Investigation of nonlinear Lamb wave/damage interaction: numerical and experimental approaches

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Abstract: One of the most important issues in engineering is the monitoring and the early detection of structural damages to prevent catastrophic failures. This process is referred to as Structural Health Monitoring (SHM) and is expected to provide considerable improvements with respect to safety and maintenance costs. More particularly, the focus is here put on composite structure representative of aeronautic applications and the damages to be monitored are of *"delamination"* type. One of the most commonly used method in that context is the ultrasonic wave-based method, since it is sensitive to the presence of damage and able to monitor large areas with few sensors. However, the conventional ultrasonic methods are sensitive to gross defects or open type damage, but merely sensitive to micro fatigue cracks or contact type nonlinear damage such as small delamination in composite structures. A finite element (FE) method is here used to build up a numerical model for investigating wave propagation properties in a composite plate representative of aeronautic application with and without a *"delamination"* type damage. A surface-to-surface contact model is used in the damaged model to simulate the wave/damage interaction. Experimental data for a healthy plate and a damaged plate with one delamination are used for comparison with the numerical results. In both simulations and experiments, Piezo-electric patches (PZTs) are used to generate tone-burst signals with different central frequencies able to excite Lamb waves inside the plate. Results show that the outputs from the FE model are well consistent with experimental outputs in frequency domain, indicating that the FE models is appropriate for simulating the wave/damage interaction in a composite plate.

Key words: Structural Health Monitoring (SHM); composite structures; delamination; Finite Element (FE) simulation