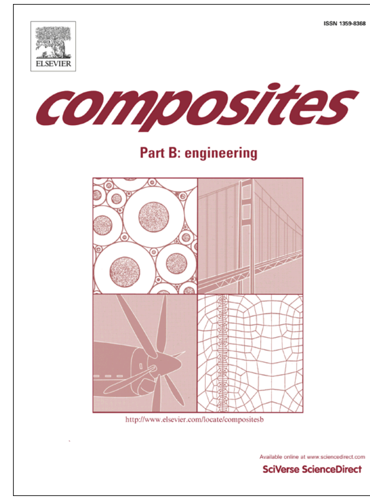

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Damage Classification in Carbon Fibre Composites Using Acoustic Emission: A Comparison of Three Techniques

John P. McCrory[1], Safaa Kh. Al-Jumaili[1,3], Davide Crivelli[2], Matthew R. Pearson[1], Mark J. Eaton[1], Carol A. Featherston[1], Mario Guagliano[2], Karen M. Holford[1], Rhys Pullin[1]

[1]Cardiff School of Engineering, Cardiff University, Cardiff, Wales; Phone: +442920875924
[2]Department of Mechanical Engineering, Politecnico di Milano, via La Masa, 1 - 20156 Milano
[3]University of Basrah, Basrah, Iraq
mccroryjp@cardiff.ac.uk, al-jumailisk@cardiff.ac.uk, davide.crivelli@polimi.it, pearsonmr@cardiff.ac.uk, eatonm@cardiff.ac.uk, featherstonca@cardiff.ac.uk, mario.guagliano@polimi.it, holford@cardiff.ac.uk, pullinr@cardiff.ac.uk

Abstract:
Classifying the type of damage occurring within a structure using a structural health monitoring system can allow the end user to assess what kind of repairs, if any, that a component requires. This paper investigates the use of acoustic emission (AE) to locate and classify the type of damage occurring in a composite, carbon fibre panel during buckling. The damage was first located using a bespoke location algorithm developed at Cardiff University, called delta-T mapping. Signals identified as coming from the regions of damage were then analysed using three AE classification techniques; artificial neural network (ANN) analysis, unsupervised waveform clustering (UWC) and corrected measured amplitude ratio (MAR). A comparison of results yielded by these techniques shows a strong agreement regarding the nature of the damage present in the panel, with the signals assigned to two different damage mechanisms, believed to be delamination and matrix cracking. Ultrasonic C-scan images and a digital image correlation (DIC) analysis of the buckled panel were used as validation. MAR's ability to reveal the orientation of recorded signals greatly assisted the identification of the delamination region, however, ANN and UWC have the ability to group signals into several different classes, which would prove useful in instances where several damage mechanisms were generated. Combining each technique's individual merits in a multi-technique analysis dramatically improved the reliability of the AE investigation and it is thought that this cross-correlation between techniques will also be the key to developing a reliable SHM system.

Keywords: A. Carbon fibre, B. Buckling, C Damage mechanics, D Acoustic emission

1. Introduction

With the increasing use of composite materials throughout the civil aerospace and renewable energy sectors the need for structural health monitoring (SHM) of composite structures has never been more apparent [1, 2]. SHM describes a method of continuously monitoring a structure for damage or decay through the use of permanently mounted or embedded sensors. A reliable SHM system would allow a structure to operate for longer between planned, routine manual inspections resulting in less downtime and hence lowering the costs associated with maintenance over the course of the service life. Being aware of the integrity of a structure throughout the entirety of its use is also inherently safer than inspecting its condition at intervals. Thus, an SHM system would be best suited for use on safety critical