Predicting Viscoelastic Behavior of Fabric Composites Using Finite Element Based Micromechanics Model

Anand Vijay Karuppiah, Kevontrez Jones, Abhiruchika Sriyarathne
Faculty: Suresh Keshavanarayana, PhD
Department of Aerospace Engineering, College of Engineering

Advanced textile composites have become widespread in many aerospace structural applications due to their unique ability of conforming to complex structural curvatures while maintaining their desirable properties. Besides all of its advantages, their long term application is restricted by its time dependent viscoelastic behavior, in which the state of stress decays as a function of time. In an attempt to predict this macro-level stress relaxation behavior, micromechanics model of 8-harness (8HS) woven fabric is assembled to capture the effects of the individual constituents and their microstructure. The model is developed from the microscopic images of composite cross-sections using the subcell modeling approach and idealized to contain a linearly viscoelastic matrix and orthogonally interlaced unidirectional composite tows. Periodic boundary conditions are applied to recreate the Representative Volume Element of woven fabric lamina. From the comparison, it was observed that the numerical results of 8HS model are in good agreement with experimental results. This finite element analysis based on the fruitful combination of mechanics of material and microstructure not only estimates the viscoelastic response of woven composite, but also predicts the state of stress and its variation in the adjacent tows and matrix regions.