Stability Analysis of Isotropic Rotor-Bearing Systems With Internal Damping Using Finite Elements

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ABSTRACT

This paper deals with the stability analysis of self-excited bending vibrations of linear isotropic rotor-bearing systems with internal damping using the finite element method. The rotor system consists of uniform circular Rayleigh shafts with both internal viscous and hysteretic damping, symmetric rigid disks, and discrete isotropic damped bearings. By combining the sensitivity analysis and the eigenvalue problem of the rotor dynamics equations presented in complex form, it is proved theoretically that the whirling motion of the rotor system becomes unstable at all speeds beyond the threshold speed of instability. Furthermore, it is found that the rotor stability is always improved by increasing the damping provided by the bearings, whereas increasing internal hysteretic damping will result in a reduction of the threshold speed of instability. Numerical examples are given to confirm the validity of the theoretical results, and to study the combined influence of internal damping and isotropic bearing damping on the rotor stability.

Keywords: isotropic rotor-bearing systems, internal viscous and hysteretic damping, stability investigation, stability threshold and whirling speeds, finite elements