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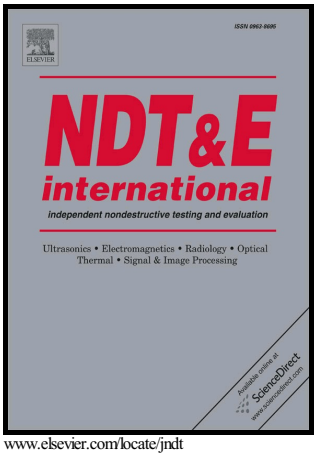

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Feature guided wave inspection of bond line defects between a stiffener and a composite plate

Xudong Yu[a], Zheng Fan[a,*], Michel Castaings[b], Christine Biateau[b]

[a] *School of Mechanical and Aerospace Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798*

[b] *Univ. Bordeaux, CNRS, Bordeaux INP, Arts et métiers Paris Tech, I2M UMR 5295, F-33400, Talence, France*

Abstract

Adhesive bonding is widely used in aerospace composite structures. A continuous well-cured bond can offer good joint strength and improved fatigue and impact resistance, and is therefore crucial to the performance of the entire structure. This paper explores the feasibility of using feature guided waves (FGW) for rapid screening of the bond line between a stiffener and a carbon fiber reinforced polymer (CFRP) composite panel. Such FGWs are capable of focusing the wave energy along the stiffener and the bond layer, with limited radiation to the adjacent plate. The Semi-Analytical Finite Element (SAFE) approach is employed to understand the modal properties of FGWs that exist in the structure, and criteria are suggested to choose proper mode-frequency combination that is sensitive to adhesive defects. A shear horizontal type FGW mode is identified to be well suited, as it is easy to excite, and propagates with little dispersion and relatively low attenuation, while it retains sufficient energy around the bond layer. Both 3D Finite Element (FE) simulations and experiments are performed to study the interaction of the selected FGW mode with defects in the adhesive bond, and the results show excellent agreement. The reflection behavior and the wave-defect resonance phenomenon are investigated, which demonstrate the capability of the FGW for the bond line inspection.

Keywords: Feature guided waves, Bond line inspection, Composite laminates

1. Introduction

Fiber reinforced polymer composites have been increasingly incorporated into passenger aircrafts for decades, due to their high strength to weight ratio and good stiffness properties. In these composite structures, adhesive bonding is the most common means to fix skins to reinforcing elements, such as spars and stiffeners, since it offers uniform stresses (i.e. low stress concentration) across the bond line, increased joint strength, and good sealing performance. Also, compared to mechanical fastenings and welding, the bonding allows complex shapes and dissimilar materials to be joined with ease, and

*Corresponding author
Email address: ZFAN@ntu.edu.sg (Zheng Fan)