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A Three Dimensional Thermodynamically Based Function for the Progressive Failure of Unidirectional Composites

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Abstract

A thermodynamically-based work potential theory for modeling progressive damage for laminated, unidirectional composites assuming plane stress (2D Schapery's theory) is extended to three dimensioanl (3D). An internal state variable, S, is defined to account for the dissipated energy due to damage evolution in the form of microstructural changes in the matrix. With the stationary of the total work potential with respect to the internal state variable, a thermodynamically-consistent set of evolution equations is derived. The internal state variable is related to the transverse and shear moduli through microdamage functions. In the first part of this work, coupon specimens are prepared to conduct experiments to characterize the relations between the internal state variable and the transverse modulus as well as shear modulus. The information is subsequent used for the prediction of three point bending test. In the second part of this work, objectivity is studied. Three separate methods utilizing different definitions of a reduced internal state variable or of the order of the polynomials are used to represent the matrix microdamage functions are employed. The three methods are implemented in a user defined subroutine within a commercial finite element method software package. Results from numerical simulations of a center-notched composites panel are compared. The agreement in the maximum stress predictions among the three methods indicates that objectivity, with respect to the functional form of the microdamage functions, is satisfied.

Keyword: unidirectional composites; Schapery's theory; progressive failure

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