

Title: Fatigue and Fracture Behaviour of Piping Components under Different Mechanical and Environmental Conditions (F2BPIPE-MEC) [NCP 040303]

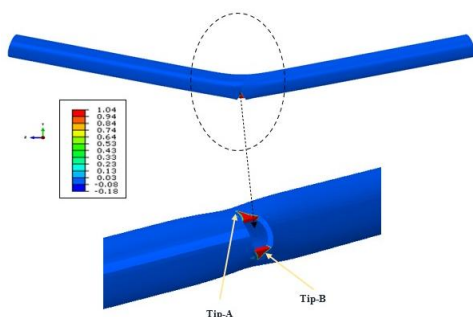
Duration: April 2024 to March 2026

Deliverables:

- A model to evaluate fracture parameters based on energy principles
- A model to predict remaining life for pipes under combined bending and torsion
- Studied the re-rounding behaviour of dents in pipes under internal pressure
- Generated J - R curves for welded pipes under monotonic and cyclic loading
- Studied the effect of temperature on crack growth behaviour of piping components
- A model for remaining life and residual strength prediction of piping components under variable amplitude loading

Significant Achievements:

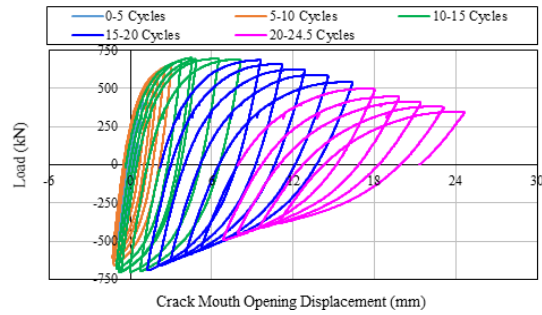
- Numerical studies were carried out on the fracture assessment of through-wall cracked similar metal welded pipes and dissimilar metal welded pipes using the energy-based phase field (PF) model.
- Investigated the effect of combined bending and torsion on crack growth behaviour of SA 312 Type 304LN stainless steel pipe with a circumferential part-through crack and proposed expressions for SIF considering equivalent moment due to bending and torsion.
- Studied re-rounding behaviour of API 5L X46 Grade steel pipes with and without internal pressure.
- Generated crack growth resistance (J - R) curves for the notched pipe specimens made of SA 312 Type 304LN stainless steel subjected to static monotonic and cyclic loading using different analytical approaches. Failure assessment diagrams were also constructed for these welded pipes.
- Performed fracture studies on pipe weld joints having circumferential through-wall notch (i) of thermally aged and (ii) at an elevated temperature of 300 °C.
- Developed a variable-amplitude fatigue crack growth model incorporating overload retardation, and used SCADA loading data for remaining life assessment.



Phase-field simulation of crack propagation in a similar metal welded pipe



Deflected shape of the dissimilar pipe weld joint after fracture test at elevated temperature



Load vs. CMOD for a dissimilar metal pipe weld joint during fracture test at elevated temperature

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