Simplified fatigue assessment according to EN13445-3 Clause 17 and AD 2000 S 1

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Online version: https://nextgen.sant-ambrogio.it/KB969721
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With NextGen it is possible to calculate an item subjected to fatigue "by formulae", for projects according to EN 13445 or AD 2000. This allows a fatigue calculation in a simpler and faster way than normally needed when a finite analysis is involved.

> *For detailed fatigue analysis, described in chapters EN 13445 Clause 18 and AD 20000 S 2 there is a dedicated article.*

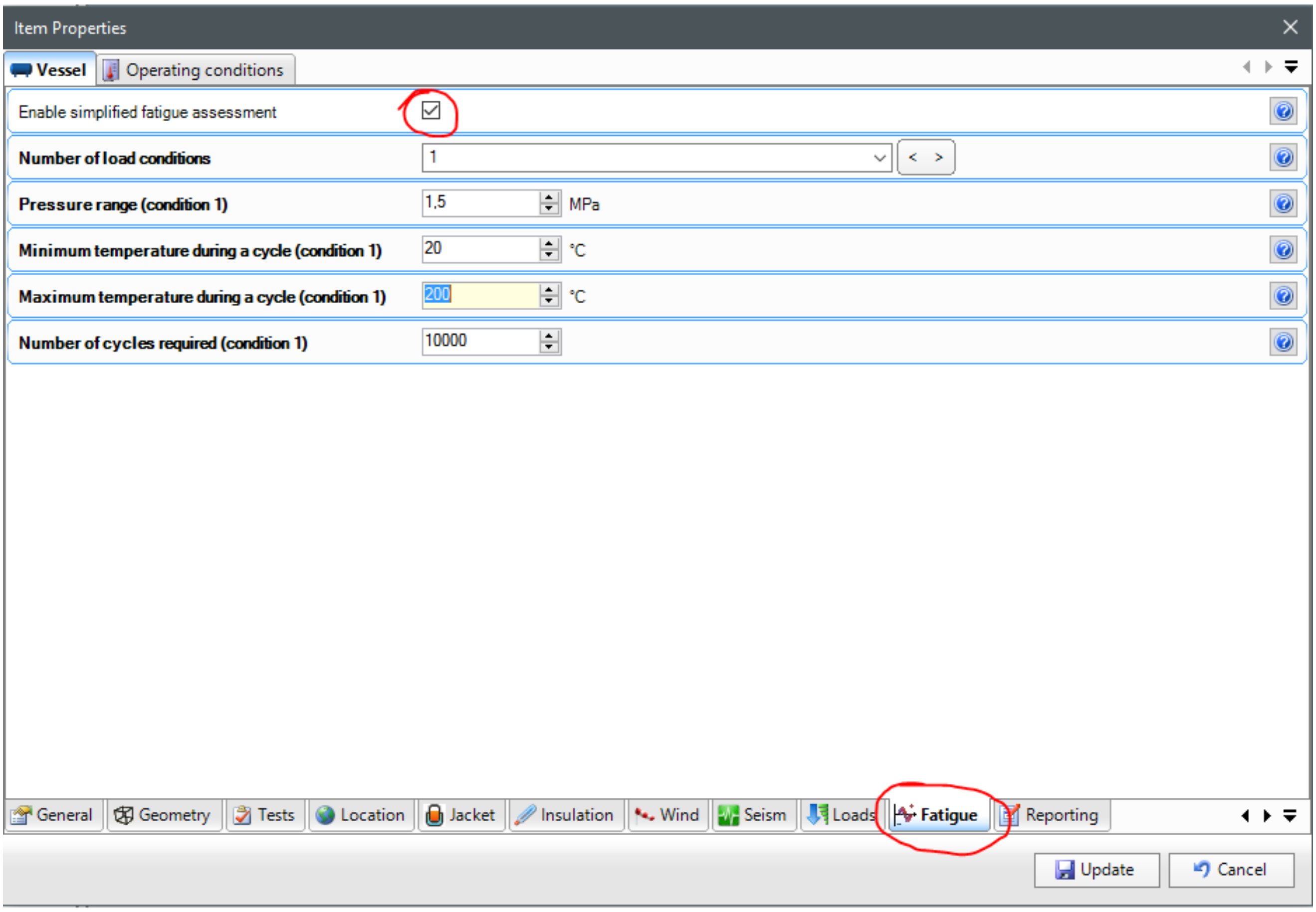
Fatigue calculation is composed by two main operations:

- Definition on Item level of fatigue conditions and required number of cycles
- Definition on Component level of weld details or critical non-welded parts

This article shows examples from EN 13445, but the same considerations apply to AD 2000. See the respective chapters of the standards for more information about the calculation implementations.

Item properties definition

General definition of fatigue occurs in Item properties (File > Item properties > Fatigue). Fatigue detail fields appear once "Enable simplified fatigue assessment" is enabled:

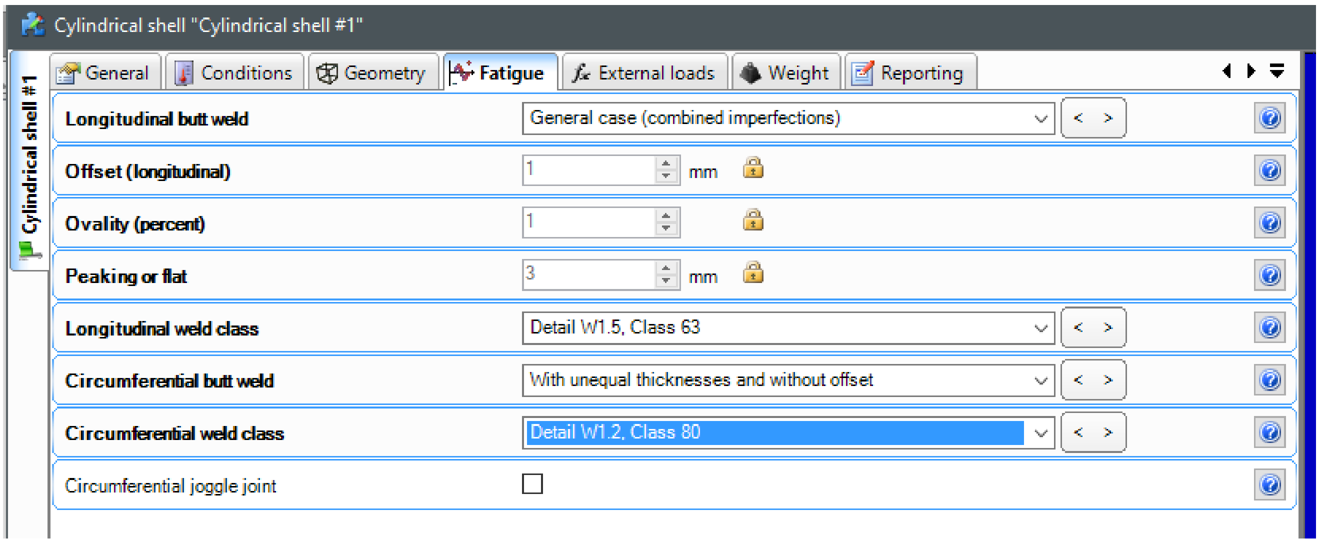


> *Warning: Setting these properties alone* ***does not produce any checks***. *Without the following steps, no fatigue analysis will be performed.*

Components properties definition

After this options are defined, enabled components will show a new "Fatigue" tab: welded and unwelded critical areas details are then available under this tab according to what's stated in calculation code.

The following screenshot shows definition of details on a cylindrical shell:



In this example both longitudinal and circumferential welds are defined. Longitudinal weld has a general case of combined imperfections, with default automatically calculated values for offset, ovality and peeking. As always, user can manually set values by unlocking the padlock icon. For both welds a weld class is defined.

> *All properties under this section have a contextual help ("?" button) that shows suggestions and tables taken from the calculation code.*

Calculation occurs like other pressure parts, in real time once all data are filled in. Detailed calculation is available in calculation report; component report is enriched with a new section:

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Load condition 1, load details			
Design pressure	P	=	1.00 MPa
Pressure range	ΔP	=	1.50 MPa
Minimum operating temperature during cycle	Tmin	=	20.00 °C
Maximum operating temperature during cycle	Tmax	=	200.00 °C
Design temperature	T	=	200.00 °C
Number of required fatigue cycles	Nreq	=	10 000
Highest allowable stress between involved materials contributing to Pmax	f	=	183.33 MPa
Ultimate tensile strength at room temperature	Rm	=	510.00 MPa
Yield strength at design temperature	Rp0.2/T	=	275.00 MPa
Load condition 1, Longitudinal butt weld			
Maximum allowable pressure (component)	Pmax	=	14.07 MPa
Nominal thickness	en	=	7.11 mm
Inside diameter	Di	=	154.08 mm
Offset	δo	=	1.00 mm
Peeking or flat	δpf	=	3.00 mm
Ovality	u	=	1%
Partial stress factor	η1=(3·δo)/en	=	0.42194
Partial stress factor	η2=1.5·u·(Di/en)	=	0.32506
Partial stress factor	η4=6·δpf/en	=	2.53165
Stress factor	η=(1+η1+η2+η4)·z	=	4.27865
Pseudo-elastic stress range	Δσ=(ΔP/Pmax)·η·f	=	83.60 MPa
Equivalent number of full pressure cycles	Neq	=	12.10611
Thickness correction factor	Ce	=	1.00000
Assumed mean cycle temperature	T*=0.75·Tmax+0.25·Tmin	=	155.00 °C
Temperature correction factor	CT	=	0.97071
Weld class	C	=	63
Endurance limit	ΔσD	=	46.43 MPa
Cut-off limit	Δσcut	=	25.52 MPa
Fictitious stress range for insertion into the fatigue design curves	Δσ*=[Δσ/Ce·CT]	=	86.12 MPa
Number of allowable fatigue cycles	N=5e+6·(0.737·C/Δσ*)³	=	783 460
Partial fatigue damage index	D=Nreq/N	=	0.01276

Complete item report has a summary page stating how much each component detail weights in the total damage index:

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Load condition, component, detail	**Required cycles**	**Allowable cycles**	**Damage index**
1, Cylindrical shell #1, Longitudinal butt weld	10000	783459	0,013
1, Cylindrical shell #1, Circumferential butt weld	10000	Unlimited	0,000

Load conditions index

1: ΔP=1.50 MPa - Tmin=20.00 °C - Tmax=200.00 °C - Required cycles=10000

Allowable number of cycles: 783459 (limited by Load condition 1, Cylindrical shell #1, Longitudinal butt weld)