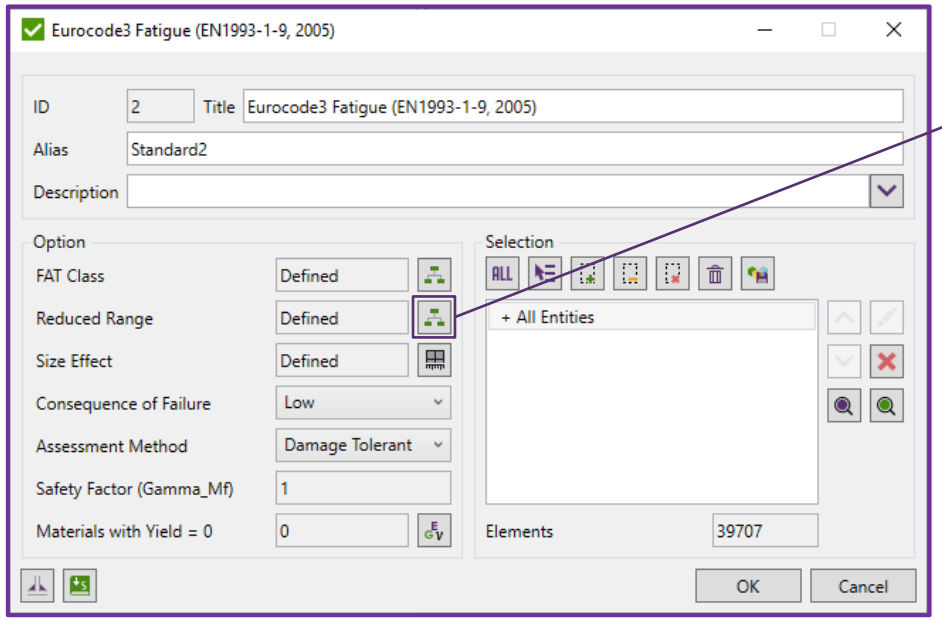
Reduced Range

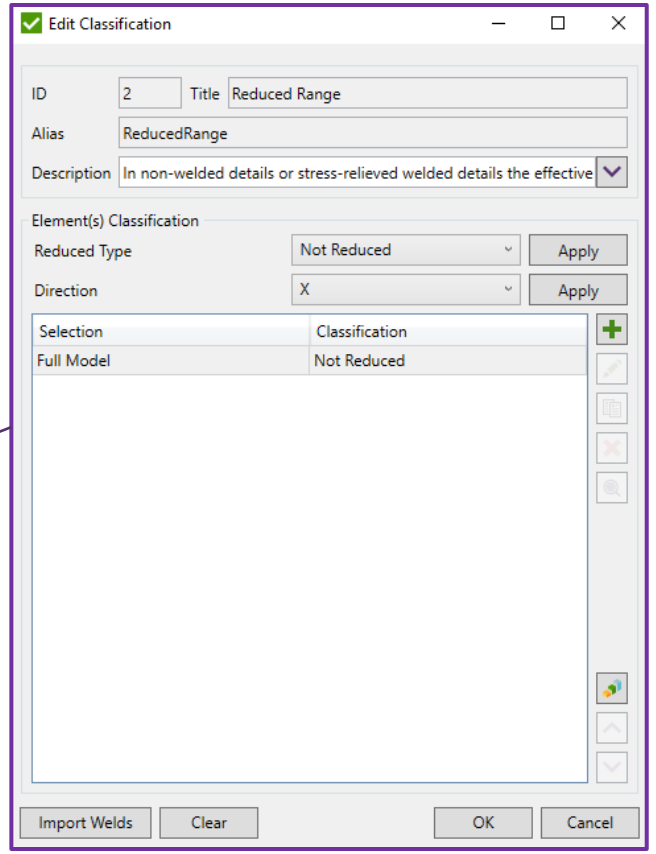
In non-welded details or stress-relieved welded details the effective stress range may be calculated by adding the tensile portion of the stress range and 60% of the magnitude of the compressive portion of the stress range:

EN 1993-1-9 : 2005 (E)



By default, delta stress is set to Not Reduced. Press  to specify the selection which should use reduced stress range:





Size Effect

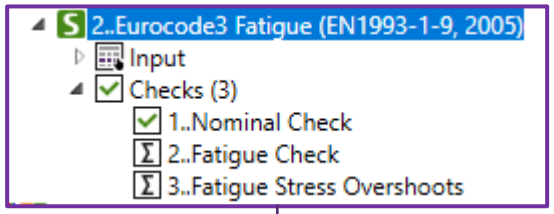
For some details from tables 8.1 to 8.10, depending on the wall thickness, a *Size Effect* (k_s) should be applied. By default size effect is not applied. Press  to specify the selection which should use size effect:

7.2.2 Size effect

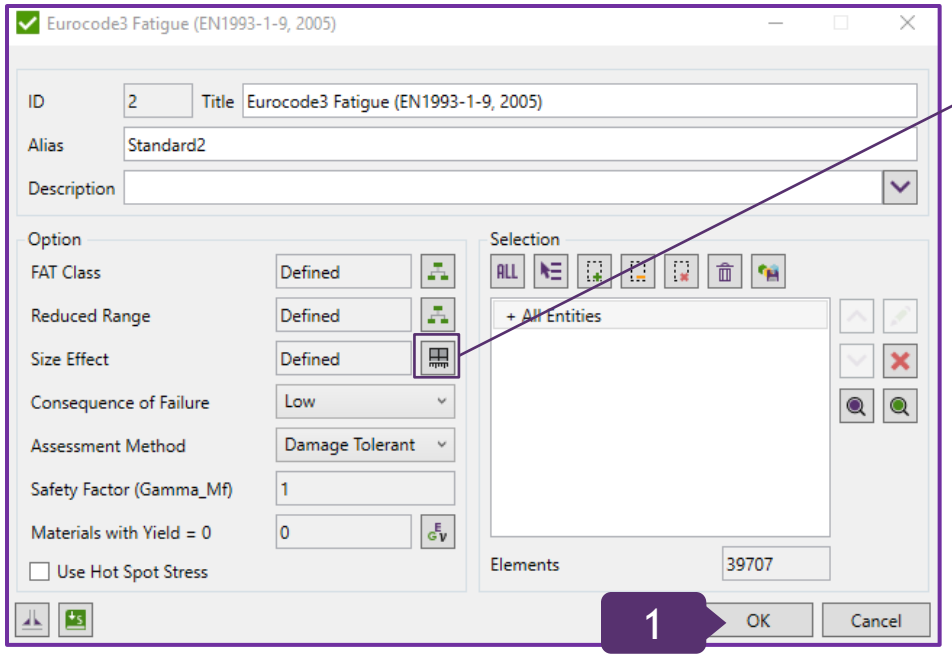
(1) The size effect due to thickness or other dimensional effects should be taken into account as given in Table 8.1 to Table 8.10. The fatigue strength then is given by:

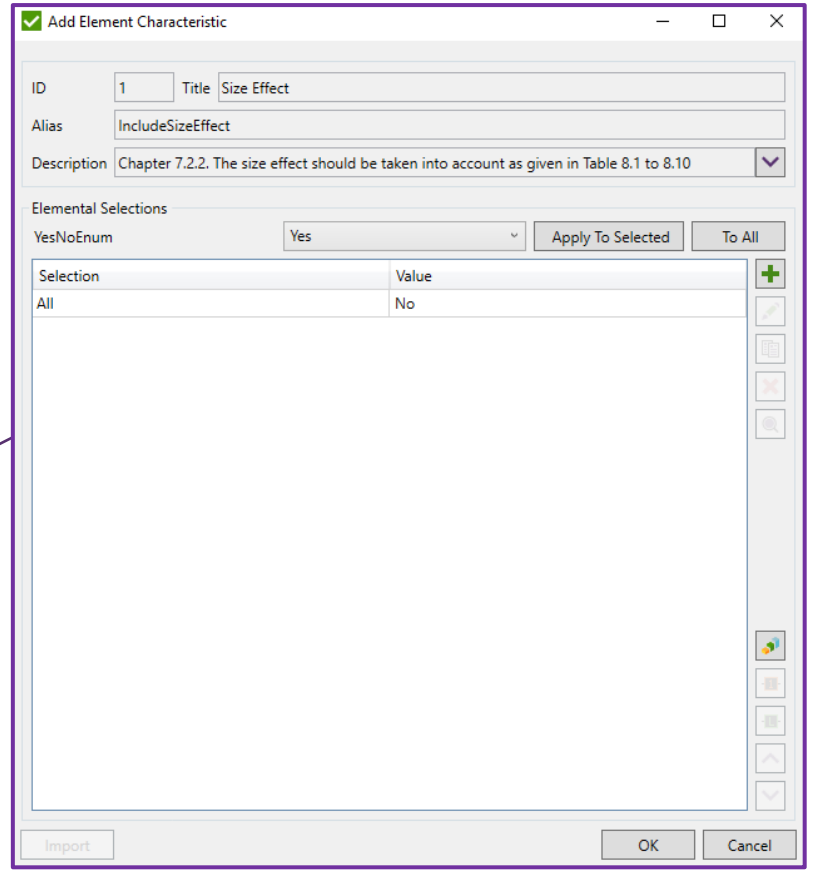
$$\Delta\sigma_{C,red} = k_s \Delta\sigma_C \qquad (7.1)$$

1 **Press *OK***



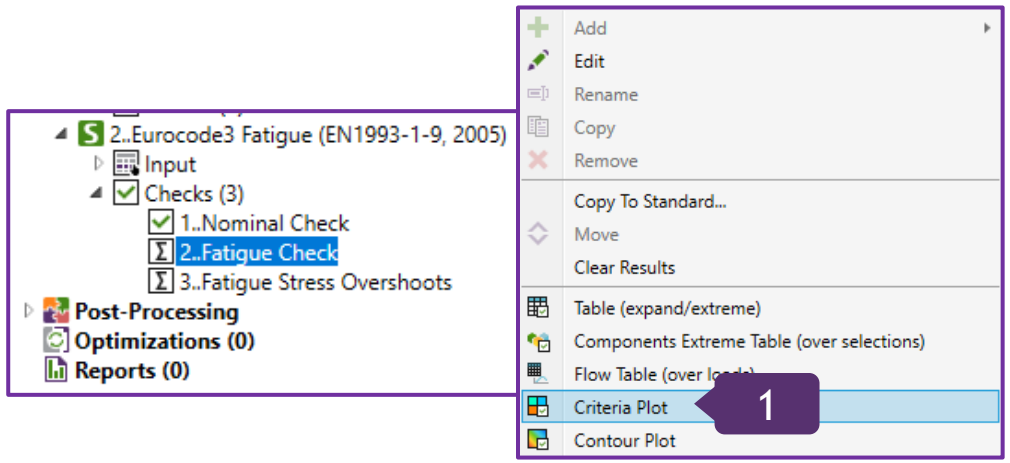
The Standard has been created.

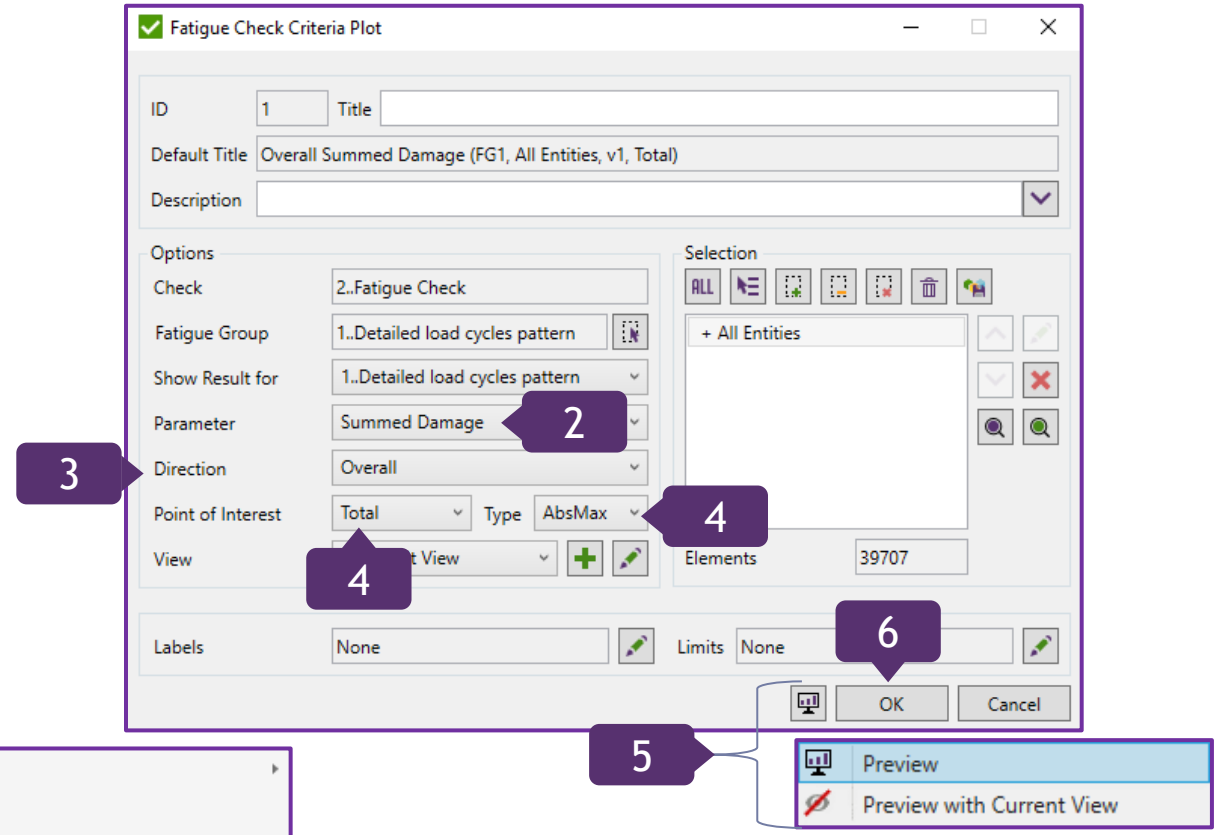




Fatigue Damage Plot

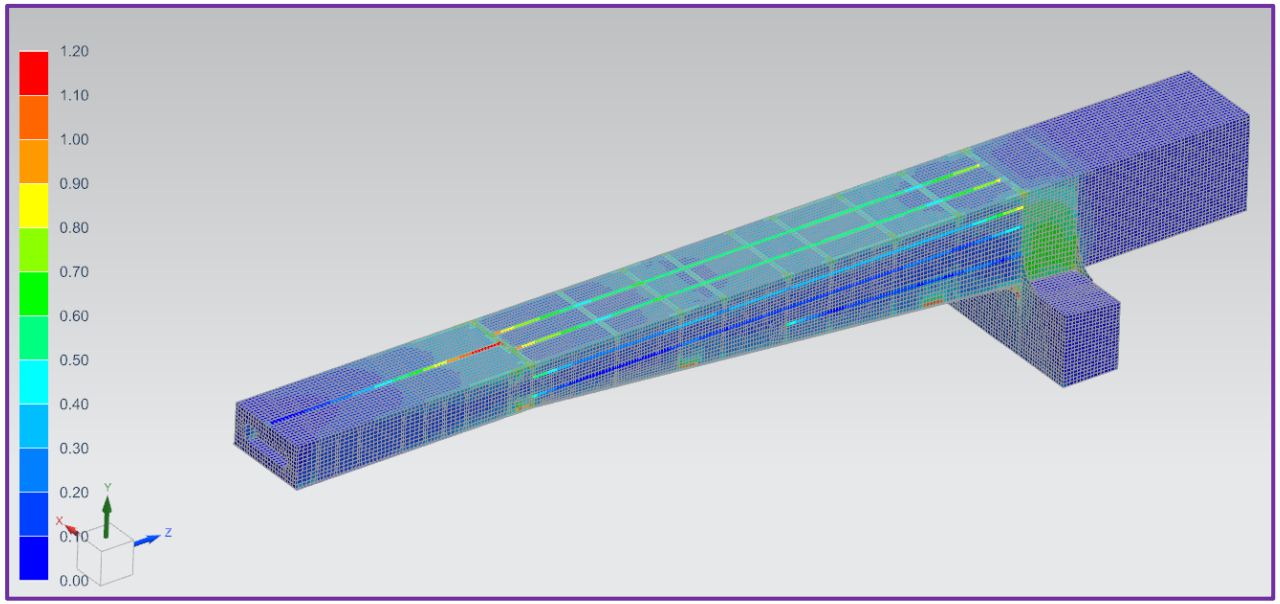
1. Execute *Criteria Plot* in 2..Fatigue Check context menu
2. Parameter: *Summed Damage*
3. Direction: *Overall*
4. Point of interest: *Total*; Type: *AbsMax*
5. Press and then *Preview*
6. Press *OK*



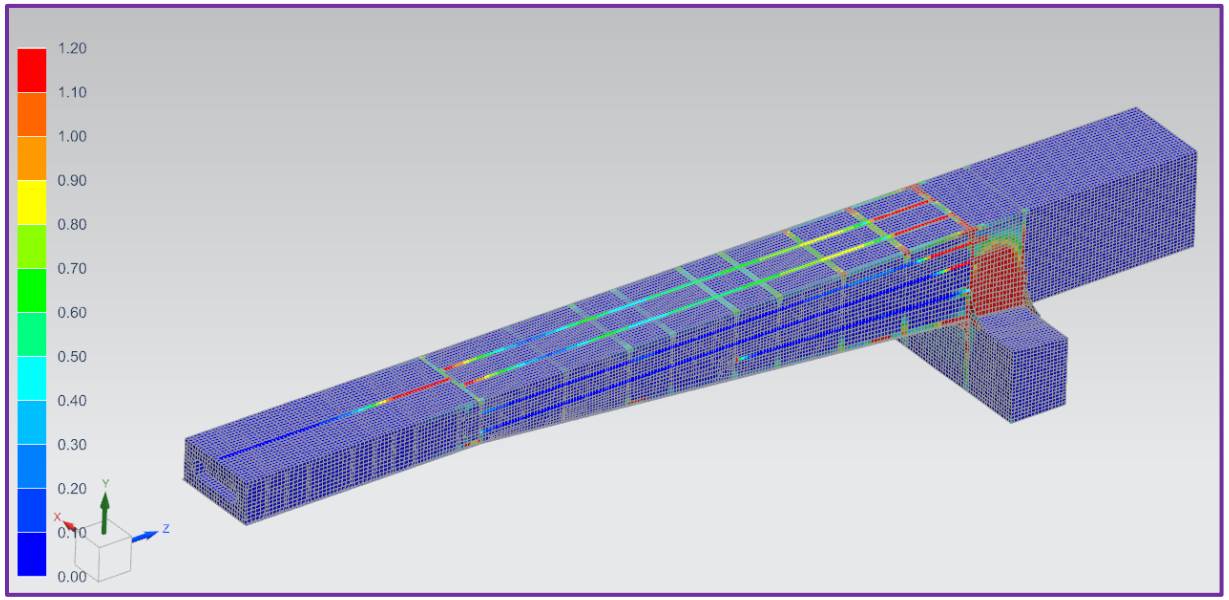


Comparison of Criteria Plots

F.E.M. 1.001 Utilization Factor



Eurocode 3 Utilization Factor at 2 million cycles



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 uploaded via this link:

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