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Post-critical behavior of Beck's column with a tip mass. (English) Zbl 1116.74372

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Summary: This study examines how a tip mass with rotary inertia affects the stability of a follower-loaded cantilevered column. Using nonlinear modeling and perturbation analysis, expressions are set up for determining the stability of the straight column and the amplitude of post-critical flutter oscillations. Bifurcation diagrams are given, showing how the vibration amplitude changes with follower load and other parameters. These results agree closely with numerical simulation. It is found that sufficiently large values of tip mass rotary inertia can change the primary bifurcation from supercritical into subcritical. This can imply very large motions for follower loads just beyond critical, contrasting the finite amplitude motions accompanying supercritical bifurcations. Also, the straight column may be destabilized by a sufficiently strong disturbance at loads far below the value of critical load predicted by linear theory. A similar change in bifurcation is found to occur with increased external (as compared to internal) damping, and with a shortening in column length. These effects are not revealed by linear modeling and analysis, which may consequently fail to predict even qualitatively the real critical load for a column with tip mass.

MSC:

74K10 Rods (beams, columns, shafts, arches, rings, etc.)

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