Dynamics of a Rigid Rotor in Non-Linear Squeeze-Film Dampers

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ABSTRACT

The unbalance response of a rigid rotor supported by three types of squeeze-film damper configurations, namely, dampers without centering springs, eccentric dampers with centering springs, and concentric dampers with centering springs, was numerically investigated in the work reported herein. This study revealed a wide range of qualitative behavior in the response of the rotor. Jump phenomena were observed in the rotor response for the dampers with centering springs for both eccentric and concentric modes of operation. The response of the rotor in the dampers without centering springs exhibited period-doubling bifurcation and chaos. Vibrations at one-third of the rotating speed were also observed in the rotor response at certain magnitude of the unbalance forec. Period-doubling bifurcation and chaotic motion were also observed in the response of the rotor in eccentric squeeze-film dampers with centering springs. The onset of bifurcation and chaos in the response of the rotor in these dampers occurred at a higher level of unbalance force as compared to the case of the rotor in the dampers without centering springs. Chaotic or non-synchronous vibrations were, however, not observed in the response of the rotor in concentric squeeze-film dampers. At relatively large magnitudes of unbalance force, the rotor response in all damper configurations was synchronous.

Although the utilization of squeeze-film dampers without centering springs has the advantage of lower cost and less space requirement as compared to those with centering springs, such dampers may exhibit chaotic and other non-synchronous vibration at moderate levels of unbalance force. Such vibrations may also occur in eccentrically operated squeeze-film dampers with centering springs, albeit at a higher level of unbalance force. The use of centralizing mechanism in conjunction with these dampers to produce concentric rotor whirl orbits has been shown to eliminate non-synchronous and chaotic vibrations.