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A modified Schapery theory to predict the progressive failure of CFRP

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Abstract

Schapery theory, a thermodynamically-based work potential, is widely employed for describing material micro-structure changes in Carbon Fiber Reinforced Composites (CFRCs). Many well-accepted Schapery models utilize an approximation, $\nu_{ij} \cdot \nu_{kl} \approx 0 (i, j, k, l = 1, 2, 3)$, to formulate the matrix micro-damage evolution equation. In contrast to that, a modified Schapery model from using full elastic strain energy expression, W_{Strain} , is presented and investigated. Our comparison results indicate that employing such approximation in 3D Schapery model introduces a spurious elastic strain energy term, predicts less matrix micro-damage accumulations and subsequently overestimates the degraded Young's modulus. The role of W_{Strain} in Schapery theory, model simplification approach, the applicability of the proposed 3D Schapery model as well as the consistency of using secant material assumption are discussed thereafter. In addition, the discrepancy between utilizing secant and tangent modulus degradation functions are also studied. We hope these findings could aid in the elucidation of the Schapery model formulation and benefit its application on simulating undulated fiber tows in textile composites.

Keywords: Schapery theory, Progressive failure, three dimensional, CFRCs

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