Bifurcations And Chaos Of An Immersed Cantilever Beam In A Fluid And Carrying An Intermediate Mass

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Summary

The concern of this work is the local stability and period-doubling bifurcations of the response to a transverse harmonic excitation of a slender cantilever beam partially immersed in a fluid and carrying an intermediate lumped mass. The unimodal form of the non-linear dynamic model describing the beam-mass in-plane large-amplitude flexural vibration, which accounts for axial inertia, non-linear curvature and inextensibility condition, developed in Al-Qaisia et al. (2000 Shock and Vibration 7, 179-194), is analyzed and studied for the resonance responses of the first three modes of vibration, using two-term harmonic balance method. Then a consistent second order stability analysis of the associated linearized variational equation is carried out using approximate methods to predict the zones of symmetry breaking leading to period-doubling bifurcation and chaos on the resonance response curves. The results of the present work are verified for selected physical system parameters by numerical simulations using methods of the qualitative theory, and good agreement was obtained between the analytical and numerical results. Also, analytical prediction of the period-doubling bifurcation and chaos boundaries obtained using a period-doubling bifurcation criterion proposed in Al-Qaisia and Hamdan (2001 Journal of Sound and Vibration 244, 453-479) are compared with those of computer simulations. In addition, results of the effect of fluid density, fluid depth, mass ratio, mass position and damping on the period-doubling bifurcation diagrams are studies and presented.

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