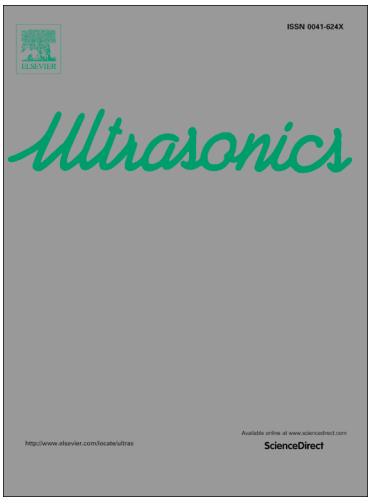

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Weld inspection by focused adjoint method

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Abstract

This paper reports a methodology for the non-destructive ultrasonic evaluation of welds, based on probing, residue back-focusing and topological energy calculation using an enhanced (focused) adjoint method. The proposed method combines the advantages of time reversal to compensate for the cumulative distorsions experienced by a wave propagating in a heterogeneous medium, and topological imaging to highlight the defect location. The synergistic effect of this combined approach makes it possible to detect anomalies in the most efficient way. The method paves the way towards a matched-insonification imaging of anomalies in anisotropic media.

Keywords: Topological energy, Adjoint method, Wave focusing, Weld inspection, Finite element modeling

1. Introduction

The non-destructive evaluation (NDE) of austenitic welds using ultrasounds (US) has been gaining a lot of attention in structural health monitoring, which is aimed at damage detection and characterization and structure integrity assessment. Austenitic steels are popular in civil engineering, shipbuilding industries, petrochemical, aviation, and nuclear power plants due to their corrosion resistance, relatively high ductility and high strength compared with typical carbon steels (mild steels or low-alloy steels). The defects that usually encountered in welding include incomplete penetration, incomplete fusion, undercutting, and porosity. More crucially, cracking defects may occur during solidification of the melt pool, which is problematic as they act as stress concentration sites. This could lead to premature failure via fatigue, as well as providing sites open to hydrogen-assisted cracking. However, detecting and locating anomalies is a difficult task since weld microstructures induce strong US-wave deviation and splitting phenomena.

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