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DAMAGE MECHANICS APPROACH FOR THE ANALYSIS OF CASTING MATERIALS UNDER THERMO-MECHANICAL FATIGUE

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High-temperature components, for example turbochargers, are often subject to complex thermal and mechanical loading paths. Non-uniform temperature distribution and constraints by neighboring components result in complex timely varying stress and strain states during operation. The aim of this paper is to analyze inelastic behavior of a casting material Ni-resist D-5S in a wide stress, strain rate and temperature ranges. The material model is presented including a constitutive equation for the inelastic strain rate tensor, a non-linear kinematic hardening rule and a damage evolution equation. To calibrate the model, experimental databases from creep and low cycle fatigue (LCF) tests are applied. They include creep curves for temperatures within the range 600-800°C and stress levels from 10MPa to 150MPa. The LCF data collects a family of hysteresis loops for the strain rate of 10^{-3} 1/s, the strain amplitude from 0.4% to 2% and temperature levels within the range 200-800°C. For the verification of the model, simulations of the material behavior under uniaxial TMF loading conditions are performed. The results for the stress responses and life-times are compared with experimental data.

A procedure for accelerated time integration is required for the analysis of components subjected to many cycles of thermo-mechanical loading. In this presentation we discuss an adaptive extrapolation method for the rapid integration of the constitutive and evolution equations.