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Practical Long Range Guided Wave Inspection - Applications to Pipes and Rail

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Abstract

The inspection of large structures using conventional ultrasonic bulk wave techniques is slow because scanning is required if the whole structure is to be tested. Ultrasonic guided waves potentially provide an attractive solution to this problem because they can be excited at one location on the structure and will propagate many metres. However, guided wave testing is complicated by the presence of many possible wave modes, most of which are dispersive. These guided wave characteristics offer a wealth of opportunities for the extraction of information about the structure, but it is crucial to manage this complexity if the test is to be useable in industrial practice. This paper concentrates on long range testing using frequencies below 100 kHz. The progress from research work to a robust, commercial pipe testing system will be discussed, together with more recent research on applications to plates and railroad rails. The paper concludes with a discussion of future research opportunities.

Guided wave inspection potentially enables a large area of structure to be tested from a single transducer position, so avoiding the time-consuming scanning required by conventional ultrasonic or eddy current methods. However, until recently, this potential has only been realised in a small number of practical applications. This is largely due to the difficulty of controlling the different possible modes and propagation directions so that the signal-to-coherent noise ratio is satisfactory and simple, easily interpretable signals are obtained. It is therefore important for research in this field to concentrate both on exploring the opportunities offered by the multiple possible modes, and on managing the complexity that the presence of so many modes can produce.

It has been shown that an array of transducers acting as point sources provides a basis from which these problems can be overcome and examples of pipe, rail and plate testing have been presented. To date, most applications have been on simple structures with a low density of joints, stiffeners etc. Future research directions include the inspection of more complex structures and developing techniques to test systems where the attenuation is very high.