Damage Evolution in Composites with a Homogenization Based Continuum Damage Mechanics Model

Somnath Ghosh and Jayesh Jain
Department of Mechanical Engineering, the Ohio State University, RoomW496, Scott Laboratory, 201 West 19th Avenue, Columbus, Ohio, USA, 43210
E-mail: ghosh.5@osu.edu

Abstract:

This paper develops a three dimensional homogenization based continuum damage mechanics (HCDM) model for fiber reinforced composites undergoing micromechanical damage. Micromechanical damage in the representative volume element (RVE) is explicitly incorporated in the form of fiber-matrix interfacial debonding. The model uses the evolving principal damage coordinate system (PDCS) as its reference in order to represent the anisotropic coefficients. This is necessary for retaining accuracy with non-proportional loading. The material constitutive law involves a fourth order orthotropic tensor with stiffness characterized as macroscopic internal variable. Damage in 3D composites is accounted for through functional forms of the fourth order damage tensor in terms of macroscopic strain components. The HCDM model parameters are calibrated by using homogenized micromechanical solutions for the RVE for a few strain histories. The proposed model is validated by comparing the CDM results with homogenized micromechanical response of single and multiple fiber RVE's subjected to arbitrary loading history. Finally the HCDM model is incorporated in a macroscopic finite element code to conduct damage analysis in a structure. The effect of different microstructures on the macroscopic damage progression is examined through this study.