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Analysis of a Self-Acting Air Journal Bearing: Effect of Dynamic Deformation of Bump Foil

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Abstract : A theoretical investigation on the effects of both steady-state and dynamic deformations of the foils on the dynamic performance characteristics of a self-acting air foil journal bearing operating under small harmonic vibrations is proposed. To take into account the dynamic deformations of foils, the perturbation method is used for determining the gas-film stiffness and damping coefficients for given values of excitation frequency, compressibility number, and compliance factor of the bump foil. The nonlinear stationary Reynolds' equation is solved by means of the Galerkins' finite element formulation while the finite differences method are used to solve the first order complex dynamic equations resulting from the perturbation of the nonlinear transient compressible Reynolds' equation. The stiffness of a bump is uniformly distributed throughout the bearing surface (generation I bearing). It was found that the dynamic properties of the compliant finite length journal bearing are significantly affected by the compliance of foils especially when the dynamic deformation of foils is considered in addition to the static one by applying the principle of superposition.

Keywords : elasto-aerodynamic lubrication, air foil bearing, steady-state deformation, dynamic deformation, stiffness and damping coefficients, perturbation method, fluid-structure interaction, Galerk infinite element method, finite difference method
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