Physically-based notch strain methods for fatigue life prediction of welded tubular connections in offshore wind turbine support structures

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Abstract

Given the increasing demand for energy and the need to address climate change, offshore wind energy is a valuable renewable energy source. To make wind energy an economical energy resource, upscaling of offshore wind turbine support structures is necessary. Welded joints in support structures are critical locations for fatigue failure, particularly with uncertain aero- and hydro-dynamic loading conditions. The present work focuses on the development of a physically based (PB) notch strain methodology for fatigue life assessment of welded tubular joints in offshore wind turbine (OWT) support structures.
To incorporate the welding microstructure effect in structural steels like S355 ferritic-pearlitic steel, PB cyclic plasticity model is presented for the effects of welding zones on the cyclic elastic-plastic response of welded tubular joints. A modified Neuber method is combined with the PB cyclic plasticity model and global-local modelling of welded joints in the NREL OC4 reference jacket structure under dynamic loading, to demonstrate the PB notch strain methodology. The significance of this study is that we can capture welding-induced microstructure effects on localised notch strain for fatigue life prediction in a computationally efficient method.

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