Experimental analysis of the reflection behavior of ultrasonic waves at material boundaries

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ABSTRACT

Structural Health Monitoring of systems and especially material-based components is often based on the analysis of ultrasonic waves, using active guided wave approach as well as the passive Acoustic Emission approach allowing in-situ non-destructive testing. The properties of ultrasonic waves change depending on their propagation path, particularly affecting amplitude and frequency. Frequency, frequency changes, as well as frequency distributions are commonly used as features to classify damage mechanisms. Modes can serve as an additional damage indicator to distinguish between different damage mechanisms and provide a more precise estimation of propagation velocity. Therefore, these two parameters, frequency and mode, directly influence classification and localization results. In this contribution, the reflection behavior of Lamb waves in carbon fiber reinforced plastic specimen is analyzed. The influence of boundary conditions on reflections is investigated by varying these conditions. Finally, a novel approach of automated reflection and mode detection as well as isolation is presented based on time-frequency and correlation analysis. The isolation of relevant signal parts is based on detecting local maxima in the time-frequency domain. The experimental results provide new insights into the propagation behavior of ultrasonic waves and their reflections at material boundaries, showing a decreasing frequency with an increasing number of reflections. The result is helpful to interpret reflections and understand the behavior of Lamb waves at material boundaries.