Forward and inverse scattering analyses for defects in anisotropic and viscoelastic solids

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Abstract

The ultrasonic non-destructive testing (UT) has attracted attention over the past few decades. The final goal of UT is to identify the position, shape, size of defects. The ultrasonic waves satisfy the elastic wave equations in elastic materials. Therefore, numerical simulation of the ultrasonic wave propagation is reduced to solving partial differential equations with initial and boundary conditions for the elastodynamics. Numerical simulation tools are useful to understand the elastic wave propagation behavior. In general, numerical simulation tools for elastic wave propagation are helpful to obtain scattered waveforms corresponding to those at each ultrasonic transducer location in UT experiments. The pure scattered waveforms obtained by numerical simulation tools are utilized to confirm the validity of developed inverse scattering techniques because scattered waveforms in UT experiments normally include some signal noise. That is to say, the use of such pure scattered waveforms with no signal noise is convenient to check the validity of the developed inverse scattering formulation. For these reasons, the presenter has developed forward and inverse analysis methods for UT. In this presentation, a convolution quadrature based time-domain boundary element method [1] is demonstrated through some simple numerical examples for anisotropic- and visco- elastodynamics. Elastic constants used in the numerical examples are determined by utilizing the laser ultrasonic visualization testing [2]. Also, inverse scattering techniques based on the Born approximation [3] and a machine learning are presented for defects using scattered wave forms obtained by a forward analysis method.

Keywords: Convolution quadrature method, boundary element method (CQM), anisotropic elastodynamics, viscoelastodynamics, inverse scattering, machine learning, Elastic wave scattering, Born approximation, ultrasonic non-destructive testing (UT).

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