Influence of discretization as a parameter in predicting the fatigue life of CT specimen using a finite element approach

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Aim :

To signify the importance of discretization when applied to crack related problems and estimate the difference in solutions FEM provides when numerically solving a simple CT specimen with different mesh properties.

Tasks :

- To design a 3D CAD model of the CT specimen accordingly from the dimensions derived from the experimental specimen.
- To assign the BC's and crack properties to specimen with respective data.
- Numerically solve the specimen using different mesh properties.
- Evaluate the difference in fatigue life FEM provides and graphically compare the results with experiments.

INTRODUCTION

1. Finite Element Method → Discretisation (Mesh)
2. Problem Statement
3. Different types of Meshing techniques
4. CT Specimen

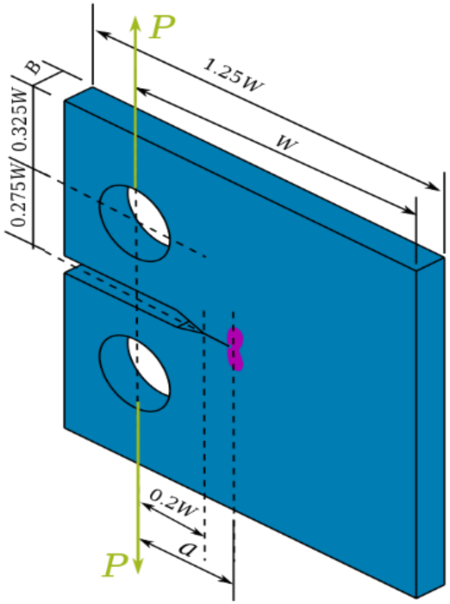


Fig 1. CT Specimen [6]

Experimental Setup

1. Experiment performed on a BiSS-ITW make, 250 kN capacity (Model: Median 250) servo hydraulic common testing machinery
2. A digital microscope is inserted to precisely measure the length of the fatigue crack with particular to its overdone number of cycles

Table 1. Tensile properties of Aluminium alloy

Material	σ_y(MPa)	σ_u(MPa)	E (GPa)	Poisson Ratio	% Elongation at break
Al Alloy	517	597	74	0.33	8

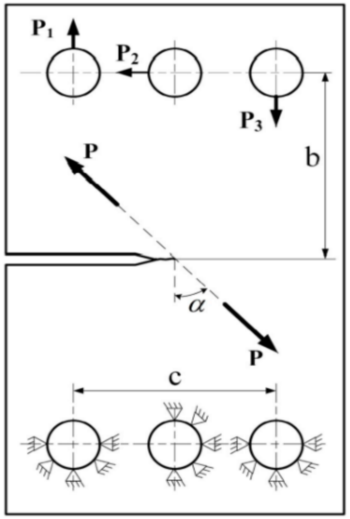


Fig 2. BC of the setup [8]

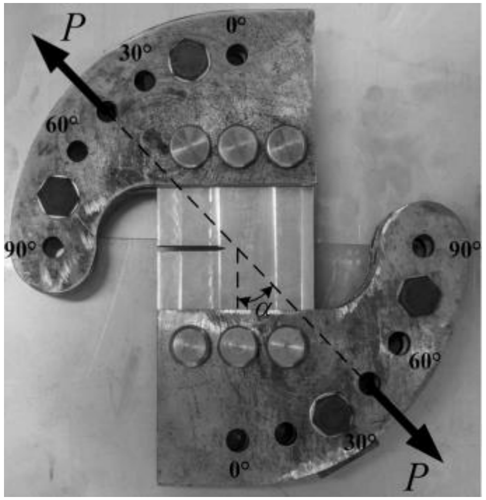


Fig 3. Experimental Setup [8]

Computational Approach

Table 2. Mesh properties

Parameter	Fine Mesh	Coarse Mesh
No.of. Nodes	476973	63779
No.of. Elements	284946	37807
Element size	0.5 mm	1.5 mm
Element order	Quadratic	Quadratic
Span angle centre	Fine	Coarse
Refinement	2	3

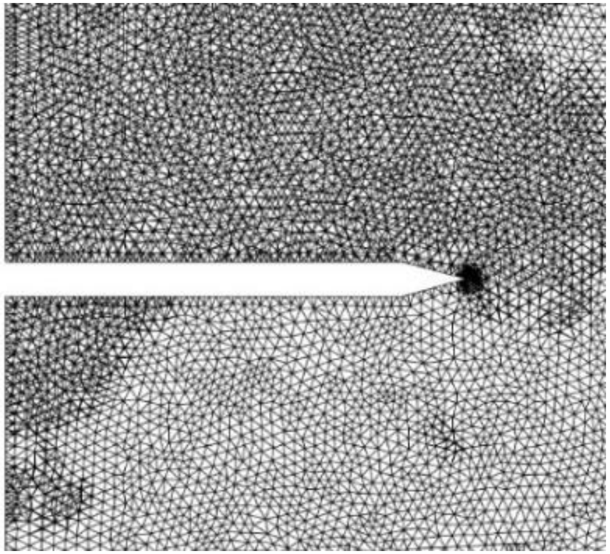


Fig 4. Fine Mesh

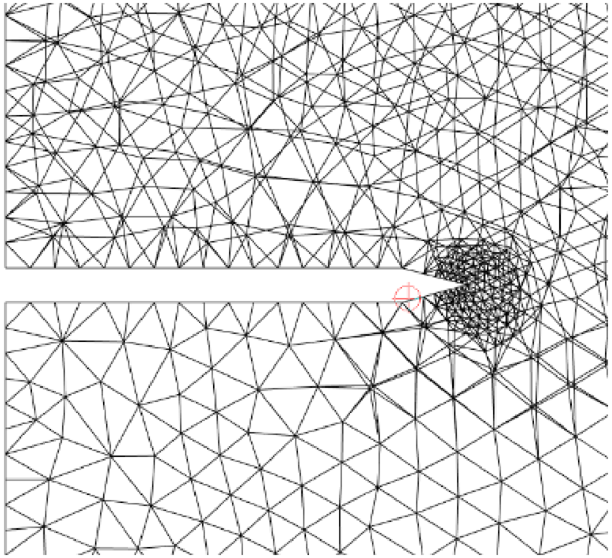


Fig 5. Coarse Mesh

Fatigue Crack Assignment

1. Pre-meshed Crack
2. Co-ordinate system
3. Fatigue Crack
4. Paris Law properties

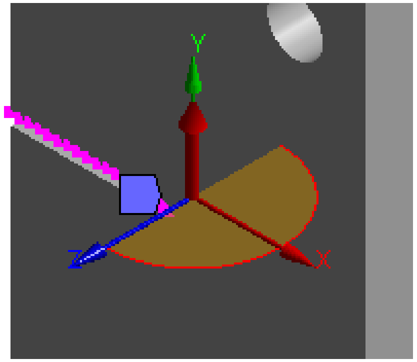
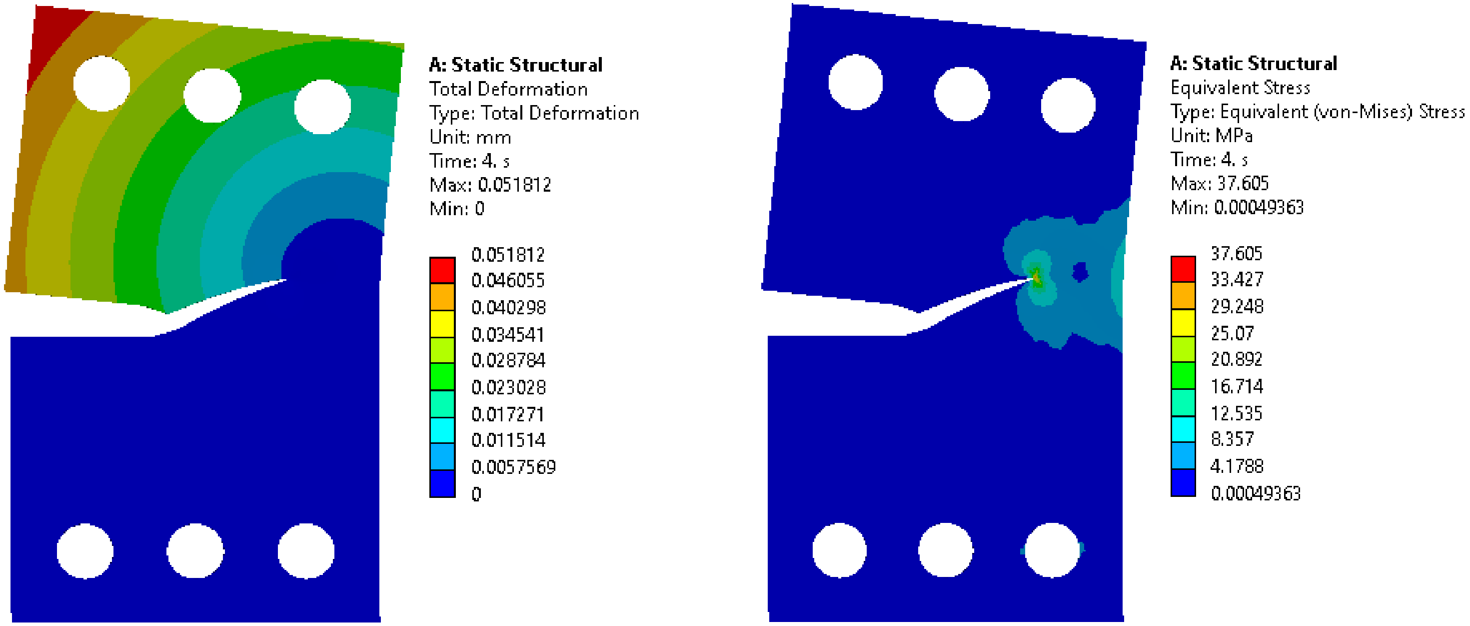


Fig 6. Isometric view of pre-meshed crack

Table. 3 Paris law properties of Al alloy [11]

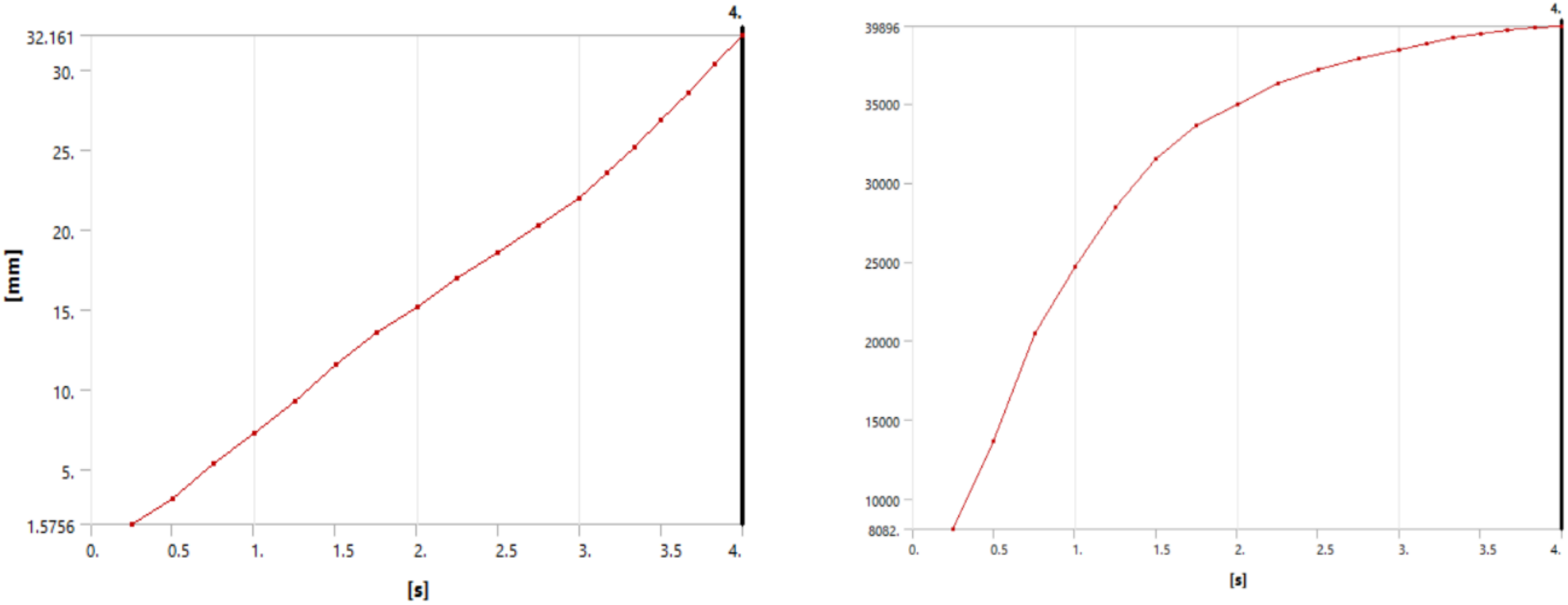
Material	Unit for constants	Material constant C	Material constant m
Al Alloy	mm, tonne mm s^-2	4.33e-07	2.61

Results of Numerical simulation



(a) (b)

Fig 7. (a) Total Deformation and (b) Equivalent von-mises stress



(a) (b)

Fig 7. (a) Crack extension plot and (b) No.of.cycles plot

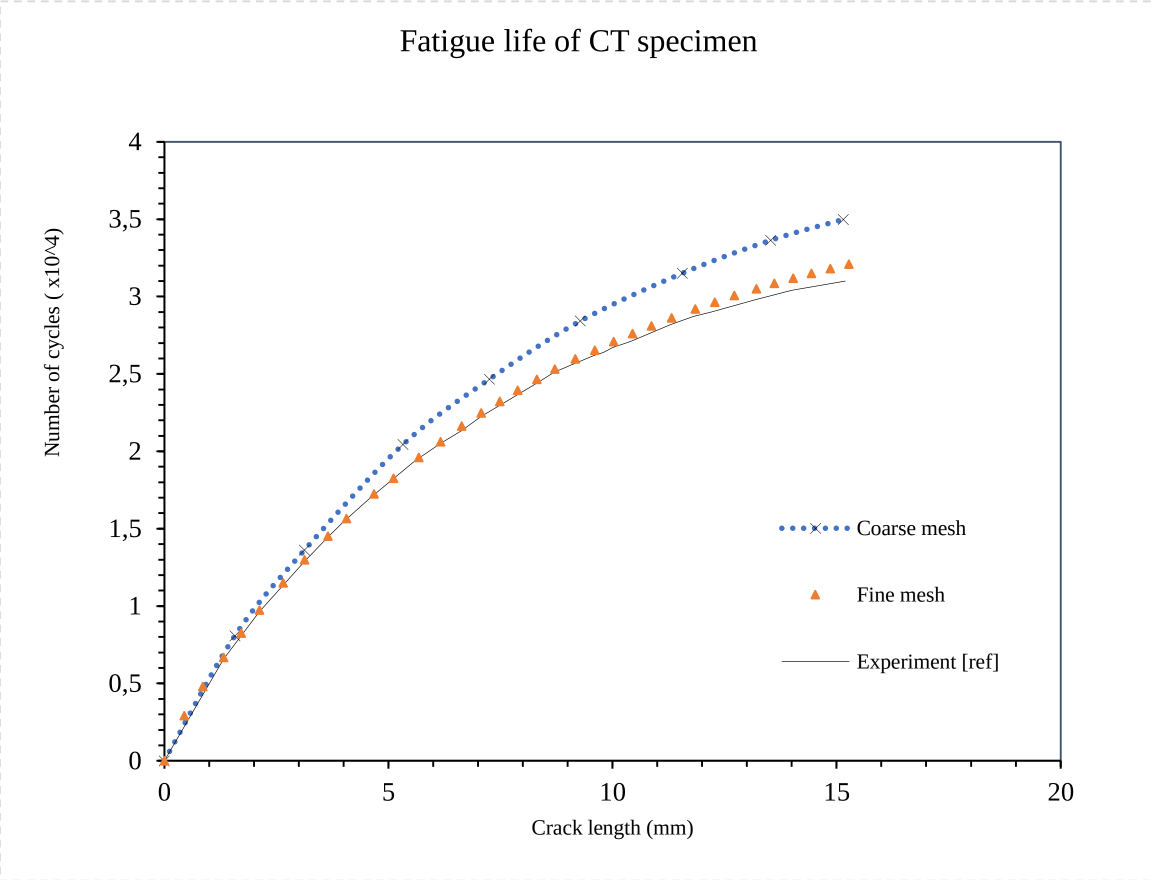
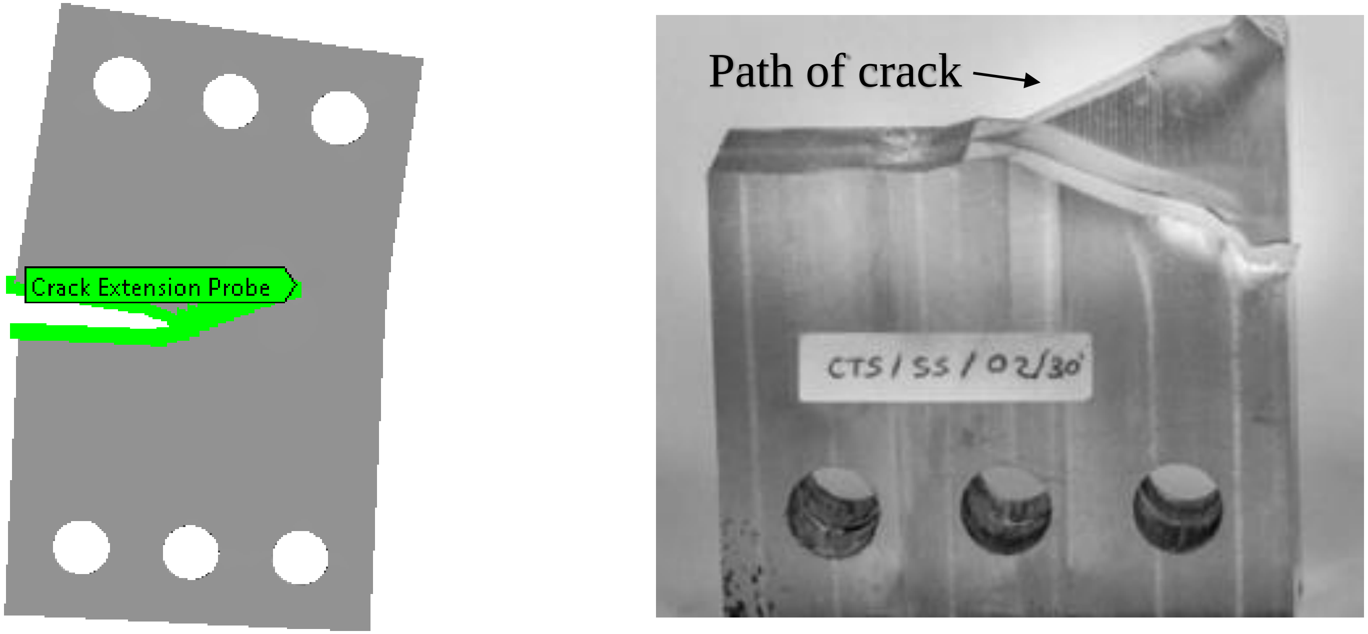


Fig 8. Fatigue life of CT specimen



(a)

(b) [8]

Fig 9. (a) Numerical crack extension and (b) Experimental fracture

Conclusion

1. A HCF test of a CT specimen was evaluated, and the experiment was carried out numerically with FEM with different mesh properties.

2. Fine mesh comprised of 284946 elements with an element size of 0.5mm and the coarse mesh consisted of 37807 elements with an elements size of 1.5mm.

3. Comparing the conclusive data, the fine meshed specimen exhibited crack properties 86 % in accordance to experiments.

4. The coarse meshed specimen lagged resemblance and came in at 23 % with experiments.

5. Practically, it would be evident to state that the fine meshed specimen would resemble the experimental results, but this research primarily focused on the difference in the solutions FEM would provide and how important discretisation would be to solve fatigue and fracture related problems

Acknowledgement

This research was funded by a grant (No. S-MIP-23-122/2023) from the Research Council of Lithuania.

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