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DESIGN AND ANALYSIS OF 3D WOVEN COMPOSITES AT FAILURE

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3D woven composites have superior fracture toughness, fatigue life, and damage tolerance compared to laminated composites [1] due the presence of through thickness reinforcement (see Figs 1 and 2). These properties lead to high levels of energy absorption in 3D woven parts, enabling the manufacturing of 3D woven parts suitable to replace the traditional high strength metal ones used in the aerospace and automotive industries, at a lighter weight. In addition, 3D weaving technology allows for the fabric to woven in a near-final shape, reducing complexity and cost of manufacturing [2].

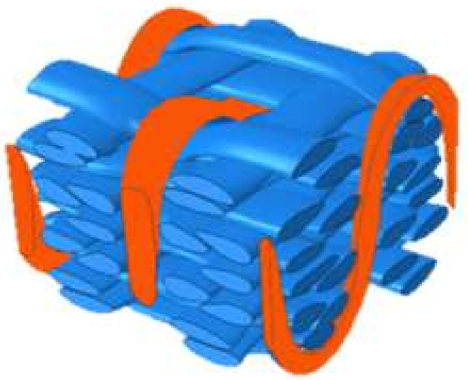

Figure 1 Unit cell of Orthogonal Architecture

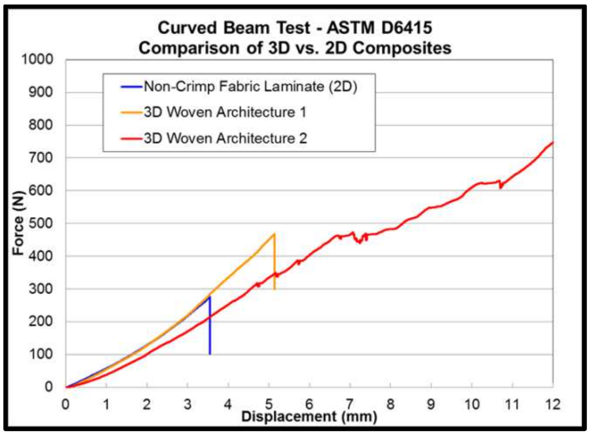

Figure 2 NCF vs. 3D woven comparison

The goal of this study is to develop a macro-scale finite element material model [3] to predict the energy absorption of 3D woven composites that can be easily calibrated from standard experimental setups, such as those in ASTM standards. Since the characterization of failure includes regions of softening behavior, a characteristic length scale is present in the model as to prevent the incidence of pathological mesh dependence [4]. This material model is then used to design and predict the stiffness and energy absorption of a beam subjected to 3-point bending. The results are validated with experimental data obtained from physical parts, showing the finite element models accurately predict the part’s mechanical behavior.

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