

“PAPER FOR THE YOUNG SCIENTIST AWARD”

Harmonic Scattering of S_0 Lamb Wave - A Computational Study

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Abstract

Harmonic scattering of S_0 waves from local early-stage damage modeled as nonlinear elastic inclusion is demonstrated using numerical simulations for the interaction of single frequency wave, and one-way two-wave mixing by varying intensity of local damage and damage size. Recent advances in nonlinear ultrasonic techniques such as harmonic generation show its sensitivity towards the detection of micro-scaled damages like dislocation substructures, micro-cracks, and micro-voids, etc. Interaction of monochromatic elastic wave with uniformly distributed micro-scaled early-stage damages generates higher harmonics and the amplitudes of the higher harmonics can be correlated to the intensity of the averaged damage present inside the material. In practice, thin plates under the impact, fatigue, and fracture contain highly local early-stage damages. To understand and get more insight into the interaction of the nonlinear ultrasonic S_0 guided wave and resulting in harmonic scattering from local damages modeled as a nonlinear elastic material with maintaining the same linear impedance as of the linear elastic material, this investigation is carried out. The existence of backscattered waves is shown due to the interaction of monochromatic waves and one-way two-wave mixing. Amplitudes of harmonics are highly sensitive to the input frequencies, frequency combinations, intensity of local damages, and damage sizes. The presence and absence of backscattered higher harmonics are demonstrated by considering different case studies of harmonic scattering from local damage. Similarities of the observed harmonically scattered elastic lamb waves are drawn by comparing with the harmonic scattering of the nonlinear light waves well known as the ‘Raman Scattering’ in nonlinear optics.