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Borys Drach, Igor Tsukrov, Anton Trofimov, Todd Gross, Andrew Drach

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Comparison of stress-based failure criteria for prediction of curing induced damage in 3D woven composites

Borys Drach*, Mechanical & Aerospace Engineering, New Mexico State University, Las Cruces, NM

Igor Tsukrov, Mechanical Engineering, University of New Hampshire, Durham, NH

Anton Trofimov, Center for Design, Manufacturing and Materials, Skolkovo Institute of Science and Technology, Skolkovo, Russia

Todd Gross, Mechanical Engineering, University of New Hampshire, Durham, NH

Andrew Drach, Institute for Computational Engineering & Sciences, University of Texas at Austin, Austin, TX

*Corresponding author:

Borys Drach

Mechanical and Aerospace Engineering

New Mexico State University

P.O. Box 30001, MSC 3450

Las Cruces, NM 88003-8001

phone: +1 (575) 646-8041

e-mail: borys@nmsu.edu

ABSTRACT

Several stress-based failure criteria (von Mises, dilatational strain energy density, parabolic stress and Drucker-Prager) are implemented in a numerical model of a 3D woven composite to predict initiation of damage due to cooling after curing. It is assumed that the composite is completely cured at elevated temperature and the residual stresses arise due to difference in the thermal expansion coefficients of fibers and matrix. The stresses are found by finite element analysis on the mesoscale while the effective thermoelastic properties of fiber tows are determined by micromechanical modeling. The matrix is modeled as an isotropic material with temperature dependent elastic properties and thermal expansion coefficient.

Comparison of numerical simulation results with the microcomputed tomography data obtained for a one-by-one orthogonally reinforced carbon/epoxy composite shows that the parabolic stress and the dilatational strain energy criteria provide the most accurate predictions of cure-induced damage. However, the accuracy of the parabolic failure criterion is dependent on the choice of the mechanical tests used to determine the values of its two material parameters.

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