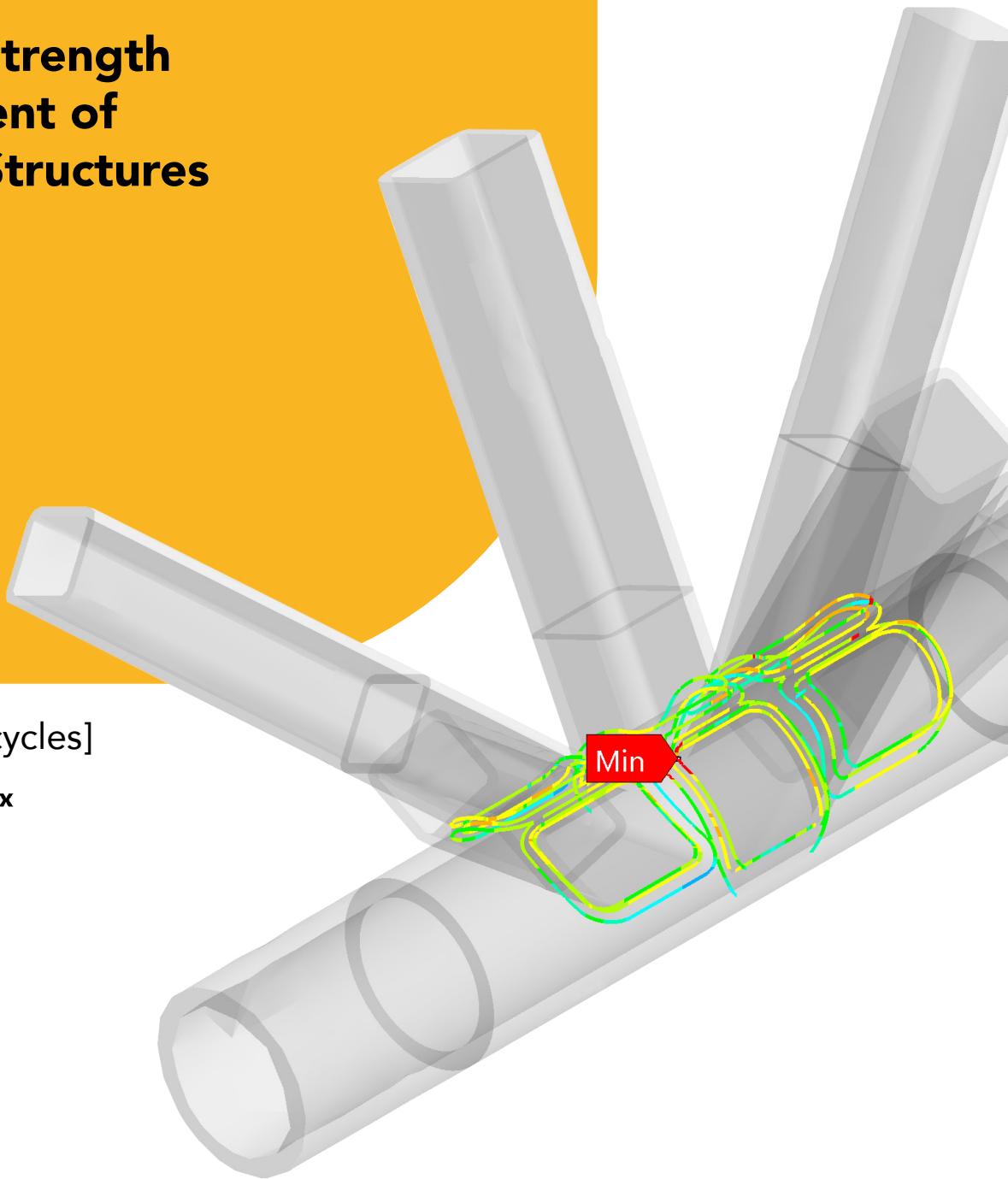
PSM APP

Automated implementation
of the **Peak Stress Method**
in Ansys® Mechanical

Fatigue Strength Assessment of Welded Structures



Fatigue life [cycles]

3.54e+10 Max
5.21e9
7.67e8
1.13e8
1.66e7
2.44e6
3.59e5
5.29e4
7.78e3
1.15e3 Min

UNIVERSITÀ DEGLI STUDI DI PADOVA

DEPARTMENT OF INDUSTRIAL ENGINEERING

ZAMPERLA
THE AMUSEMENT GROUP

In modern engineering, the **fatigue design of large-scale welded structures** involves complex geometries and real-life time-variant multiaxial loadings.
Design methods currently available do not always guarantee accurate fatigue strength estimations, particularly when **non-classified welded joints** are considered.

The Peak Stress Method (PSM) is a FE-oriented local approach to estimate the fatigue lifetime of welded structures **under Constant Amplitude (CA) and Variable Amplitude (VA) uniaxial and multiaxial loadings**, starting from the local geometry of the welds. Despite considering local stress at the fatigue critical locations (weld toes and weld roots), **the PSM adoptes relatively coarse FE mesh patterns**.

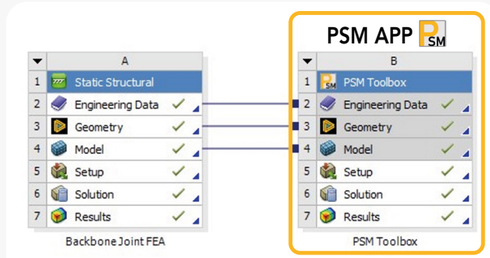
Fatigue strength assessment based on the local geometry of the welds

- **Local fatigue analysis** of 3D welds starting from stress results of a linear elastic FE analysis
- **Assessment of welded structures** under CA and VA multiaxial loads
- **Import load spectra or load time histories** coming from in-field acquisitions, multi-body analyses
- Features PSM-based fatigue design curves **validated against more than 2000 experimental results**
- Fatigue life estimation of structural steel/ aluminium alloys welded structures using PSM design curves
- **Shape and size effects** of the welded structure **are included** in the method

Automated tools to speed up the fatigue design of complex structures

- **Automatic detection** of weld roots and weld toes in the structure
- **Automatic mesh generation** according to PSM requirements
- Peak-Valley reduction and **Rainflow cycle-counting** for imported VA loads data
- **Mesh-independent equivalent peak stress** and fatigue life nodal results
- **Results visualization** through edge-contour plots, graphs and tabular data compatible with MS® Excel
- **Time ratio ~ 1/10 ÷ 1** between PSM App analysis and linear elastic FE analysis (in CA load cases)

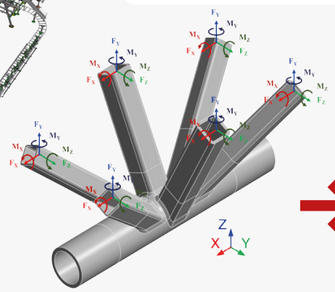
Automated fatigue analysis according to the Peak Stress Method

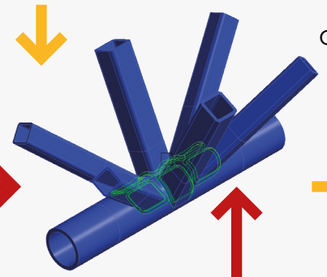


Direct integration with native Ansys® Mechanical UI as a fatigue analysis toolbox

Dedicated PSM Toolbox in Ansys® Mechanical Toolbar

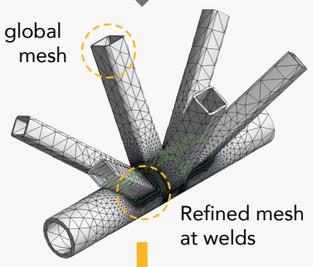
Linear elastic FE analysis



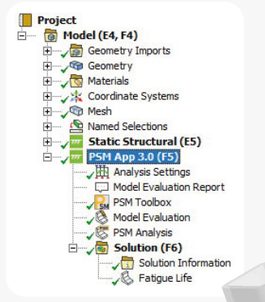


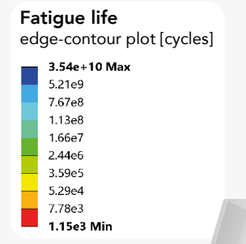
Automated mesh generation in compliance with the PSM

Coarse global mesh



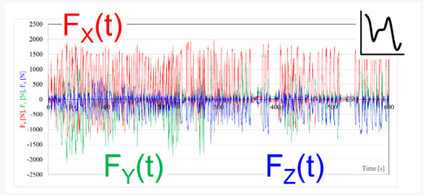
Refined mesh at welds





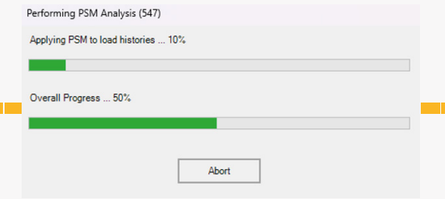
Thunderbolt Roller Coaster by Zamperla®

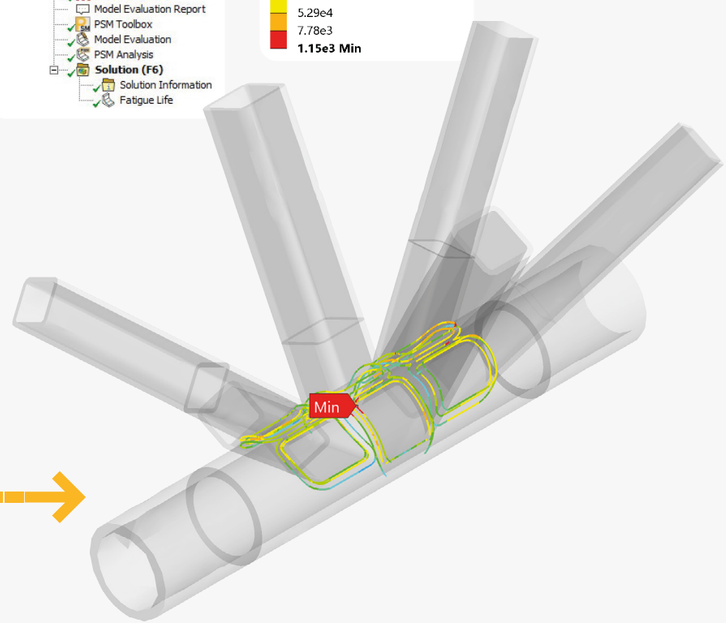
Automated identification of all weld roots/toes in the model



Load time-histories from in-field acquisition / multi-body analyses

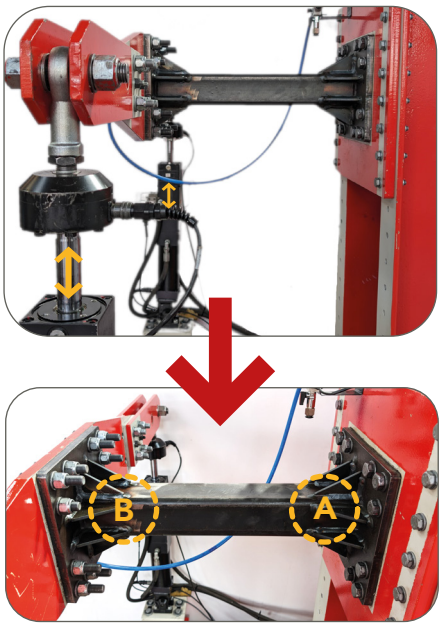
Automated fatigue strength assessment of all weld roots/toes in the model

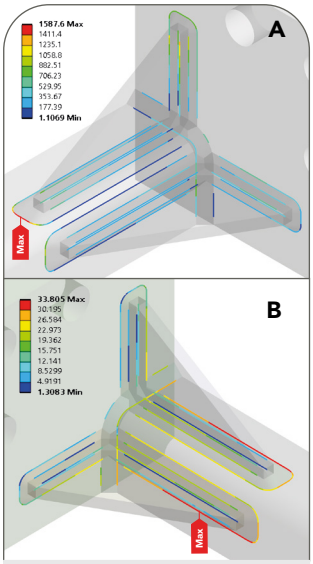




Industrial cases of welded structures → **Experimental fatigue testing** → **Automated fatigue strength assessment** PSM

Case study
Amusement park structures

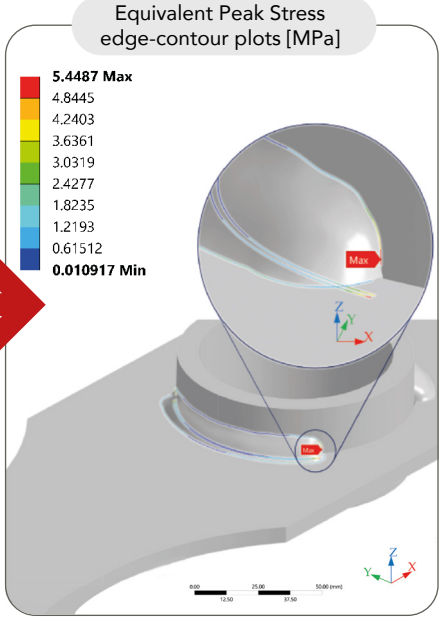




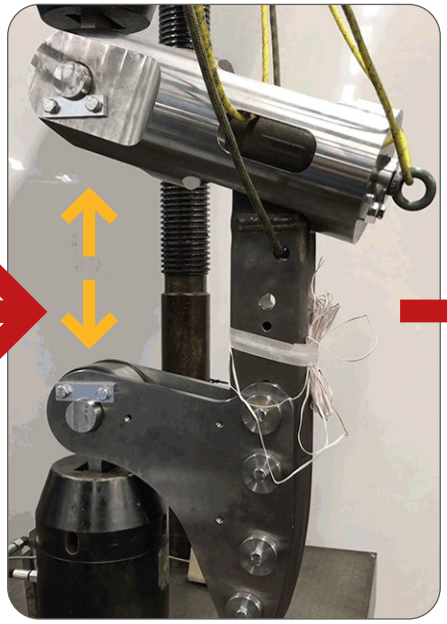
Equivalent Peak Stress edge-contour plots [MPa]

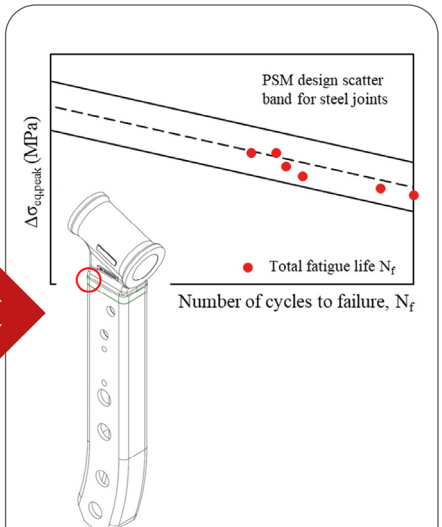
Case study
Axles of off-road vehicles

Equivalent Peak Stress edge-contour plots [MPa]



Case study Suspension for cableway vehicles





Fatigue lifetime estimations using PSM design curves

✉ **Contacts:** Prof. Giovanni Meneghetti - giovanni.meneghetti@unipd.it