The Influence of Residual Stresses on Structural Integrity of Renewable Energy Marine Structures

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Aim

To assess the influence of Residual Stresses (RS) on fatigue and structural integrity of offshore wind monopile structures, lab tests are performed on compact tension C(T) fracture mechanics specimens made of S355 structural steel weldments.

Methodology

Calibration tests at Cranfield

- Fatigue Crack Growth (FCG) tests in air with R-ratio of 0.1 at 5Hz
- Corrosion Fatigue Crack Growth (CFCG) tests in seawater with R-ratio of 0.1 at 0.3Hz

Tests at STFC

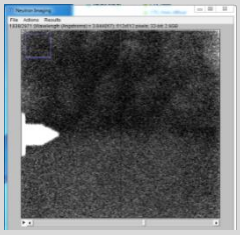
- In situ Neutron Diffraction (ND) and Neutron Imaging (NI) measurements during FCG tests in air and seawater

Finite Element (FE) predictions validated using experimental data

Experiments

ND measurements are performed on EnginX at Rutherford Appleton Laboratory

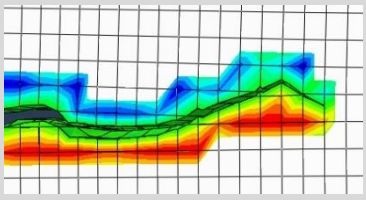
NI during FCG tests are performed in air on IMAT at Rutherford Appleton Laboratory



Radiography of the sample obtained using the MCP detectors

Numerical Analysis

- FCG modelling using the eXtended Finite Element Method (XFEM) in welded components in the presence of residual stresses
- Prediction of welding residual stress re-distribution during fatigue crack propagation in air and seawater



Preliminary Conclusions

- Tensile and compressive residual stresses have been measured in C(T) welded specimens.
- Residual stresses show beneficial and damaging effects on the fatigue crack growth behaviour of the material depending on their magnitude and direction.