

Nonlinear Wave SHM Method for Damage Detection in Composites Using an Active Piezoceramic Sensor

N. A. CHRYSOCHOIDIS and D. A. SARAVANOS

ABSTRACT
 A novel SHM methodology based on non linear ultrasonics is applied in this paper for the detection of impact damage in composites. The basic element of the proposed application of wave modulation spectroscopy in composite laminates is the usage of an active non linear acousto-ultrasonic piezoelectric sensor, involving two piezoceramic wafer actuators, each one excited with a low and high frequency signal respectively, and a piezoceramic sensor, all permanently bonded on the tested structure. Experiments are conducted on Carbon/Epoxy strips containing two types of common impact damage, matrix cracks and small delamination cracks. Measured results illustrate the effectiveness of the non linear ultrasonics methodology to detect each type of damage, as well as, the potential and benefits of the new active sensor.

INTRODUCTION
 Composite materials are nowadays extensively used in aeronautical structures to attain weight reduction, improved performance, and operation at higher loads, higher temperatures and reduced manufacturing costs. The likelihood of reliable propagation of an initial damage in composite structures during their service due to damage body impacts remains high, thus fostering development of smart composite structures with improved health monitoring capabilities based on known, one dimension permanently attached sensors and actuators. Non-linear ultrasonics NDE techniques, as a newly developed methodology for damage detection, which is, reputed to provide high efficiency on the detection of crack damage mostly in metallic components [1-2]. The objective of this paper is to investigate the potential of non-linear assessment methods to reveal impact damage in the form of matrix cracking, and delamination delamination in composite beams and to develop and evaluate a novel SHM methodology based on the usage of active piezoelectric devices.
 Non-linear ultrasonics NDE techniques are based on the exploitation of nonlinear vibro-acoustic effects for early crack detection and diagnosis. Due to inherent nonlinearity, a wave can distort, creating accompanying harmonics, multiplication of waves of different frequencies, and, under resonance conditions, changes in resonance frequencies as a function of the driving amplitude. In undamaged materials, these phenomena are very weak, while in damaged materials, they are remarkably large. The sensitivity of nonlinear methods to the detection of damage cracks, fibers, etc is far greater than that of linear ultrasonics. Non-linear methods (involves of wave spread, interaction and dispersion, and in fact, these methods appear to be more sensitive than any method currently available [3-5]. One

Visa Doctori Fellow, chryst@uic.edu, Department of Mechanical and Aeronautical Engineering, University of Paris, France.
 Professor, saravanos@uic.edu, Department of Mechanical and Aeronautical Engineering, University of Paris, France.

188

N.A. Chrysochoidis, D.A. Saravanos

Nonlinear Wave SHM Method for Damage Detection in Composites Using an Active Piezoceramic Sensor

Издательство DEStech Publications, Lancaster, 2010 год

Код: 10568

6 стр; формат: 23,5 x 16 см; библиографический список: 16 единиц
 ISBN: 978-1-60595-024-2

A novel SHM methodology based on non linear ultrasonics is applied in this paper for the detection of impact damage in composites. The basic element of the proposed application of wave modulation spectroscopy in composite laminates is the usage of an active non linear acousto-ultrasonic piezoelectric sensor, involving two piezoceramic wafer actuators, each one excited with a low and high frequency signal respectively, and a piezoceramic sensor, all permanently bonded on the tested structure. Experiments are conducted on Carbon/Epoxy strips containing two types of common impact damage, matrix cracks and small delamination cracks. Measured results illustrate the effectiveness of the non linear ultrasonics methodology to detect each type of damage, as well as, the potential and benefits of the new active sensor.

Ключевые слова:

Содержание.

Nonlinear Wave SHM Method for Damage Detection in Composites Using an Active Piezoceramic Sensor