CRACKING AND DELAMINATION MODELING IN COMPOSITE LAMINATES
BY USING MESH INDEPENDENT APPROACH

Iarve¹, E.V, Whitney¹, T. and Mollenhauer² D.

¹ University of Dayton Research Institute, Dayton OH, USA, endel.iarve@wpafb.af.mil
² Air Force Laboratory, WPAFB, OH

ABSTRACT

Three-dimensional ply level modeling of multiple matrix cracking and delamination near an open hole in a quasi-isotropic composite laminate was performed. A mesh independent displacement discontinuity modeling method based on higher order shape functions was constructed for this purpose. The mesh configuration is dictated by the boundaries of the specimen, such as the presence of a hole, whereas the matrix cracking surfaces are aligned with the fiber direction in a given ply. The surface of the displacement jump associated with matrix cracking was defined in terms of the domain Heaviside function approximated by using higher order polynomial B-splines. Several matrix cracks in each ply of a [0/45/90/-45] composite were modeled and their effect on the fiber direction stress magnitude in the 0° was examined. Up to 35% relaxation of the of the fiber direction strain amplitude was predicted due to matrix cracking (splitting) of the 0° ply. Moiré interferometry was used to experimentally determine the strain and displacement fields in the surface layer of the same composite, previously prestressed beyond the damage initiation load. Good correlation between the experimental data and the stress redistribution predicted by the mesh independent damage modeling technique was observed.