The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Finite Element Analyses of Shear Yielding and Crazing in Glassy Polymers Under Cyclic Mode I Loading

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Keywords: *Polymeric material modeling, Shear yielding, Crazing, Cyclic loading*

Shear yielding and crazing are the key deformation and damage mechanisms which govern the inelastic behaviour of glassy polymers. Much research has been devoted to modeling and understanding their occurrence and eventual competition under monotonic loading conditions; e.g. [1, 2, 3]. However, theoretical studies concerning the interaction of crazing and shear yielding under cyclic loading are still rare to date. Constitutive models for the bulk deformation behaviour of glassy polymers accounting for non-monotonic loading phenomena such as the Bauschinger effect are well established (e.g. [4]). Yet, existing crazing models are so far primarily applicable to monotonic loading.

The present work focuses on the development of a continuum-micromechanical model for crazing that realistically describes the response under cyclic loading. That is, in addition to the non-linear viscoelastic-viscoplastic stretching of the fibrillated craze matter under loading, the model accounts for fibril growth due to drawing in of bulk material as well as creep-recovery when unloaded (e.g. [5]). Within the scope of a parameter study, the model capabilities are investigated. Subsequently, detailed finite element analyses of a boundary value problem of a mode I crack under cyclic loading conditions are conducted in order to analyze the competition between shear yielding and crazing.

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