Surface crack detection in thin plate using time reversal analysis of SH Guided waves

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ABSTRACT

In recent years, the importance of nondestructive testing (NDT) for quality assurance and maintenance of aging infrastructures has been increasing. The ultrasonic nondestructive testing (UT) is one of the NDT methods, and widely used in the engineering fields. The main goal of UT is to detect defects in materials. Generally, UT with guided waves is applied to the detection of defects in thin plates. The most important advantage of the guided waves is the efficient inspection for the structures, such as thin plates and pipes where they can propagate over long distances. On the other hand, due to the wave dispersion and wave mode excitability of the plate, the wave propagation inside plates becomes more complex, and the interpretation of the results of UT might be difficult. Therefore, in this research, a defect detection by using the time reversal method, first developed by Fink (1992), that takes advantage of the reciprocity and reversibility of the fundamental solution. However, it is difficult to determine the convergence point of the time reversal waves, which is corresponding to the location of the defect. In the present study, the topological sensitivity (Bonnet 2006) is utilized as the indicator of defect detection for the time reversal method. The topological sensitivity is a design sensitivity index used in the topology-optimization, which has been recently attracted as one of the most flexible structural optimization methods. In this presentation, we firstly explain the problem to be solved for the scattering problem of 2-D SH guided waves. Next, the forward analysis method for demonstrating the scattered wave fields by the interaction between incident waves and defects is discussed. After that, time reversal wavefields obtained by the time reversal of the received waveforms are demonstrated. Finally, the topological sensitivity obtained from the forward and time reversal analysis results is calculated to detect surface cracks in thin plates, and the effectiveness of our proposed method is discussed.

REFERENCES

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