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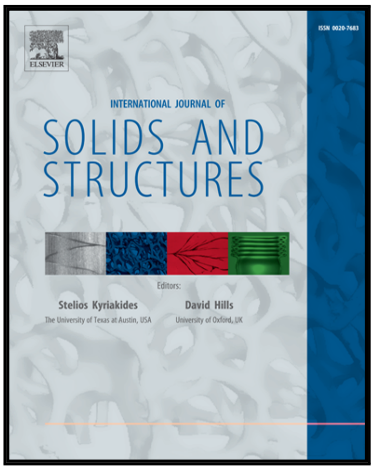

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Patrick Zerbe, Benjamin Schneider, Egon Moosbrugger, Michael Kaliske

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A viscoelastic-viscoplastic-damage model for creep and recovery of a semicrystalline thermoplastic

Patrick Zerbe[a,b,*], Benjamin Schneider[a], Egon Moosbrugger[a], Michael Kaliske[b]

[a]Corporate Sector Research and Advance Engineering, Robert Bosch GmbH, Renningen, 70465 Stuttgart, Germany
[b]Institute for Structural Analysis, Technische Universität Dresden, 01602 Dresden, Germany

Abstract

Thermoplastics subjected to static mechanical loads tend to creep, i.e., deform with respect to time. Motivated by creep experiments, a finite strain material model is proposed. The approach models recoverable and irrecoverable deformations through viscoelastic and viscoplastic contributions, respectively. The viscoelasticity is based on a generalized Maxwell model and the viscoplastic component has a quadratic pressure-dependent flow potential and a typical creep viscosity function. An isotropic damage formulation models the degradation of material properties with respect to time. However, a newly proposed recovery variable hinders the damage evolution especially in long-term processes. A reduced predictor-corrector scheme is presented for an efficient solution of the implicit numerical integration of the model in the context of Finite Element calculations. Creep experiments with constant load and cyclic loading-unloading are shown to characterize the mechanical long-term behavior of polyoxymethylene, a semicrystalline thermoplastic. Finite Element calculations of the experiments with the proposed material model demonstrate its capability to model the long-term deformation behavior of polyoxymethylene.

Keywords: polymer, thermoplastics, polyoxymethylene, creep, recovery, finite element method, viscoplasticity, viscoelasticity, damage, cyclic, lifetime

1. Introduction

Thermoplastics have a tendency to creep, i.e., time-dependent increasing deformation under static loads. In the course of the present study, experiments have been conducted at 60 °C on a polyoxymethylene (POM), a semicrystalline thermoplastic. Exemplary results are outlined here as motivation for a proposed material model. They are presented in more detail in Section 3. First,

*Corresponding author

Email addresses: `patrick.zerbe@de.bosch.com` (Patrick Zerbe), `benjamin.schneider3@de.bosch.com` (Benjamin Schneider)