Decomposition of Fundamental Lamb Wave Modes in Complex Metal Structures Using COMSOL Multiphysics®

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Abstract

Structural Health Monitoring Systems are being highly investigated to evaluate the health of a structure and detect any damages occurring in real time. Such systems require intensive data analysis which gets even more intricate when working with complex structures due to undesirable boundary wave reflections. Guided wave signals are normally mixed with reflected signals from structural boundaries which makes it difficult to identify and localize damages. In this work, COMSOL Multiphysics® was used to better understand the reflection phenomenon of guided Lamb waves in complex isotropic structures and how such waves could be studied to characterize a damage. Aluminum plates with different sizes and shapes were modeled using the Structural Mechanics module and coupled with different piezo-ceramic transducers acting as actuators and sensors to stimulate and sense first order Lamb wave modes. This was accurately modeled using the built-in coupling between the Solid Mechanics and Electrostatics interfaces under the Piezoelectric Devices Physics. Recorded signals were analyzed and decomposed into an incident, reflected, and mode changing packets. Simulation models were validated by experimental measurements and good agreement was achieved. Such analysis is a step forward to better understand the propagation of incident and reflected Lamb waves in complex structures. In addition, dissecting the propagating Lamb wave in a structure aids in identifying the interaction of guided waves with structural defects and localizing damages.

Figures used in the abstract

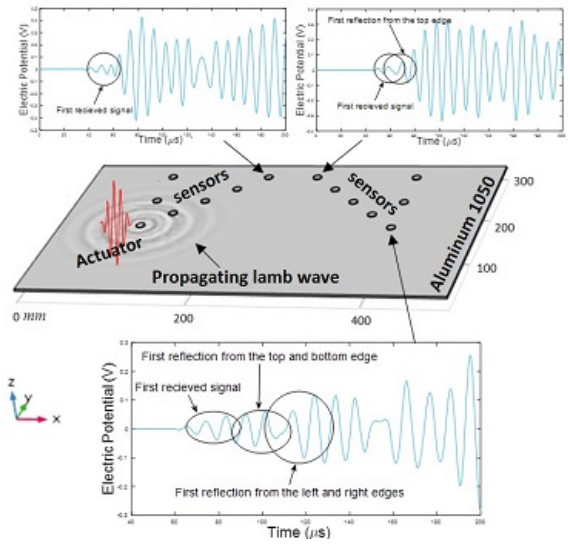

Figure 1: Lamb wave generation and detailed characterization modeled using Solid Mechanics and Electrostatics interfaces.