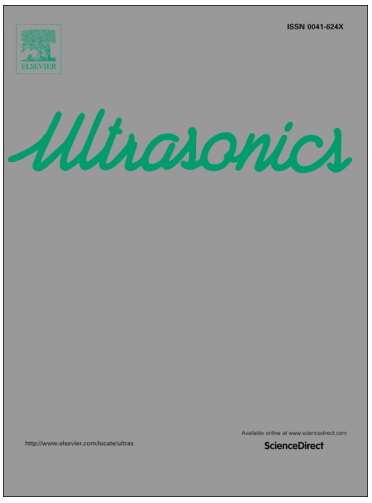

Transmission of Lamb waves across a partially closed crack: Numerical analysis and experiment

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Transmission of Lamb waves across a partially closed crack: Numerical analysis and experiment

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Abstract

The transmission characteristics of Lamb waves across a partially closed through-thickness crack in a plate are investigated numerically and experimentally. In the numerical analysis, the spectral element method is used to simulate the transmission of the lowest-order symmetric (S0) and antisymmetric (A0) Lamb modes across a crack in a low-frequency range. The analysis is carried out for an open crack with traction-free surfaces as well as for a partially closed crack modeled as a spring-type interface characterized by normal and tangential stiffnesses. The transmission ratios of both modes are obtained from the spectral amplitude of the simulated transmission waveforms for different crack lengths and interfacial stiffnesses. The numerical results show that the transmission ratio of the S0 mode increases monotonically with the interfacial stiffness, but that of the A0 mode depends on the interfacial stiffness in a non-monotonic manner depending on the frequency. The Lamb wave transmission measurements are carried out for aluminum alloy plates with artificial slits or a fatigue crack. The experimental results for the plates with slits show reasonable agreement with the numerical results for open cracks. The measured transmission ratio of the S0 mode is shown to decrease with the tensile load applied to the plate, but that of the A0 mode shows different load dependence for different frequencies. The qualitative features of the experimental results for the fatigue crack are discussed based on the numerical simulation for closed cracks.

Key words: Structural health monitoring; Lamb wave; Closed crack; Spectral element method; Spring-type interface model