ELASTIC PROPERTY PREDICTION OF LONG FIBER COMPOSITES USING A UNIFORM MESH FINITE ELEMENT METHOD

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ABSTRACT

This research numerically evaluates elastic non-isotropic material properties of fiber reinforced composite materials. Calculations are performed with a finite element mesh composed of a uniform array of three dimensional finite elements. To better represent spatial inhomogeneities, an increased number of Gauss points are employed during elemental stiffness calculations. Rather than making a complex finite element mesh with element boundaries at all fiber-matrix interfaces, Gauss points are used to define materials points as in fiber depending on where the point lies within the model. A correction factor is applied to accommodate strain differences within elements that contain both fiber and matrix, allowing for greater accuracy in the uniform mesh elements. In this approach, fewer elements can be used to model a composite system enabling computational time and demands of memory to be reduced. The method also avoids complex meshing routines that are required when fiber-matrix interface geometries are needed.

The uniform mesh finite element method developed here is used to predict effective properties for curved long fiber composites and for an actual long fiber composite sample provided by Oak Ridge National Laboratory. The results of the curved fiber uniform finite element models are compared to modified Halpin-Tsai and Tandon-Weng micromechanical models where a good agreement is demonstrated. A convergence analysis is performed to show stability and convergence of results. Image processing techniques are applied to the Oak Ridge National Laboratory sample in order to extract a model from the CT data which was provided.