Modelling Inelastic Behaviour of Polyoxymethylene under Cyclic Loading

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ABSTRACT

Analysis of inelastic behaviour under cyclic loading paths is crucial for the fatigue life-time predictions of many materials. Numerical predictions of phenomena like cyclic softening, ratcheting etc, are expensive as time-step procedures should be applied for many loading cycles and extremely small time steps are usually required in the case of rapid loading changes. The focus of this contribution is the inelastic behaviour of Polyoxymethylene (POM). This semi-crystalline thermoplastic has a wide range of engineering applications due to relatively high long term strength.

In this contribution a multi-axial inelastic constitutive model is developed and calibrated against experimental data on creep for POM. The model includes a constitutive equation for the inelastic deformation rate tensor and evolution equations for a backstress tensor and a scalar valued damage variable to account for kinematic hardening and tertiary creep stage. The model takes into account significant volume changes in the inelastic range.

The proposed model is applied to analyse material responses under various cyclic loading regimes. To predict the long term material behaviour efficiently rapid estimation methods are developed. They include a two-time scales approach and an extrapolation procedure to allow a fast prediction of the cycle count until failure. The developed simplified methods are benchmarked against the proposed model regarding accuracy and savings of computational time.