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Experimental investigations on the fatigue resistance of automatically welded tubular X-joints for jacket support structures

Prof. Peter Schaumann, LUH
***Karsten Schürmann**, LUH*
Dr. Andreas Pittner, BAM
Prof. Michael Rethmeier, BAM

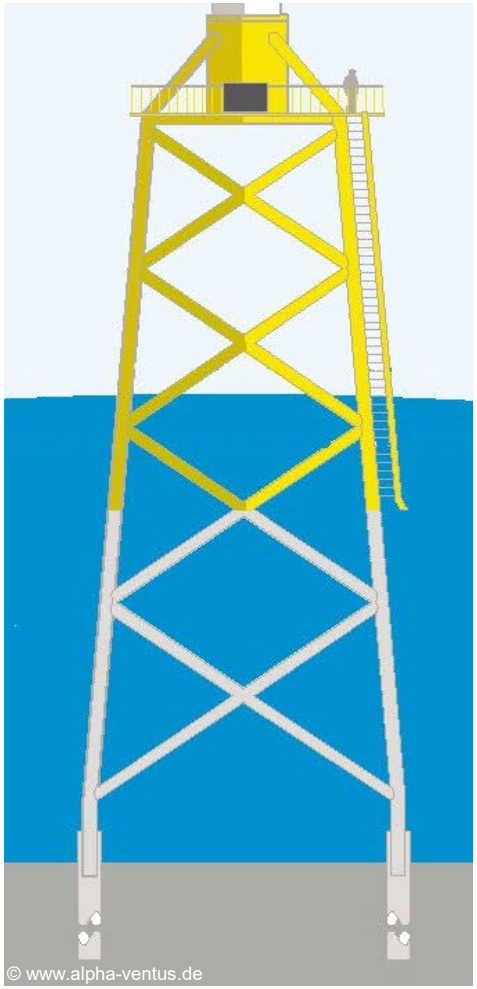
Leibniz Universität Hannover

Institute for Steel Construction
Prof. Dr.-Ing. Peter Schaumann

ForWind
Center for Wind Energy Research
Bremen
Hannover
Oldenburg

Motivation

- Innovative standardised jacket foundations



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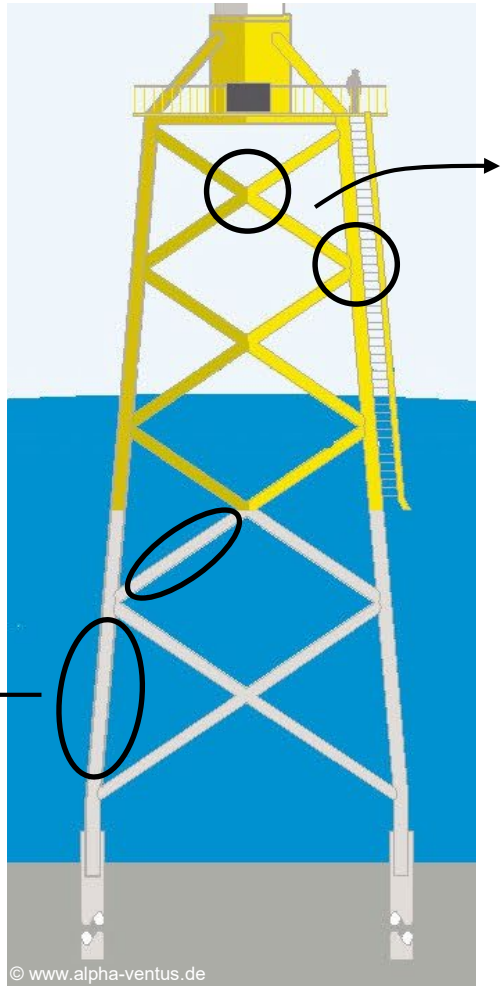
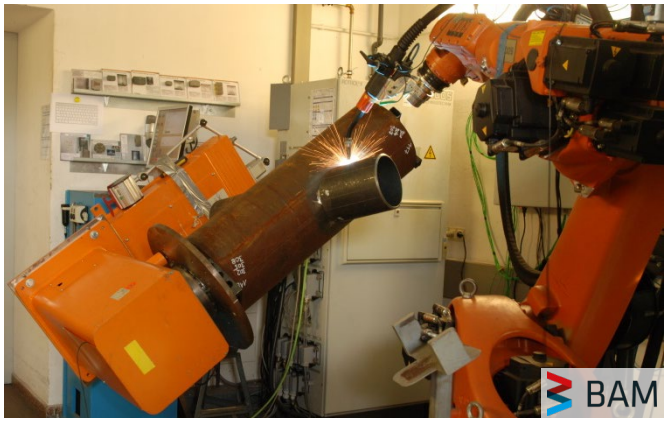
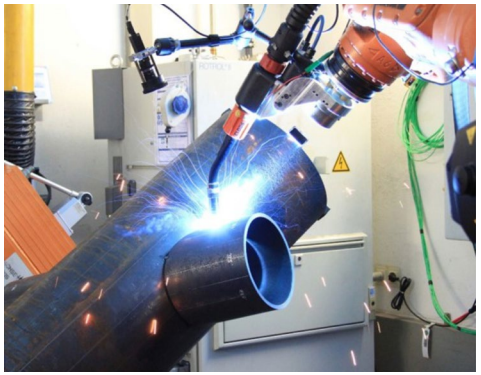
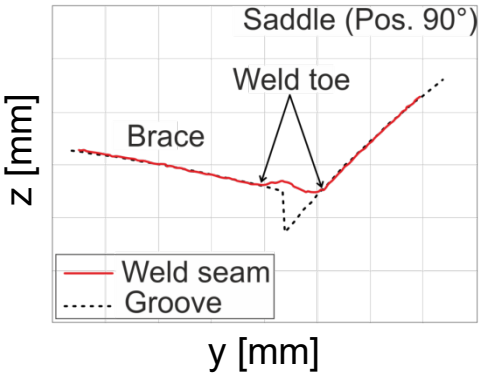




Outline

Automatically Welding Procedure

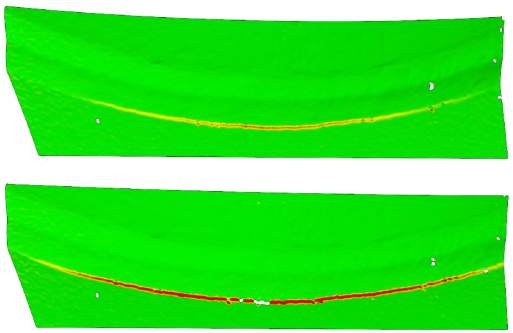


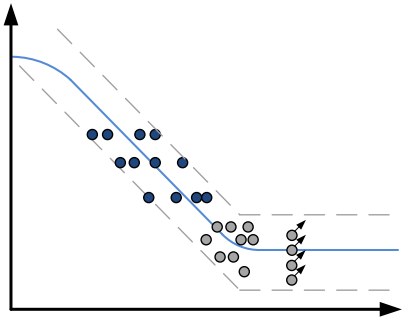


BAM

Axial Fatigue Tests

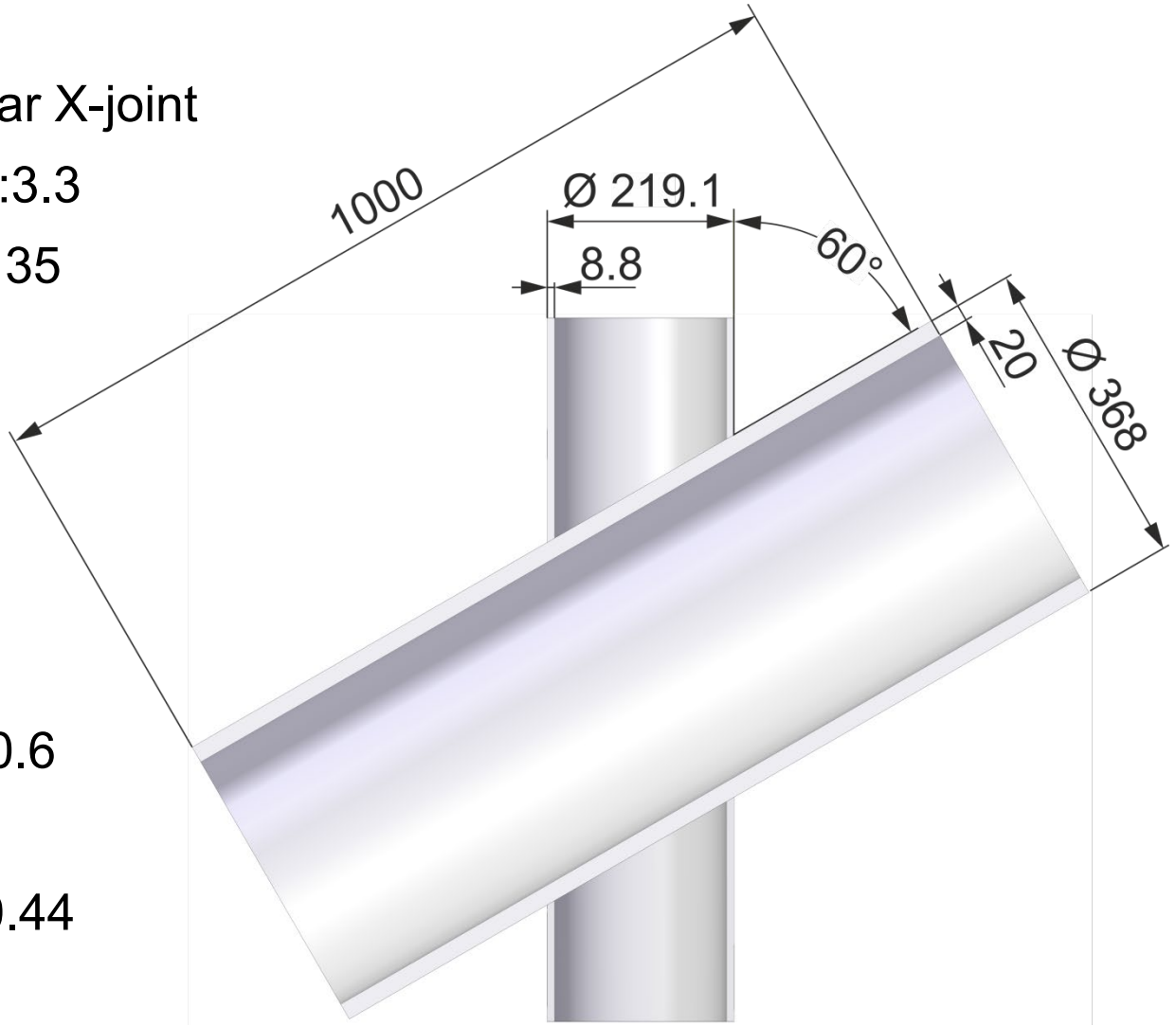
Fatigue Test Analysis





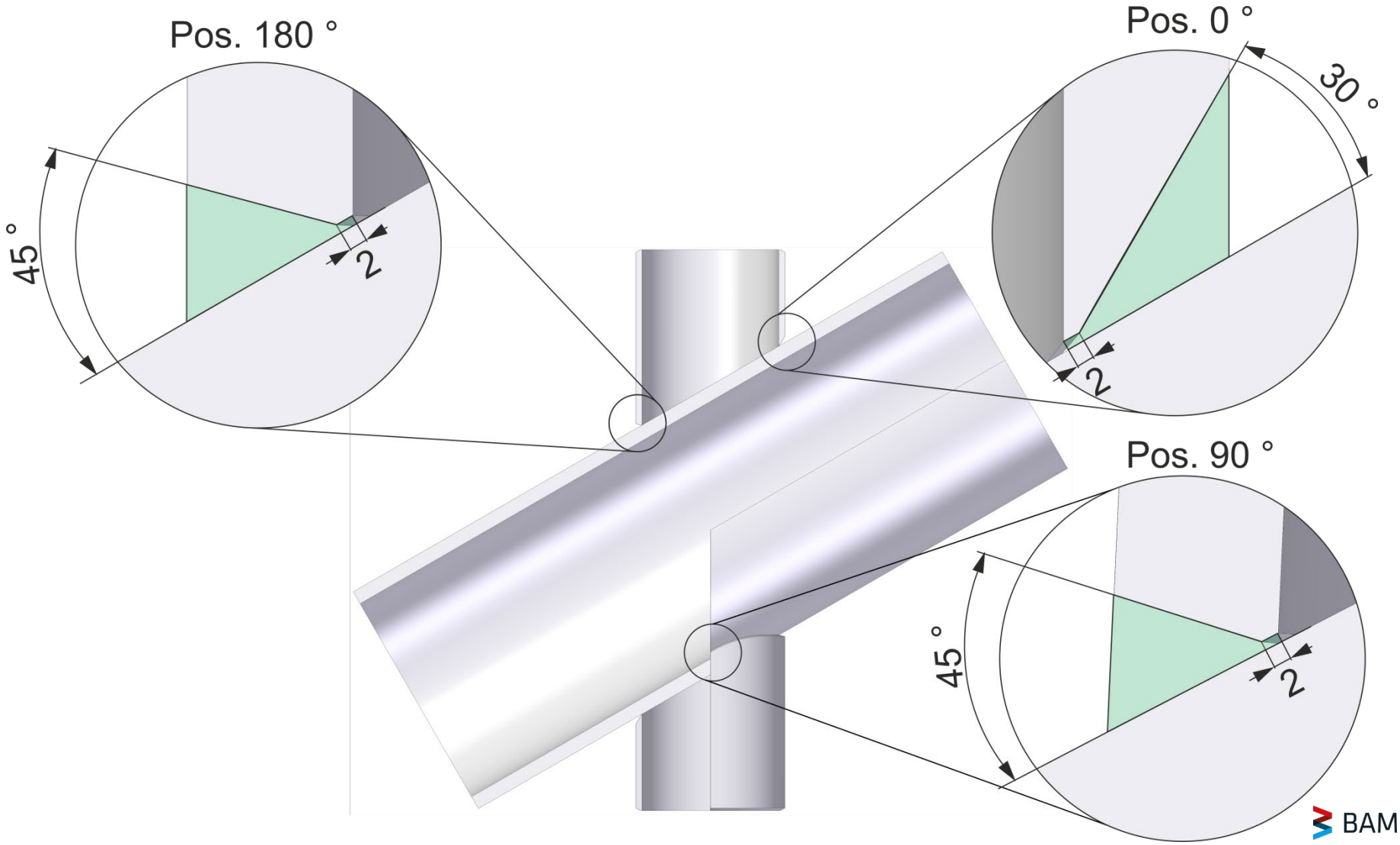
Geometrical Dimensions

- Scaled tubular X-joint
  - Scaling 1:3.3
- S355 J2 + Z 35



- $\beta = \frac{d_{Brace}}{D_{Chord}} = 0.6$
- $\tau = \frac{t_{Brace}}{T_{Chord}} = 0.44$

Weld Seam Preparation



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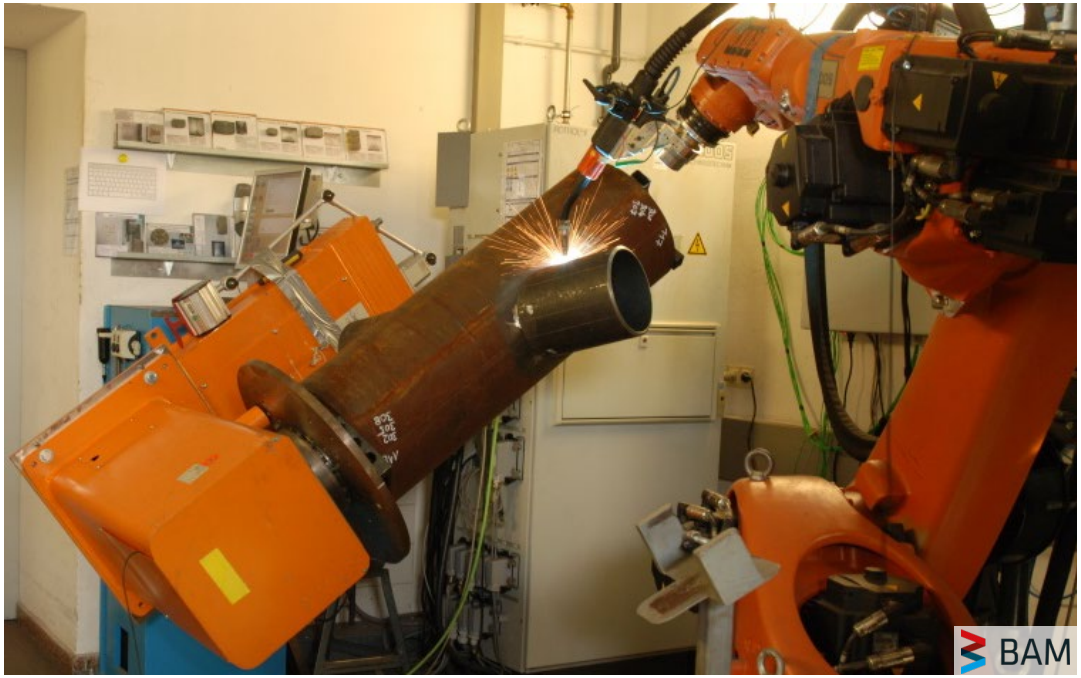
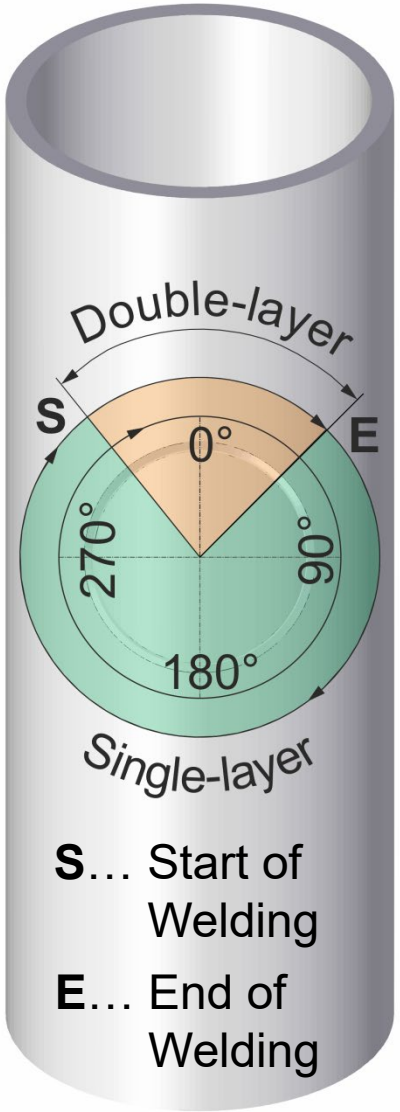
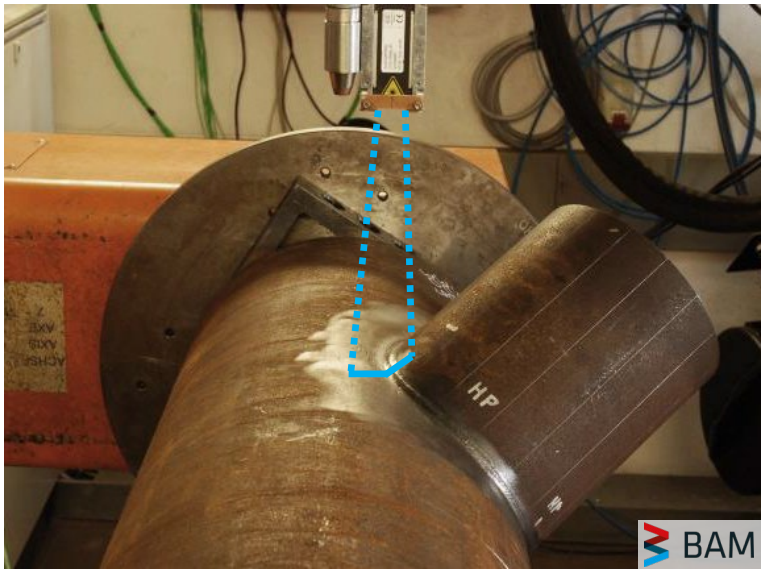
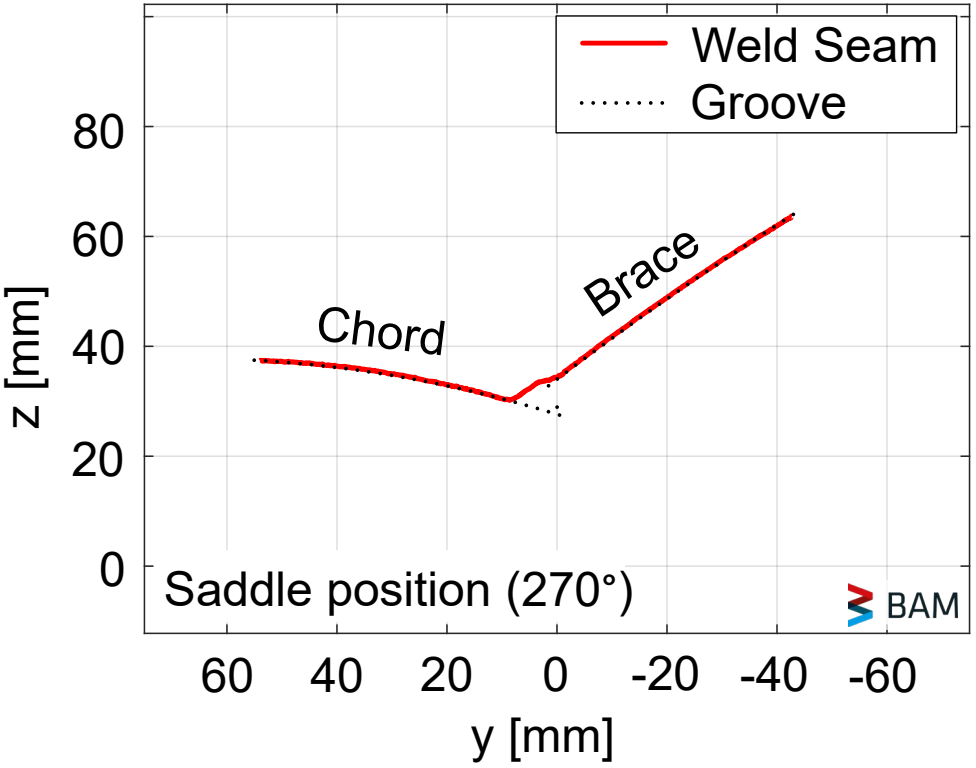




Laser Scanning of Weld Geometry

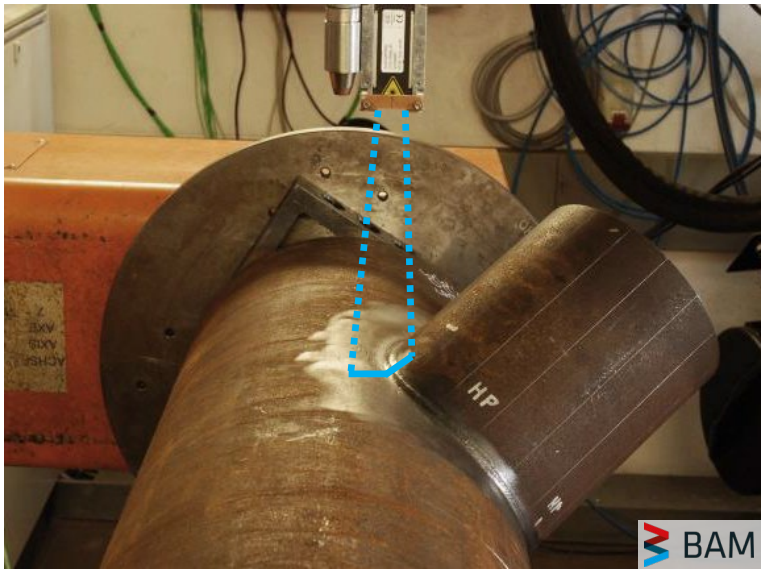
- Scanning of weld geometry utilizing a blue line laser
- Input for numerical analysis

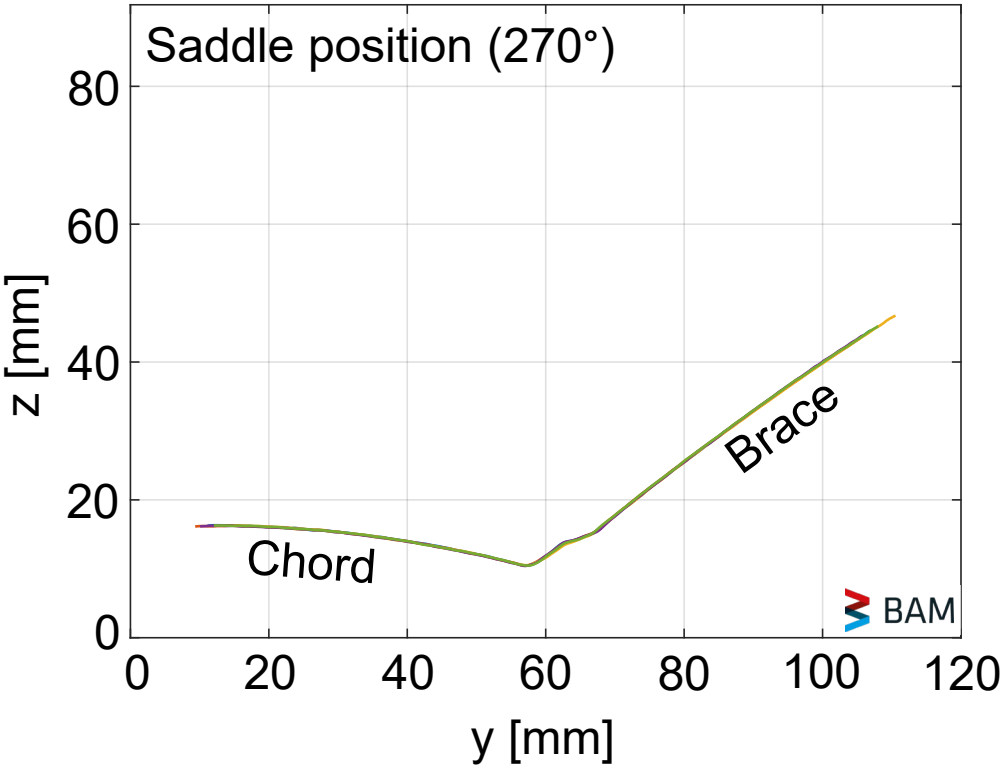




Reproducibility of Weld Geometry

- Comparing weld geometry of 28 tubular X-joints

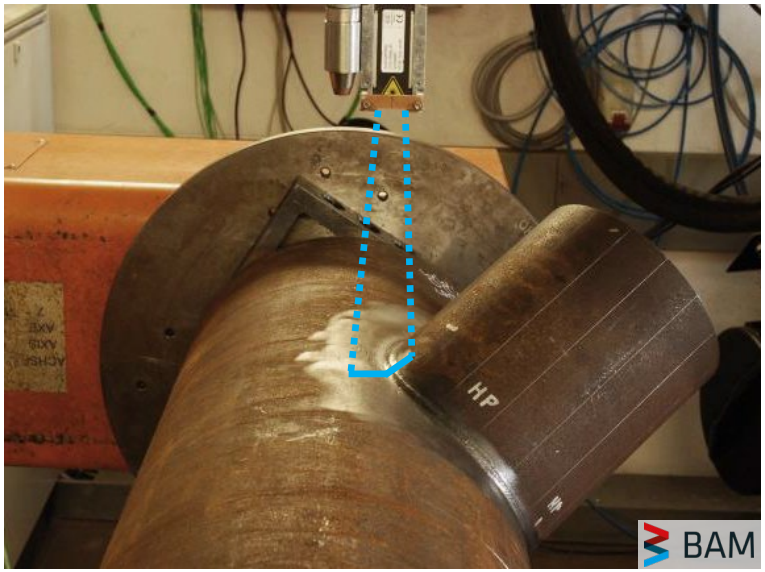


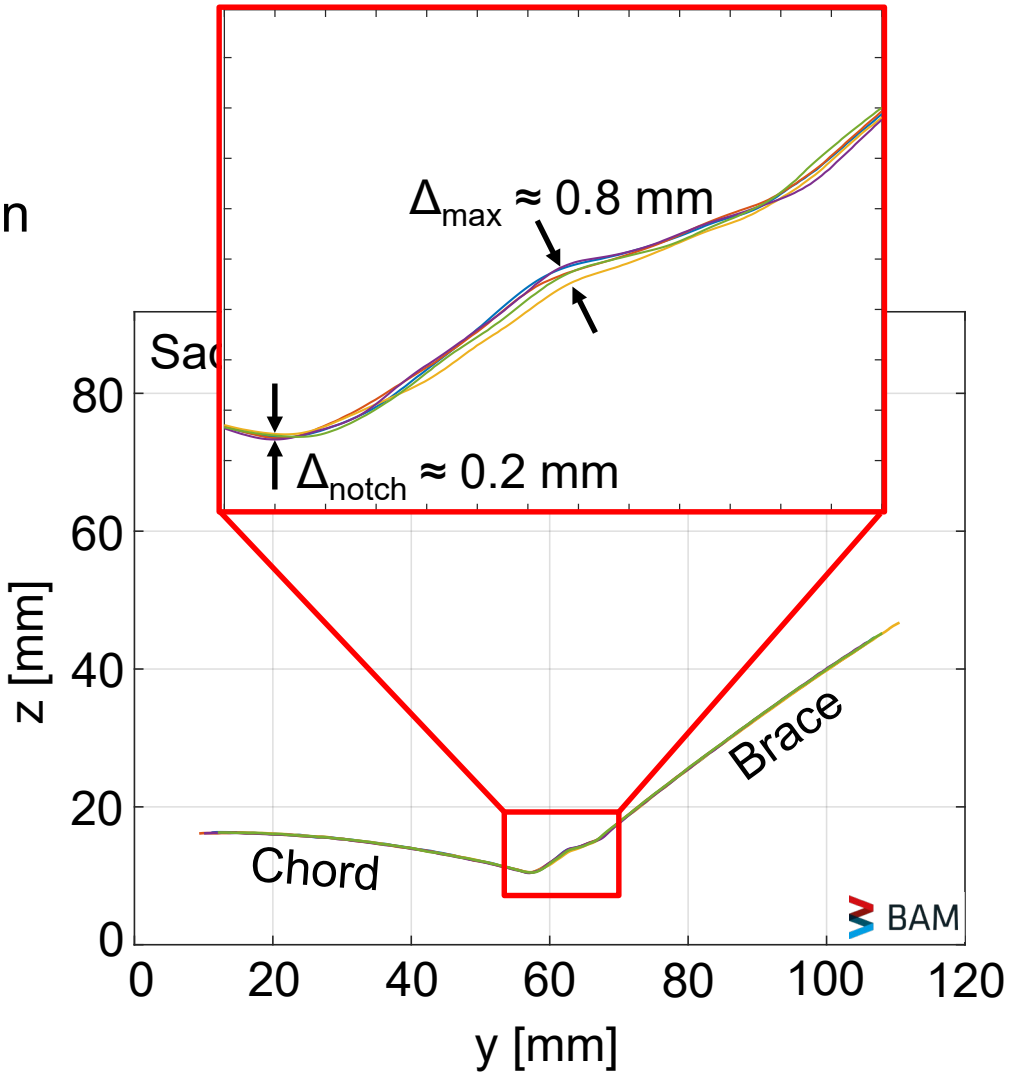


Reproducibility of Weld Geometry

- Comparing weld geometry of 28 tubular X-joints

  →Good reproducibility is given



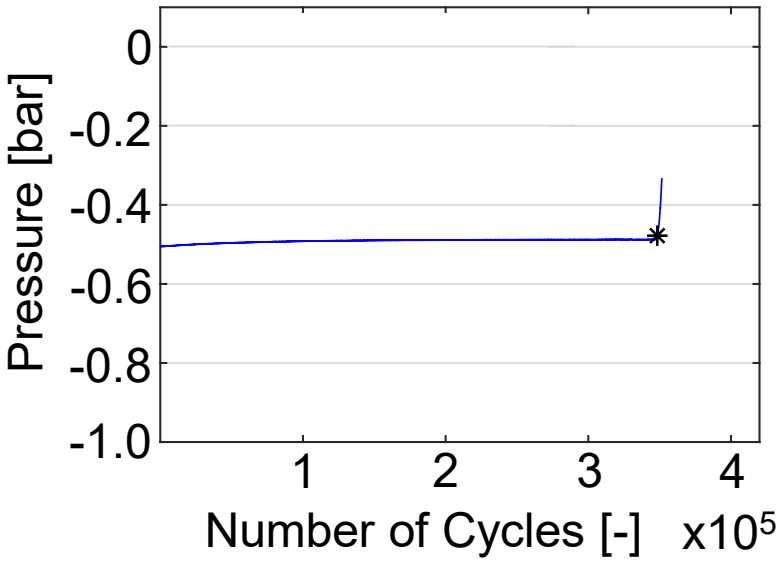


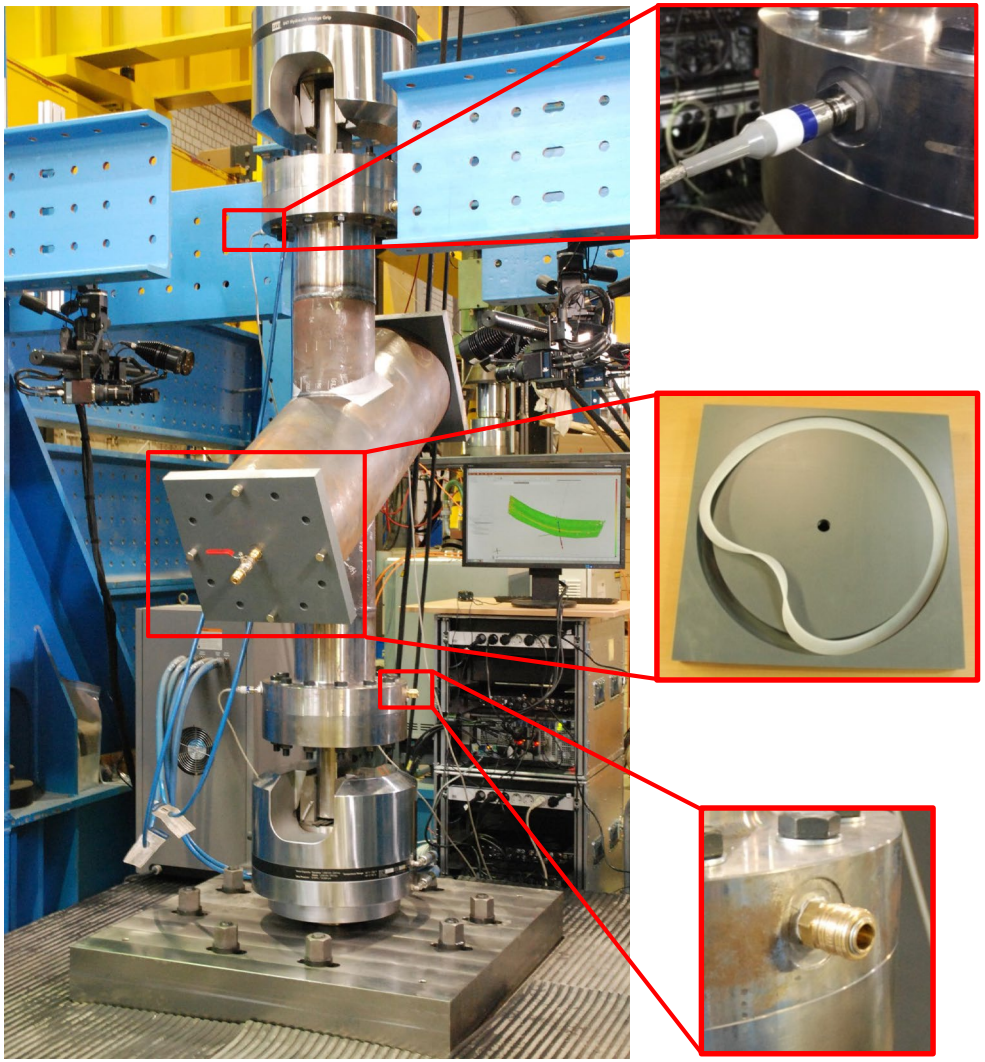
Test Setup of Axial Fatigue Tests

- High cycle fatigue range;
  R = 0.1; f = 5 Hz

Test Setup of Axial Fatigue Tests

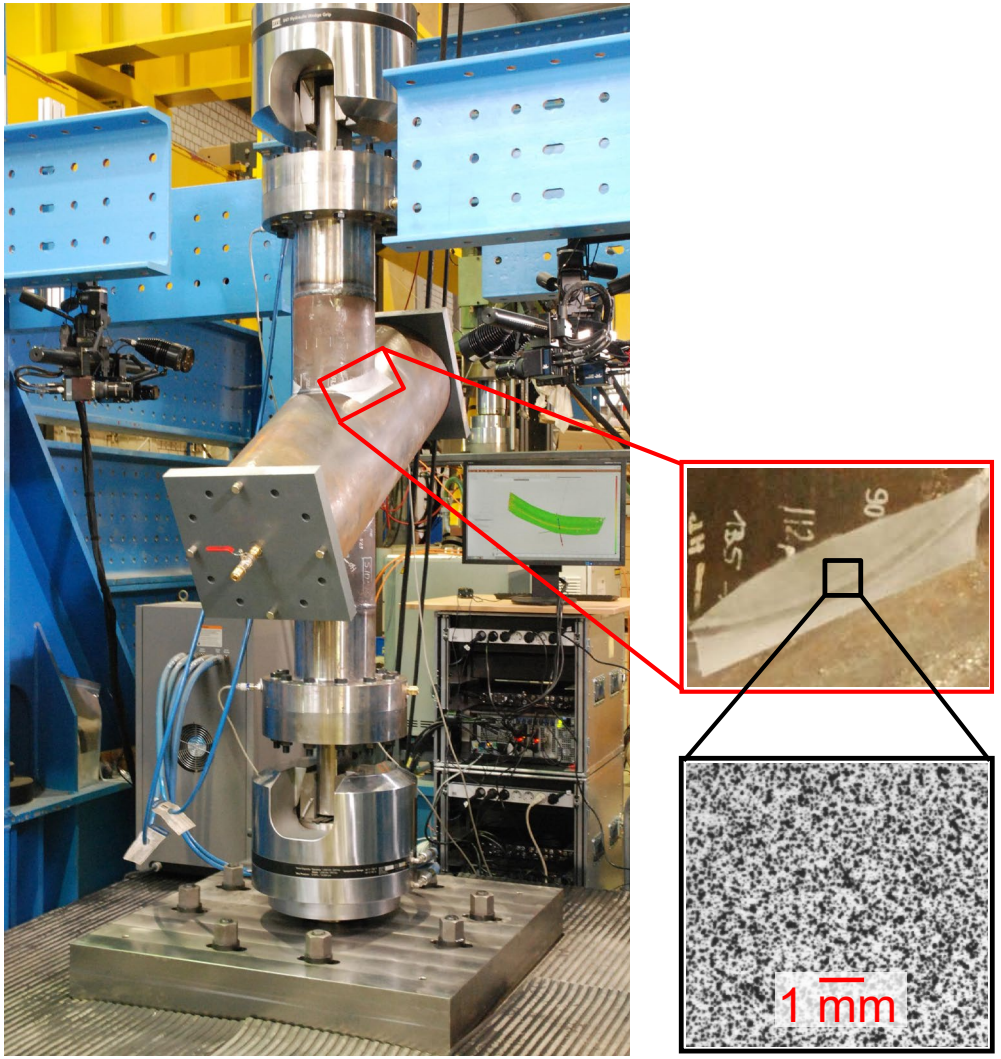
- High cycle fatigue range; R = 0.1; f = 5 Hz
- Through thickness crack
  →Loss of over/under pressure



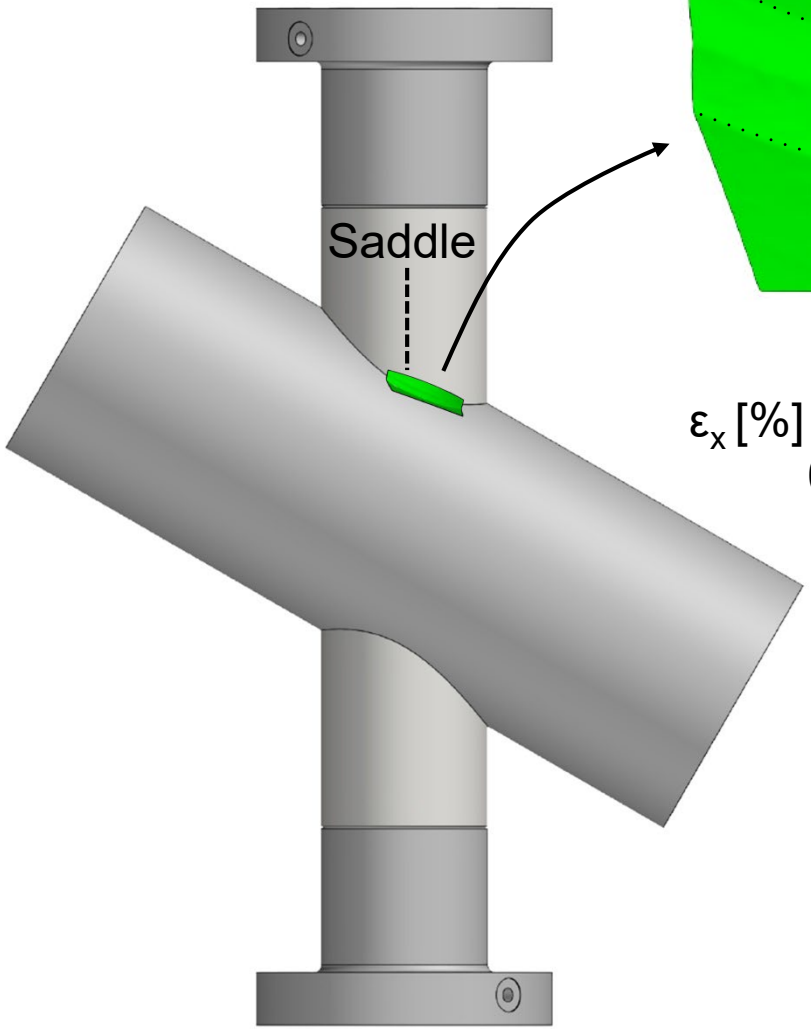


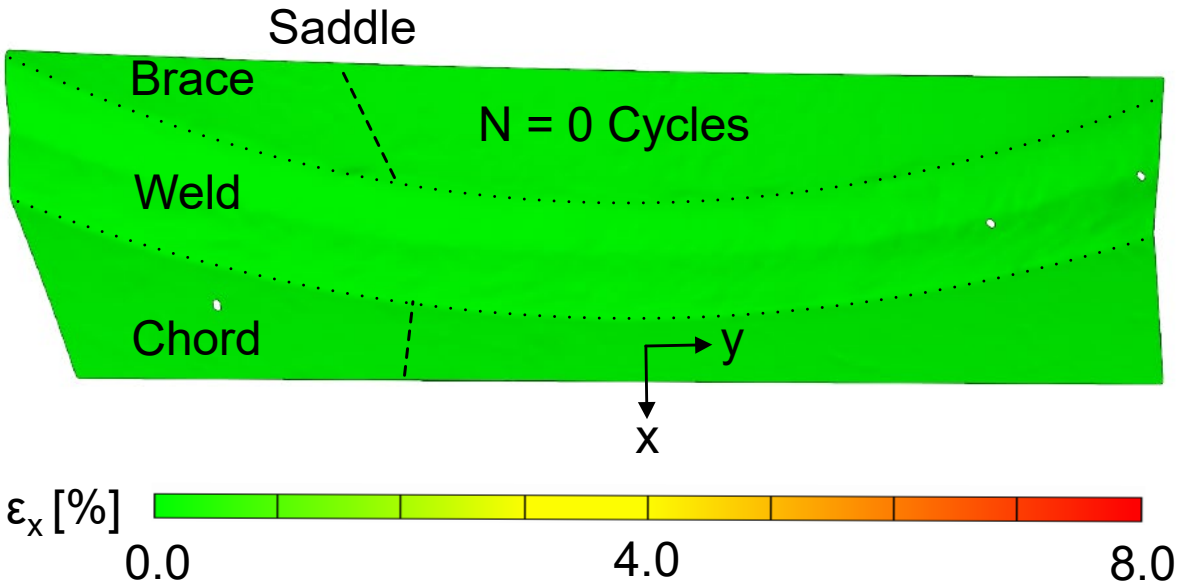
Test Setup of Axial Fatigue Tests

- High cycle fatigue range; R = 0.1; f = 5 Hz
- Through thickness crack
  →Loss of over/under pressure
- Optical digitization of damage development



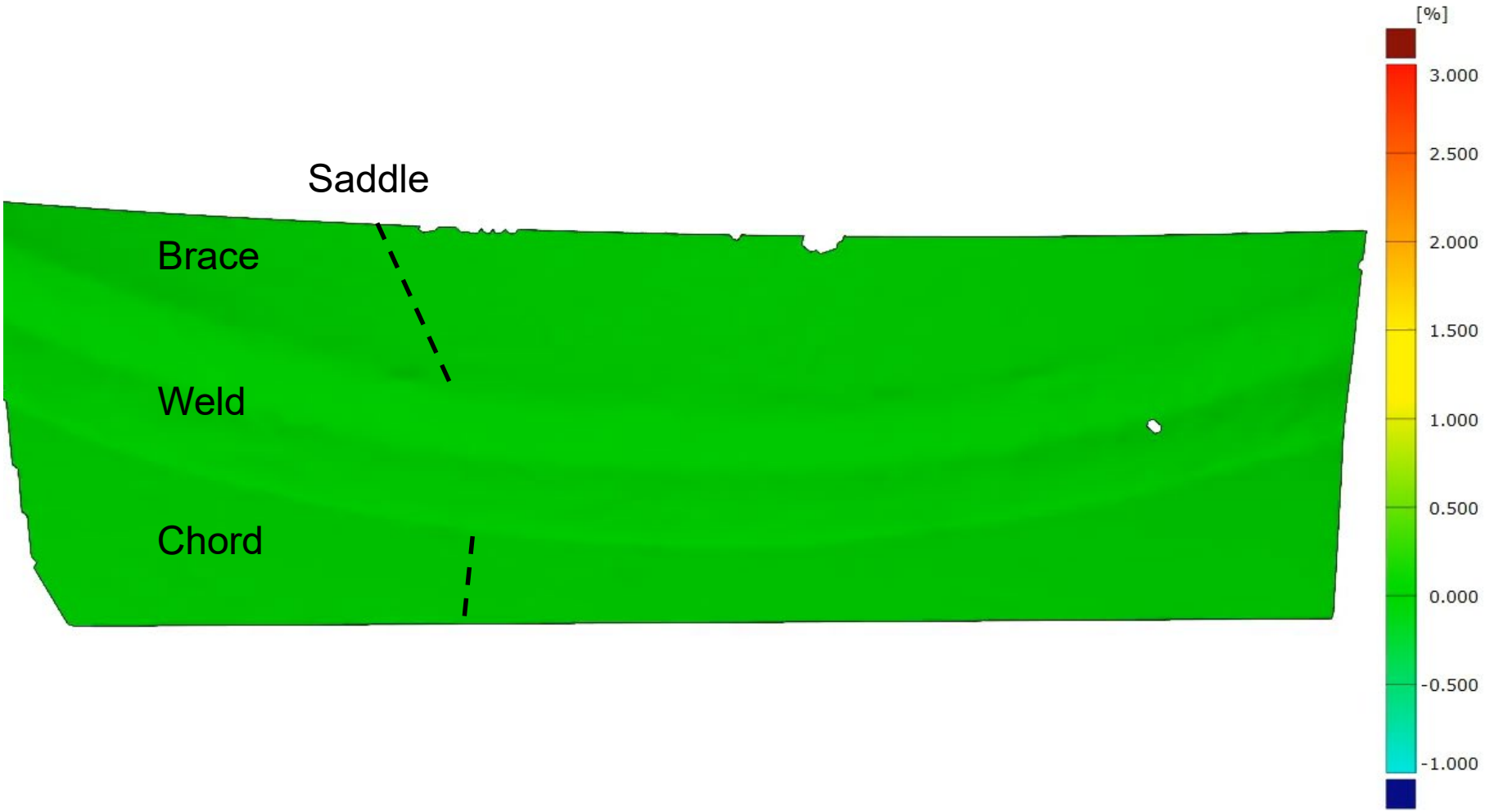
Fatigue Damage Digitization



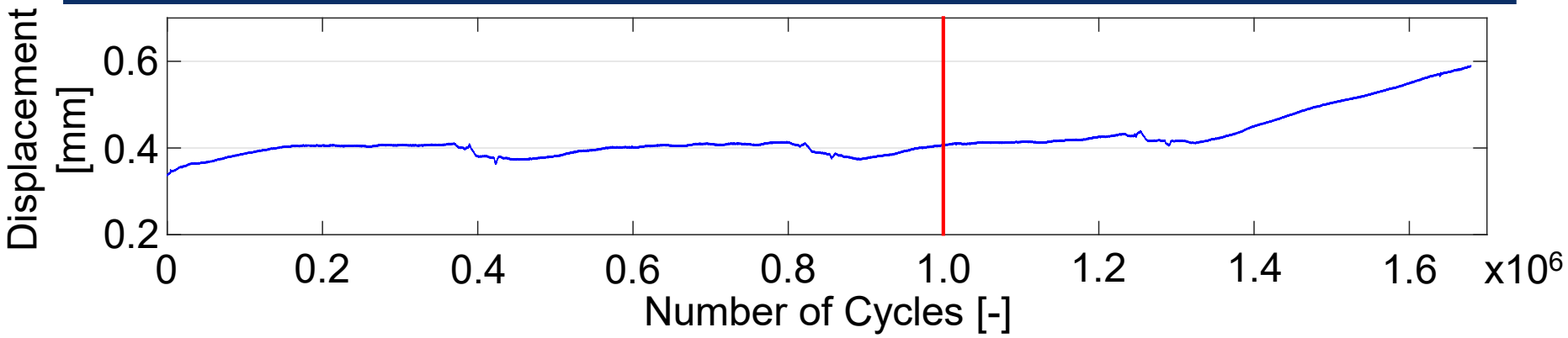


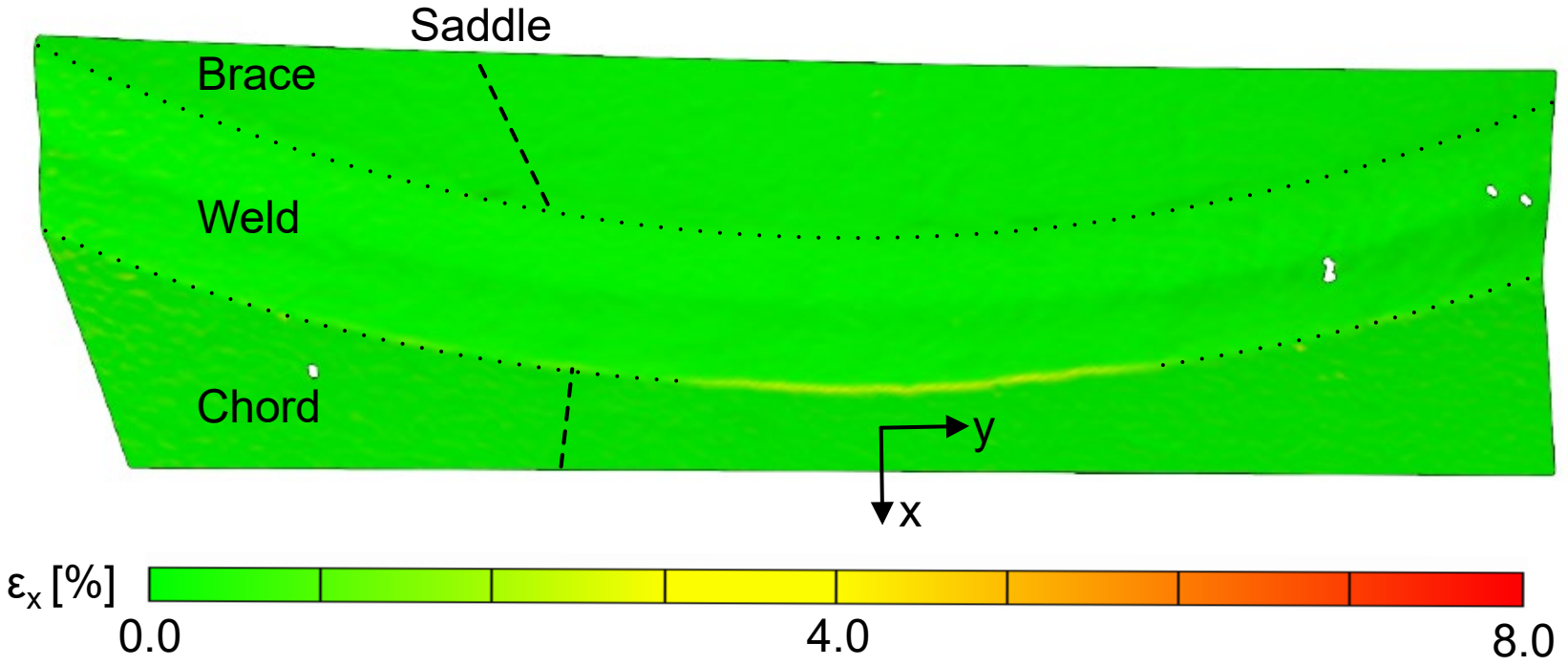
- Digital image correlation measurement of fatigue damage development
  - 3D surface model of hot spot for unloaded X-joint
- Axial fatigue test with $\Delta\sigma_N$ = 41.3 MPa

Fatigue Damage Digitization



Fatigue Damage Development





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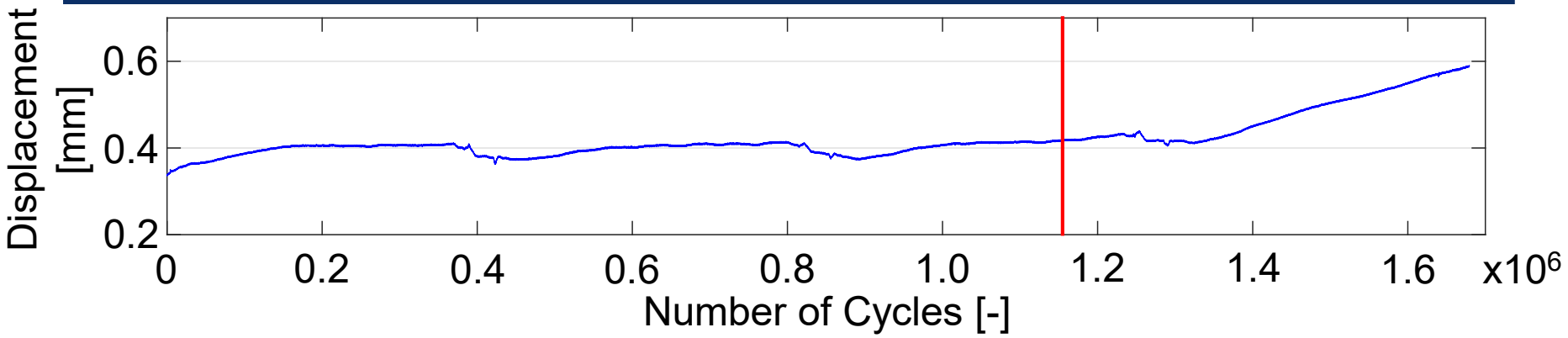

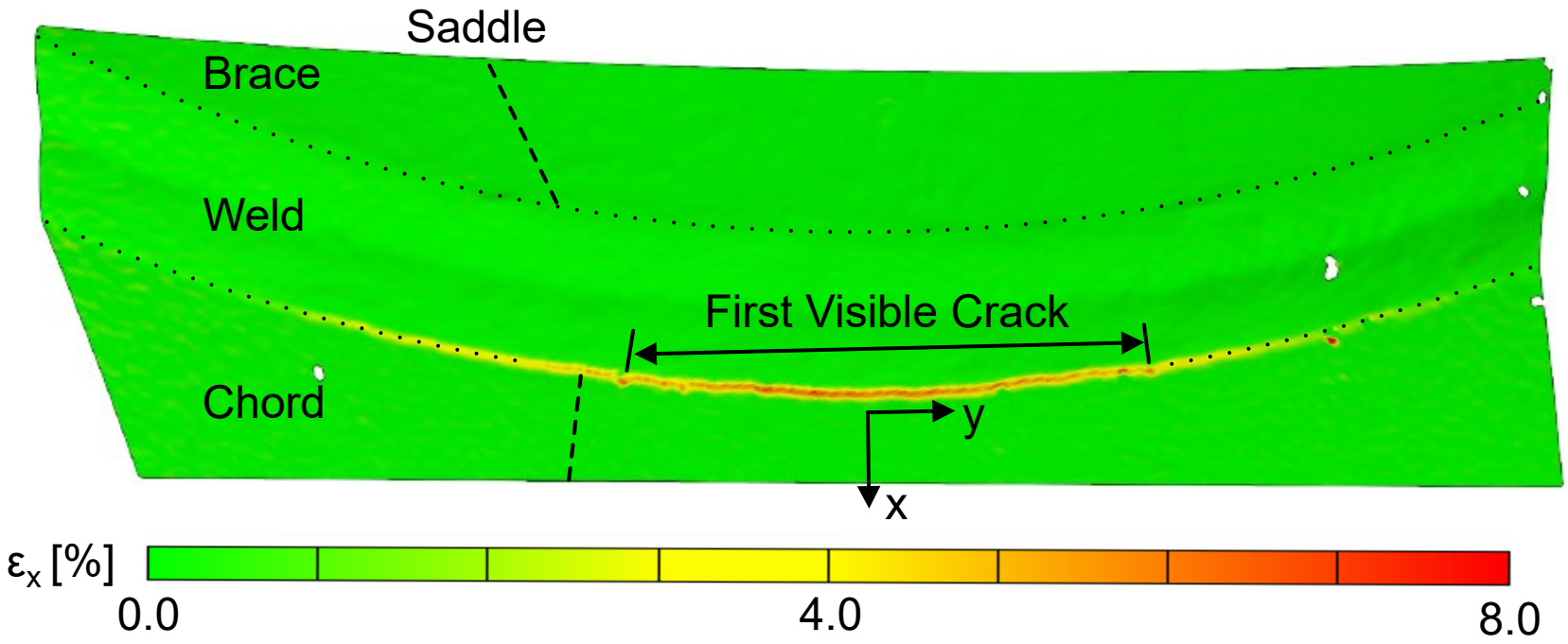

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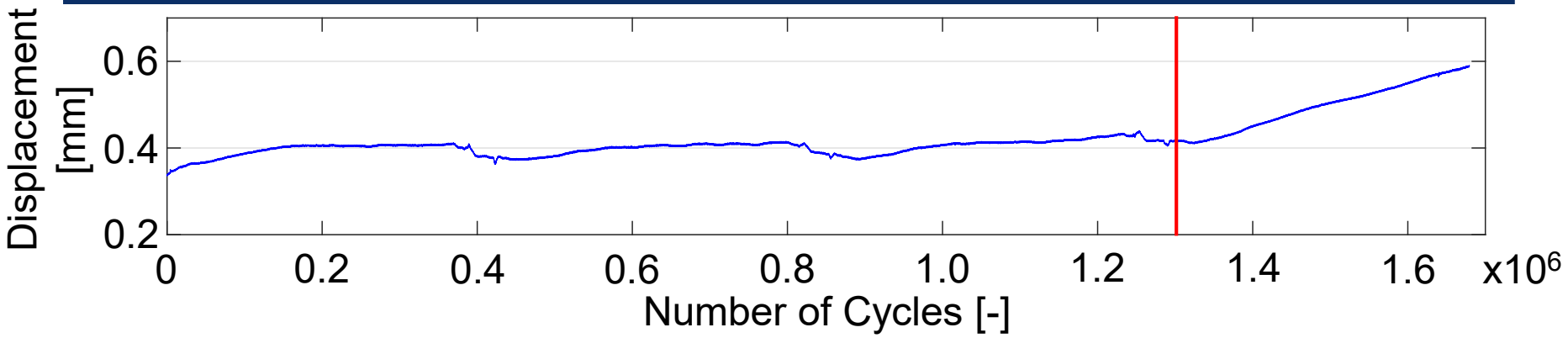

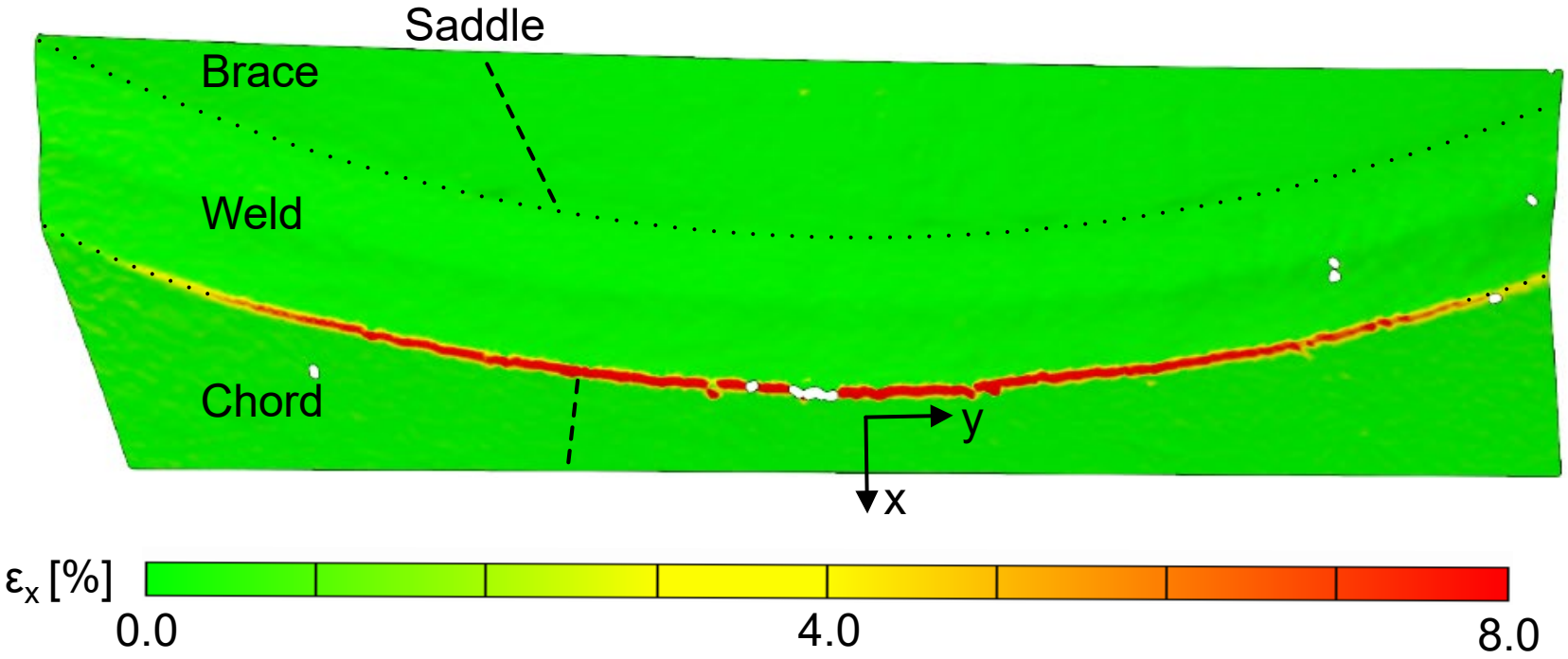

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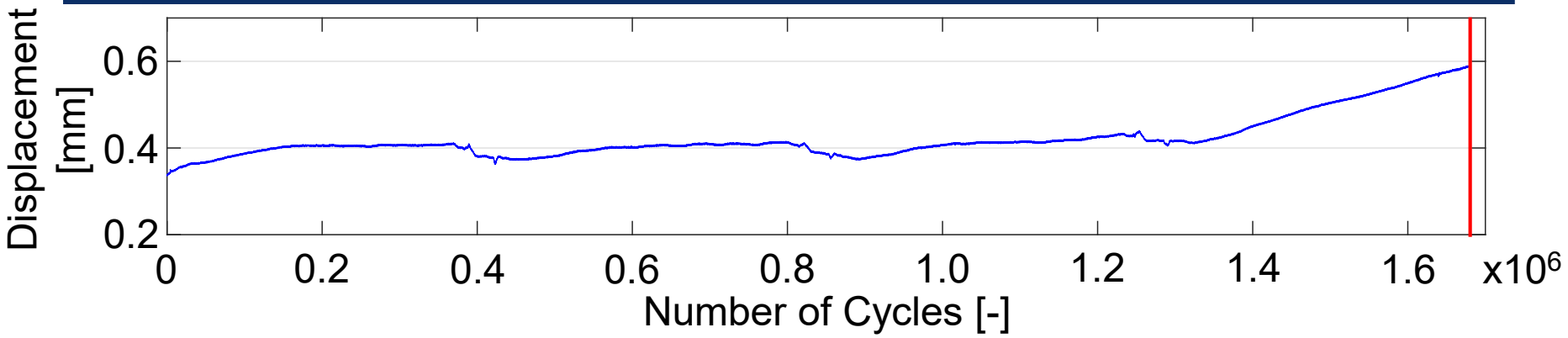
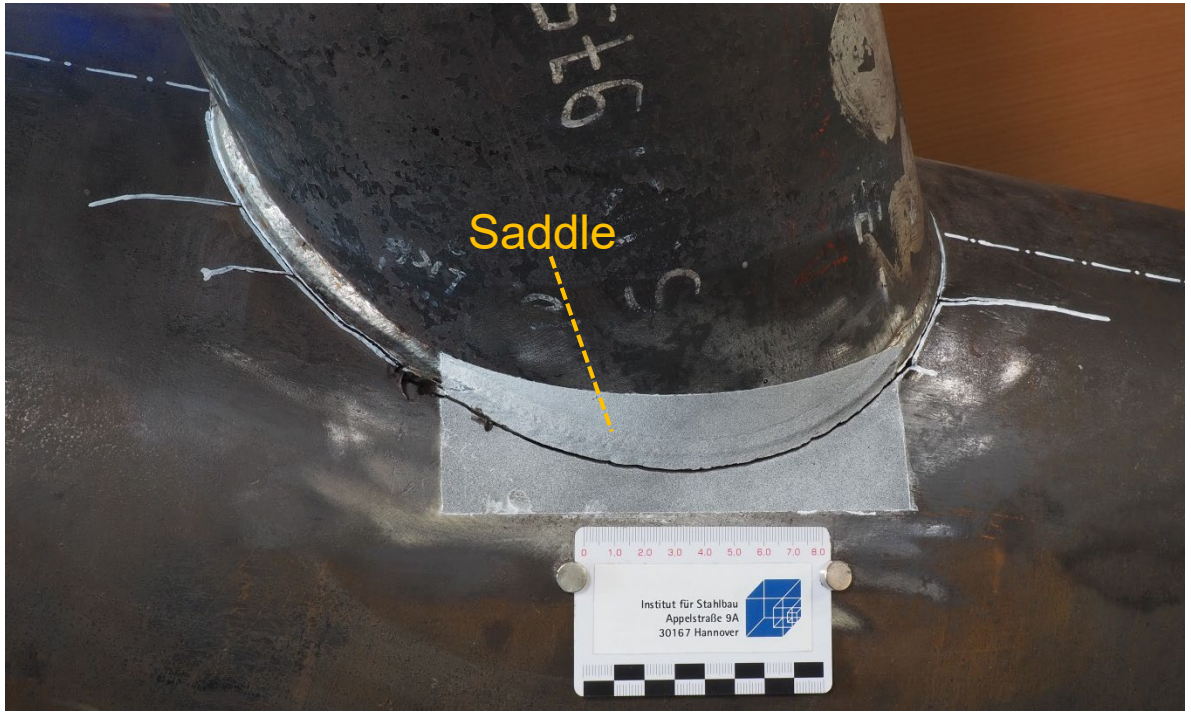
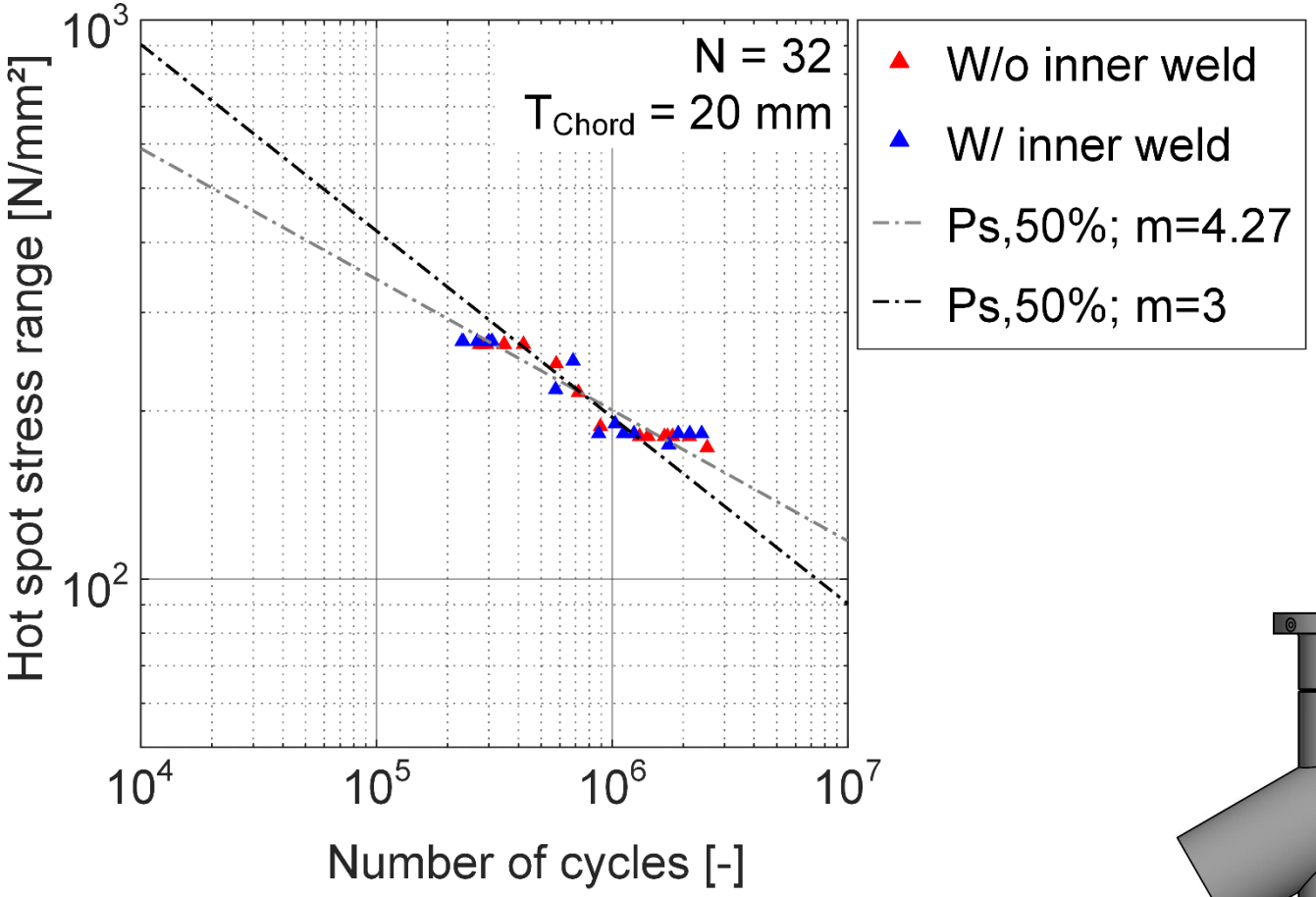
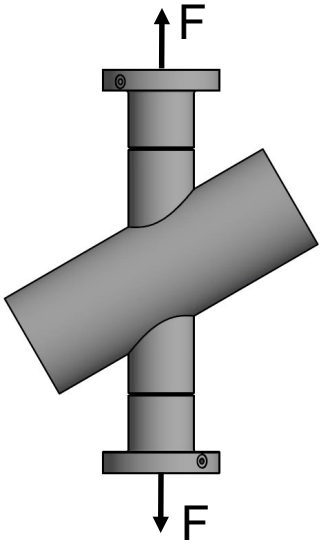




S-N Curve acc. to EC3 Background Doc.





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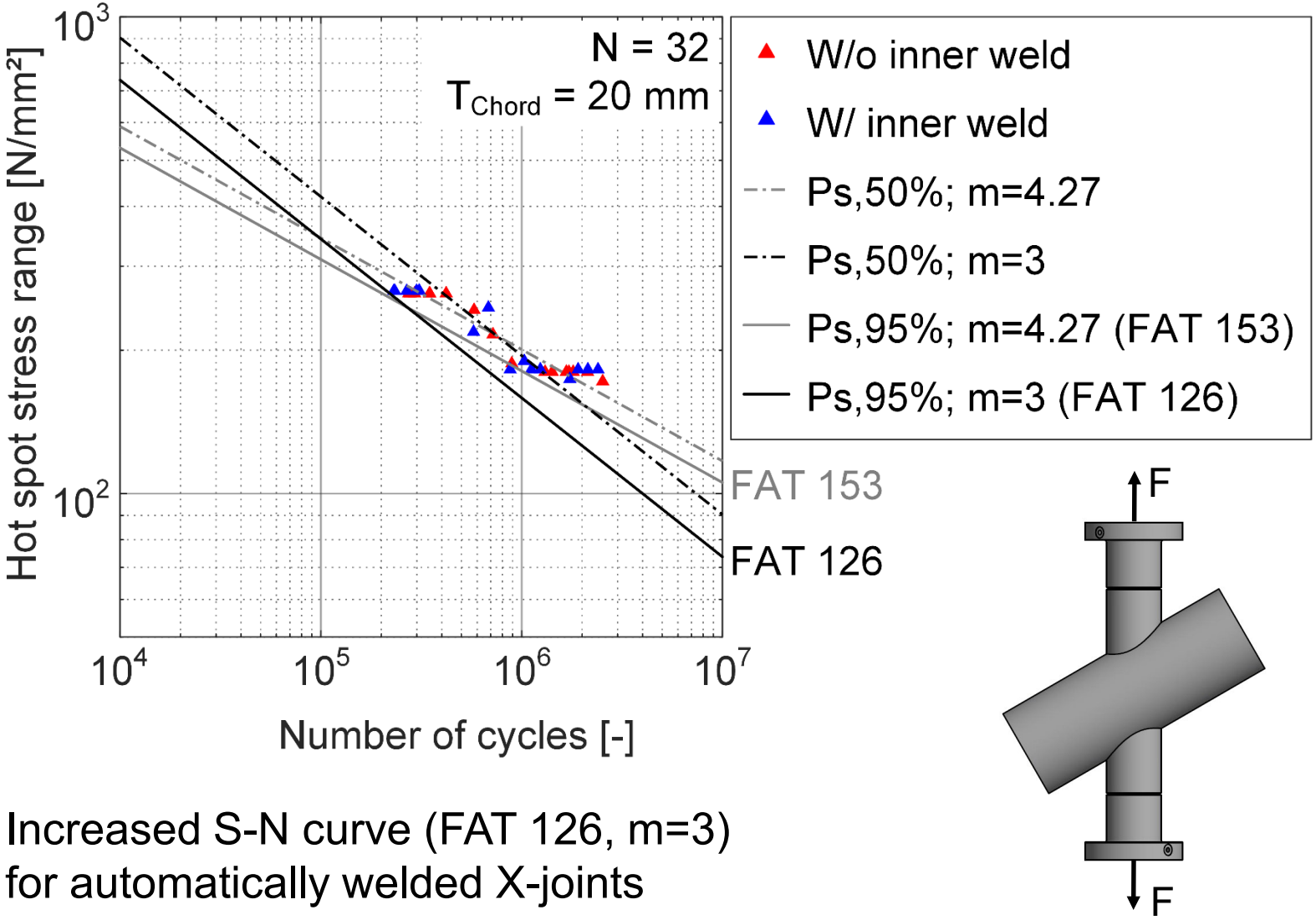

- Increased S-N curve (FAT 126, m=3) for automatically welded X-joints

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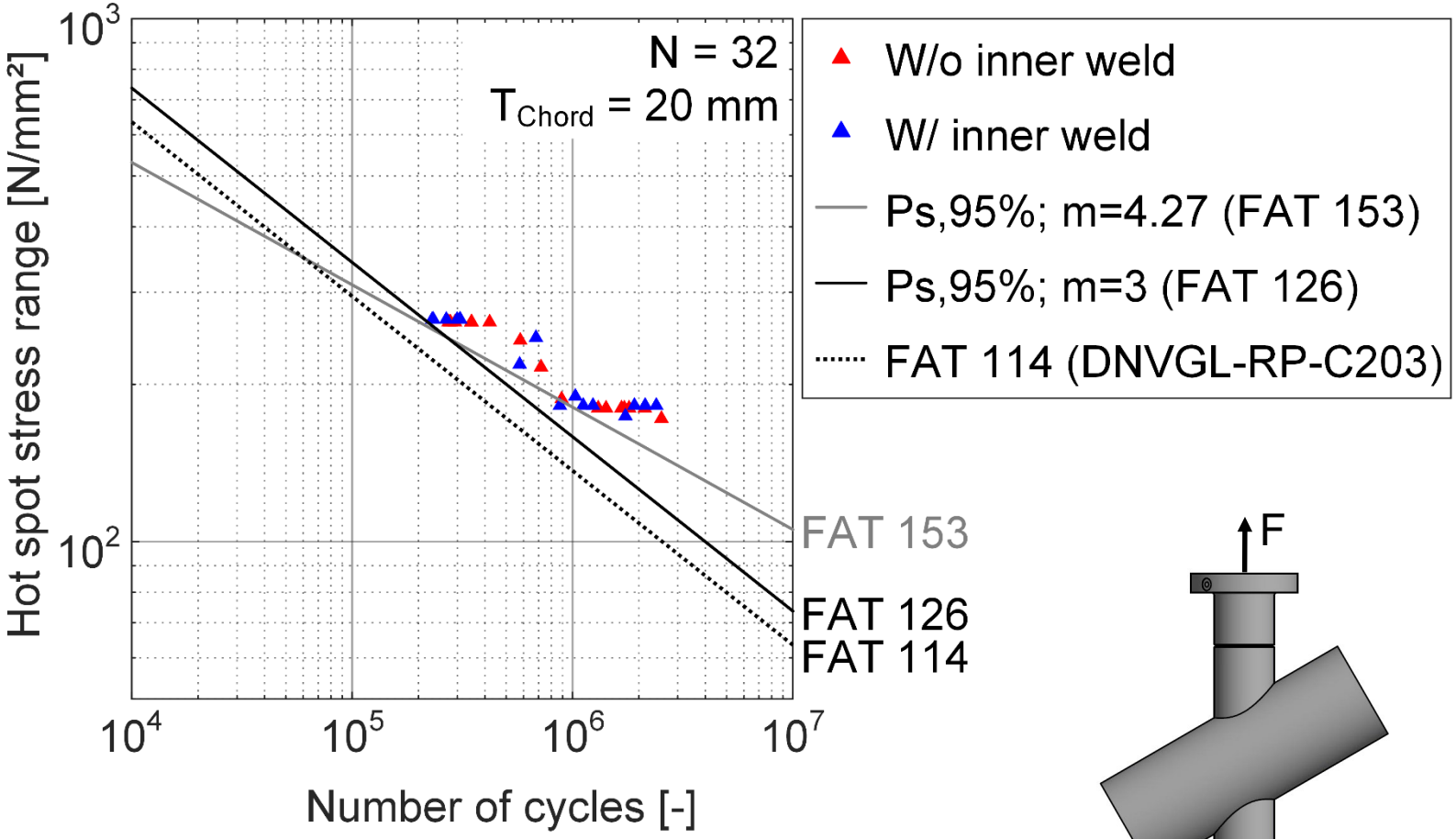

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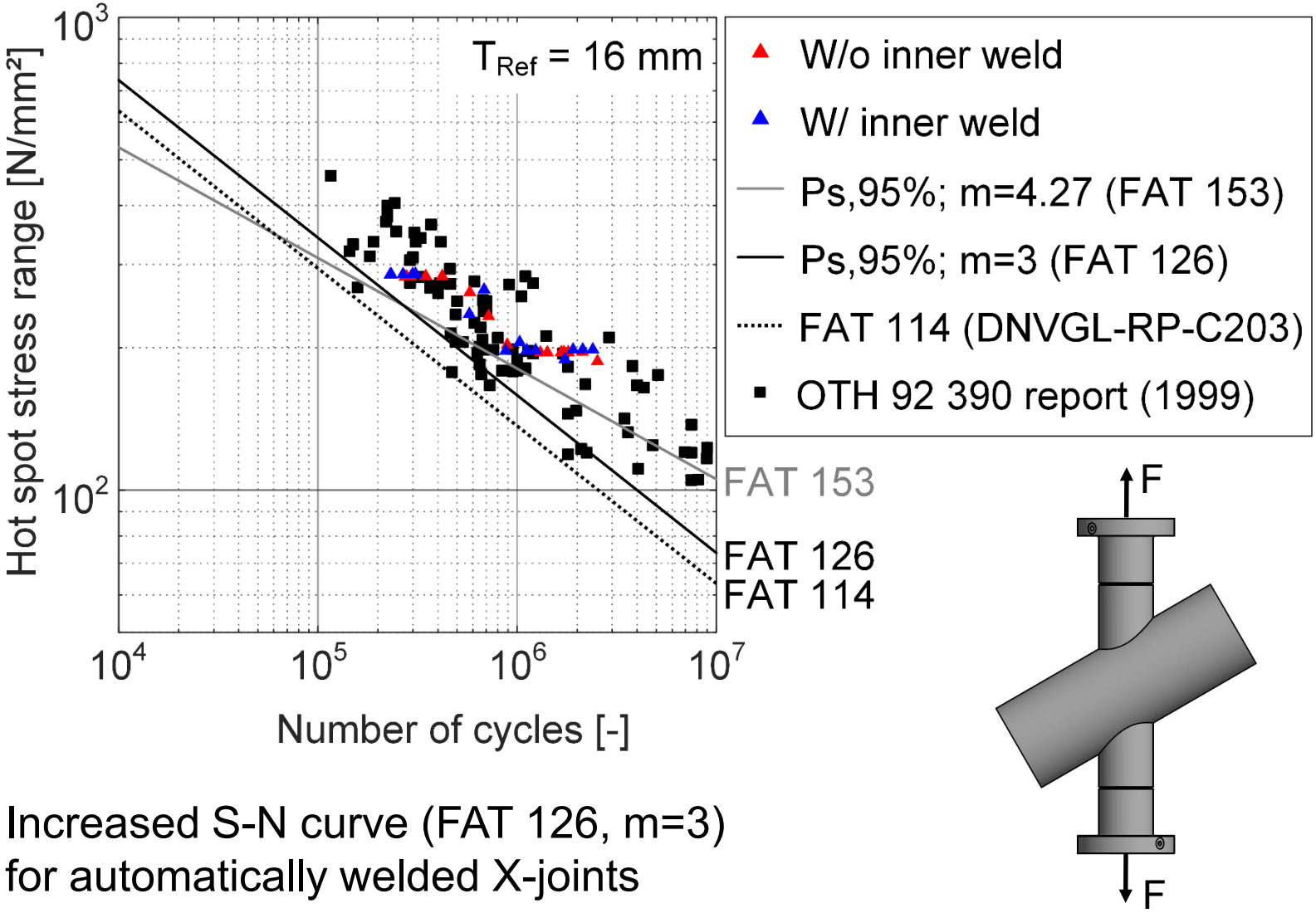
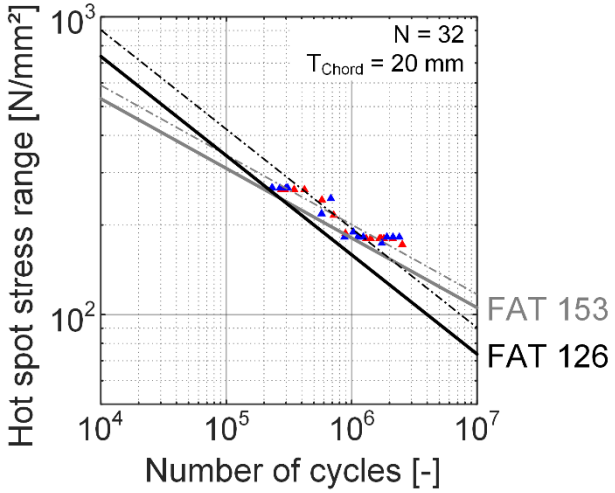


- Increased S-N curve (FAT 126, m=3) for automatically welded X-joints

Summary and Outlook

Fatigue resistance of automatically welded tubular X-joints

- 32 fatigue tests on single- and double-sided automatically welded X-joints
- Increased S-N curve (FAT126) for the robot welded tubular X-joints
- Monitoring of damage/crack development utilizing DIC possible
- Improving the automatically welding procedure



Thank you for your attention!

www.stahlbau.uni-hannover.de www.forwind.de

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Federal Ministry of Economics and Technology

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