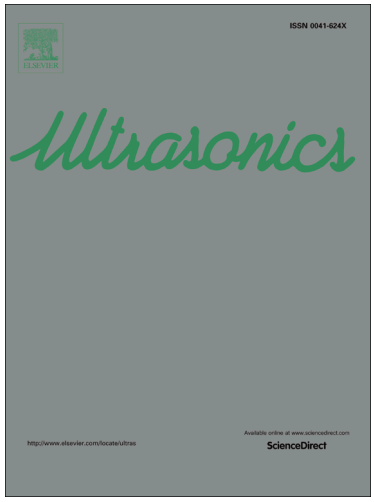

Measurement of Weld Penetration Depths in Thin Structures Using Transmission coefficients of Laser-generated Lamb Waves and Neural Network

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Measurement of Weld Penetration Depths in Thin Structures Using Transmission coefficients of Laser-generated Lamb Waves and Neural Network

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Abstract. The Laser/EMAT ultrasonic (LEU) technique has shown the capability to measure weld penetration depths in thick structures based on ray-tracing of laser-generated bulk and surface waves. The ray-tracing method is not applicable to laser-generated Lamb waves when the LEU technique is used to measure weld penetration depths in thin structures. In this work, transmission coefficients of Lamb waves present in the LEU signals are investigated against varying weld penetration depths. An artificial neural network is developed to use transmission coefficients of sensitive Lamb waves and LEU signal energy to predict weld penetration depths accurately. The developed method is very attractive because it allows a quick inspection of weld penetration depths in thin structures.

Keywords: weld penetration depth; laser/EMAT, ultrasonic; Lamb waves; neural network

1. INTRODUCTION

Weld penetration depth (WPD) is a key measurement of weld quality because it directly affects the strength of welded parts. Traditionally, cut-check is used to determine whether welding settings in a production line are producing satisfactory WPDs [1]. The cut-check method is direct but costly and inefficient. Different non-destructive testing techniques have been extensively studied or developed for inspection of weld qualities[2], such as visual inspection[3], radiographic inspection[4, 5], magnetic particle inspection[6, 7], liquid penetrant inspection, alternating current field measurement[8], eddy current inspection[9], infrared thermography method[10-13], traditional ultrasonic testing[14] and so on. However, a WPD monitoring technique which can be fully automated and used in real time is still missing. Visual inspection is heavily relying on the experience of operators and not applicable for internal WPD. Radiographic inspection is hazardous to operators and not suitable for real-time inspection. Magnetic particle inspection requires strict sample preparation and is only good at crack detection. Liquid penetrant inspection is not able to detect internal defects and also very inefficient. Alternating current field measurement and eddy current are both good at crack detection only. Infrared thermography method is indirect measurement in nature and difficult to detect internal