Accepted Manuscript

A coupled hyperelastic-plastic-continuum damage model for studying cyclic behavior of unfilled engineering polymers

Amir K. Shojaei, Pieter Volgers

PII: S0142-1123(17)30397-3
DOI: https://doi.org/10.1016/j.ijfatigue.2017.10.006
Reference: JIJF 4480

To appear in: *International Journal of Fatigue*

Received Date: 28 June 2017
Revised Date: 2 October 2017
Accepted Date: 4 October 2017

A coupled hyperelastic-plastic-continuum damage model for studying cyclic behavior of unfilled engineering polymers

Amir K. Shojaei, and Pieter Volgers

[1]DuPont Performance Materials, Chestnut Run Plaza, Wilmington, DE, 19805, USA
[2]DuPont Performance Materials, European Technical Centre, CH-1217 Meyrin, Geneva, Switzerland

Abstract

History of accumulated fatigue damage and induced plastic strain are salient design criteria in many structural elements in aerospace, automotive and healthcare industries. A successful fatigue engineering tool should be able to predict the cyclic permanent set as well as the fatigue damage, and lifetime. When an engineering polymer is subjected to cyclic loads, the unloading curves may deviate from the so-called *linear unloading* response. It is argued that previously developed fatigue computational tools, e.g. [1, 2], might overpredict the residual plastic strain in real applications. This work aims at accommodating the observed nonlinear unloading curves into the previously developed fatigue modeling framework that significantly improves the predicted permanent deformation. To accomplish this task a *hyperelastic* material model is coupled with plasticity, and Continuum Damage Mechanics (CDM). The developed hyperelastic-plastic-CDM framework is implemented in Finite Element Analysis (FEA) software, *viz.* Abaqus, through user-defined material laws for structural analysis. The hyperelastic material model within the small strain framework can effectively capture elastic loading and unloading responses. The enforced coupling between hyperelastic, plastic, and CDM models results in more accurate prediction of the progressive fatigue damage and permanent set in unfilled polymers. The performance of the developed framework is compared with the experimental data and it is shown that the developed framework performs well in capturing progressive permanent set, and fatigue damage in unfilled polymers. The proposed framework may improve the precision of cyclic analysis in unfilled polymers and may help engineers in their design optimization cycles.