Investigation of dispersion effects in plates from a numerical point of view

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Abstract

The application of Lamb waves for damage detection in structural health monitoring techniques is challenging due to their multi-modal, dispersive nature and wave propagation complexity, in particular for complicated geometries and anisotropic materials. Compound wave-structure interactions and nonlinear features of elastic wave propagation have attracted significant attention lately. They provide potential new opportunities for feature discovery and identification in a variety of applications. Due to significant complexity associated with wave propagation in composite and nonlinear media, numerical modelling and simulations are employed to facilitate design and development of new measurement, monitoring and characterization systems. However, since very high spatio-temporal accuracy of numerical models is required, it is critical to evaluate their spectral properties and tune discretization parameters for compromise between accuracy and calculation time. When numerical models are employed, additional sources of errors are introduced. Hence, the paper discusses estimation and analysis of errors for numerical schemes for dynamic transient phenomena. Elastic guided waves in plates, i.e. Lamb waves, are characterized by their spectral properties, namely dispersion and excitability curves. Spectral properties of a numerical model depend not only on plate's geometry and material constants, but are also sensitive to discretization parameters. Linear and nonlinear characteristics are analyzed. Numerical results are validated against analytical calculations. Furthermore, a logistic function is provided in order to estimate numerical models convergence.