858. Structural health monitoring (SHM) for composite structure undergoing tensile and thermal testing

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Abstract. Application of ultrasonic guided waves generated by piezoelectric smart transducers has become one of the widely-used techniques in structural health monitoring. This technique has led to significant improvements and profound effects in the field of aircraft reliability and safety. Lamb wave propagation on composite plate-like structure undergoing mechanical testing is investigated in the paper. Smart PZT actuator/sensor is bonded on the carbon-fiber and glass-fiber epoxy composites, which are subjected to tensile and thermal stress tests. The acquired results indicate the changes in scattering waves in composites materials due to the applied thermal and tensile force. Wavelet analysis was incorporated in this research work in order to distinguish different structural status.

Keywords: Lamb waves, structural health monitoring, piezoelectric transducer, composite structure, wavelet analysis.

Introduction

The safety in maintenance, repair and overhaul (MRO) for the aviation industry is paramount to ensure the compliance for the aircraft airworthiness at its highest level especially for civilian and air transport type aircrafts. A single unattended minor flaw or defect may lead to fatal catastrophic consequences and incur substantial financial losses [1]. There are many approaches in order to ensure the safety of air travel such as condition monitoring, scheduled inspections and reliability studies [2]. Nondestructive testing (NDT) is one of the most popular and very effective inspection techniques to monitor the damage and determine the level of defect. It can be noted that the inspection requires the aircraft to be grounded and demand the skills and manpower to perform the assessment. In other words, NDT is carried out only when a defect is detected or instructed [3].

Comprehensive and reliable monitoring methods are needed to detect the damage at the earlier stage. This is why researchers spent a significant effort to implement structural health monitoring (SHM) by using various techniques such as [4] Acoustic Emission (AE) through PZT transducers [5, 6], Fiber Bragg Grating (FBG) [7], Compact Vacuum Monitoring (CVM) [8] and Polyvinylidene fluoride (PVDF) [9] sensors. Currently motivations in investigating the SHM systems are studied from specimen to component levels. A recent novel method in SHM involves the integration of smart structures and materials [10, 11].

The primary motivation of SHM is to detect the anomaly of aircraft structure at the earliest stage as possible. Preventive steps can be taken at this stage and it will lead to cost saving and degree of repair needed. There are different procedures used to interpret the data retrieved from the SHM methods such as statistical analysis [12, 13], finite element [14, 15] and artificial intelligent protocols [16]. Among the methods stated, the statistical approach is much simpler to analyze, however it requires machine learning and a high amount of data analysis in order to ensure high data reliability [17]. A simple pattern comparison of a test signal with a baseline has shown an adequate promising result [18]. Moreover, the processed data is not convincing if