
Optimization of impact properties and weaving patterns of woven composites

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Abstract

Fibre Reinforced Polymer (FRP) laminates are used extensively in automotive and aerospace components because to their reduced weight, increased design freedom, increased durability, and reduced susceptibility to corrosion. Several possible weave architectures (combinations of weave patterns and material choices) present a challenging question about how they could influence the physical and mechanical properties of woven fabrics and reinforced structures. Predictions of elastic and impact properties of patterns in woven fabric composites are proposed based on unit cells. This study addresses the optimization of the impact properties within woven fabric composite unit cells with multiple designs based on periodic boundary conditions and evolutionary algorithms. Furthermore, the study permits a reliable prediction of mechanical behavior of woven fabric composites unit cells in which the weave patterns are the variables. The models are treated as a single-ply for each weave pattern embedded in a matrix pocket. The analyzed weave patterns are created by TexGen, the simulation is done with ABAQUS. At the unit cell level, effective elastic properties of the yarn were estimated from Finite Element (FE) simulations using periodic boundary conditions. Then the energy absorption capacity of the laminates was analyzed on a macroscopic scale. An evolutionary algorithm is adopted in optimizing the energy absorption capacity of woven fabric composites with recombination and mutation operators. We present a parameter study to investigate the effect of various geometric parameters. Those parameters include the gap length, the shape of the yarn section, the yarn thickness, the constituent materials, the fiber volume fraction and the elastic properties. By examining this optimized model through the pre-determined parameters as mentioned above, an optimal parameter set for composite's performance can be properly selected.

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