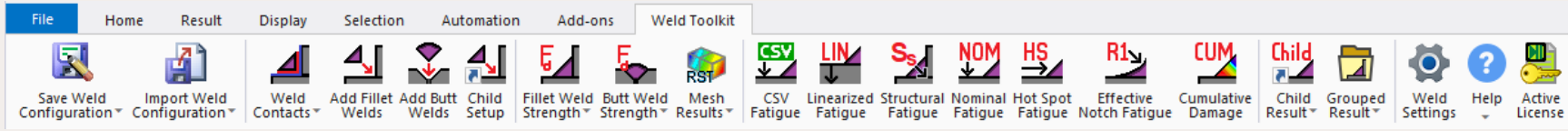
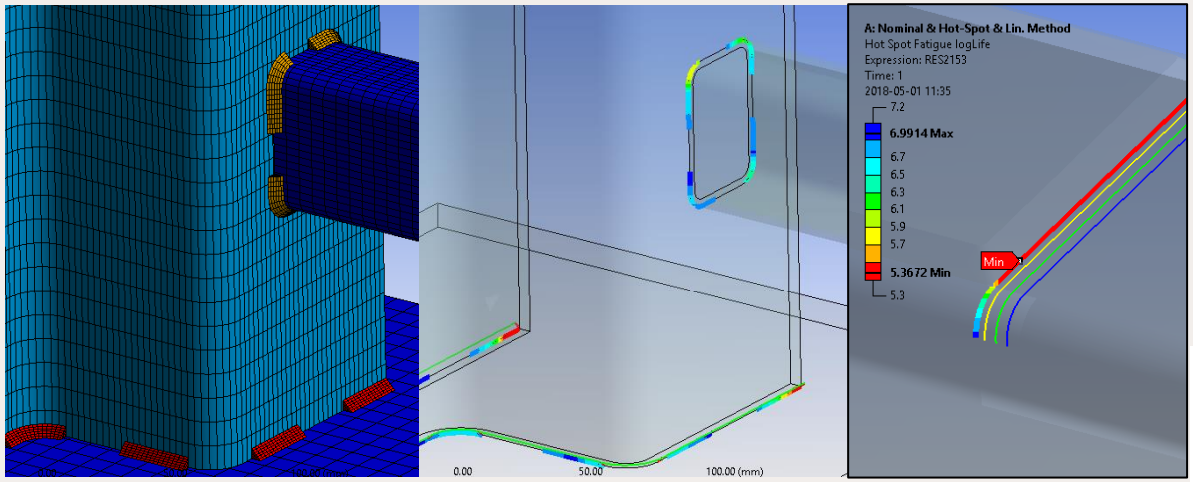
EDRMedeso Weld Toolkit

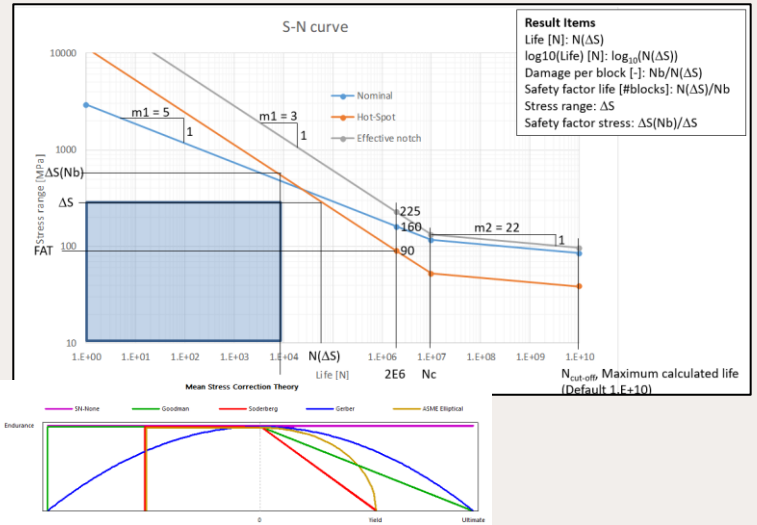
Ansys Mechanical 2024 R1

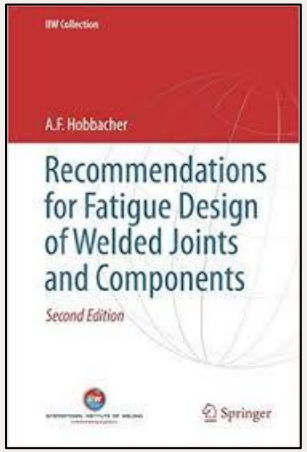
Weld Toolkit



- Main Features:
  - Automation and parametric solid weld creation without CAD in Mechanical.
  - Evaluate strength according to Eurocode 3, AWS D1.1/AISC 360-16 or user defined codes.
  - Evaluate fatigue according to Linearized Stress, Structural Stress, Nominal, Hot-Spot and Notch method.
  - Fatigue S-N curves from IIW, Eurocode 3, Eurocode 9, DNV or user defined S-N curves.
- Business Value:
  - Ansys unique automatic weld creation replaces manual CAD work, meshing & contact setup.
  - Ease of use in pre/post processing. Evaluation of hundreds of welds in minutes instead of days.
  - Visualize the strength utilization, calculated weld thickness or fatigue life direct on the model.
  - Automatic weld report for each selected analysis.







Save and Import Weld Configuration

- Welds and result objects can be reused between models and projects to speed up preparation and post processing. By using “Named Selections” the scooping is applied automatic.

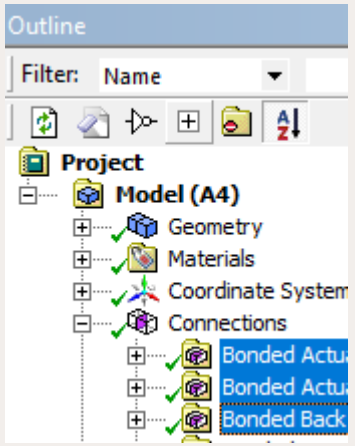
- Save Weld Configuration writes a text file in the current solution folder.
  All or selected fillet/butt weld and result objects form the current analysis are exported.
  The file can be used as a template for creating user defined weld configurations.

- Import Weld Configuration reads a weld configuration file and creates all weld objects in the file unless an object with the same name already exists.

- The Save/Import option can be used to copy the weld setup from a Structural analysis to a Thermal analysis or from one analysis to another.
  It can also be used if the weld configuration is defined outside of Mechanical or by another automation app/Wizard.

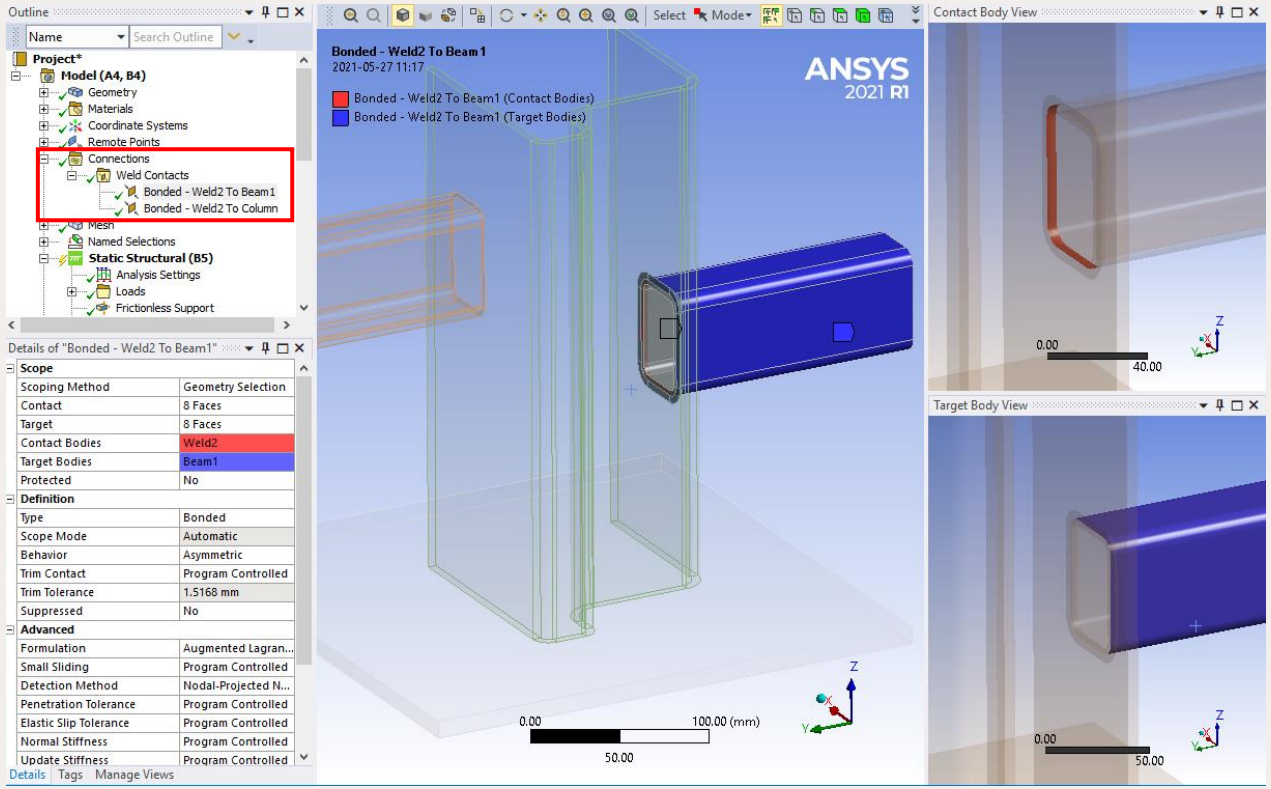
Optimize Bonded Contacts

- Bonded face to face contacts can be optimized for weld strength evaluation by setting the smaller face as “Contact” and the larger face as “Target” and change behavior to “Asymmetric”.
- Select the “Connections” folder, “Contacts” folders or individual “Contacts” and click the button “Optimize Bonded Contacts” to update all selected objects.
- An info message will show the number of selected contacts to optimize and how many that was updated.



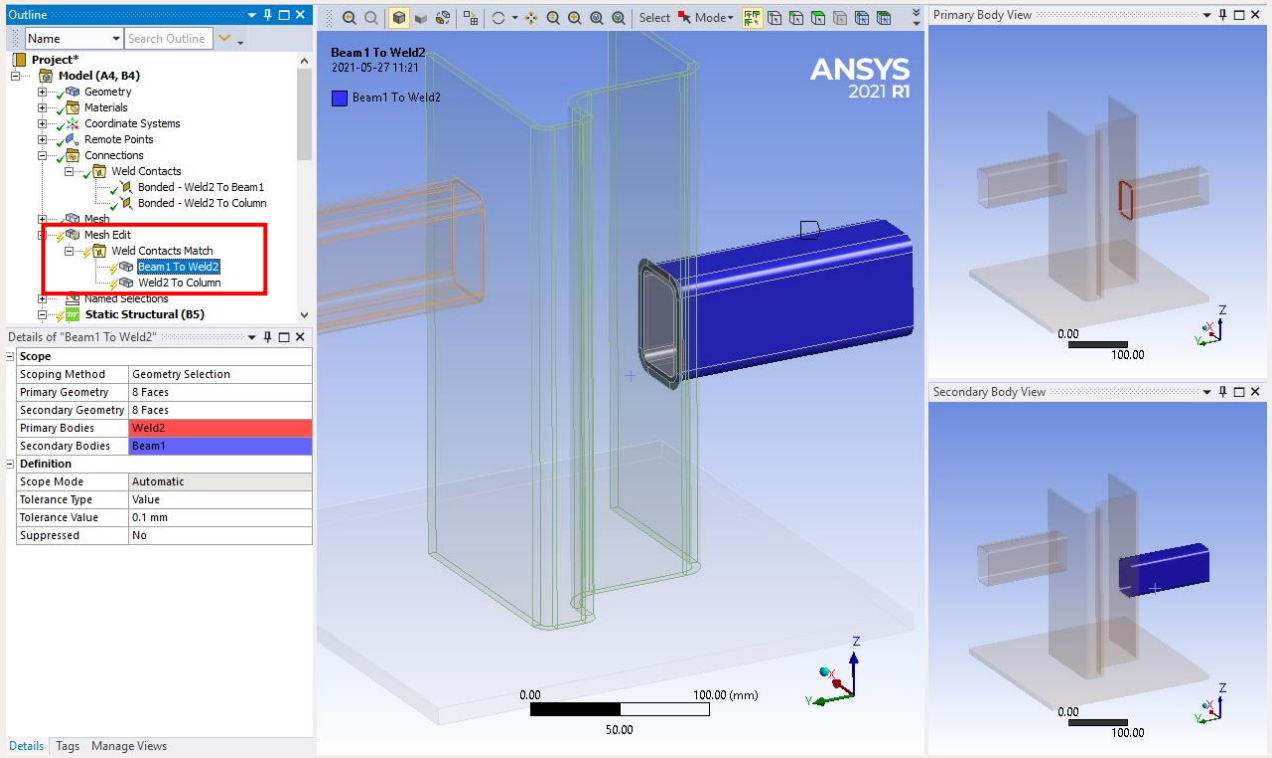
Create Weld Contacts

- Managing contacts for large assemblies with many welds is important to get consistent results.
- “Create Weld Contacts” will create a “Weld Contacts” Connection folder and create bonded contacts for all parts containing “weld” in the name.
- Delete any existing duplicate weld contacts in other contacts folders.
- The created contacts can be edited.
- Tip: Multi-select parts in Geometry group and press “F2” to rename.



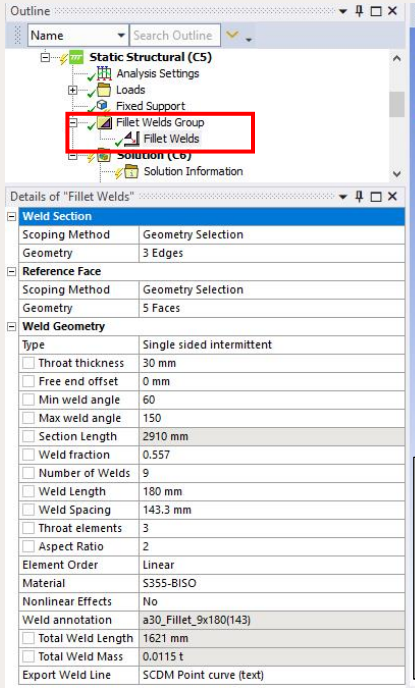
Weld Contacts Match

- For tetrahedron meshed parts the weld contact match can be used to create a “Weld Contacts Match” folder in “Mesh Edit” and create corresponding mesh imprint for the weld contacts.
- The mesh imprint will improve the contact calculation as the contact and target mesh will match.
- Note: If the parts belong to a multi-body part with option “imprint” this is not needed.

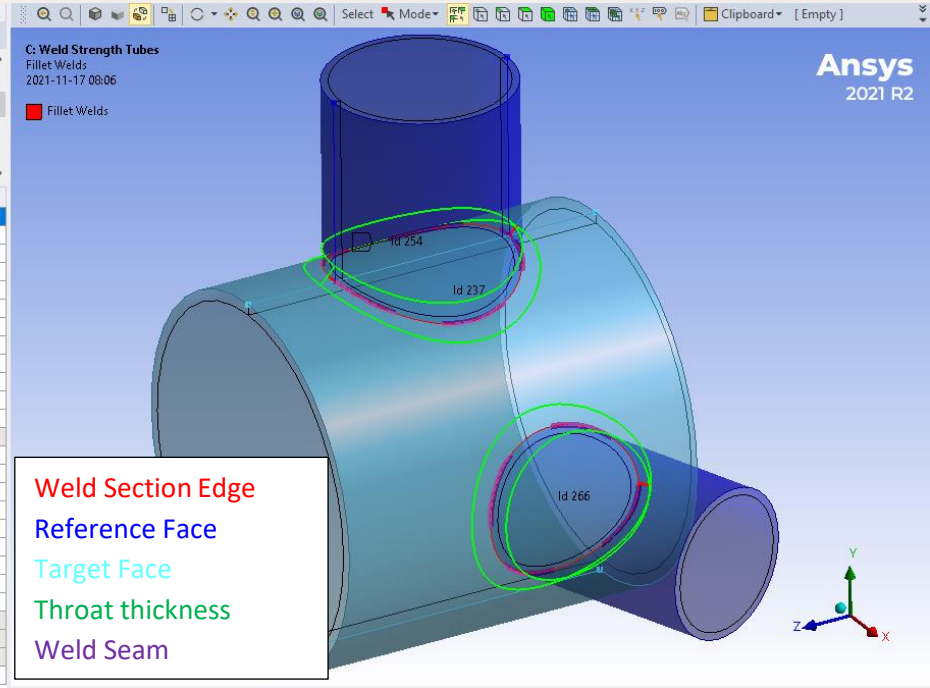


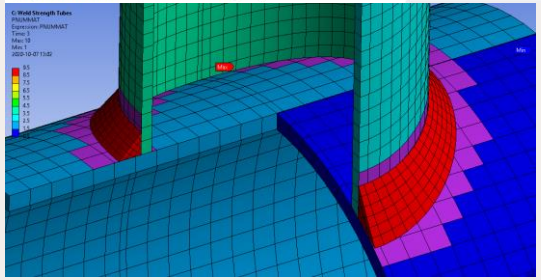
Add Fillet and Butt Weld

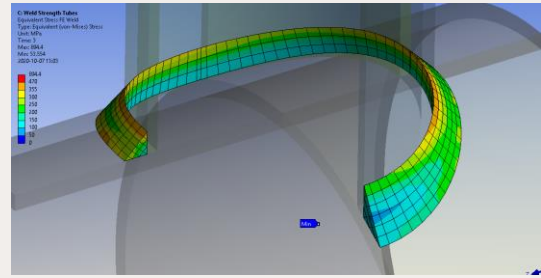
- The *Fillet* and *Butt weld* feature can model weld joints with solid elements to get best possible accuracy of the joint stiffness, also including intermittent weld.
- The weld geometry is parametric and is visualized with a green line at the weld throat section.
- To create welds, select a group of edges located at the weld root and the connected faces. Select material and throat thickness.
- The weld size and properties can be changed without needing to re-mesh or update the contacts in the model. The weld meshing and contact setup is fully automatic and done when solving.



Weld Section	
Scoping Method	Geometry Selection
Geometry	3 Edges
Reference Face	
Scoping Method	Geometry Selection
Geometry	5 Faces
Weld Geometry	
Type	Single sided intermittent
Throat thickness	30 mm
Free end offset	0 mm
Min weld angle	60
Max weld angle	150
Section Length	2910 mm
Weld fraction	0.557
Number of Welds	9
Weld Length	180 mm
Weld Spacing	143.3 mm
Throat elements	3
Aspect Ratio	2
Element Order	Linear
Material	S355-BISO
Nonlinear Effects	No
Weld annotation	a30_Fillet_9x180(143)
Total Weld Length	1621 mm
Total Weld Mass	0.0115 t
Export Weld Line	SCDM Point curve (text)

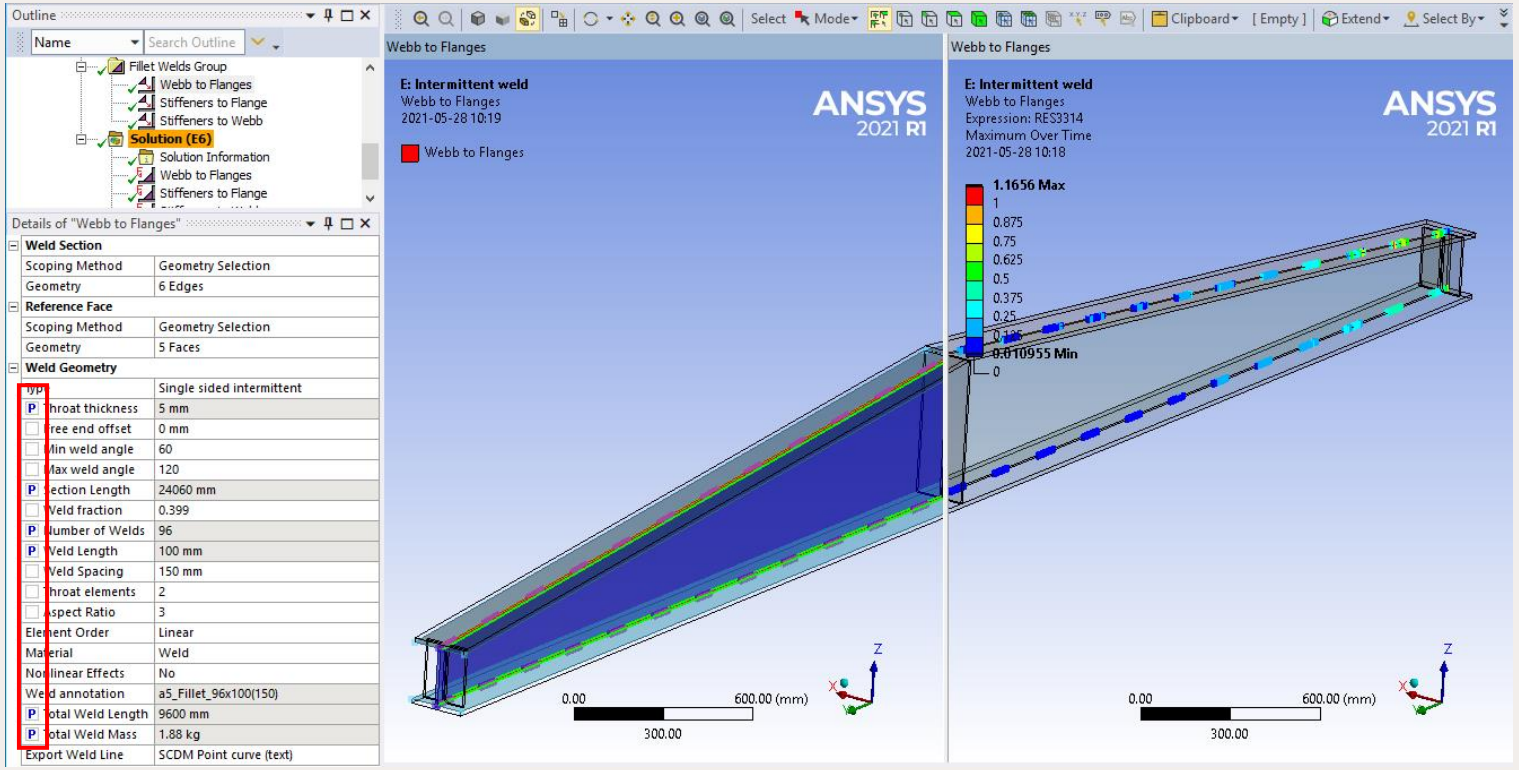






Intermittent Welds and Optimization

- Intermittent welds saves cost in production using less weld filler material and shorter welding time.
- The throat thickness, section length and spacing can be defined as parameters in a design point study to see the impact on weld mass, weld utilization, local deformation and stress.

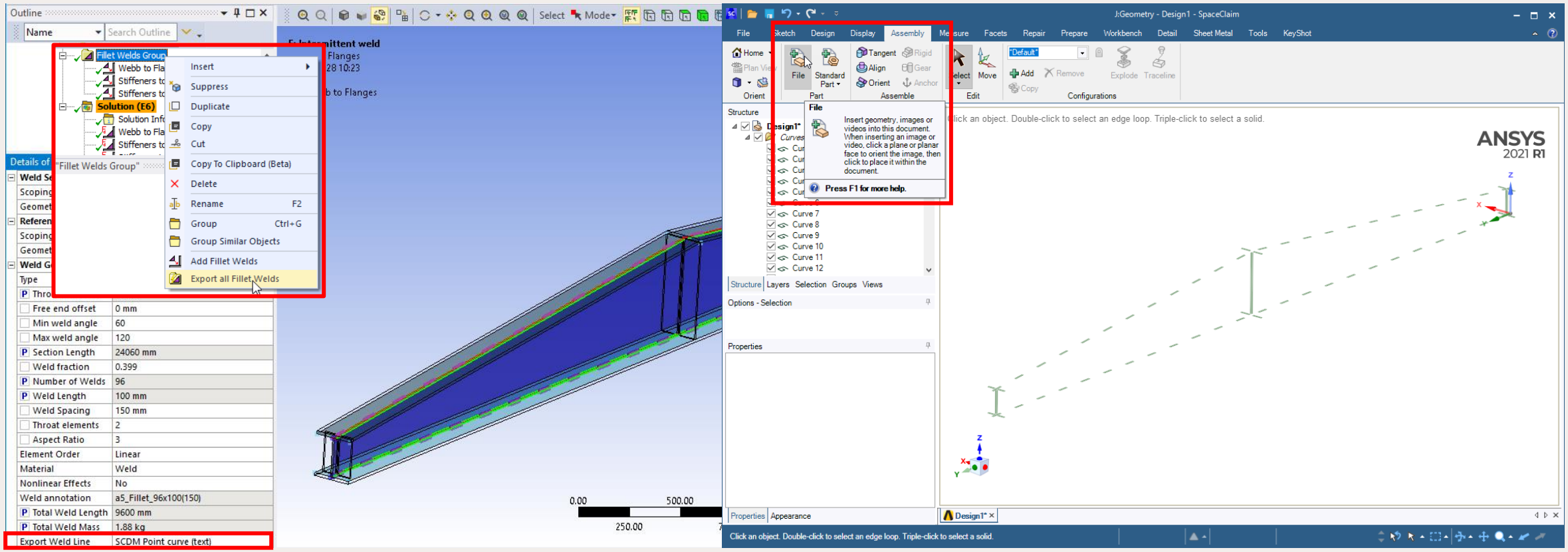


Outline of Schematic E8: Parameters

	A	B	C	D
1	ID	Parameter Name	Value	Unit
2	Input Parameters			
3	Intermittent weld (E1)			
4	P3	Webb to Flanges Number of Welds	96	
5	P4	Webb to Flanges Throat thickness	5	mm
6	P6	Webb to Flanges Weld Length	100	mm
*	New input parameter	New name	New expression	
8	Output Parameters			
9	Intermittent weld (E1)			
10	P1	Webb to Flanges Section Length	24060	mm
11	P2	Webb to Flanges Total Weld Length	9600	mm
12	P5	Webb to Flanges Total Weld Mass	1.88	kg
13	P7	Webb to Flanges Maximum	1.1656	
14	P8	Weld Fraction	0.399	
*	New output parameter		New expression	
16	Charts			

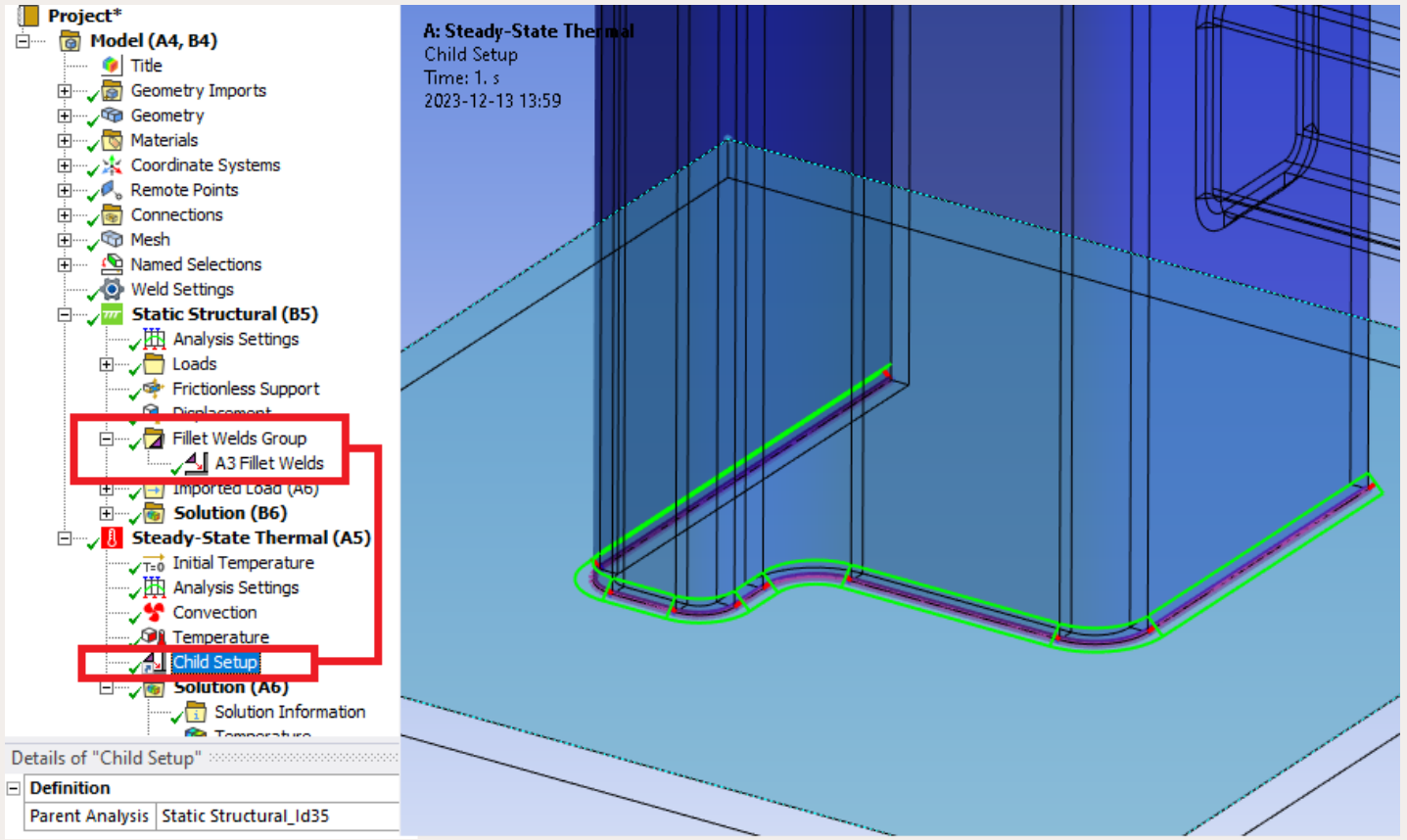
Weld line export

- The defined weld lines can be exported to Design Modeler or Space Claim line files.



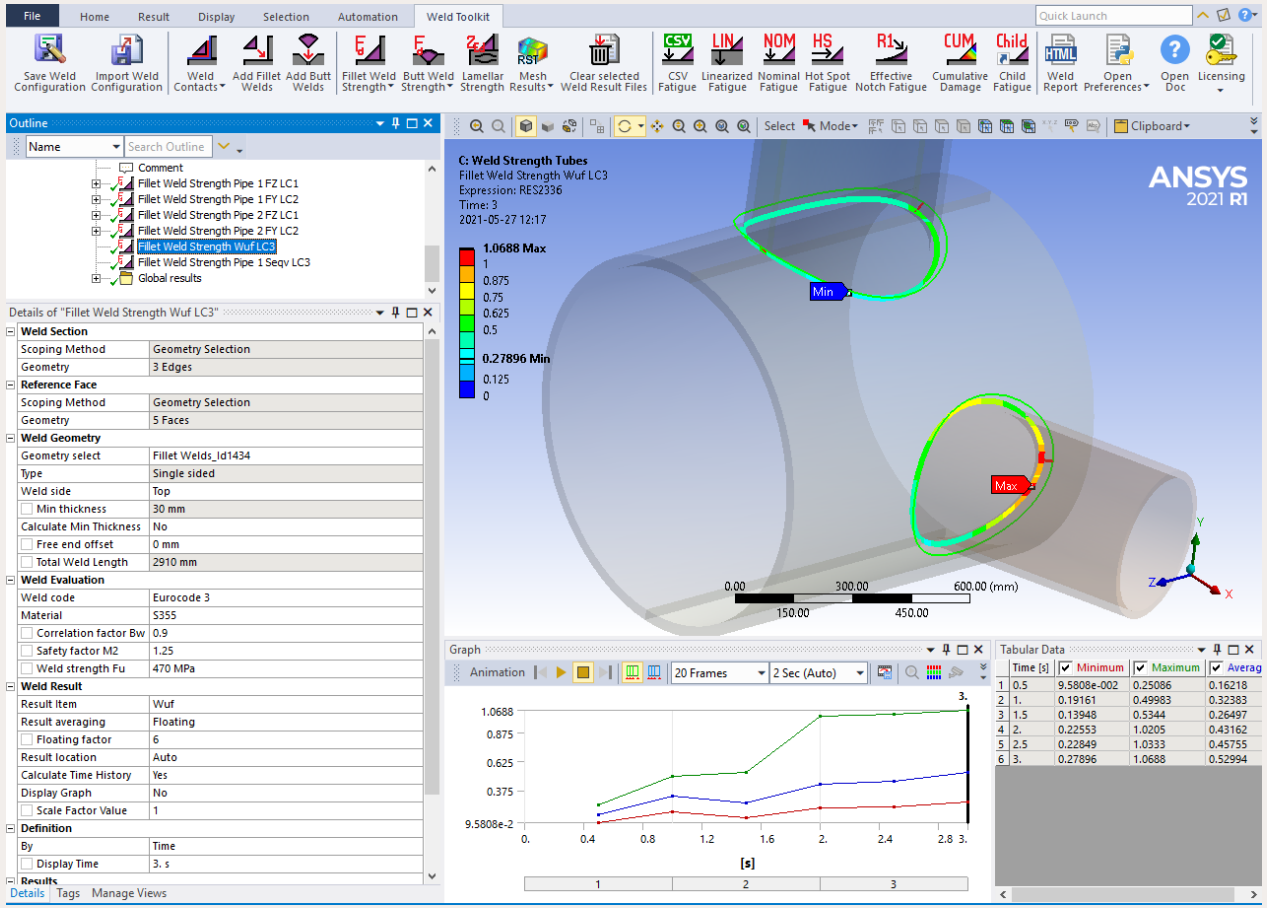
Child Setup

- The Child Setup let you re-use the Add Welds Group setup from one linked parent analysis.
- If updating the weld setup in the parent analysis the linked setup will automatically get the new data.



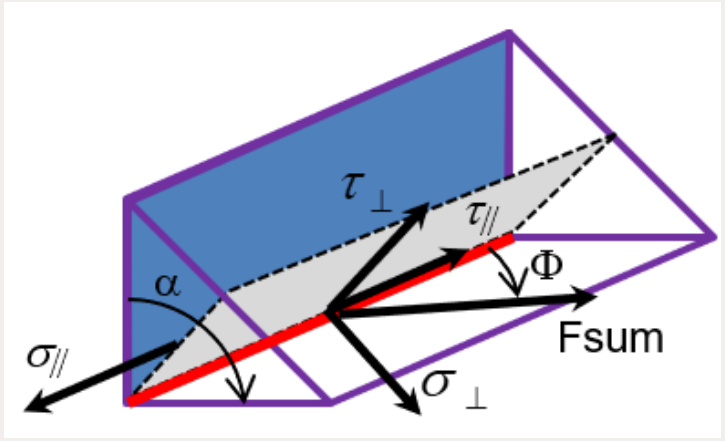
Weld Strength

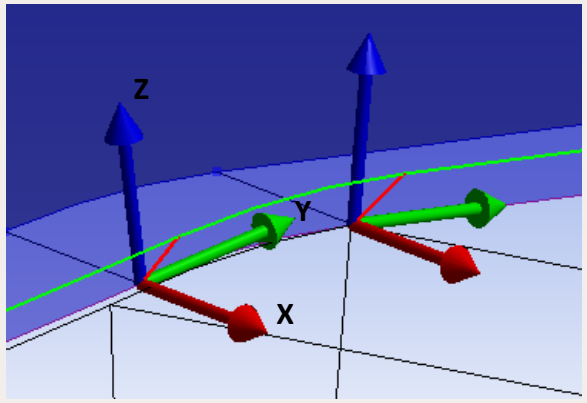
- *Weld Strength* results evaluate stresses and forces from each throat section in the selected group of welds.
- Weld utilization factor, W*uf*, can be post processed according to Eurocode 3 or AWS D1.1/AISC 360-16 or user defined codes.
- Results are plotted on the geometry and listed in csv files used by the “Weld Report” feature or external use in e.g. Excel.
- Standard Mechanical features “Calculate Time History” and “Maximum Over Time” can be used to see the worst case for all loads steps and all welds in one plot!



Weld Strength – Stress components

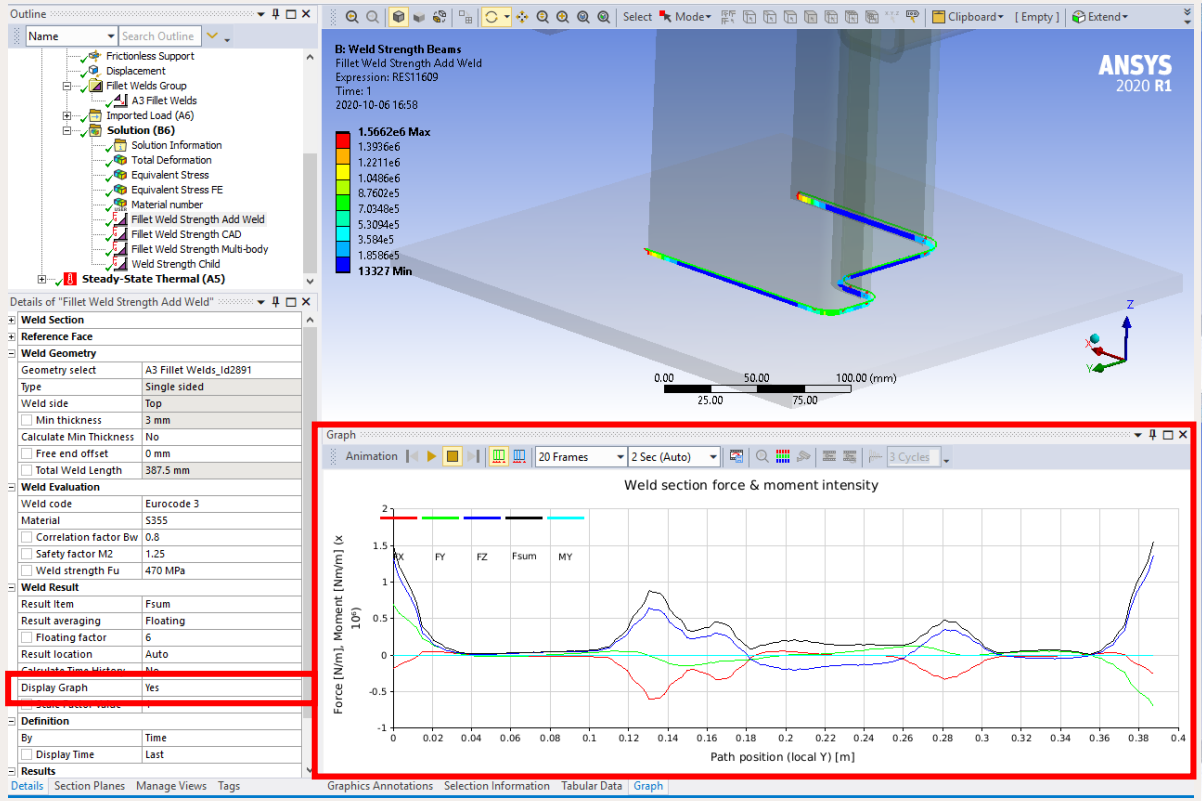
- The weld strength evaluation is based on the “directional method” where the structural component stresses in the weld section is derived from section forces. The method is therefore mesh size independent.
- The stresses are evaluated in a local coordinate system that follows the geometry.
- Results can be evaluated at different section angles, α, and in addition to the component stresses the force angle, Φ, between the weld line and the total force, *Fsum*, and local bending moment, *My*, around local weld axis Y is available to use in the evaluation.

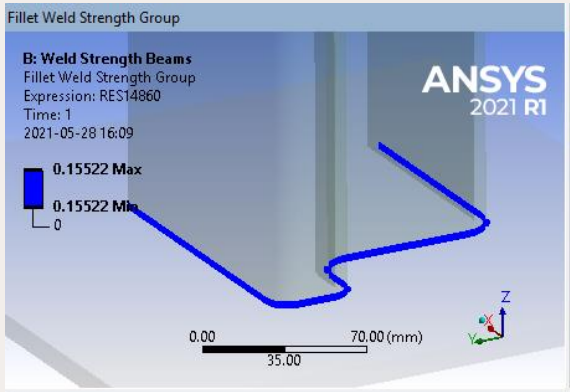


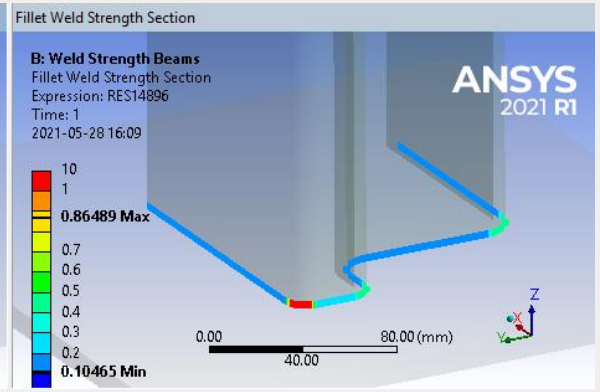


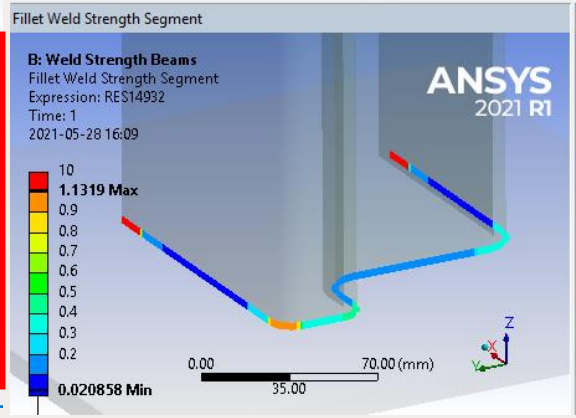
Weld Strength – Path & Average

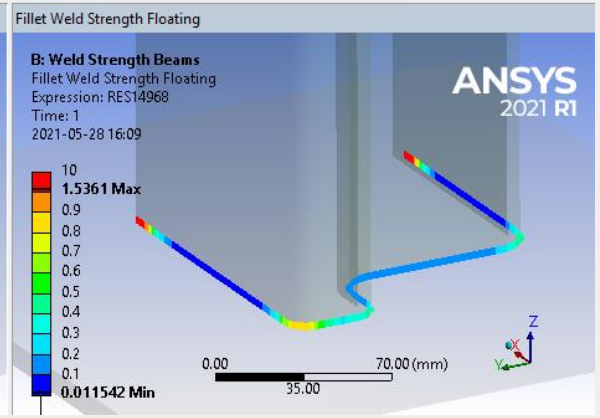
- A path plot of a single weld seam can be displayed in the Graph window.
- Results can be averaged in different ways, *Group, Section (Constant), Section (Linear), Segment, Floating*





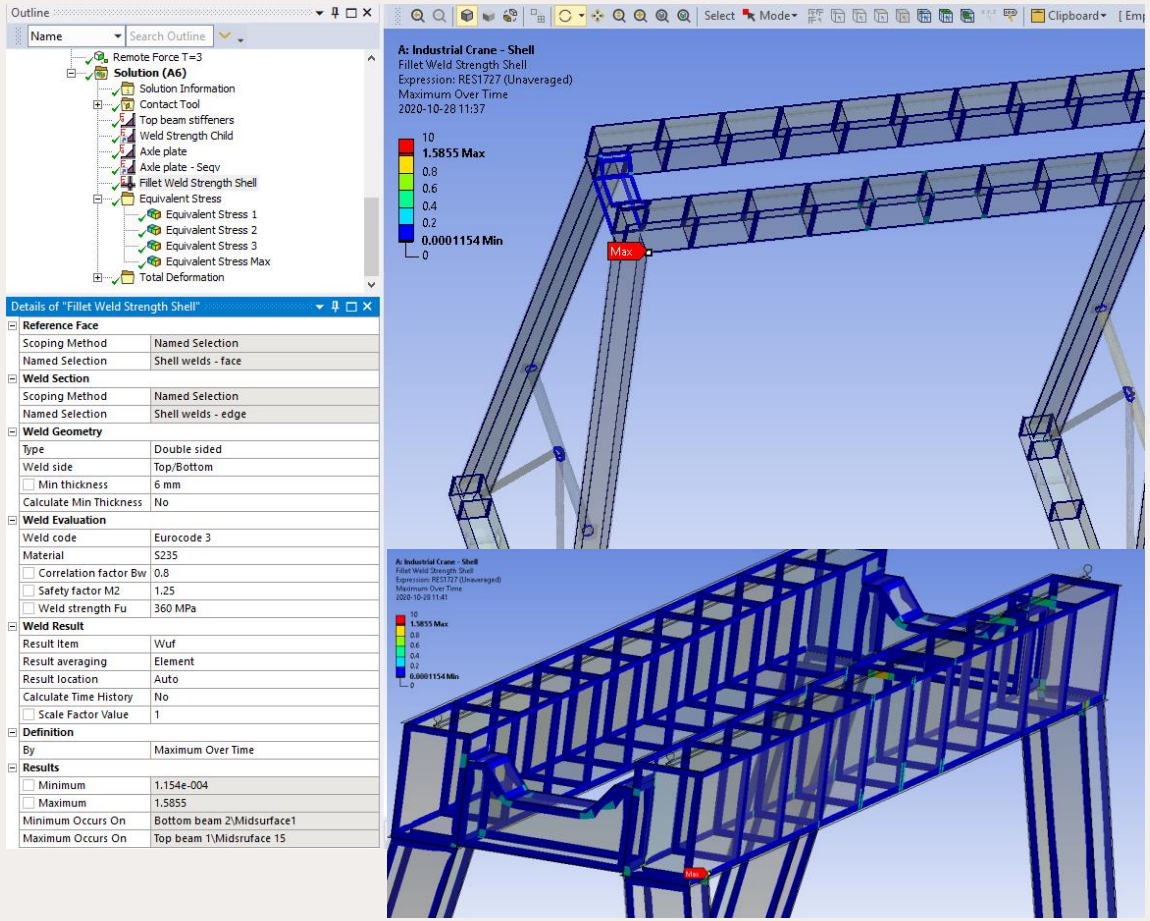






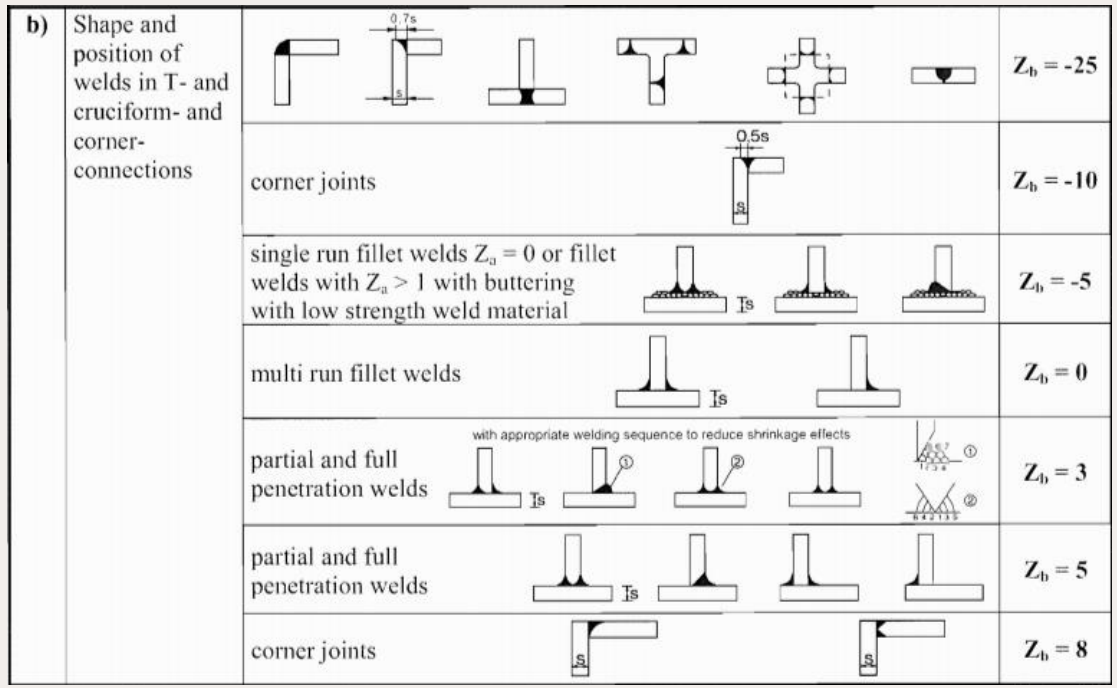
Weld Strength Shell

- *Weld Strength Shell* result can be used to evaluate large shell models with multiple cruciform joints.
- Result average can be “*Section*” or “*Element*”. (Element size is >> the weld throat size.)



Lamellar Strength

- The risk for lamellar tear can be evaluated according to Eurocode 3 with the “Lamellar Strength” result.
- Depending on the weld shape, weld position, boundary conditions and loading direction the required material quality can be evaluated.



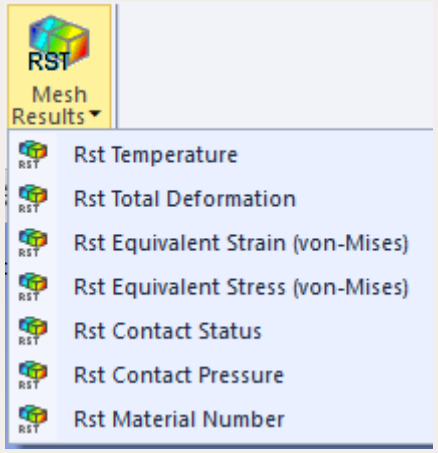
b)	Shape and position of welds in T- and cruciform- and corner-connections	
		$Z_b = -25$
	corner joints	$Z_b = -10$
	single run fillet welds $Z_a = 0$ or fillet welds with $Z_a > 1$ with buttering with low strength weld material	$Z_b = -5$
	multi run fillet welds	$Z_b = 0$
	partial and full penetration welds	$Z_b = 3$
	partial and full penetration welds	$Z_b = 5$
	corner joints	$Z_b = 8$

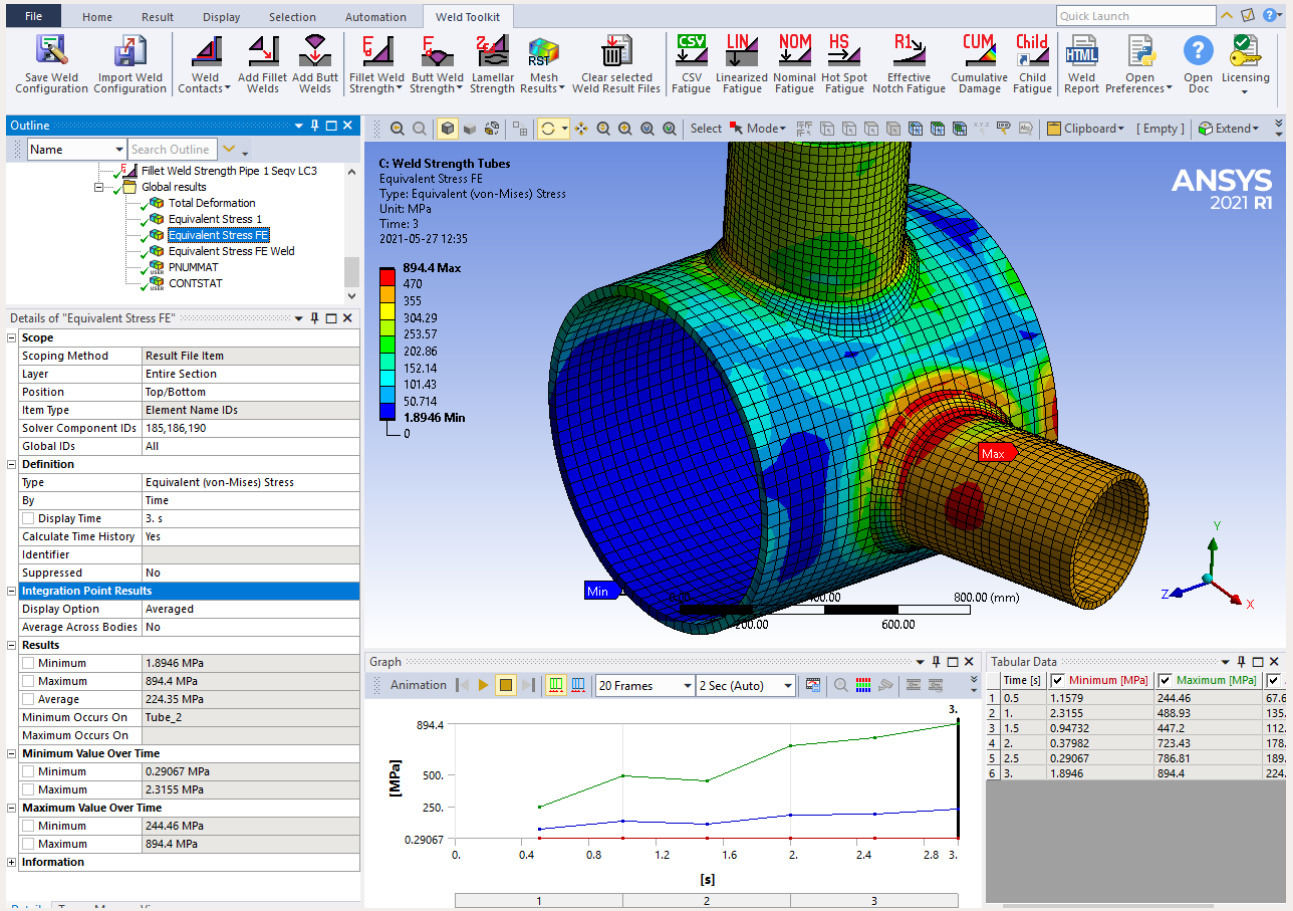
Details of "Lamellar Strength"

Weld Section	
Scoping Method	Geometry Selection
Geometry	4 Edges
Reference Face	
Scoping Method	Geometry Selection
Geometry	2 Faces
Weld Geometry	
Geometry select	Fillet Welds_Id76
Type	Single sided
Weld side	Top
Throat thickness	1 [mm]
Plate thickness	100 [mm]
Predominant compressive load	Evaluate
Weld Evaluation	
Weld code	Eurocode 3
Weld depth factor, Za	0
Weld shape factor, Zb	0
Plate thickness factor, Zc	15
Free shrinkage factor, Zd	Not possible Zd=5
Preheating factor, Ze	Without preheating Z
Required Z-value, Z_Ed	20
Lamellar strength, Z_Rd	Evaluate
Weld Result	
Result Item	Z_Rd
Result averaging	Section
Calculate Time History	Yes
Total Weld Length	60 [mm]
Definition	
By	Time
Display Time	Last
Results	

Mesh Result

- FE-based results for fillet and butt welds can be easily plotted using the predefined items in the drop-down menu *Mesh Results*.





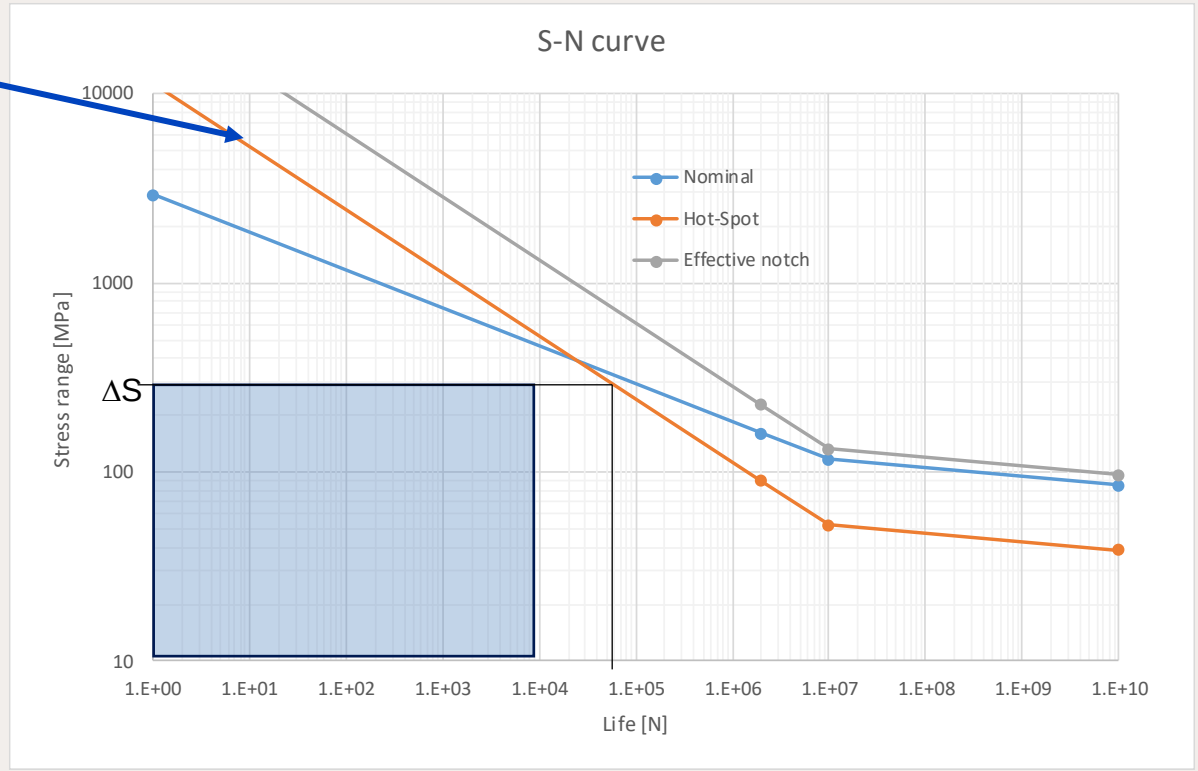
Fatigue methods

- The fatigue evaluation is based on IIW methods and uses a selected S-N curve (FAT class) to derive the fatigue life and damage based on the stress range, $\Delta\sigma$, from the selected fatigue method and load case.

S-N curve	
FAT Class	IIW FAT90 steel
FAT (@ Nfat cycles)	90 MPa
FAT factor	1
Nfat	2000000
Nc	10000000
Slope m1	3
Slope m2	22

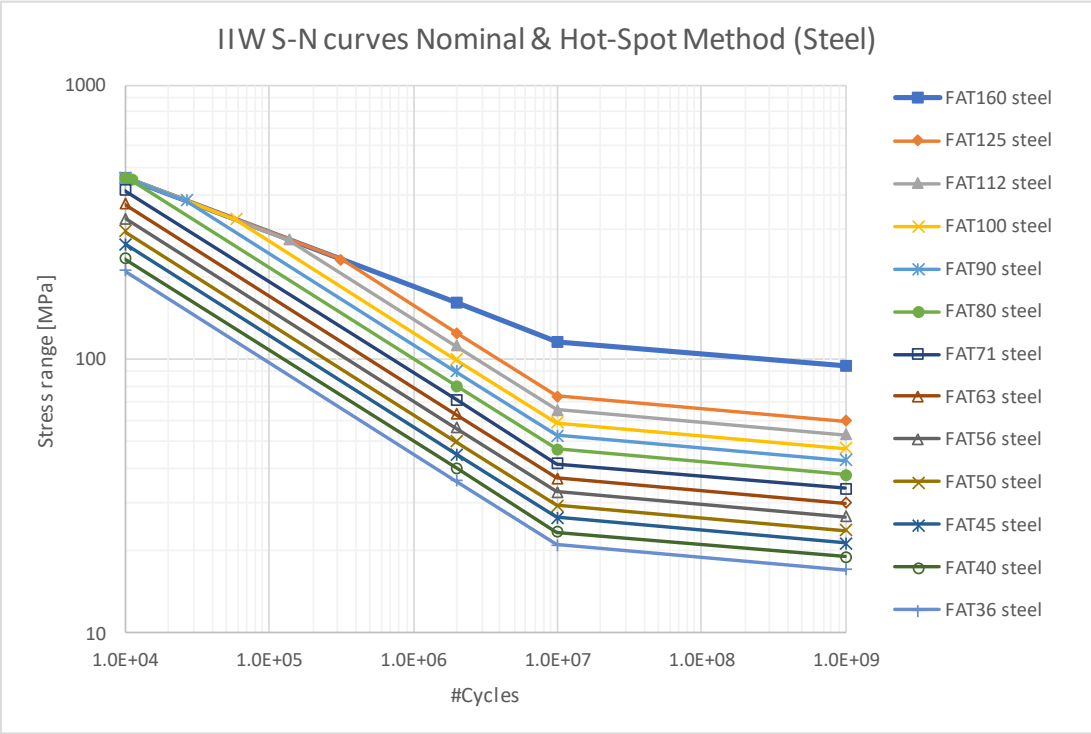
Fatigue Result	
Result Item	Life [N]
Definition	
By	
Display Time	
Results	
Minimum	
Maximum	

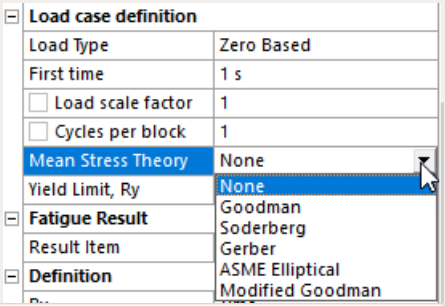
Life [N]
log10(Life) [N]
Damage per block [-]
Safety factor life [#blocks]
Stress range
Safety factor stress [-]
Stress utilization [-]
Life quality [-]
Stress max
Stress avg

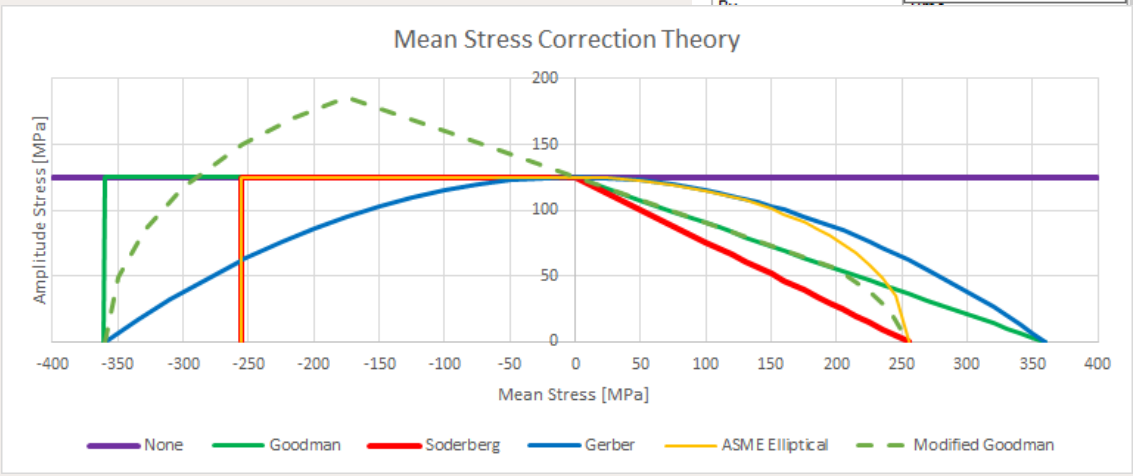


Fatigue S-N curves and MSC Theory

- The S-N curves are independent from Engineering Data and is applied for each fatigue result independent.
- User defined curves can be added in addition to the curves from IIW, Eurocode 3, Eurocode 9 and DNV.
- Mean Stress Correction can be applied in CSV, Linearized, Nominal and Hot-Spot method.

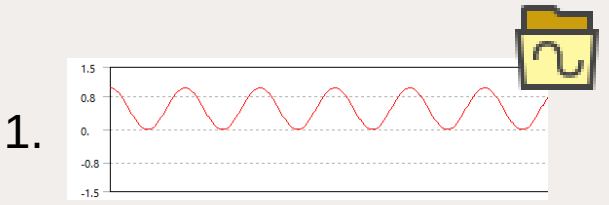


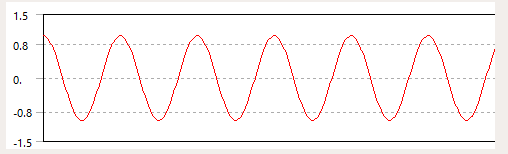


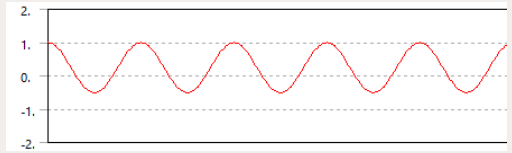


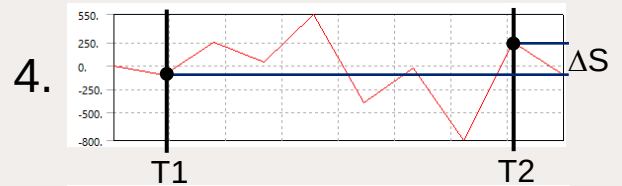
Fatigue Load Case Definition

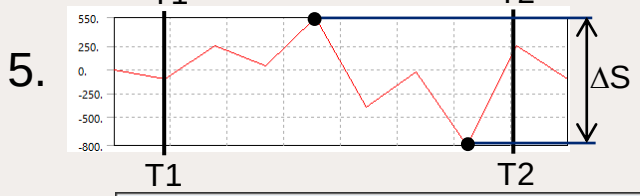
1. Zero Based
   Calculates a pulsating stress range (Loading Ratio = 0).
2. Fully Reversed
   Calculates an alternating stress range (Loading Ratio = -1).
3. Ratio (Loading Ratio)
   Calculates a stress range with custom Loading Ratio.
4. Load Combination
   Calculates the stress range between two selected steps.
5. Load Scanning
   Calculates the maximum stress range within the selected steps.
6. Solution Combination
   Calculates the stress range from summing the steps in Solution Editor.
7. Solution Scanning
   Calculates the maximum stress range within the steps in Solution Editor.
8. Random
   Calculates the damage using the “Steinberg formulation”

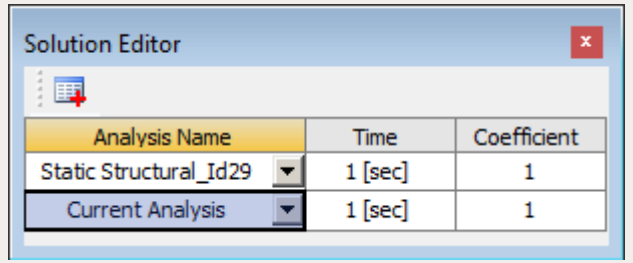






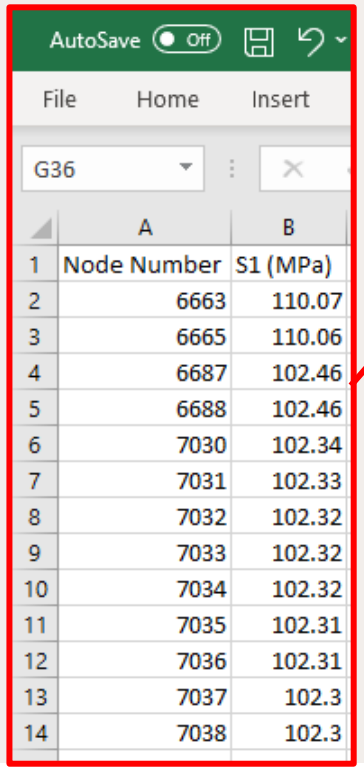






CSV Fatigue

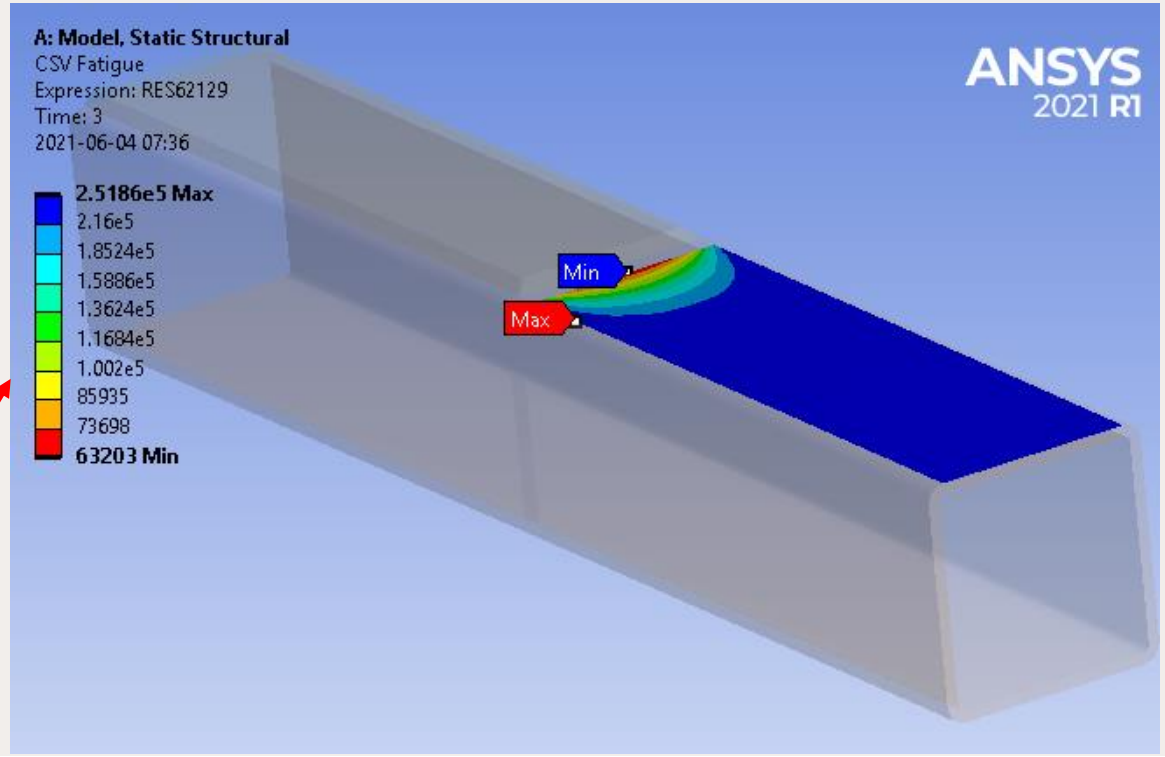
- CSV Fatigue is a generic method to post process fatigue from stress results saved in a CSV text file.



	A	B
1	Node Number	S1 (MPa)
2	6663	110.07
3	6665	110.06
4	6687	102.46
5	6688	102.46
6	7030	102.34
7	7031	102.33
8	7032	102.32
9	7033	102.32
10	7034	102.32
11	7035	102.31
12	7036	102.31
13	7037	102.3
14	7038	102.3

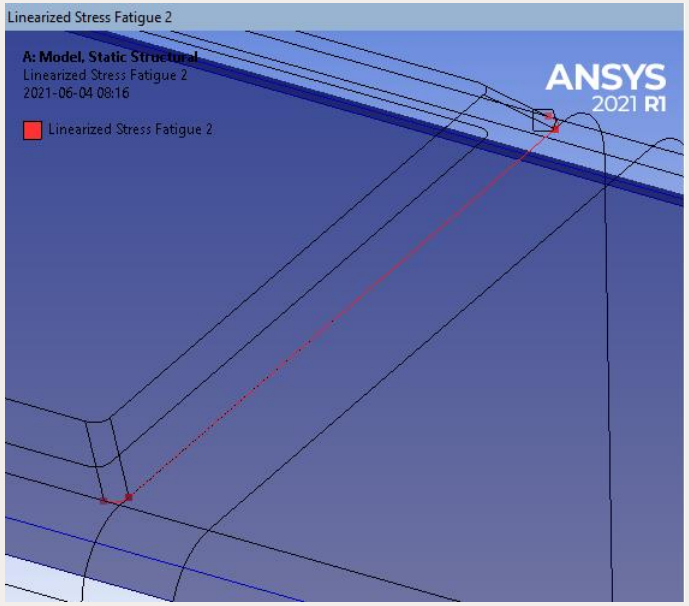
Details of "CSV Fatigue"

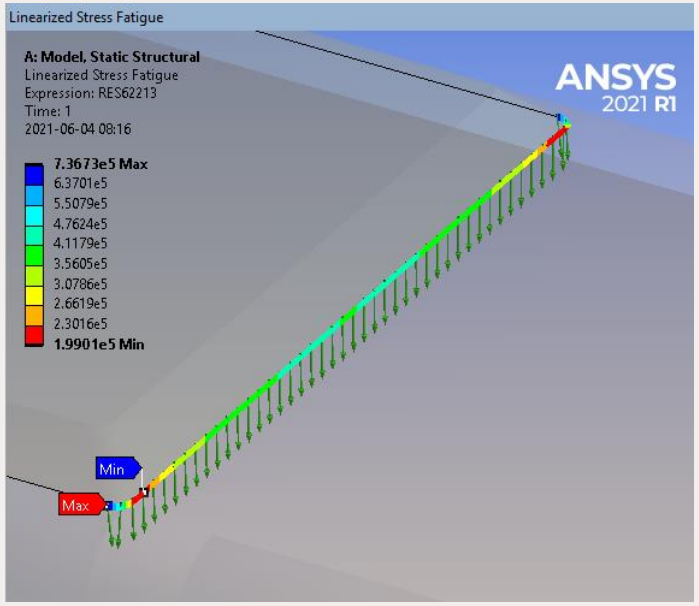
CSV Geometry	
Scoping Method	Geometry Selection
Geometry	1 Face
CSV Method	
CSV File	C:\MagnusG\MaxPrin.csv
CSV Stress	S1 (MPa)
Result Location	Node
S-N curve	
FAT Class	IIW FAT50 steel
FAT (@ Nfat cycles)	50 MPa
FAT factor	1
Nfat	2000000
Nc	10000000
Slope m1	3
Slope m2	22
Load case definition	
Load Type	Zero Based
Load scale factor	1
Cycles per block	10000
Mean Stress Theory	None
Fatigue Result	
Result Item	Life [N]
Definition	
By	Time
Display Time	Last



Linearized Fatigue

- Linearized Fatigue evaluates the linearized stress through the material thickness for all matching nodes of a selection between inside and outside of a solid part. This allows for efficient evaluation of e.g. nozzles and other pressure vessels according to ASME.
- All stress types (*Principal, Sum of Principal, Intensity, Equivalent, Normal, Shear*) and stress items (*Membrane, Bending, Membrane+Bending, Peak, Total*) can be used.



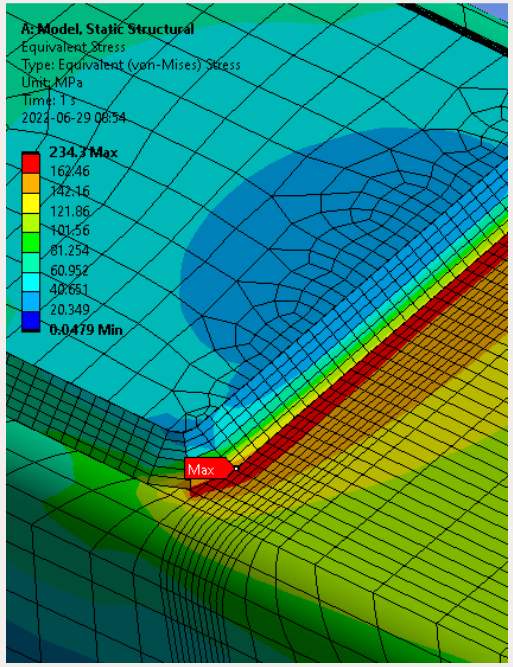


Details of "Linearized Stress Fatigue"

Inside face	
Scoping Method	Geometry Selection
Geometry	3 Edges
Outside face	
Scoping Method	Geometry Selection
Geometry	3 Faces
Linearized Method	
Linearized Parent	None
Stress Type	Linearized Absolute Principal St..
Stress Item	Membrane+Bending
Result Side	Inside
Corner Nodes Only	Yes
Pinball Region	12 mm
S-N curve	
FAT Class	IIW FAT100 steel
FAT (@ Nfat cycles)	100 MPa
FAT factor	1
Nfat	2000000
Nc	10000000
Slope m1	3
Slope m2	22
Load case definition	
Load Type	Zero Based
First time	1 s
Load scale factor	1
Cycles per block	1
Mean Stress Theory	None
Fatigue Result	
Result Item	Life [N]
Create Path	Click here to create path!
Linearized Stress Result	
Membrane+Bending (Inside)	215.8 MPa
Membrane+Bending (Center)	112.2 MPa
Membrane+Bending (Outside)	-45.06 MPa

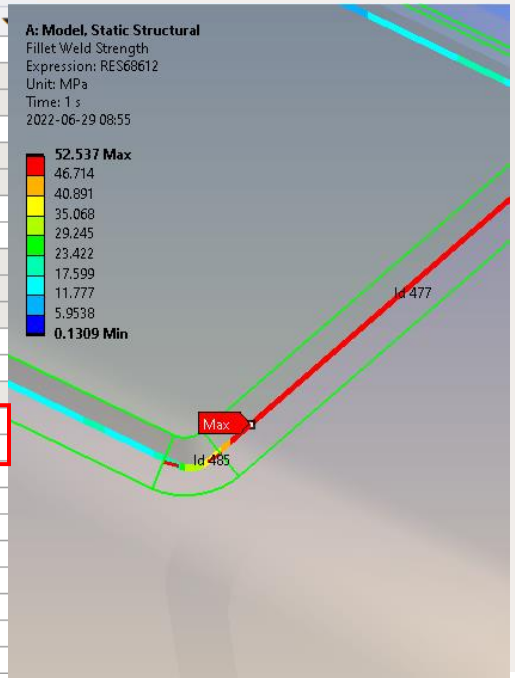
Structural Stress Fatigue

- Structural Stress fatigue uses the stress from a fillet weld strength result as input for life calculation. The weld stress is based on nodal forces in the weld section and both shell and solid models are supported.
- Stress type can be any of the weld section component stresses ($\sigma_{\perp}$, $\sigma_{//}$, $\tau_{\perp}$, $\tau_{//}$), derived stresses (σ_b, σ_s, σ_{tot}, τ_{tot}) or the equivalent stress defined in the selected weld code (σ_{eqv}).
  E.g. DNV Fatigue (2.3.4); $\sigma_{eqv} = \Delta\sigma_w = \mathrm{sqrt}(\Delta\sigma_{\perp}^2 + \Delta\tau_{\perp}^2 + 0.2*\Delta\tau_{//}^2)$



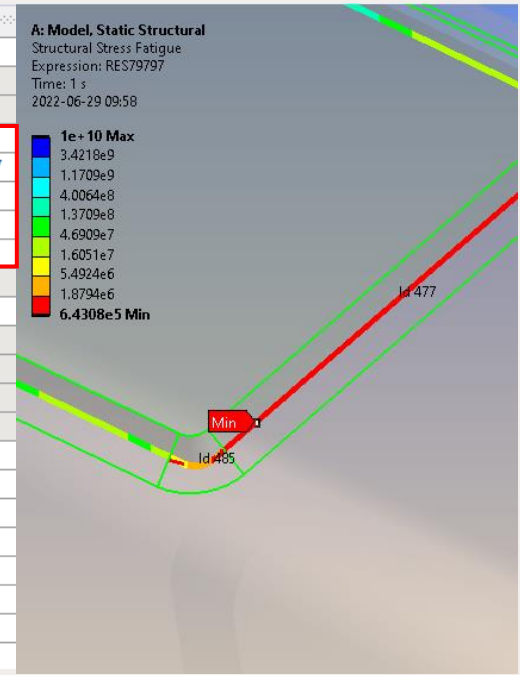
Details of "Fillet Weld Strength"

Weld Section	
Scoping Method	Geometry Selection
Geometry	5 Edges
Reference Face	
Scoping Method	Geometry Selection
Geometry	6 Faces
Weld Geometry	
Geometry select	A7 Fillet Welds_Id935
Type	Single sided
Weld side	Top
Min thickness	7 mm
Calculate Min Thickness	No
Free end offset	0 mm
Total Weld Length	1346 mm
Weld Evaluation	
Weld code	DNV Fatigue (2.3.4)
Material	Unknown
Correlation factor Bw	0.8
Safety factor M2	1.25
Weld strength Fu	360 MPa
Weld Result	
Result Item	Seqv
Result averaging	Floating
Floating factor	6



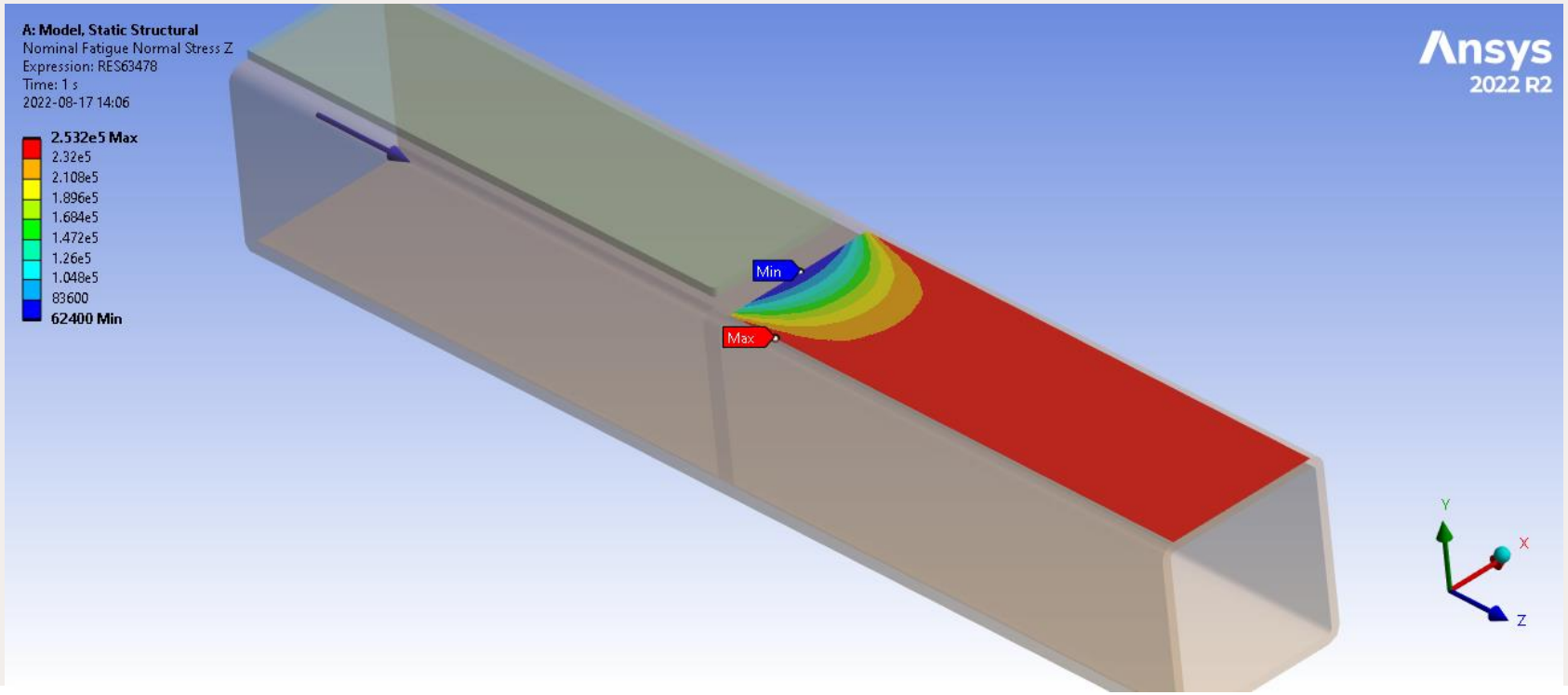
Details of "Structural Stress Fatigue"

Weld Section	
Scoping Method	Geometry Selection
Geometry	5 Edges
Structural Method	
Weld Result Parent	Fillet Weld Strength_Id937
Stress Type	Seqv
S-N curve	
FAT Class	DNV T.2-1 W3
FAT (@ Nfat cycles)	45.35 MPa
FAT factor	1
Nfat	1000000
Nc	10000000
Slope m1	3
Slope m2	5
Ncutoff	10000000000
Load case definition	
Load Type	Zero Based
First time	1 s
Load scale factor	1
Cycles per block	1
Fatigue Result	
Result Item	Life [N]



Nominal Fatigue

- Nominal fatigue is similar to Ansys fatigue module and evaluates the fatigue from surface stress of a part.
- Stresses type can be any of: *Principal, Sum of Principal, Intensity, Equivalent, Shear (Max), Normal X/Y/Z or Shear XY/YZ/XZ.*
- Stress singularities on boundary conditions can be excluded with a new option.



Details of "Nominal Fatigue Normal Stress Z"

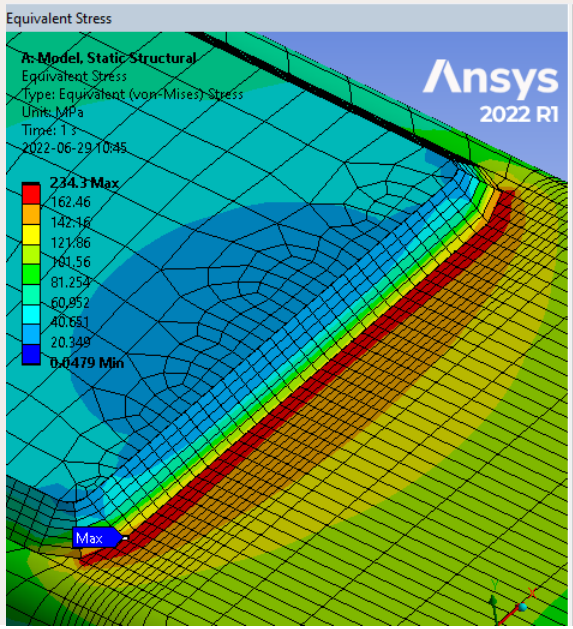
Base Material Face	
Scoping Method	Geometry Selection
Geometry	1 Face
Shell face	Top
Nominal Method	
Stress Type	Normal Z
Coordinate System	Global Coordinate System
Exclude boundary nodes	Yes
S-N curve	
FAT Class	IIW FAT50 steel
FAT (@ Nfat cycles)	50 MPa
FAT factor	1
Nfat	2000000
Nc	10000000
Slope m1	3
Slope m2	22
Ncutoff	10000000000
Load case definition	
Load Type	Solution Combination
Solution Combination	Tabular Data
Cycles per block	1
Mean Stress Theory	None
Yield Limit, Ry	360 MPa
Fatigue Result	
Result Item	Life [N]

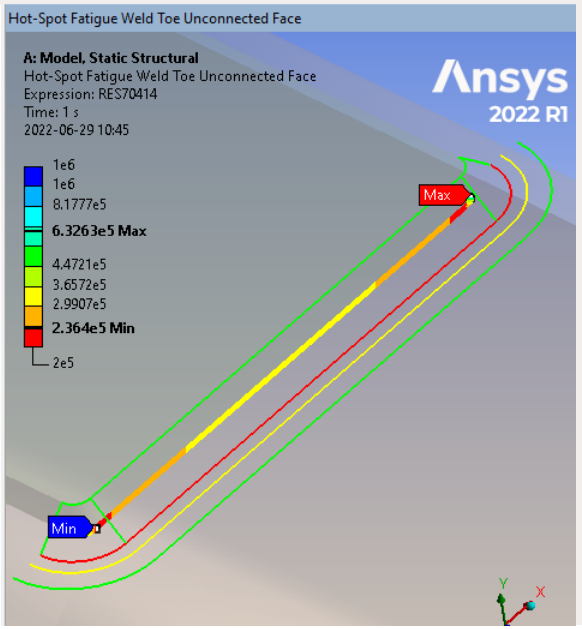
Hot-Spot Fatigue

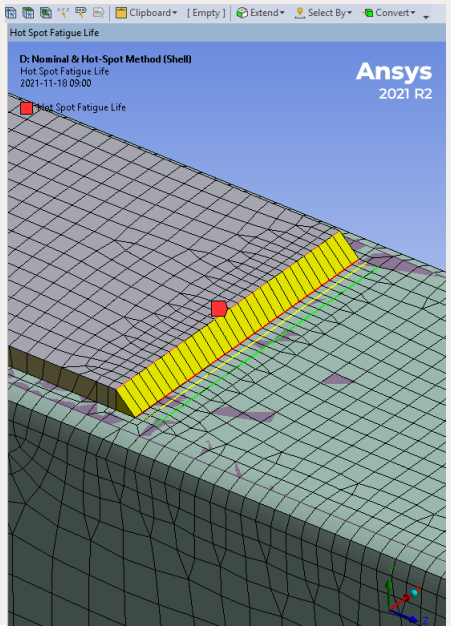
- Hot-Spot Fatigue is a common method to extrapolate surface stress remote from a hot-spot location.
  It is a way to derive the Geometric stress at a weld toe and eliminate the stress singularities at the toe.
- Available stresses types: *Normal, Parallel, Shear, Shear (Max), Principal (no limit), Principal (IIW limit) , Principal (normal) , Principal (parallel), Equivalent, Equivalent (DNV).*
- Weld codes defines the location for extrapolation and corresponding fatigue class (FAT).
- It can be used with the “Add fillet weld” to automatically define the offset based on weld size.
- The “Weld” mesh control can create suitable mesh imprints for extrapolation locations on shell models.

Details of "Hot-Spot Fatigue Weld Toe Unconnected I

Hot Spot Section	
Scoping Method	Geometry Selection
Geometry	3 Edges
Reference Face	
Scoping Method	Geometry Selection
Geometry	6 Faces
Reference location	Weld Toe Unconnected Face
Throat thickness	7 mm
Hot Spot Method	
Stress Type	Normal
Extrapolation	Linear
Material thickness	10 mm
a	0.4
b	1
S-N curve	
FAT Class	IIW FAT100 steel
FAT (@ Nfat cycles)	100 MPa
FAT factor	1
Nfat	2000000
Nc	10000000
Slope m1	3
Slope m2	22
Ncutoff	10000000000
Load case definition	
Load Type	Zero Based
First time	1 s

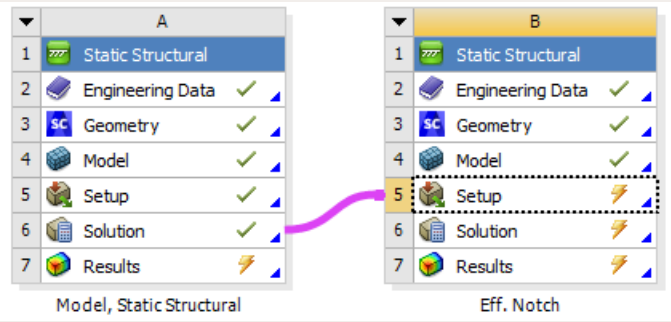


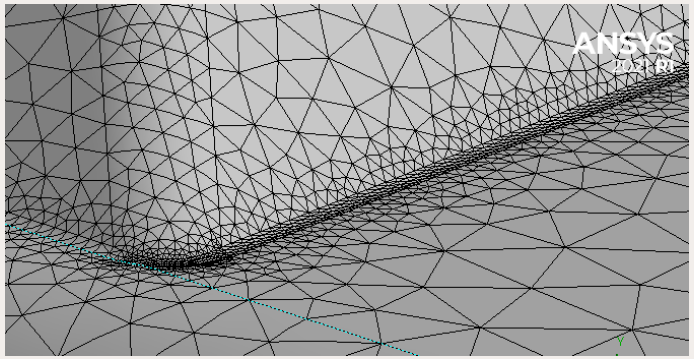




Effective Notch Fatigue

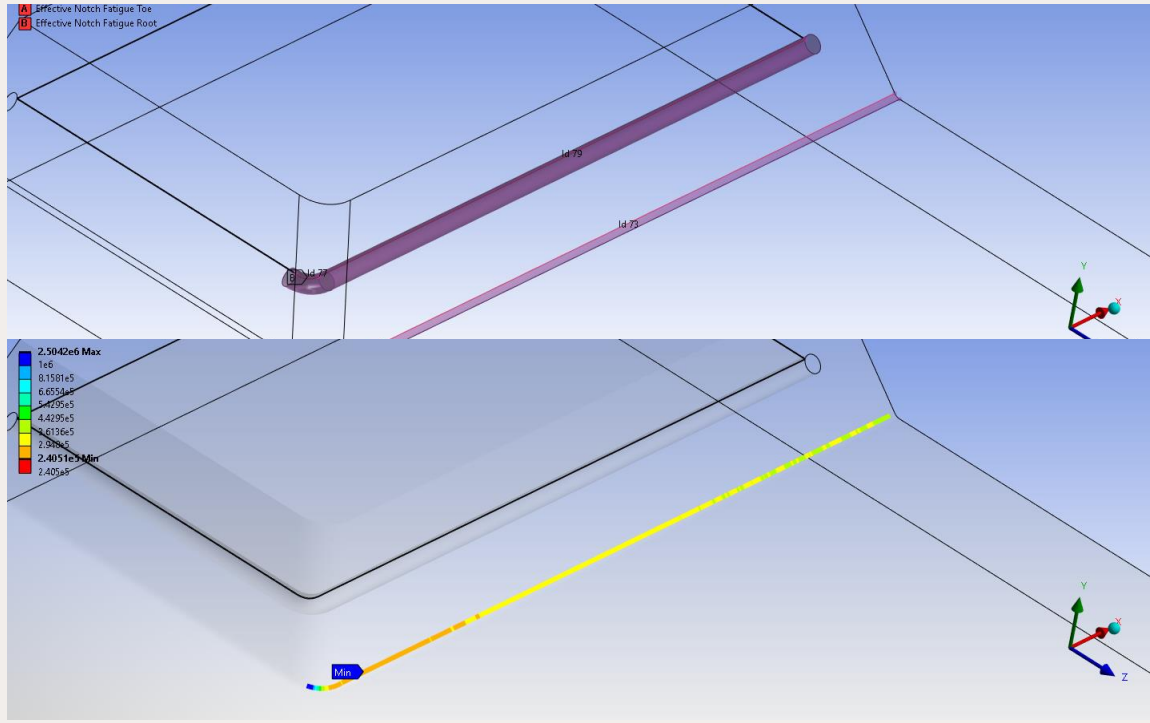
- Effective Notch Fatigue is used to evaluate the weld toe or weld root fatigue using a detailed notch mesh (in a sub model). The notch is usually a 1 mm fillet and used together with a specific fatigue class (FAT).
- Available notch stress: *Tangential*, *Parallel, Principal, Sum of Prin., Stress Int., Equivalent or Shear (Max)*.
- The result from the notch is plotted on the notch edge (similar to Hot-Spot) and is excluding results on BC.





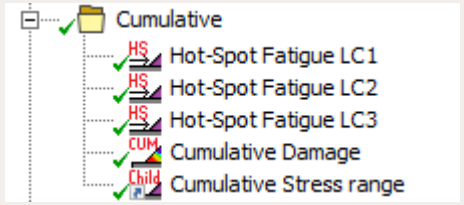
Details of "Effective Notch Fatigue Toe"

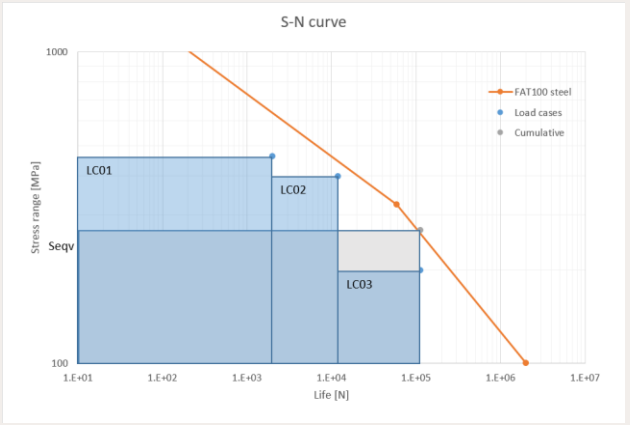
Effective Notch Edge	
Scoping Method	Geometry Selection
Geometry	2 Edges
Effective Notch Face	
Scoping Method	Named Selection
Named Selection	Toe face
Effective Notch Method	
Stress Type	Tangential (IIW default)
Exclude boundary nodes	Yes
S-N curve	
FAT Class	IIW FAT225 R1 steel
FAT (@ Nfat cycles)	225 MPa
FAT factor	1
Nfat	2000000
Nc	10000000
Slope m1	3
Slope m2	22
Ncutoff	10000000000
Load case definition	
Load Type	Zero Based
First time	1 s
Load scale factor	1
Cycles per block	200000
Fatigue Result	

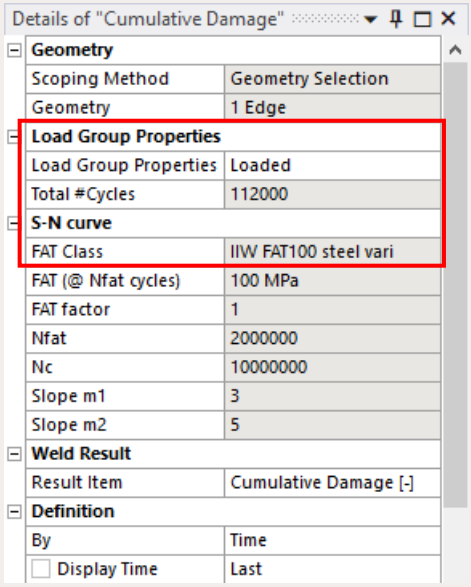


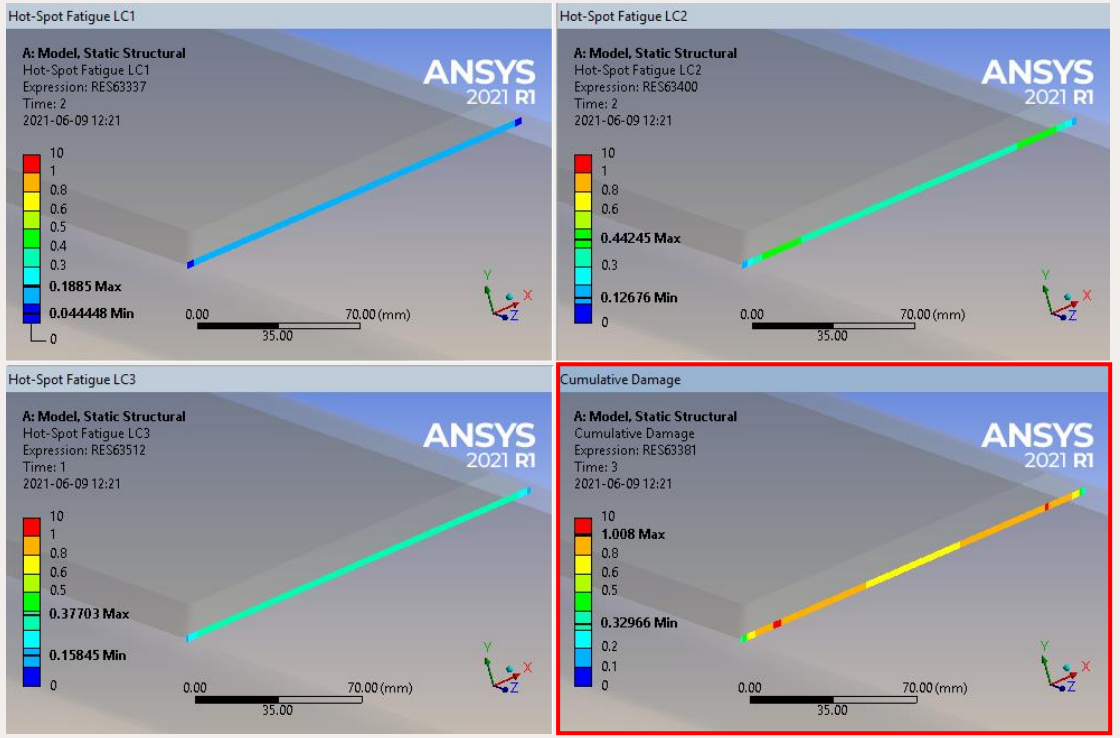
Cumulative Fatigue

- The total damage from a duty cycle can be evaluated using Cumulative Fatigue.
- Each individual event (load case with number of cycles) is defined using one of the available methods and then grouped in the model tree together with the Cumulative fatigue result object.



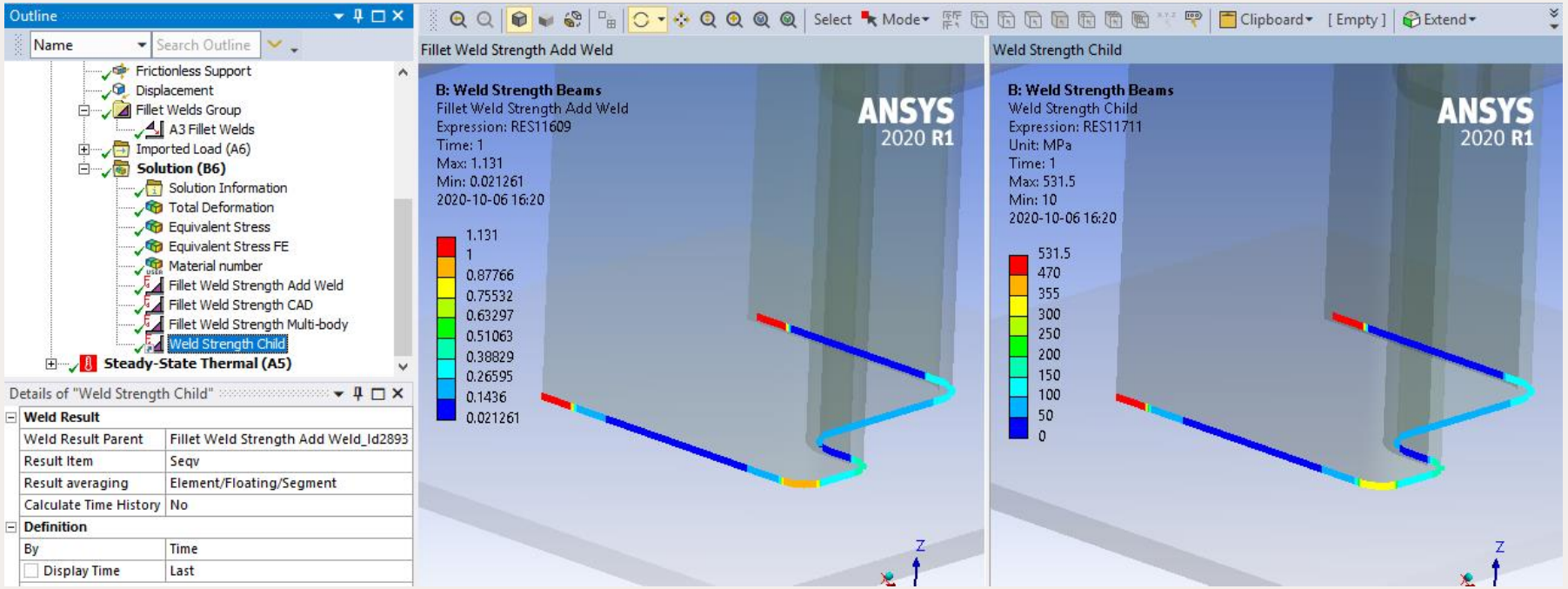






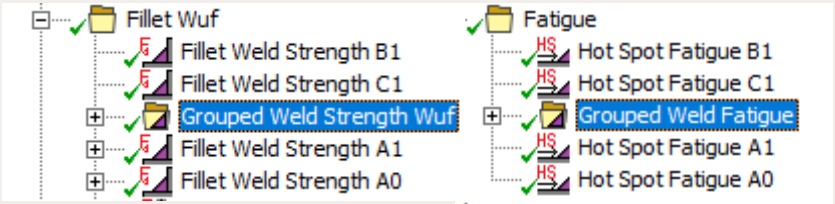
Child Result

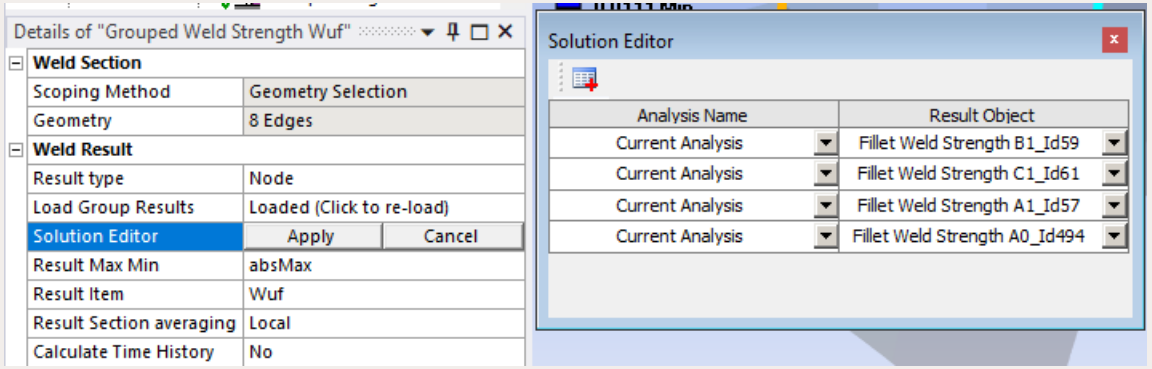
- The Weld Child Result let you select a parent result and plot a different result item (and/or time/set number) while keeping all other settings the same as in the parent result.
- This result object does not output any summary tables to the bolt report since they are listed for the parent result object. When clearing and edit the parent the children are updated as well.

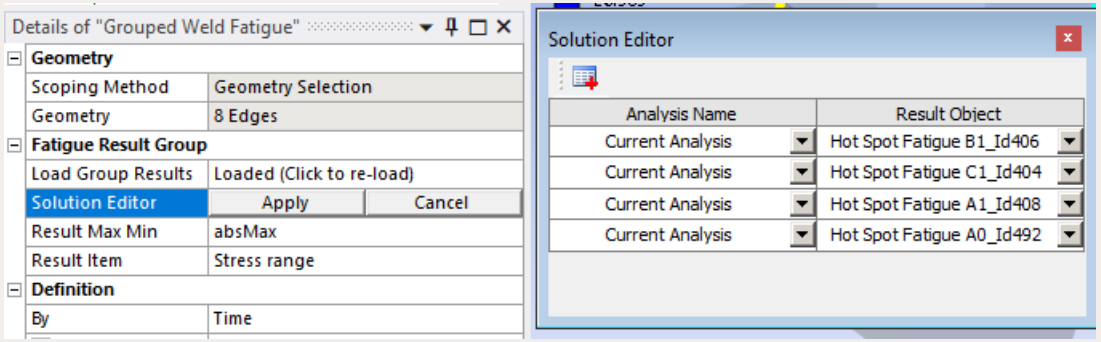


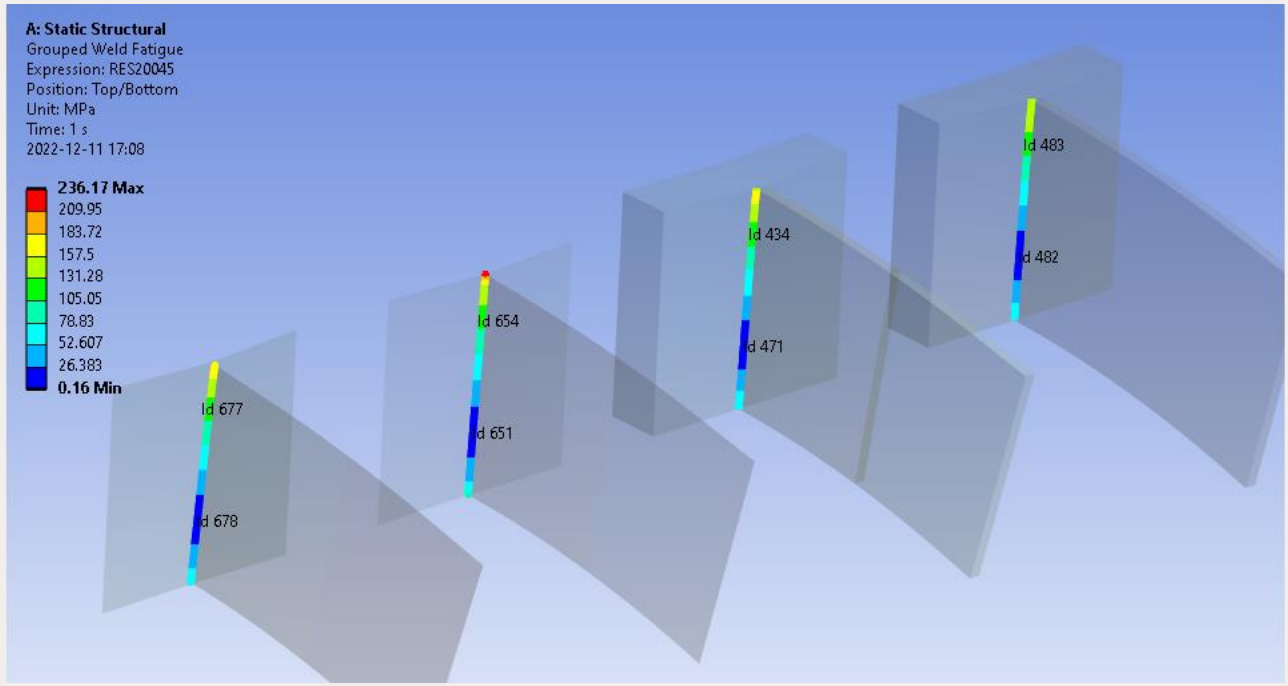
Grouped Result

- *Grouped Weld Strength/Fatigue* result combine many results within the same group in the model tree or from selected results from different analysis using the Solution Editor into one plot.
- The results *absMax*, *Max* or *Min* results can be evaluated to see the overall max from several load cases.



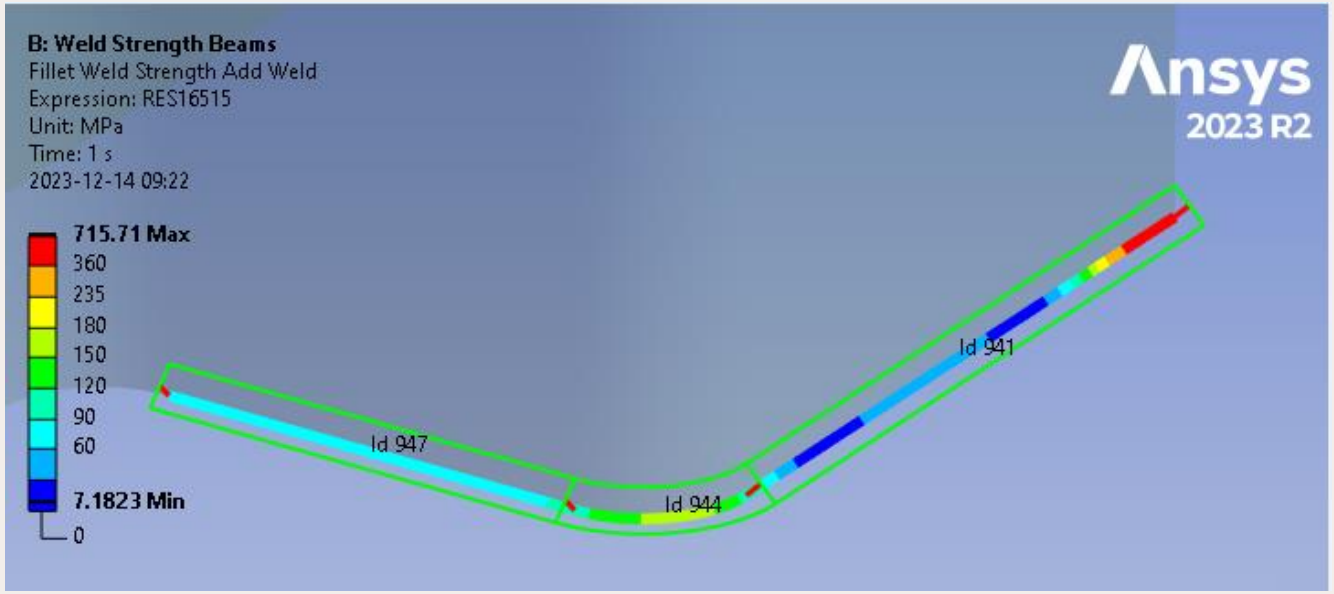






Worksheet Preview

- The “Worksheet Preview” is a feature in the *Report Generator* app that displays all details of a weld object including the result summary tables in the “Worksheet” window. (Report Generator license is not needed.)
- This feature is useful to look at the design values and different result items in the summary tables.



Fillet Weld Strength Add Weld Preview

Fillet Weld Strength Add Weld

Table 1. Fillet Weld Strength Add Weld property list

Result Name		Fillet Weld Strength Add Weld	Id 3074
Weld Geometry		Geometry select	A3 Fillet Welds_Id2978
Weld type	Single sided	Weld Side	Top
Min thickness	3.0 mm	Calc Min thickness	No
Free end offset	0.0 mm		
Total Weld Length	177.1 mm		
Weld Evaluation			
Weld code	Eurocode 3	Material grade	S235
Factor, α_w	0.6	Factor, β_w	0.8
Nominal weld strength, f_u	360. MPa	Safety factor, γ_{M2}	1.25
Dimensional equivalent stress, $f_{u.Seqv}$	360. MPa	Dimensional normal stress, $f_{u.Sn}$	259.20 MPa
Weld Result			
Weld result item	Seqv	Scale Factor Value	1.0
Weld result averaging	Floating	Floating factor	6.0
Weld result location	Auto	Stress Type (Wuf calculation)	Absolute Stress
Definition			
By	Time	Display Time	Last

Table 2. Fillet Weld Strength Add Weld summary

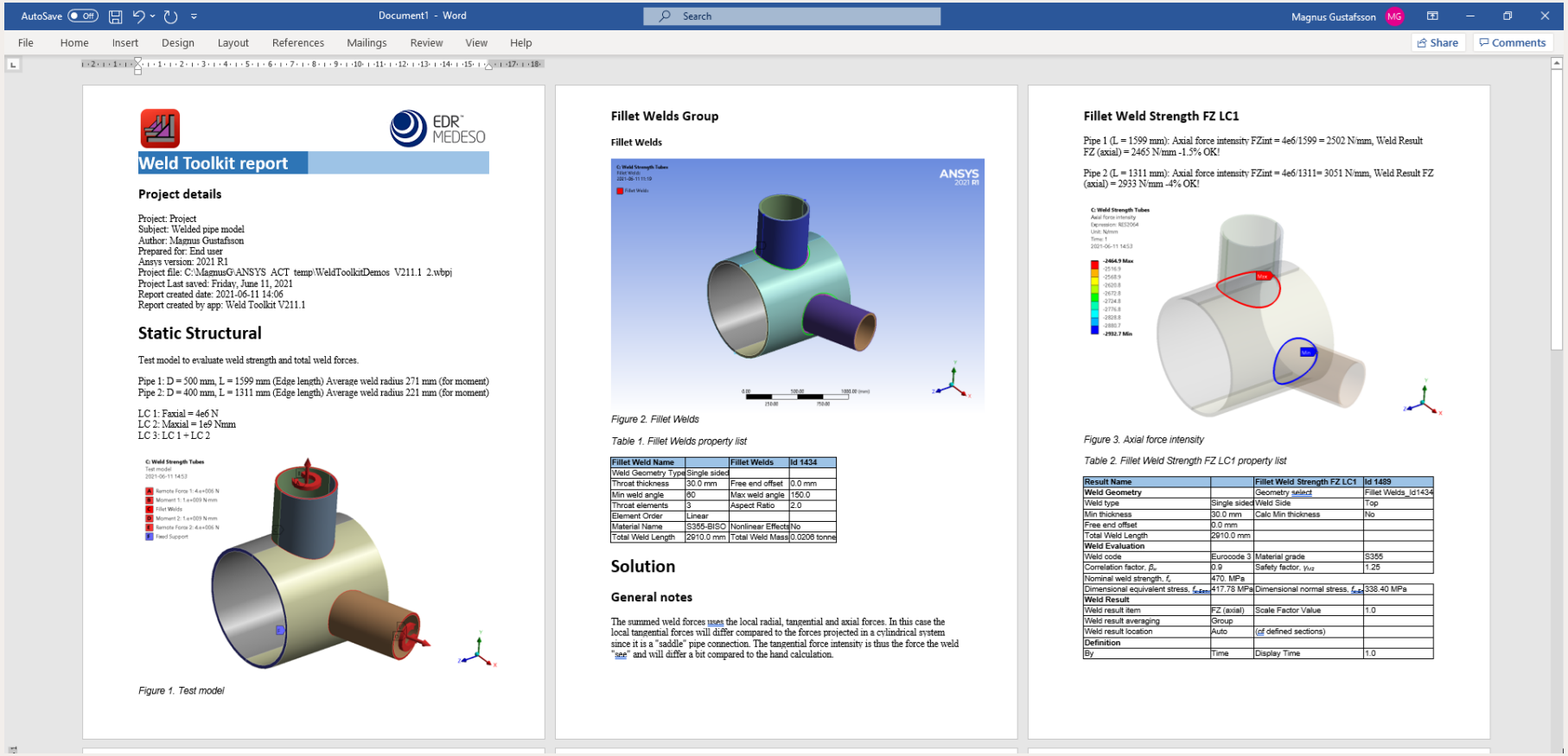
Group	Sect Id	Sect L [m]	a_{min} [mm]	FX (radial) [N/m]	FY (para) [N/m]	FZ (axial) [N/m]	FT (total) [N/m]	MY (para) [Nm/m]	Phi [deg]
1	941	0.095	3.0	-3.327e+04	7.808e+04	1.738e+05	1.934e+05	6.644e+02	66.2
1	944	0.024	3.0	-3.047e+05	-4.922e+04	3.160e+05	4.417e+05	5.509e+02	83.6
1	947	0.059	3.0	-1.281e+04	-6.635e+04	-1.078e+05	1.273e+05	3.137e+02	58.6

Table 3. Fillet Weld Strength Add Weld summary

Group	Sect Id	Wuf [-]	σ_{eqv} [MPa]	σ_{norm} [MPa]	τ_{para} [MPa]	τ_{norm} [MPa]	τ_{tot} [MPa]	σ_{para} [MPa]	σ_{bend} [MPa]	σ_{struc} [MPa]
1	941	0.244	87.8	-48.8	26.0	33.1	42.1	-49.3	442.9	491.7
1	944	0.564	149.1	-146.3	-16.4	2.7	16.6	-86.8	367.2	513.5
1	947	0.184	66.3	22.4	-22.1	-28.4	36.0	1.6	209.1	231.5

Weld Report

- A HTML formatted report of all welds and weld results including any comments, figures and images is created with a click on “Weld Report ” using the Report Generator app. (Report Generator license is not needed.)
- The report can be imported to Microsoft Word (Insert>Text from File…).



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Weld Toolkit report

Project details

Project: Project
Subject: Welded pipe model
Author: Magnus Gustafsson
Prepared for: End user
Ansys version: 2021 R1
Project file: C:\MagnusG\ANSYS ACT temp\WeldToolkitDemos V211.1 2.wbpj
Project Last saved: Friday, June 11, 2021
Report created date: 2021-06-11 14:06
Report created by app: Weld Toolkit V211.1

Static Structural

Test model to evaluate weld strength and total weld forces.

Pipe 1: D = 500 mm, L = 1599 mm (Edge length) Average weld radius 271 mm (for moment)
Pipe 2: D = 400 mm, L = 1311 mm (Edge length) Average weld radius 221 mm (for moment)

LC 1: Faxial = 4e6 N
LC 2: Maxial = 1e9 Nmm
LC 3: LC 1 + LC 2

Figure 1. Test model

Fillet Welds Group

Fillet Welds

Figure 2. Fillet Welds

Table 1. Fillet Welds property list

Fillet Weld Name		Fillet Welds	Id 1434
Weld Geometry Type	Single sided		
Throat thickness	30.0 mm	Free end offset	0.0 mm
Min weld angle	60	Max weld angle	150.0
Throat elements	3	Aspect Ratio	2.0
Element Order	Linear		
Material Name	S355-BISO	Nonlinear Effects	No
Total Weld Length	2910.0 mm	Total Weld Mass	0.0206 tonne

Solution

General notes

The summed weld forces uses the local radial, tangential and axial forces. In this case the local tangential forces will differ compared to the forces projected in a cylindrical system since it is a "saddle" pipe connection. The tangential force intensity is thus the force the weld "see" and will differ a bit compared to the hand calculation.

Fillet Weld Strength FZ LC1

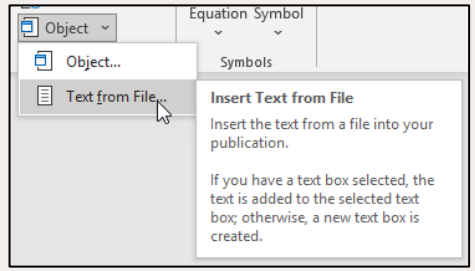
Pipe 1 (L = 1599 mm): Axial force intensity FZint = 4e6/1599 = 2502 N/mm, Weld Result FZ (axial) = 2465 N/mm -1.5% OK!

Pipe 2 (L = 1311 mm): Axial force intensity FZint = 4e6/1311= 3051 N/mm, Weld Result FZ (axial) = 2933 N/mm -4% OK!

Figure 3. Axial force intensity

Table 2. Fillet Weld Strength FZ LC1 property list

Result Name		Fillet Weld Strength FZ LC1	Id 1489
Weld Geometry		Geometry select	Fillet Welds_Id1434
Weld type	Single sided	Weld Side	Top
Min thickness	30.0 mm	Calc Min thickness	No
Free end offset	0.0 mm		
Total Weld Length	2910.0 mm		
Weld Evaluation			
Weld code	Eurocode 3	Material grade	S355
Correlation factor, β_w	0.9	Safety factor, γ_{M2}	1.25
Nominal weld strength, f_v	470. MPa		
Dimensional equivalent stress, $f_{v,Ed}$	417.78 MPa	Dimensional normal stress, f_{wd}	338.40 MPa
Weld Result			
Weld result item	FZ (axial)	Scale Factor Value	1.0
Weld result averaging	Group		
Weld result location	Auto	(of defined sections)	
Definition			
By	Time	Display Time	1.0



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User defined Weld codes & S-N Curves

- Weld Settings control panel to edit default values for add welds, strength and fatigue results.
- User define weld strength codes and material grades can be added in addition to Eurocode 3 and AWS.
- User defined weld fatigue S-N curves (FAT class) can be added in addition to IIW, Eurocode 3/9 and DNV.

Details of "Weld Settings"

General Settings	
Show Weld Id number	Yes
Store Results At	All Available Time Points
Post processing MAPDL license	Default
Add Weld Settings	
Weld Strength Settings	
Default weld size	3 mm
Weld size increment	1 mm
Maximum Weld size	99 mm
Calculate Time History	No
Always Plot Fillet Weld	No
Always Plot Weld CSYS	No
Always Plot APDL CSYS	No
Plot Weld Node CSYS	No
Condensed Segment CSV	No
Print Group average in Weld Report	No
Weld Force Extraction	Contact Element
Weld Fatigue Settings	
Weld Code Editor	
Edit Weld Code	No
FAT Class Editor	
Edit FAT Class	No

Material grade

Name	Weld Yield Strength, Fy	Weld Ultimate Strength, Fu	Factor, alfaw	Factor, betaw	Safety factor, gammaM2	Load factor, gammaL
S235	0 [MPa]	360 [MPa]	0.6	0.8	1.25	0
S275	0 [MPa]	410 [MPa]	0.6	0.85	1.25	0
S355	0 [MPa]	470 [MPa]	0.6	0.9	1.25	0
S420	0 [MPa]	520 [MPa]	0.6	1	1.25	0
S460	0 [MPa]	540 [MPa]	0.6	1	1.25	0

FAT Class List

FAT Class	FAT (@ Nfat cycles)	Nfat	N0	Nc	Ncutoff	Slope, m0	Slope, m1	Slope, m2
IIW FAT160 steel	160 [MPa]	2000000	0	10000000	10000000000	3	5	22
IIW FAT125 steel	125 [MPa]	2000000	314018	10000000	10000000000	5	3	22
IIW FAT112 steel	112 [MPa]	2000000	137805	10000000	10000000000	5	3	22
IIW FAT100 steel	100 [MPa]	2000000	58902	10000000	10000000000	5	3	22
IIW FAT90 steel	90 [MPa]	2000000	26727	10000000	10000000000	5	3	22
IIW FAT80 steel	80 [MPa]	2000000	11049	10000000	10000000000	5	3	22
IIW FAT71 steel	71 [MPa]	2000000	4514	10000000	10000000000	5	3	22
IIW FAT63 steel	63 [MPa]	2000000	1842	10000000	10000000000	5	3	22
IIW FAT56 steel	56 [MPa]	2000000	761	10000000	10000000000	5	3	22

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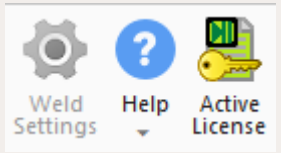

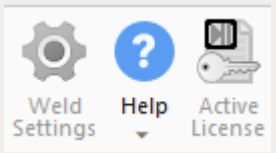

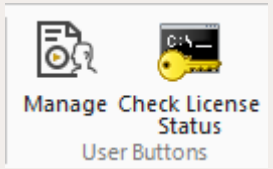

References

- Weld Strength calculation according to:

  Eurocode 3: EN 1993-1-8:2005. Design of steel structures - Part 1-8: Design of joints
  [Authority: The European Union Per Regulation 305/2011, Directive 98/34/EC, Directive 2004/18/EC]

  AWS D1.1/AISC 360-16 Specification for Structural Steel Builds

- Lamellar Strength according to:

  Eurocode 3: EN 1993-1-10:2005. Design of steel structures - Part 1-10: Material toughness and through-thickness properties
  [Authority: The European Union Per Regulation 305/2011, Directive 98/34/EC, Directive 2004/18/EC]

- Weld Fatigue calculation according to:

  Recommendations for Fatigue Design of Welded Joints and Components, Second Edition. A.F. Hobbacher. International Institute of Welding (IIW)

  RP-C203: Fatigue design of offshore steel structures DNVGL-RP-0005:2014-06

  EN 1993-1-9:2005 Eurocode 3: Design of steel structures - Part 1-9: Fatigue
  [Authority: The European Union Per Regulation 305/2011, Directive 98/34/EC, Directive 2004/18/EC]

  EN 1999-1-3:2007 Eurocode 9: Design of aluminum structures - Part 1-3: Structures susceptible to fatigue
  [Authority: The European Union Per Regulation 305/2011, Directive 98/34/EC, Directive 2004/18/EC]

Thank You!

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