APCOM & ISCM
11-14th December, 2013, Singapore

Micromechanical modeling for initial cracking at the free edge of angle-ply CFRP laminates

***T. Okabe[1], Y. Sato[1], and K. Yoshioka[2]**

[1]Department of Aerospace Engineering, Tohoku University, 6-6-01 Aoba-yama, Aoba-ku, Sendai, Miyagi 980-8579, Japan.
[2]Toray Composites (America), Inc., 19002 50th Avenue East, Tacoma, WA 98446, USA.

*Corresponding author: okabe@plum.mech.tohoku.ac.jp

Laminates of angled unidirectional CFRP are often used in designing structures. Singularities appear in the interlaminar area of the free edge because of differences in elastic properties between plies. We investigate the initial cracking of angle-ply laminates considering the free-edge effect. Multiscale modeling is applied to predict initial cracking of angle-ply laminates. This multiscale modeling consists of two scale analyses. On a macroscopic scale, each ply is modeled as a homogeneous body, and 3D finite-element analyses are performed to predict singular strain fields of the free edge. An elasto–plastic constitutive model based on the Sun and Chen model is applied to represent the nonlinear behavior of the free edge. On a microscopic scale, 3D periodic unit cell analyses are performed by application of the macroscopic strains obtained by macroscopic analyses. A damage growth model based on continuum damage mechanics is applied for matrix, and the initial cracking is predicted.

Keywords: Polymer matrix composites, Micromechanical modeling, Matrix crack, Periodic unit cell simulation, Continuum damage mechanics