ANALYSIS OF FATIGUE STRAIN FIELDS WITH SYNCHROTRON X-RAY DIFFRACTION AND 3D NUMERICAL COMPUTATION

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Abstract:

When designing lightweight materials, engineers prioritise resource preservation but often encounter issues with fatigue. Various experimental methods exist to study fatigue cracks; nevertheless, transmission photo-elasticity is only effective for transparent materials, and post-failure metallography and micro-indentation cannot obtain fatigue test data. Synchrotron X-Ray Diffraction (S-XRD) experiments allow us to get data from the bulk of metallic materials.

It was conducted a study on a CT bainitic steel sample that was 3.3mm thick. During the fatigue test, we applied 30,000 loading cycles at a frequency of 20 Hz, followed by an 8,800 N load. We analysed strain fields along the crack growth direction εxx and loading direction εyy. Both experimental and Finite Element Methods (FEM) data showed promising results, as observed in the similar strain field shapes with similar maximum values. We observed symmetry along the X-axis, consistent with mode I loading.

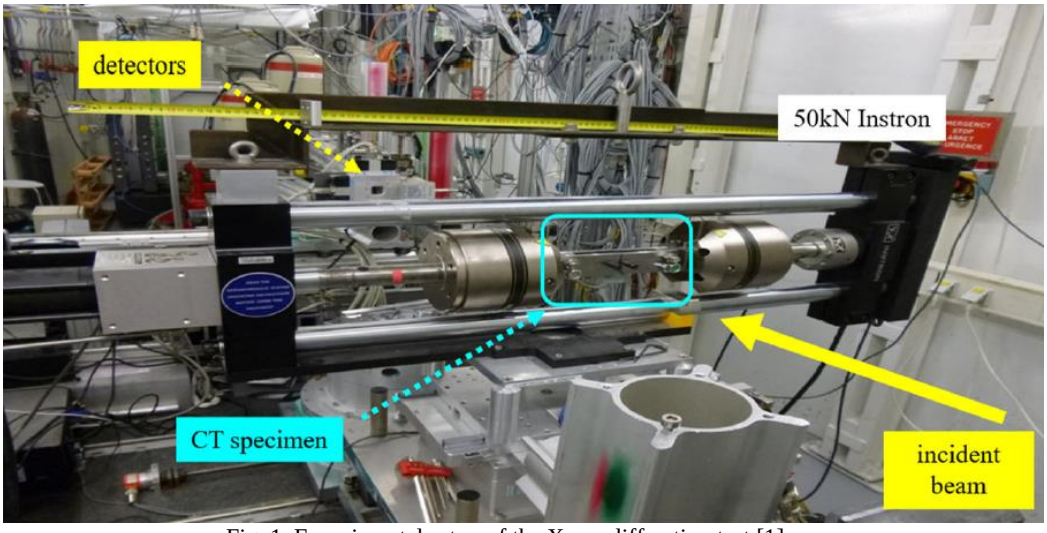

Fig. 1. Experimental setup of the X-ray diffraction test [1]

REFERENCES

[1] M. Carrera *et al.*, "Characterisation of the crack tip plastic zone in fatigue via synchrotron X-ray diffraction," *Fatigue Fract Eng Mater Struct*, vol. 45, no. 7, pp. 2086–2098, Jul. 2022, doi: 10.1111/ffe.13705.