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Damage and failure of triaxial braided composites under multi-axial stress states

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Abstract

Damage and failure of triaxial braided composites under multi-axial stress states was investigated. In order to introduce different multi-axial stress states in the material, uni-axial tensile tests were performed at different off-axis orientations. Three braid architectures, comprising braiding angles of 30°, 45° and 60° were each loaded parallel to their axial, transverse and braid yarn direction. Digital image correlation measurement techniques were used to quantify the effects of the textile architecture and its heterogeneity on the strain field, to identify and locate constituent failure mechanisms and to investigate damage initiation and development. In order to identify the driving physical mechanisms behind the material non-linearity, the evolution of the damage variable and the accumulated inelastic strain was quantified using incremental loading/unloading experiments. A high-speed camera was employed in order to study the dynamic nature of catastrophic failure. The triaxial braids within this study exhibited severe non-linearities in the mechanical response before final failure as a result of extensive matrix cracking. While we found the underlying textile architecture to slightly reduce the elastic properties compared to equivalent tape laminates, it functions as a natural crack arresting grid. As a result

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