High-Frequency Guided Ultrasonic Waves to Monitor Corrosion Thickness Loss

Paul Fromme¹, Fabian Bernhard², Bernard Masserey². ¹Department of Mechanical Engineering, University College London, WC1E 7JE, United Kingdom; ²Department of Mechanical Engineering, University of Applied Sciences, Fribourg, Switzerland

Corrosion due to adverse environmental conditions can occur for a range of industrial structures, e.g., ships and offshore oil platforms. Pitting corrosion and generalized corrosion can lead to the reduction of the strength and thus degradation of the structural integrity. The nondestructive detection and monitoring of corrosion damage in difficult to access areas can be achieved using high frequency guided ultrasonic waves propagating along the structure. Using standard ultrasonic transducers with single sided access to the structure, the two fundamental Lamb wave modes were selectively generated, penetrating through the complete thickness of the structure. The wave propagation and interference of the guided wave modes depends on the thickness of the structure.

Laboratory experiments were conducted and the wall thickness reduced initially uniformly by milling of the steel structure. Further measurements were conducted using accelerated corrosion in a salt water bath. From the measured signal change due to the wave mode interference, the wall thickness reduction was monitored and good agreement with theoretical predictions was achieved.

Corrosion can lead to non-uniform thickness reduction and the influence of this on the propagation of the high frequency guided ultrasonic waves was investigated. The wave propagation in steel specimens with varying thickness was measured experimentally and the influence on the wave propagation characteristics quantified. Numerical simulations for the guided wave propagation were performed using 2D Finite Difference Modeling (FDM) and compared to the experimental results. The influence of different modeling strategies was investigated, using either a stepped grid or an adaptive mesh to approximate the varying plate thickness.