Study of the cyclic variability of the Taylor-Quinney coefficient using a thermo-viscoelastic-viscoplastic-damage model for thermoplastics

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ABSTRACT

A thermo-viscoelastic-viscoplastic ductile damage model has been developed to study the cyclic variability of the Taylor-Quinney coefficient during the anelastic deformation of semi-crystalline thermoplastics. The model is mainly devoted to describe both recoverable and irrecoverable mechanisms occurring during the cyclic deformation of such materials. The proposed model was incorporated into the framework of Thermodynamics of Irreversible Processes and Generalized Standard Materials formalism to offer the thermodynamic consistency of all constitutive equations. The numerical implementation of the proposed model was based on the well-known return mapping algorithm using the convex cutting plane form [1]. The model was calibrated and validated across monotonic tensile and cyclic tensile-tensile tests by comparing predicted and experimentally observed energy responses [2]. A FE parametric study has been conducted on a Meuwissen structure with the help of the commercial finite element code to evaluate the capability of the proposed model to describe the material rate sensitivity as well as both the variability of the Taylor-Quinney coefficient and the thermomechanical damage during the loading. A fair agreement in terms of energy balance responses has been demonstrated; the model was relevant for predicting the anelastic thermomechanical behaviour of the wet thermoplastic polymer considered. The numerical findings have shown a good accordance with the experimental observations conducted on the polymer material where the mean strain, self-heating and Taylor-Quinney coefficient have been observed to increase with increasing loading rates.

REFERENCES