

Fundamental Understanding of Pipeline Material Degradation under Interactive Threats of Dents and Corrosion



U.S. Department of Transportation
Pipeline and Hazardous Materials Safety
Administration

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Main Objective

Evaluate interactive threats of external mechanical dents and secondary features, through integrated **lab-scale experimental** and **numerical framework** to **characterize** and **better predict** the remaining safe life and operating pressures, while projecting the needs for mitigation measures.

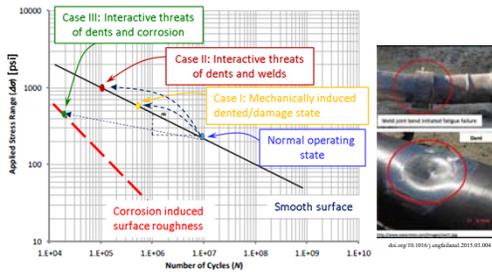


Figure 1. Hypothesized interactive threats effects on the fatigue life of the pipeline material.

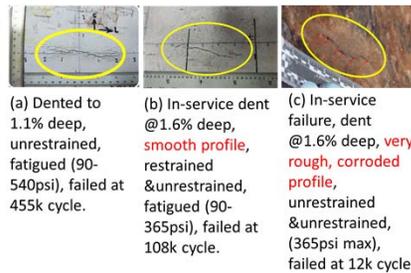


Figure 2. Post analysis of the role of the dents on the fatigue life of the pipeline, highlighting the role of interactive threats. (M. Piazza, 2018 R&D forum)

Expected Results or Results to Date

Identify Physics of Interactive Threats: Provide fundamental understanding of measurable degradation parameters at the local level, that can assist in the variance reduction of threat assessment of the damage at the pipeline structure scale.

Model Based Prediction: Provide lab-scale experimentally calibrated framework.

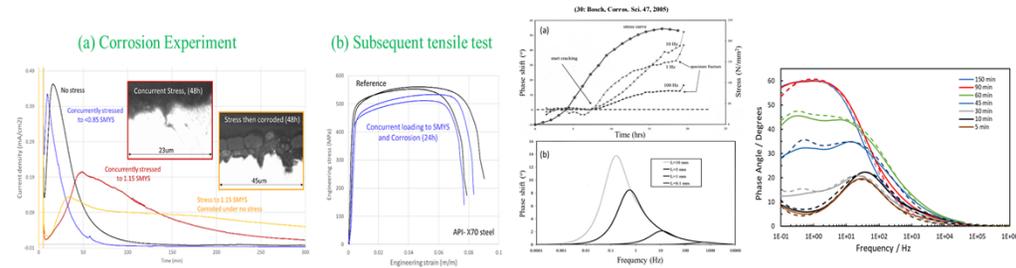


Figure 5. Interactive threats simulation: Samples subjected to residual stress level in excess of SMYS showed significant corrosion, GB grooving and reduction in both strength and ductility.

Figure 6. (a) EIS phase shift evolution during slow strain rate SCC test in 304 SS. (b) Dependence of phase shift on crack length. (c) Preliminary EIS measurement on corroded X70 steel showing impedance phase shift evolution for different exposure time at constant potential.

Project Approach/Scope

Provide detailed understanding of the material strength and toughness under interactive threats of (a) dents (especially plain dents) and (b) progressive corrosion environment. Reduce variance in predicting failure limits and/or remaining fatigue life.

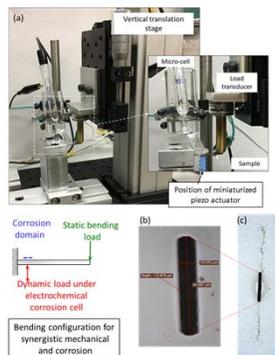


Figure 3. (a) Proposed micro-electrochemo-mechanical experimental setup.

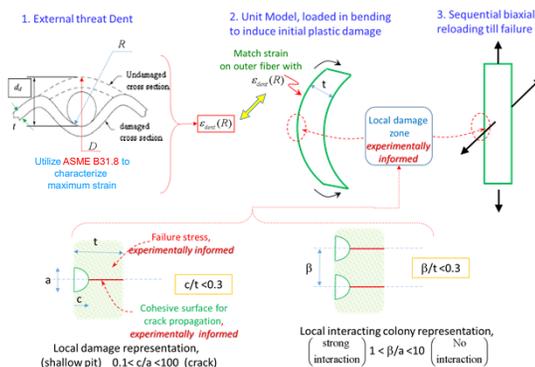


Figure 4. Multiscale Multi-threat analysis at the structure scale, utilizing ASME B31.8 calibration.

Acknowledgments

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References

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