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DELAMINATION GROWTH BEHAVIOR IN LAMINATED COMPOSITES UNDER COMPRESSIVE FATIGUE LOADS

Abstract

Laminated composites are known for their high strength to weight ratio and have attained a certain position as structural materials for aircraft, in which the unavoidable delamination is considered as one of the most critical damage modes. Components that contain delaminations and are subjected to monotonic or cyclic loads display low structural stiffness and delaminations might extend and further decrease the load-carrying capacity of composite laminates. Although several decades have elapsed since the recognition of the importance of delamination failure, it still remains a determining factor limiting the use of structural elements made of laminated composites. New developments, predominantly in the aircraft field, compel us to complete the knowledge of delamination growth behavior under compressive fatigue loads, which is essential to establish design allowable guidelines for structures. This study aims to determine the fatigue delamination growth behavior by both compressive fatigue experiments and numerical methods. Compressive fatigue testing was performed on T700/epoxy composite laminates. The components of energy release rate were calculated using VCCT by standard ABAQUS procedures. Furthermore, we put forward a simplified model to predict delamination growth behavior, based on the empirical parameters obtained by curve fit of experimental data. In conclusion, the following key results were obtained:

- The energy release rate reduces as the delamination grows. Because of the mode changing of buckling behavior, the level of normalized energy components varies with delamination growth and the delamination position.
- Delamination growth behavior is immensely related to loading levels (δmax), initial delamination length (l), and delamination position (h/T). Higher values of δmax, l and h/T ratio result in higher levels of both delamination growth rate and stabilized delamination length when the growth rate tends to zero, which can be interpreted by the computed energy release rates and the increasing fracture resistance as delamination grows.
- Using the simplified model we have accomplished the prediction of fatigue delamination growth behavior. The similarity between numerical results and experimental results proves the engineering validation of this numerical model.