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EXPERIMENTAL CHARACTERISATION AND COMPUTATIONAL MODELLING FOR CYCLIC ELASTIC- PLASTIC CONSTITUTIVE BEHAVIOUR AND FATIGUE DAMAGE OF X100Q FOR STEEL CATENARY RISERS

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Abstract: New higher strength steels are required for deep and ultra-deepwater steel catenary risers (SCRs). In this work, the cyclic elastic-plastic-damage behaviour of X100Q, a candidate next-generation SCR material is experimentally characterised and modelled. The material is shown to exhibit early life (primary) fatigue damage followed by the more conventional (secondary) fatigue damage; as a result, it is necessary to demarcate the observed cyclic softening into dynamic recovery and damage-induced softening. An automated constitutive parameter optimisation process in combination with a new two-stage cyclic damage evolution model successfully predicts the effect of strain-range on damage evolution. The model is implemented in a user material (UMAT) subroutine for multiaxial application, within a hierarchical global-local modelling methodology for dynamic fatigue analysis of an SCR girth weld geometry. The interdependency between fatigue damage-induced material degradation and cyclic plasticity at the weld is shown for a range of load cases.

Keywords: Damage mechanics; Fatigue; Offshore; Welded joints

1. Introduction

High-strength low-alloy (HSLA) steels are an important category of engineering materials, which are used across a variety of domains, from the automotive and shipbuilding industries to applications such as pipelines and cranes. Some of the key

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