University of Strathclyde Glasgow

Corrosion and fatigue protection of offshore wind Turbine structures using additive manufacturing technology (COATing)

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Aim and objectives

Aim: The main aim of this project is to develop multi-metallic functionally graded OWT structures with built-in corrosion-fatigue damage resistance characteristic using additive manufacturing techniques. The proposed methodology is expected to significantly increase the design life of OWT support structures and reduce the O&M costs by creating smart structures which are engineered for operation in the hostile offshore environments. The plan for developing the proposed 12-month research work is built around the following objectives:

Objectives

- To develop corrosion-fatigue tolerant matrix microstructures using additive manufacturing techniques to inhibit damage evolution at the micro- and meso level; (WP1, WP2)
- To create large-scale coupons with corrosion and fatigue durability at the macro level; (WP3)
- To investigate the nucleation and growth of corrosion pits in multi-metallic additively manufactured samples with various seawater exposure times; (WP3)
- To examine the fatigue resistance of additively manufactured coupons in the presence of corrosion pits; (WP4)
- To quantitatively analyse the corrosion and fatigue resistance of additively manufactured coupons compared to traditional multi-pass butt-welded geometries; (WP4)
- To evaluate the socio-economic impacts of the proposed manufacturing approach on the design and life assessment of OWT support structures; (WP5)
- To propose optimum multi-metallic alloys combination and the cost-effective additive manufacturing technique for corrosion-fatigue life enhancement in OWT support structures; (WP5)

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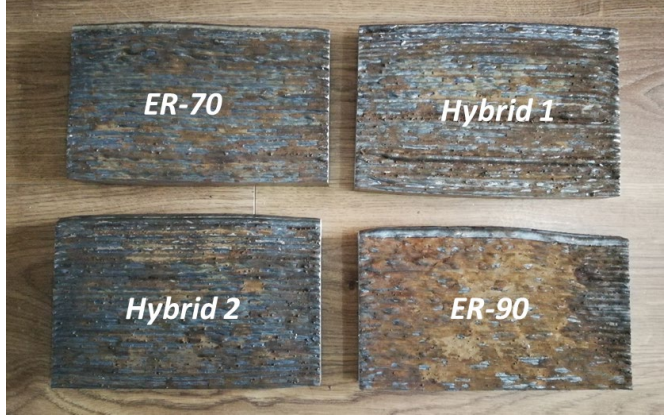
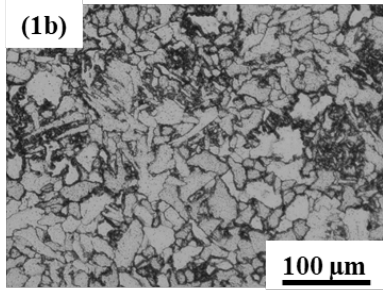
Work Package 1 (Design and fabrication)

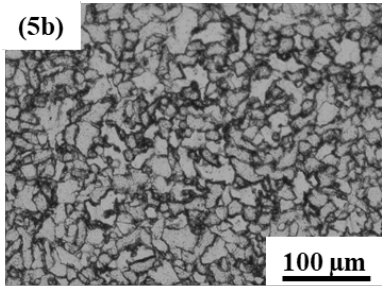
- Additive manufacturing of samples for corrosion-fatigue behaviour
- Process: Wire + arc additive manufacturing
- Material: ER70, ER90 and Hybrid (ER70+ER90)



Work Package 2 (Characterisation)

- Tensile, *Hardness (Hv)*
- Microstructure and texture analysis
- Characterisation tools: SEM, EBSD, EDS, OM



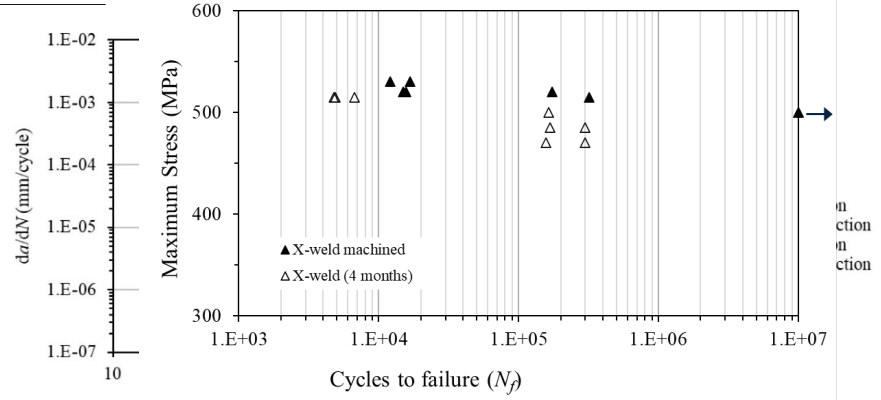


Work Package 3 (Pitting corrosion analysis)

- Fatigue sample preparation
- Corrosion damage according to ASTM D1141-98

Work Package 4 (Fatigue testing and analysis)

- Durability (S-N) analysis of different materials exposed to different corrosion times: effect of pit size and microstructure
- Material data: fatigue crack growth rate, fracture toughness, tensile testing



Work Package 5

- Evaluation of the project impacts on potential reductions in O&M costs, LCoE and CO_2 emissions by enabling life extensi
- A list of recommendations for implementation of the advance manufacturing technologies in offshore wind industry.

Q & A