Finite Element Analysis of Transverse Mechanical Properties of Generally Cylindrical Orthotropic Constitutive Modeling of 3-Phase Matrix-Filled Carbon Nanotube

Master's Thesis Defense in Mechanical Engineering
California Polytechnic State University, San Luis Obispo

Presented by Christopher Hawkins
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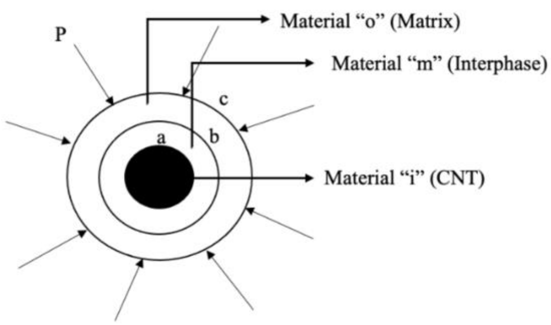

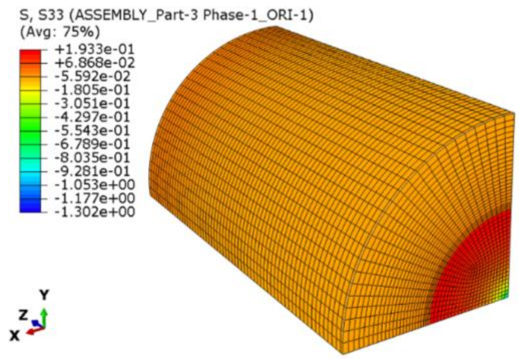

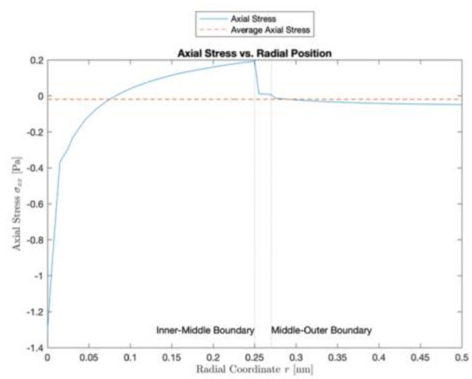

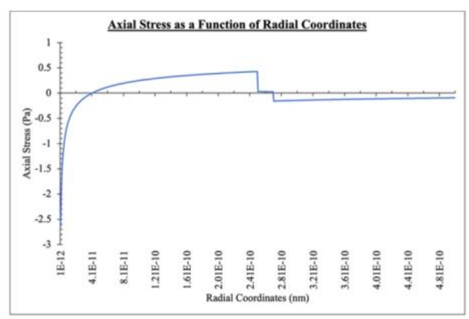

Fiber-reinforced composites are increasingly popular due to their specific strength and stiffness, making them ideal for high-performance applications. However, these materials primarily exhibit superior properties in-plane, while their out-of-plane characteristics remain weaker. Previous research has shown that the most effective method to enhance out-of-plane properties involves the incorporation of carbon nanotubes. Experimental tests have demonstrated significant improvements in properties such as tension, flexural, short beam shear, and fracture toughness. Alongside these experimental studies, analytical equations have been developed to predict the behavior of these composites under various loading conditions, including tension, bending, shear, and fracture. Existing models primarily address axial and radial loads in two-phase composites, with some extending to axial loading in three-phase models. More recently, a three-phase analytical model has been proposed to predict transverse properties under radial load. However, this model has yet to be validated through finite element analysis. To bridge this gap, this study employs Abaqus to develop a finite element model consisting of three orthotropic materials subjected to uniform external radial pressure. This approach allows for the investigation of micromechanical behavior and the determination of transverse properties in carbon nanotube composites. A parametric study varying the matrix volume fraction further demonstrates the robustness and potential of the model as a design tool. The results are then compared with analytical solutions to validate the predicted transverse properties under a radial pressure load.

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