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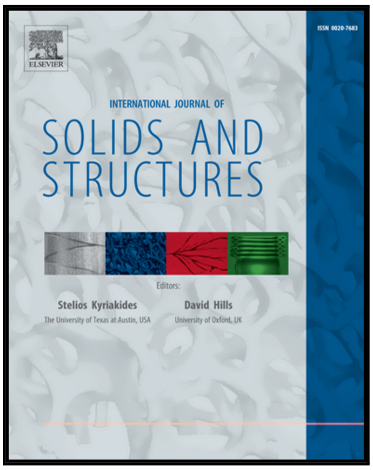

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Identifying design parameters controlling damage behaviors of continuous fiber-reinforced thermoplastic composites using micromechanics as a virtual testing tool

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Abstract

In this paper, we propose a micromechanical approach to predict damage mechanisms and their interactions in glass fibers/polypropylene thermoplastic composites. First, a representative volume element (RVE) of such materials was rigorously determined using a geometrical two-point probability function and the eigenvalue stabilization of homogenized elastic tensor obtained by Hill-Mandel kinematic homogenization. Next, the 3D finite element models of the RVE were developed accordingly. The fibers were modeled with an isotropic linear elastic material. The matrix was modeled with an isotropic linear elastic, rate-independent hyperbolic Drucker-Prager plasticity coupled with a ductile damage model that is able to show pressure dependency of the yield and damage behavior often found in a thermoplastic material. In addition, cohesive elements were inserted into the fiber-matrix interfaces to simulate debonding. The RVE faces are imposed with periodical boundary conditions to minimize the edge effect. The RVE was then subjected to transverse tensile loading in accordance with experimental tensile tests on $[90]_8$ laminates. The model prediction was found to be in very good agreement with the experimental results in terms of the global stress-strain curves, including the linear and nonlinear portion of the response and also the failure point, making it a useful virtual testing tool for composite material design. Furthermore, the effect of tailoring the main parameters of thermoplastic composites is investigated to provide guidelines for future improvements of these materials.

Keywords: thermoplastic composites, micromechanics, RVE modeling, transverse tensile