

Damage Initiation and Progression in Multidirectional Laminates with a Hole

J. R. Schaff

United Technology Research Center, Hartford, CT

and

R. Y. Kim

University of Dayton Research Institute, Dayton, OH

ABSTRACT

Holes are pervasive in load-bearing composite structures within the aerospace industry, as a result of the use of mechanical fasteners in assembly and cutouts to accommodate wiring and hydraulic lines. In this work, static loading experiments were conducted on composite laminates to document the initiation and growth of damage and to record changes in the strain field. The main objective of this work was the development of an experimental database for comparison with the results from a three-dimensional stress analysis based on spline variational theory. Two multidirectional laminates considered in this study were $[0/90]_2s$ and $[\pm 30/90]_s$ of IM7/5250-4 (graphite fiber/toughened BMI). For each loading increment strains were recorded at a number of locations in close proximity to the hole as well as far field, and the specimen was subjected to x-radiography. Acoustic emission was also monitored during loading and compared to strains and radiographic images to identify damage initiation and progression. Experimental strains were well with the analytical strains at low loadings, prior to extensive damage development. The details of damage progression in these laminates discussed.