

Micro- and Mesomechanics of 8-harness Satin Woven Fabric Composites: I — Evaluation of Elastic Behavior

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Abstract

In part I of this two-part paper, simplified two-dimensional micromechanics and mesomechanics models have been introduced to predict the elastic behavior of 8-harness satin (8HS) woven fabric composites. The woven warp and fill tows were independently treated as unidirectional composites and composite cylinder assemblage (CCA) theory was adopted to predict tow elastic properties from constituent fiber and matrix properties. Since evaluation of woven lamina stiffness requires an accurate description of tow geometry, a method was also developed to describe arbitrary tow geometries by mathematically fitting cubic splines and/or polynomials to micrographs of composite cross-sections. Finally, classical lamination theory was introduced to determine the overall elastic behavior of an n -layered composite laminate, assuming the woven lamina was a modified, two-layer laminate.

The simplified mechanics model was evaluated using results from numerical strain energy and equivalent force approaches and results from a series of experimental Iosipescu shear tests and off-axis tensile tests on T650-35(3k), 8HS woven graphite-PMR 15 composites. Issues regarding exclusion of a matrix layer in the simplified, 2-layer laminate analysis were addressed in the strain energy analysis of an idealized 3-D, representative volume element (RVE). The mechanics model was found adequate in estimating the lower bounds of 8HS woven fabric, composite elastic properties. The model also provided a reasonable estimation of symmetric cross-ply composite properties.

Keywords: Micro-mechanics; Mesomechanics