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A through-process, thermomechanical model for predicting welding-induced microstructure evolution and post-weld high-temperature fatigue response

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ABSTRACT: This paper is concerned with the development of a modelling framework to predict the effects of welding and post-weld heat treatment on thermo-mechanical performance of welded material, as a step towards a design tool for industry. A dislocation mechanics, through-process finite element model, incorporating thermal, microstructural and mechanical effects is presented, for predicting thermo-mechanical fatigue of welds. The model is applied to multi-pass gas tungsten arc welding of 9Cr martensitic steel. The predicted high-temperature low-cycle fatigue performance of cross-weld samples is comparatively assessed for a range of different post-weld heat treatment durations. It is shown that longer post-weld heat-treatment (PWHT) durations increase the predicted number of cycles to failure and that Vickers hardness gradient across the heat-affected zone can be used an indicator of fatigue life.

KEY WORDS: Finite-element, welding, fatigue, microstructure, constitutive