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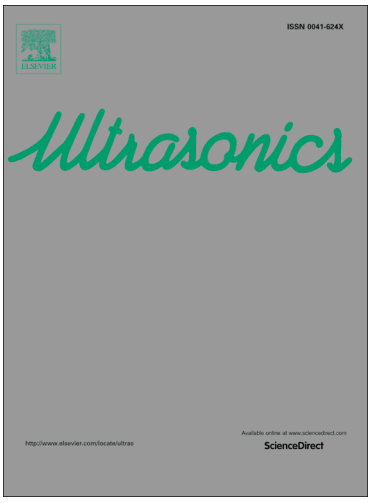

Lamb waves and electro-mechanical impedance based damage detection using a mobile PZT transducer set

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ACCEPTED MANUSCRIPT

Lamb waves and electro-mechanical impedance based damage detection using a mobile PZT transducer set

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Abstract

Lamb waves and electro-mechanical impedance (EMI) based methods are increasingly used in damage detection owing to their high sensitivity to small structural defects. Lamb wave based methods are effective in detecting damages in a large area and electro-impedance based methods are suitable for characterizing the identified damage. Based on these two methods, a novel combined damage detection method is presented in this research. To achieve this, first, a mobile transducer set is developed, which can be used for both the Lamb waves and EMI based methods. Then, a baseline-free damage detection strategy that combines the Lamb waves and EMI methods is presented. Finally, a laboratory-sized test piece is used to validate the effectiveness of the proposed approach. The results achieved with the application of the presented combined method for characterizing an L-shape crack in an aluminum plate show better location accuracy and detection efficiency than those obtained by applying only one method.

Keywords: Lamb waves; electro-mechanical impedance; damage detection; mobile PZT transducer; baseline-free

1 Introduction

Engineering structures, such as those in aircraft, civil infrastructure, and heavy equipment, usually suffer adverse serving conditions or even sudden impacts, which may easily cause structural defects. Thus, damage detection techniques have always been a major industrial concern in the fields of non-destructive evaluation (NDE) and structural health monitoring (SHM). The most common NDE and SHM techniques include visual inspection, optical fibers, shearography, infrared thermography, eddy currents, ultrasonic inspection, Lamb waves, and electromechanical impedance (EMI). Among the damage detection methods, the Lamb wave based and EMI methods are being increasingly used in recent years for their high sensitivity to structural damage [1-5].

In the EMI-based method, the electrical impedance of the piezoelectric lead zirconate titanate (PZTs) can be directly related to the mechanical impedance of the

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