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On the Generation and Interpretation of Scattering Patterns from Angle-Beam Wavefield Data

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Angle-beam shear waves are shear waves propagating at an angle to the surface of a specimen and are typically generated by mode conversion at the interface of a wedge and the material of interest. Scattering of such waves is of interest to the NDE community because angle-beam inspection methods are routinely used in practice. Wavefield imaging, which refers to the acquisition of full wavefield data over a region of interest resulting from a fixed source, is useful for visualizing scattering of angle-beam waves from geometrical features of interest. More challenging, however, than visualization is quantification of such scattering, and so-called scattering patterns that show scattered energy as a function of angle are one means of doing this. The focus of this current work is the generation of such scattering patterns from wavefield data recorded before and after introduction of a scatterer. Given that it is possible to record wavefield data only on the exposed surface, such scattering patterns are generally limited to two dimensions even though scattering of the shear waves takes place in three dimensions.

Quantification of scattering can be in terms of either the direction of propagation of the scattered waves on the surface, or the direction of the observer's location relative to the scatterer. If the scattered wavefront were perfectly circular, then these two directions would be the same and the resulting scattering patterns should be equivalent. With either definition of direction, scattering patterns can be generated from either the residual wavefield after baseline subtraction [1], or by comparing the energy of the total wavefields [2]. These two approaches can give quite different results, particularly for directions in which there is significant incident energy. Here we generate scattering patterns using both definitions of direction (i.e., propagation direction versus observer direction) and both methods for quantifying scattered energy (residual wavefields versus comparison of total energy). We specifically consider scattering of shear waves from various through-holes in aluminum plates using a commercially-available transducer and wedge as the wave source and a laser vibrometer to measure the wavefield. It is shown that although the scattering patterns are different, they are generally consistent and complementary, with each method providing useful information regarding scattering.

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References:

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