Aalto University
School of Engineering

MEC-E8006 Fatigue of Structures

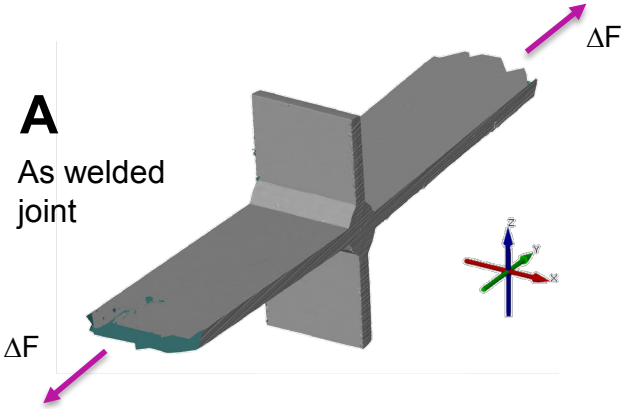
Project work descriptions

Project work cases

- The project work case (application case) is selected by team. The following options are available:
  - **A. Welded cruciform joint in low strength steel**
  - **B. Post-weld-treated joint in high strength steel**
  - **C. Cut-plate edge in high strength steel**
  - **D. Team own project work**
- All components are loaded by constant amplitude loading with selected load level.
- For option A-C, the reference material (e.g. geometry measurements, material data) is given in my course folder.
- In the option D, the reference material is defined by team using existing literature.

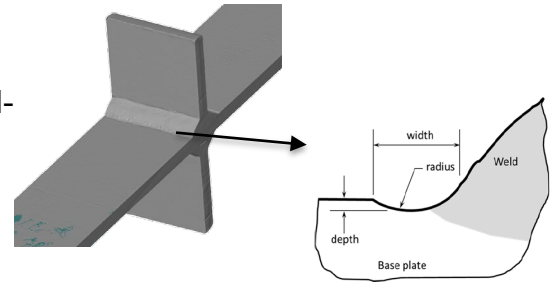
A

As welded joint



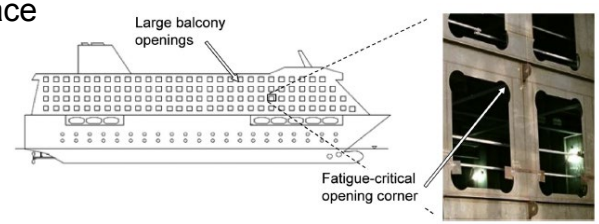
B

Post-weld-treated joint



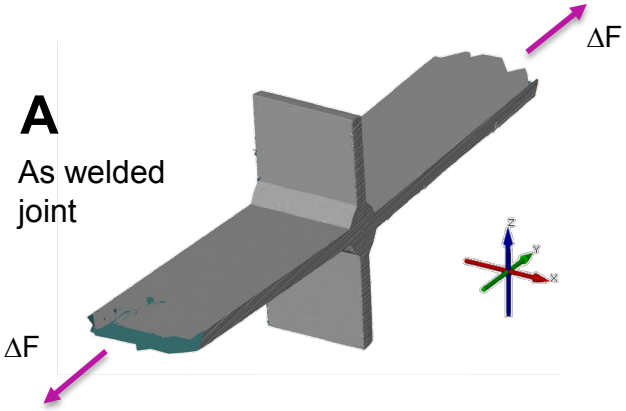
C

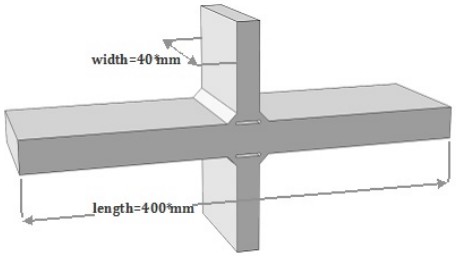
Sandblasted surface

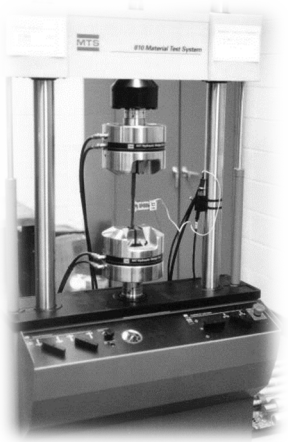


A: Welded cruciform joint in low strength steel

- Common fatigue critical detail in welded structures, such as ship, bridge, crane structures
- Fatigue test specimen including fillet welded cruciform joint
- A constant amplitude loading with load range of 45.6 kN and load ratio R=0.1



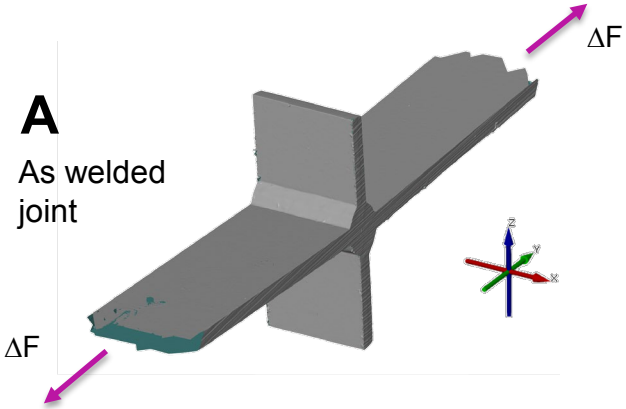


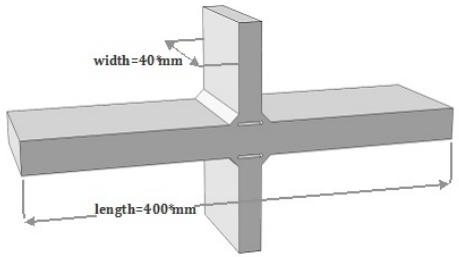


A: Welded cruciform joint in low strength steel

Table 1: Mechanical properties and the constants for stress–life curves from tests at zero mean stress on un-notched axial specimens (Unit MPa)

Material	Yield Strength σ_o	Ultimate Strength σ_u	True Fracture Strength $\tilde{\sigma}_{fB}$	$\sigma_a = \sigma'_f (2N_f)^b = AN_f^B$		
				σ'_f	A	$b = B$
AH36	425	550	980	1100	1016	-0.115

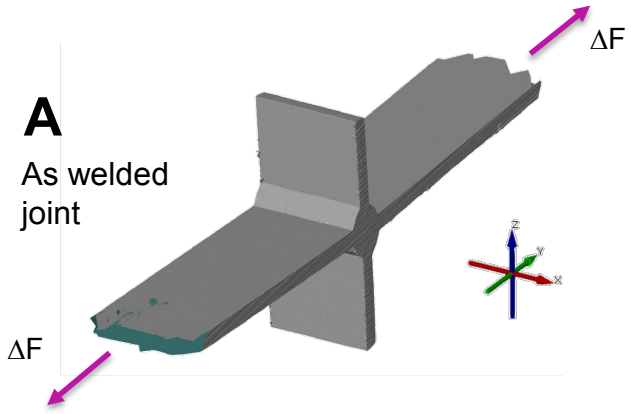


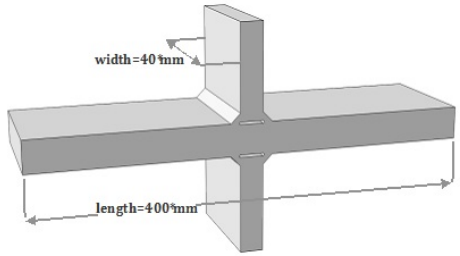


A: Welded cruciform joint in low strength steel

Table 2: Cyclic Stress–Strain and Strain–Life Constants (Unit MPa)

	Cyclic σ-ε Curve			Strain–Life Curve			
Material	E	H'	n'	σ_f'	b	ε_f'	c
AH36	210 000	794	0,143	1100	-0,115	0,632	-0,583





A: Welded cruciform joint in low strength steel

Table 3: Constants for the Walker equation

Material	Yield σ_o MPa	Toughness K_{Ic} MPa $\sqrt{m}$	Walker Equation C_0 $\frac{mm/cycle}{(MPa\sqrt{m})^m}$	m	γ $(R \geq 0)$	γ $(R < 0)$
AH36	425	190	6.89E-09	3.00	0.92	0

Table 4: Constants for the Forman equation

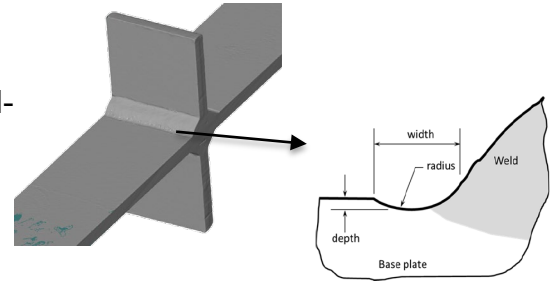
Material	Yield σ_o MPa	Toughness K_{Ic} MPa$\sqrt{m}$	Forman Equation C_2 $\frac{mm/cycle}{(MPa\sqrt{m})^{m_2-1}}$	m_2
AH36	425	190	2.30E-07	3.00

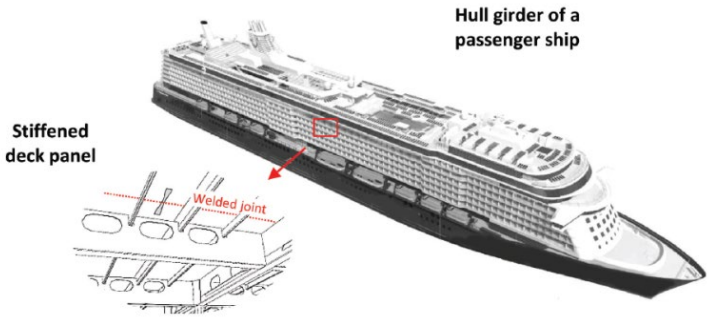
B: Post-weld treated joint in high strength steel

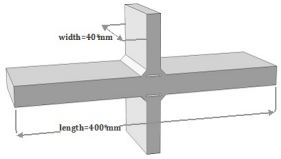
- Common fatigue critical detail in welded structures, such as ship, bridge, crane structures
- Fatigue test specimen including fillet welded cruciform joint, which is post-weld treated
- A constant amplitude loading with load range of 77.2 kN and load ratio R=-0.43

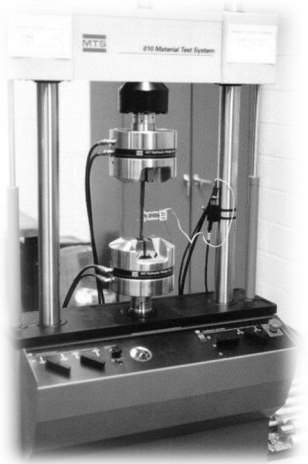
B

Post-weld-treated joint









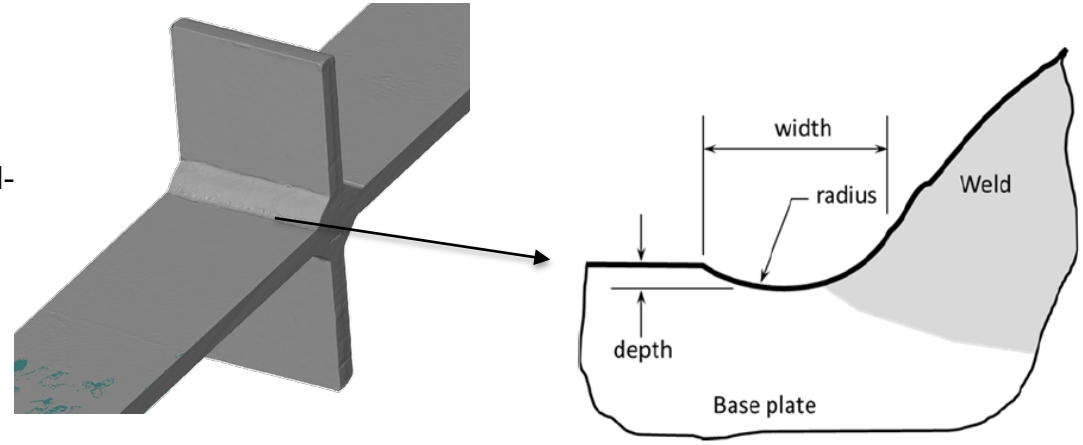
B: Post-weld treated joint in high strength steel

Table 1: Mechanical properties and the constants for stress–life curves from tests at zero mean stress on un-notched axial specimens (Unit MPa)

Material	Yield Strength σ_o	Ultimate Strength σ_u	True Fracture Strength $\tilde{\sigma}_{fB}$	$\sigma_a = \sigma'_f(2N_f)^b = AN_f^B$		
				σ'_f	A	$b = B$
S690	744	810	1220	1170	1119	-0.064

B

Post-weld-treated joint



B: Post-weld treated joint in high strength steel

Table 2: Cyclic Stress–Strain and Strain–Life Constants (Unit MPa)

Material	Cyclic σ-ε Curve			Strain–Life Curve			
	E	H'	n'	σ_f'	b	ε_f'	c
AH36	210 000	1353	0,077	1170	-0,064	1,351	-0,722

B

Post-weld-treated joint

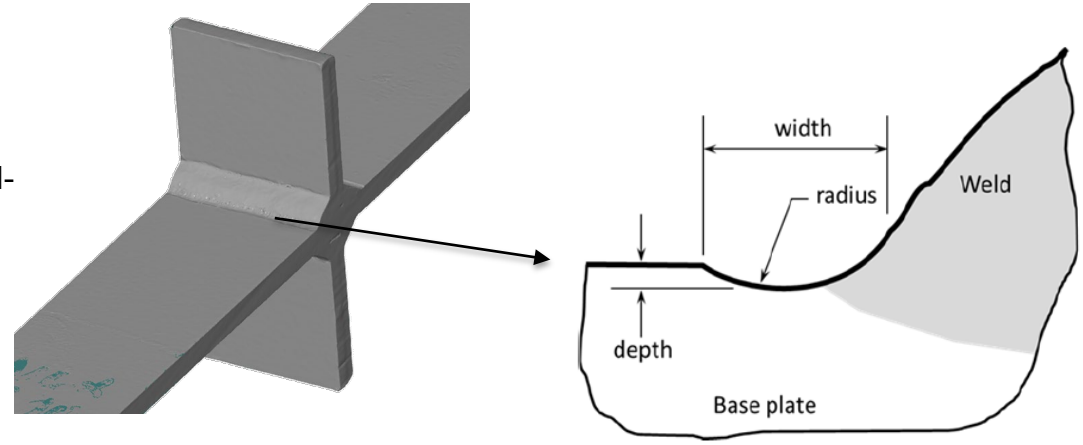


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Table 3: Constants for the Walker equation

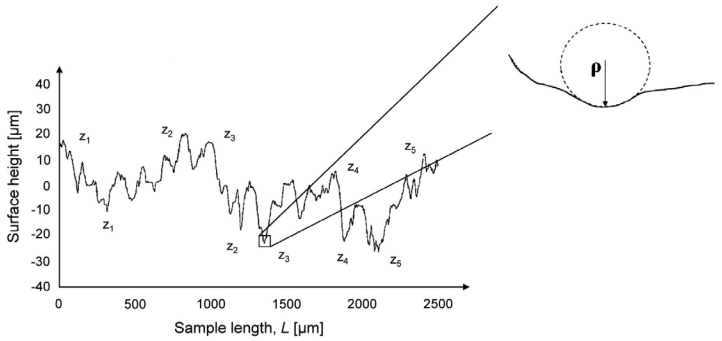
Material	Yield σ_o MPa	Toughness K_{Ic} MPa $\sqrt{m}$	Walker Equation C_0 $\frac{mm/cycle}{(MPa\sqrt{m})^m}$	m	γ $(R \geq 0)$	γ $(R < 0)$
S690	744	150	6.89E-09	3.00	0.82	0

Table 4: Constants for the Forman equation

Material	Yield σ_o MPa	Toughness K_{Ic} MPa $\sqrt{m}$	Forman Equation C_2 $\frac{mm/cycle}{(MPa\sqrt{m})^{m_2-1}}$	m_2
S690	744	150	2.30E-07	3.00

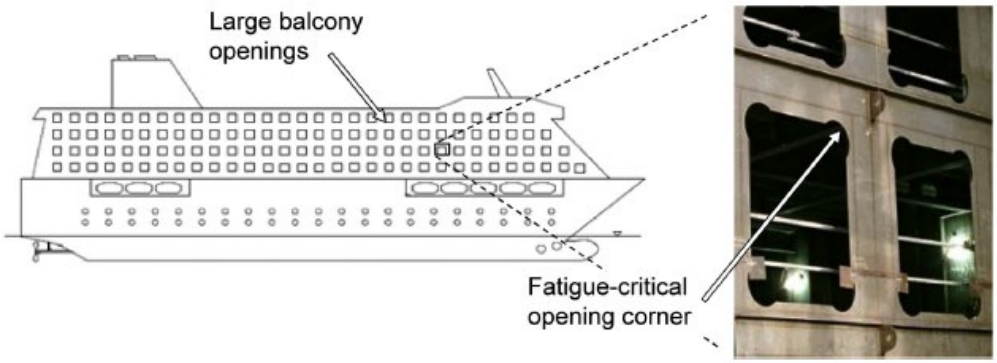
C: Cut-plate edge in high strength steel

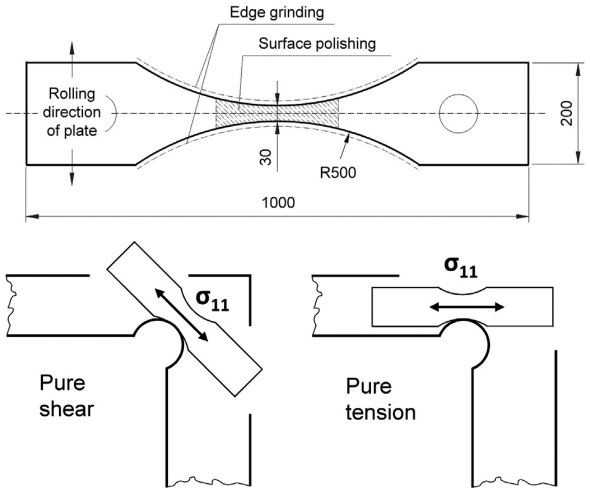
- Common fatigue critical detail in complex structures
- Fatigue test specimen including cut plate edge, which is sandblasted. The plate thickness is 15.3 mm.
- A constant amplitude loading with load range of 253 KN and load ratio R=0.1



C

Sandblasted surface





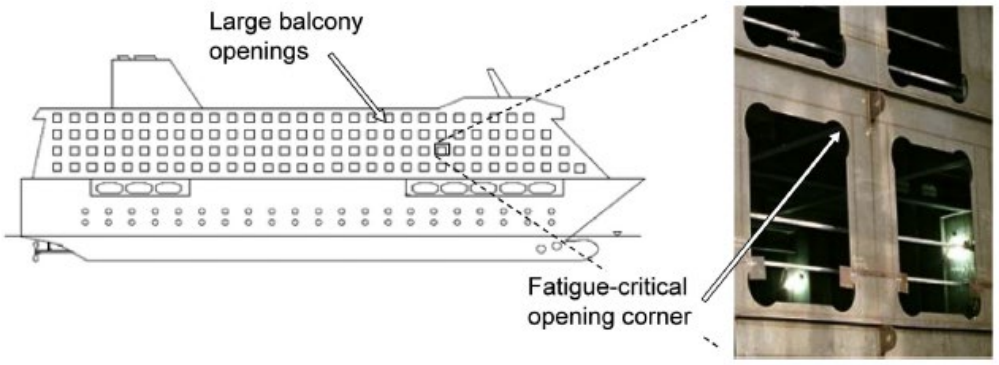
C: Cut-plate edge in high strength steel

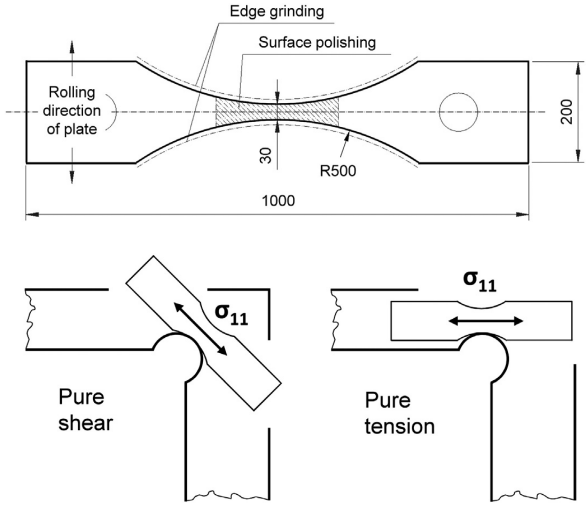
Table 1: Mechanical properties and the constants for stress–life curves from tests at zero mean stress on unnotched axial specimens (Unit MPa)

Material	Yield Strength σ_o	Ultimate Strength σ_u	True Fracture Strength $\tilde{\sigma}_{fB}$	$\sigma_a = \sigma'_f (2N_f)^b = AN_f^B$		
				σ'_f	A	$b = B$
S690	744	810	1220	1353	1294	-0.064

C

Sandblasted surface





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	Cyclic σ-ε Curve			Strain–Life Curve			
Material	E	H'	n'	σ_f'	b	ε_f'	c
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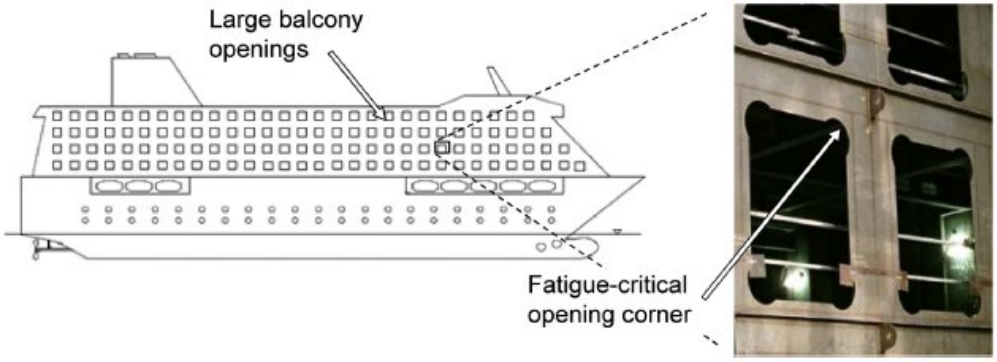
C

Sandblasted surface



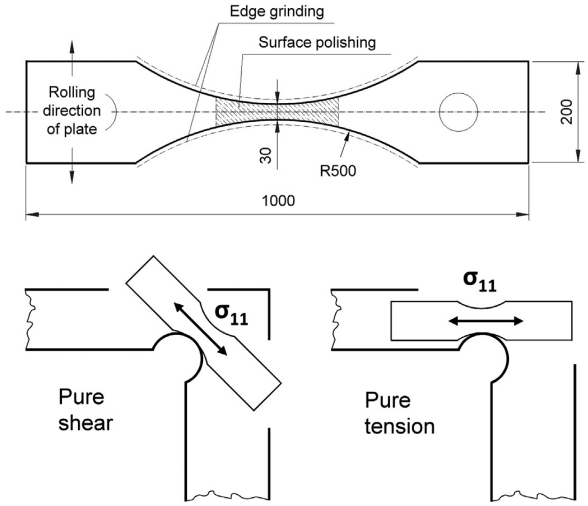


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Table 4: Constants for the Forman equation

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S690	744	150	2.30E-07	3.00

Geometry data

Download and analysis of the geometry data

1. **Download the zip-file: Project work - Geometry data.zip**
2. **Welded joint analysis (Case A and B)**
   - Use GOM software in order to analyze 3D geometry model: https://www.gom.com/3d-software/gom-inspect.html
   - Use e.g. Microsoft Excel to analyze 2D section file (*.asc files); see Example.txt and Example.xlsx files
3. **Plate edge roughness analysis (Case C)**
   - Use e.g. Microsoft Excel to analyze 2D section file; see “Roughness profile.txt” and “Roughness profile.xlsx” files