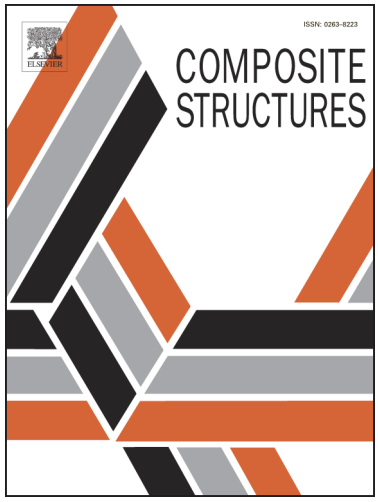

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Application of Artificial Neural Networks and Probability Ellipse methods for damage detection using Lamb waves

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Abstract

In this paper an application of Artificial Neural Networks and Probability Ellipse methods for damage detection using Lamb waves is presented. The wave propagation data are used to determine the location and degree of damage in metallic and composite plates. The structural components are to be instrumented with array of actuators and sensors (PCB) able to excite and record its dynamic response. A damage index, calculated from the measured wave propagation data in a reference state (baseline) and the current state, is introduced as a determinant of structural damage. The index is a relative measure comparing the two states of the structure under the same ambient conditions. The damage index increase its intensity when the damage size increase too. Moreover, its calculation in different paths associated with the Artificial Neural Networks or Probability Ellipse methods allow to identify position and entity of the damage. Two panels made by aluminum and fabric composite material have been used for tests . A damage entities simulated as through-thickness hole with diameter equal to 6mm has been investigated for aluminium panel while three damage entities (through-thickness hole with size equal to 2.5mm, 4.5mm and 9mm) have been investigated for that in composite material. In order to get a training, needful for the application of the ANN method, finite elements analysis have been performed for the aluminum panel taking into account several damage paths. Simulations have been performed in order to characterize the propagation path of the Lamb waves in composite plate changing the damage entities from hole diameter equal to 2.5mm up to 9mm. Damage index for each damage size for both simulations and tests will be compared. The potential applications of these methods in developing health monitoring systems in defects-critical structures and in composite material structures are discussed.

Keywords: Artificial Neural Networks (ANN), Probability Ellipse, Damage Detection, Lamb Waves, Composite Materials

1 Introduction

Damage are a main cause of structural failure and often occurs on structures. In the past decades, in order to avoid sudden failure of structural components a special attention was given at damage detection in structures in the early state. More specifically, structural health monitoring based on the vibration of structures has been at the focus of attention of many researchers in order to