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"Flaw Imaging of Long Structures using Ultrasonic Dispersion Compensation"

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Abstract

Ultrasonic flaw detection is an important issue for insuring structural reliability and remaining life prediction of industrial plants. In recent years, ultrasonic guided wave technique has been applied to long structures such as piping or plate like structure. The guided wave propagates a long distance with low attenuation and is thus an effective tool to test a long structure its entirety. However, the guided wave usually has a dispersive nature, and the received signal becomes more complicated and of longer duration compared with the input signal. Thus it is difficult to determine actual arrival time of flaw echo, and the spatial resolution of flaw image constructed using received waveforms should be low.

To overcome this problem, a dispersion compensation technique had been suggested. To compress the dispersed guided wave to a high-distance-resolution pulse, an accurate phase velocity profile is required. However, conventional phase-velocity-determination technique using two-dimensional Fourier transform analysis is time consuming and complicated.

The aim of this study is to image flaw in plate structures with high spatial resolution using ultrasonic dispersion compensation. Because the Lamb wave propagates in the plate structure, accurate phase velocity profile of the Lamb wave is required to perform dispersion compensation exactly. Though it is not easy to identify phase velocity experimentally, the group velocity profile can be easily identified by wavelet analysis. In this study, phase velocity profile was identified by group velocity profile using optimization technique. After that, ultrasonic testing was conducted for drill-hole flaw in plate. The flaw images were constructed using dispersion compensated waveforms by both synthetic aperture method and mean resultant length method. In the image constructed by synthetic aperture method, the flaw can be visualized clearly. However, noises are also observed due to the effect of grating and other propagation modes of Lamb wave. On the other hand, in the image constructed by mean resultant length method, flaw can be obtained though a lot of noises are also observed. Therefore, to improve the contrast and reduce noise, both images are multiplied. It is shown that the multiplication of both images improves signal-to-noise ratio and contrast. The flaw could be visualized with high spatial resolution.