Developing an Understanding of Shear Horizontal Transducers for Damage Detection

F. Purcell, Dr. R. Pullin, Dr. D. Crivelli and Dr. M. Eaton
Cardiff University, Queen's Buildings, 14-17 The Parade, Cardiff CF24 3AA
PurcellFA@cardiff.ac.uk

Abstract: In this work analysis was completed to examine the viability of shear horizontal (SH) waves for damage detection. Tests were undertaken to determine the ability of d_{15} mode transducers to emit and receive SH waves. The thickness shear transducers were shown to emit and receive SH_0 and A_0 waves. Further work was completed to show the directional nature of the transducer using both a 3D scanning laser vibrometer and Hsu-Nielson sources.

Using the Acousto-Ultrasonics (AU) method a direct comparison was made between thickness shear mode, producing SH and A_0 waves, and longitudinal mode, producing Lamb waves, transducers ability to detect various defects. Both transducers were mounted on a 0.9mm thick steel plate so that defects of varying size could be introduced between the transducer pairs. The pulsing transducer was driven at frequencies between 50kHz and 200kHz. The AU signals received by the thickness shear mode and longitudinal mode transducers were analysed using a cross correlation coefficient, correlating the undamaged state to the signal received at various levels of defect. The thickness mode transducers showed greater variability in cross correlation coefficient at different driving frequencies with introduction of defects compared to the longitudinal mode transducers. Using time based windowing to isolate the SH waves a comparison could be made between the cross-correlation coefficient of a signal including only SH waves and SH and A_0 waves. The Shear horizontal sensors were shown to be more sensitive to the defects than the longitudinal mode transducers.

Using a 3D scanning laser vibrometer further tests were completed to verify AU tests and show changes in cross correlation coefficient across a larger area of the plate with introduction of defects. Cross correlation values could be calculated in each axis with introduction of defect. The scanned area gave further information on optimising sensor placement for a directional shear horizontal transducer.