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Multimode long-wave approximations for thin viscoelastic coatings

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Abstract

Thin coatings arise in numerous engineering applications, including high-contrast laminates. A forced boundary value problem for a thin viscoelastic coating layer is considered, with the viscosity incorporated via Kelvin-Voigt model. A prescribed loading is acting on one of the faces, with the opposite face clamped. The focus is on the derivation of multimode, long-wave, asymptotic approximations, in contrast to previously known long-wave high-frequency approximations in the vicinity of a single cut-off frequency. For the sake of simplicity, we operate within the framework of antiplane shear setup. The main result includes a 1D multimode equation governing the antiplane shear of a viscoelastic coating, with the coefficients involving trigonometric functions of the frequency parameter. The associated dispersion relation is also discussed, being of multimode nature and approximating the long-wave behaviour of the vibration modes over a broad frequency range. The efficiency of the derived approximations is illustrated numerically via comparison with the exact solution.

Keywords:

viscoelastic coating asymptotic multimode long-wave