Failure of Notched Laminates Under Out-of-Plane Bending, Phase IV

J. Parmigiani, *Ph.D.* - Oregon State University

ABSTRACT

The design of aircraft structures made of composite materials is heavily influenced by damage tolerance requirements. The problem of predicting failure in notched laminates has been the subject of numerous studies. In general, these investigations have focused on the response of laminates to in-plane tension, compression or shear. In spite of the fact that out-of-plane bending, twisting, or shear can be an important load situation, very little research has been devoted to this topic. The overall goal of this research is to develop analysis techniques that are useful for the design of composite aircraft structures subjected to general out-of-plane loading. The approach taken is to conduct experiments and finite element modeling involving simple structures (center-notched, unstiffened laminates) under pure bending and mode III (tearing mode) shear. In partnership with The Boeing Company, this approach has been pursued in three previous projects (phases I, II, and III) as well as the current phase IV. The specific goals of phase IV have been delineated in a number of project tasks. Preliminary results for four of these tasks will be presented here. The first of these tasks; investigation, via experiment and analysis, of out-of-plane shear, consists of mode III fracture of notched composite panels. Using analysis techniques validated in earlier phases, significant pre-test modeling has been performed, test fixtures have been build, and preliminary experiments performed. Final testing will be completed upon receipt of composite panels from Boeing. Current results on a second task, investigation of the effect of additional delamination interfaces, will also be presented. The need for delamination interfaces in the FEA models was demonstrated by the compressive buckling that occurred during the out-of-plane bending experiments of phase III. An update on a third task, investigation of the effect of initiating vs. propagating interfacial toughness values on analytical results, will also be provided. Previous phases of this project used the initiating value exclusively, the goal of this task is to explore the effects of proper use of the propagating value. Finally, the current status of the task, conduction of a sensitivity study using Boeing material properties, will be discussed.