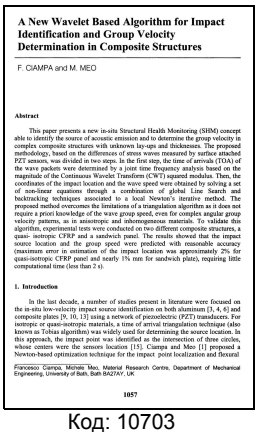

A New Wavelet Based Algorithm for Impact Identification and Group Velocity Determination in Composite Structures

F. CIAMPA and M. MEO

Abstract

This paper presents a new in-situ Structural Health Monitoring (SHM) concept able to identify the source of acoustic emission and to determine the group velocity in complex composite structures with unknown lay-ups and thicknesses. The proposed methodology, based on the differences of stress waves measured by surface attached PZT sensors, was divided in two steps. In the first step, the time of arrivals (TOA) of the wave packets were determined by a joint time frequency analysis based on the magnitude of the Continuous Wavelet Transform (CWT) squared modulus. Then, the coordinates of the impact location and the wave speed were obtained by solving a set of non-linear equations through a combination of global Line Search and backtracking techniques associated to a local Newton's iterative method. The proposed method overcomes the limitations of a triangulation algorithm as it does not require a priori knowledge of the wave group speed, even for complex angular group velocity patterns, as in anisotropic and inhomogeneous materials. To validate this algorithm, experimental tests were conducted on two different composite structures, a quasi- isotropic CFRP and a sandwich panel. The results showed that the impact source location and the group speed were predicted with reasonable accuracy (maximum error in estimation of the impact location was approximately 2% for quasi-isotropic CFRP panel and nearly 1% mm for sandwich plate), requiring little computational time (less than 2 s).

1. Introduction

In the last decade, a number of studies present in literature were focused on the in-situ low-velocity impact source identification on both aluminum [3, 4, 6] and composite plates [9, 10, 13] using a network of piezoelectric (PZT) transducers. For isotropic or quasi-isotropic materials, a time of arrival triangulation technique (also known as Tobias algorithm) was widely used for determining the source location. In this approach, the impact point was identified as the intersection of three circles, whose centers were the sensors location [15]. Ciampa and Meo [1] proposed a Newton-based optimization technique for the impact point localization and flexural

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Ключевые слова:

Содержание.