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Kosuke Kanda, Toshihiko Sugiura

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Analysis of damped guided waves using the method of multiple scales

Kosuke Kanda[a,*], Toshihiko Sugiura[a]

[a] *Department of Mechanical Engineering, Keio University, Yokohama 2238522, Japan*

Abstract

We analytically investigate the influence of damping on Lamb waves, which are a specific type of guided wave in two-dimensional plates. Considering material attenuation, we suppose that Lamé constants are complex valued. This leads to the associated wave numbers being complex, with the imaginary part of the wave number being associated with effect of attenuation of the guided wave. In this paper, we show how dispersion curves and attenuation coefficients can be obtained using the self-adjointness and the method of multiple scales (MMS), which is a type of perturbation method. Using the self-adjointness and the MMS, we can calculate the frequency- and wave number-dependent attenuation coefficients from the integral values and boundary values of a corresponding eigenfunction with respect to each propagation mode. This analytical method can yield not only dispersion curves but also mode-by-mode attenuation coefficients regardless of the numerical initial values, unlike numerical approaches using the Newton method. Thus, the proposed method can calculate the attenuation coefficients with respect to a particular mode more easily than conventional methods. Furthermore, the results obtained by proposed method were in good agreement with those obtained by the semi-analytical finite element (SAFE) method, which validates the proposed method.

Keywords: Guided waves, Lamb waves, Self-adjointness, Method of multiple scales, Attenuation coefficient

*Corresponding author
Email address: blackhole@keio.jp (Kosuke Kanda)