Ultrasonic Inspection of Bolts, Pins and Shafts

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The inspection of bolts, pins and shafts using ultrasonic methods is a common technique for detection of in-service cracking. However, many NDT Technicians do not anticipate some of the complex phenomena that occur, and that in many cases have resulted in cracks that have gone unreported or incorrectly assessed. This paper will investigate and explain two of t the unique issues associated with ultrasonic inspection of bolts, pins and shafts. Secondary Echo's from Mode Conversion When a high angle incident compression wave (close to 90°) reflects on a steel/air interface mode conversion occurs. This commonly occurs in bolts, pins and shafts as the beam spread of the probe impinges on the side wall of the component. Due to Snell's law, this mode conversion generates approximately a 33° shear wave, that then propagates across the component until reaching the opposite side, where it undergoes another mode conversion, this time reverting back to an approximately 90° compression wave. This process can occur numerous times throughout the component dependant on length and geometry. Side Wall Phase Change Destructive Interference For the detection of shallow surface transverse cracks in Bolts, Pins and Shafts, you would typically expect that the maximum amplitude of the response will be when the axis of the beam is centralized over the discontinuity (i.e. probe is as close to the edge of the sample as possible and directly above the crack). However due to a phenomenon where the reflected waves from the sidewall undergoes a phase shift at the boundary, resulting in destructive interference of the beam axis, a significant reduction in signal amplitude can occur. To minimize this effect the probe should be located at such a distance from the reflection edge of the component such that the geometric time delay of the secondary wave is greater than the axial pulse length.