Structural Health Monitoring of Composite Laminated Plates Using an Array of PWAS

Moustafa Kamel Metwally Zidan

Professor

Abstract

The advances in using composite materials in different structural applications lead to the need of continuous, robust, and structural health monitoring (SHM) systems. One of the most promising techniques for SHM is electromechanical impedance (EMI)technique which depends mainly on the coupling nature of piezoelectric ceramics. Piezoelectric wafer active sensors (PWAS) can be employed as both a well-controlled actuator and sensor at the same time for diagnostic algorithms based on EMI technique. The study presented in this paper interested in EMI technique application to detect damage in composite laminated plates by applying synchronized system of PWAS array operated remotely by exerting harmonic analysis in desired frequency ranges. Frequency ranges are selected upon modal analysis of the healthy tested structure. Harmonic analysis is carried out for different damage scenarios. Extracted electrical charge spectrum data from each PWAS for the previous scenarios can be processed to plot electrical impedance for each case. The modeling process was carried out using a finite element commercial package, ANSYS v.15.0in which multi-physics-based modeling can be used for such structure made of laminated composite material. The extracted resultant spectrum, for healthy structure, is used as a datum in which it is related to its damaged counterparts through damage identification indices such as root mean square deviation (RMSD), and damage detection index (DDI). These indices were used as indicators for the changes in the modal parameters and hence, yielded reasonable results for both damage quantification and localization purposes.

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