ON THE CYCLIC SOFTENING AND RATCHETING BEHAVIOUR OF A CSEF GAS TURBINE ROTOR STEEL AT 600^{O}C

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Abstract

Cyclic softening under load-controlled low cycle fatigue typically manifests itself by the presence of the ratcheting, which induces an accumulation of plastic and creep strain with the increasing number of cycles, leading to progressive damage and shorter fatigue lives. Therefore, improved understanding of the physical mechanisms related to the high-temperature cyclic plasticity softening behaviour of tempered martensitic CSEF steels is crucial for more accurate fatigue behaviour assessments and to maintain the safety and integrity of critical energy components. In this study, fully reversed uniaxial and multi-axial load-controlled tests on FV566 martensitic gas turbine rotor steel at 600ºC were utilized to examine the evolution of cyclic softening, ratcheting and fatigue damage under different degrees of stress states. Microstructural characterizations were conducted on the tested samples to study the evolution of the key microstructural features in the material and their roles in the damage development. A modelling framework is developed by coupling the unified viscoplastic constitutive material model with a physically based damage model, which can be used to simulate the ratcheting response and the associated microstructural degradation.

Keywords: *Low cycle fatigue; Cyclic softening; Viscoplasticity; Ratcheting; Damage; CSEF Steels*