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Dynamic Stability of Axially Moving Viscoelastic Plates under Nonuniform in-Plane Edge Excitations

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Abstract : This paper investigates the parametric stability of an axially moving web subjected to nonuniform in-plane edge excitations on two opposite, simply-supported edges. The web is modeled as a viscoelastic plate whose constitutive relation obeys the Kelvin-Voigt model, and the in-plane edge excitations are expressed as the sum of a static tension and a periodical perturbation. Due to the in-plane edge excitations, the moving plate may bring about parametric instability under certain situations. First, the in-plane stresses of the plate due to the nonuniform edge excitations are determined by solving the in-plane forced vibration problem. Then, the dependence on the spatial coordinates in the equation of transverse motion is eliminated by the generalized Galerkin method, which results in a set of discretized system equations in time. Finally, the method of multiple scales is utilized to solve the set of system equations analytically if the periodical perturbation of the in-plane edge excitations is much smaller as compared with the static tension of the plate, from which the stability boundaries of the moving plate are obtained. Numerical results reveal that only combination resonances of the summed-type appear under the in-plane edge excitations considered in this work.

Keywords : axially moving viscoelastic plate, in-plane periodic excitation, nonuniformly distributed edge tension, dynamic stability
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