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Modeling and analysis of propagating guided wave modes in a laminated composite plate subject to transient surface excitations. (English) Zbl 1454.74110

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Summary: A simplified 2D semi-analytical model based on a global matrix method is developed to investigate the dispersion characteristics of propagating guided wave (GW) modes in multilayered composite laminates due to transient surface excitations. A relatively thin symmetric eight layered cross-ply composite laminate subjected to both narrowband and broadband surface excitations is considered. The displacements and stresses in individual laminae are 'exactly' represented in the frequency-wavenumber domain in terms of four unknown constants in each layer, which are then solved by applying the interface continuity conditions and the stress conditions on the free surfaces. Spatial and time domain solutions are obtained after evaluating the wavenumber integral followed by frequency inversion using the fast Fourier transform. It is shown that the wavenumber integral technique can be exploited to obtain the far-field time domain solution for a specific propagating mode in order to study its influence on the response signal. The far-field time histories of the out-of-plane displacements due to vertical surface excitations are calculated and compared with those obtained from finite element modeling using LS-DYNA, showing good agreement between the results. It is demonstrated that the theoretical model allows for separation and identification of individual propagating modes even for broadband excitations, where the effect of dispersion results in a strong shape distortion. However, the contribution of the A0 mode is found to dominate the out-of-plane motion due to vertical surface excitation for all cases considered.

MSC:

74K20 Plates
74E30 Composite and mixture properties
74J05 Linear waves in solid mechanics

Keywords:

laminated composite; guided wave modes; analytical modeling; wavenumber integral; transient excitations; dispersion

Software:

LS-DYNA

Full Text: DOI

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