8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

ELASTOPLASTIC MICROMECHANICAL DAMAGE MECHANICS FOR COMPOSITES WITH PROGRESSIVE PARTIAL FIBER DEBONDING AND THERMAL STRESS

***J.W. Ju and K. Yanase**

Department of Civil and Environmental Engineering,
University of California, Los Angeles, CA, 90095-1593, USA
Email: juj@ucla.edu ; URL: http:www.cee.ucla.edu/faculty/ju.htm

Key Words: *Damage Mechanics, Computational Micromechanics, Composites, Fiber Debonding, Plasticity, Thermal Residual Stress, Homogenization.*

ABSTRACT

Incorporating *interfacial damage* and *thermal residual* stress, a multi-stage micromechanical elastoplastic damage formulation is proposed to predict the overall transverse mechanical behavior of fiber-reinforced ductile matrix composites. Based on the concept of equivalent inclusion and taking the progressive debonding angle into consideration, partially debonded isotropic elliptical fibers are replaced by equivalent orthotropic yet perfectly bonded elastic fibers. Up to three interfacial damage modes (no debonding, partial debonding and perfect debonding) are considered. The Weibull's probabilistic function is employed to describe the varying probability of progressive partial fiber debonding. The evolutionary effective elastic moduli of four-phase composites, composed of a ductile matrix and randomly located yet unidirectionally aligned fibers (undamaged or damaged) are derived by a micromechanical formulation.

Thermal residual stress is taken into account through the concept of thermal eigenstrain to study the effect of the manufacturing process-induced residual stress. Further, explicit exact formulation on the exterior-point Eshelby tensor for *elliptical* fiber is presented to investigate the effect on mechanical responses of multi-phase elastoplastic-damage composites due to the aspect ratio of elliptical fiber. In order to characterize the overall transverse elastoplastic damage behavior, an effective yield criterion is derived based on the statistical ensemble-area averaging process and the first-order effects of eigenstrains upon the overall yielding. The proposed multi-level micromechanical elastoplastic damage formulation is applied to the transverse uniaxial and varied stress ratios of transverse biaxial tensile loading to predict the various stress-strain responses. Finally, comparison between the present predictions and available experimental data and other simulations are performed to illustrate the potential of the proposed framework.