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TOWARDS VIRTUAL FATIGUE DAMAGE ASSESSMENTS: A MULTI-SCALE COMPUTATIONAL FRAMEWORK

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The superior mechanical properties of fibre reinforced polymer (FRP) materials make them a promising strengthening and repair material when combined with steel structures. For ships and off-shore applications, FRP has been seen to offer many advantages in improving structural and damage performance of steel components, restoring lost capacity as well as strengthening sections to resist higher loads and reducing fatigue crack growth [1].

In the goal to apply FRPs with high integrity marine applications, significant advancements in computational methods are required to efficiently model the heterogeneous material behaviour and predict the corresponding complex failure mechanisms. Multi-scale methods offer the ability to reduce the computational complexity of obtaining the unknown constitutive relationship at the macro-scale by solving a local finite element problem at the micro-scale [2].

In this work, a two-scale homogenisation implementation is presented within the framework of the commercial finite element software ABAQUS, for the analysis of heterogeneous materials and structures. Results presented demonstrate the improved computational efficiency of the proposed method when applied within a continuum damage setting. Fatigue damage progression is accounted for using micro-scale damage mechanics, able to predict the quasi-brittle fracture from initial non-critical damage, up to the final stages of structural failure. The implementation is validated against experimental results for an example marine structural component, loaded under low-cycle fatigue.

References

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