Strain-Based Damage Assessment on Single-Stiffener Composite Panels

Dimitrios P. Milanoski* and Theodoros H. Loutas

* Laboratory of Applied Mechanics and Vibrations
Dept. of Mechanical Engineering and Aeronautics
University of Patras
Patras University Campus, GR-26504 Rio-Patras, Greece
e-mail: d.milanoski@g.upatras.gr, web page: http://aml.mech.upatras.gr

ABSTRACT

Stiffened panels made of composite materials constitute one of the most usually used structural components of modern aeronautical structures. A common defect of these structures is the skin/stiffener delamination/disbond at the interface between the two constituents, as a result of inefficient manufacturing process or foreign object impacts in service. Generally, discontinuities within the volume of an elastic solid media subjected to mechanical load, cause anomalies on the strain distribution in the near vicinity of the discontinuity. Utilizing this observation, the current work investigates the effect of artificially induced disbonds between the skin and a stiffener at a co-cured CFRP/epoxy single-stiffener generic element. A structural health monitoring (SHM) methodology is proposed which utilizes strain measurements along the stringer foot and aims to assess the health state of a single-stringered element as compared with a pristine baseline. First, direct comparison of the longitudinal strain at several locations along the feet of pristine and defected-specimens with local disbonds are presented. The study is implemented with Finite Element Analysis to acquire the strain measurements under various loads and values of strains are obtained at the exact points where in reality actual Fiber Bragg Grating sensors will be located. At every position, an anomaly index is extracted regarding the strain compatibility between baseline and disbonded specimen, through which damage detection is envisaged. For that purpose, a detailed finite element model of the test article is created and numerically subjected to axial compression load using commercial Abaqus®/Standard finite element code. The behaviour of each layer was modelled as a transverse isotropic material. Initially, a linear buckling analysis on the estimation of the buckling modes of the structure is conducted, the first of which are used as initial imperfection for the imminent non-linear analysis. A global mesh of approximate 2.00 mm was chosen as this value relies on a convergence study regarding the buckling load.

REFERENCES

Bisagni, C., Vescovini, R., & Davila, C. G. (2010). Assessment of the Damage Tolerance of Postbuckled Hat-Stiffened Panels using Single-Stringer Specimens. *Proceedings 51st AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference.* Orlando, FL, USA.

Li, H. C.H., Mouritz, A. P., & Herszberg, I. (2006). Automated Characterization of Structural Disbonds by Statistical Examination of Bond-line Strain Distribution. *Structural Health Monitoring, 5*(1), pp. 83-94.

Thompson, D. J., & Wisnom, M. R. (2009). Damage Modelling and Prognosis of Delaminated Beam Structures in Bending. *17th International Conference on Composite Materials.* Edinburgh, UK.