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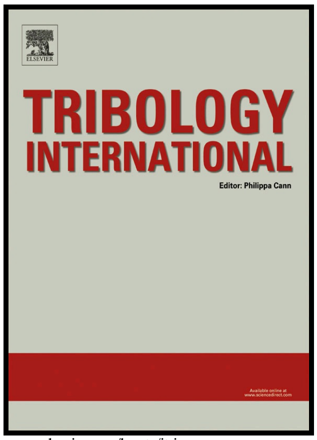

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Rotordynamic coefficients of a controllable magnetorheological fluid lubricated floating ring bearing

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Abstract

Rotordynamic coefficients of a controllable floating ring bearing (FRB) are measured in the presented study. Controllability of the bearing is achieved by using magnetorheological fluid (MRF) as lubricant along with external magnetic field. Magnetic field induced field-dependent viscosity of the MRF changes dynamic coefficients (stiffness, damping, etc.) of the bearing, and vibration amplitudes of the rotor will be suppressed by enhanced stiffness and/or damping. The rotating floating ring in the FRB separates the MRF into two lubricant films. Since the ring rotates slower than the shaft, shear rate in the outer film is lower compared to the inner film, pertaining controllability by limiting the so-called shear-thinning effect of the MRF. A test rig is built to measure and identify the rotordynamic coefficients of the MRF lubricated FRB. Coefficients of the bearing with various magnetic field strength are compared. Results show enhancements of dynamic properties of the bearing with external magnetic field, demonstrating the viability of this type of smart bearings in rotor control or behavior alteration applications.

Keywords

magnetorheological fluid, floating ring bearing, rotordynamic coefficients, bearing test

1 Introduction

Rotor vibration control has been an active research area for decades. Since the perfect balance of the rotor is impossible in reality, methods and designs for rotor vibration control mainly aim to suppress the out-of-balance force of the rotor. Ways to control rotor vibration are either active, passive or semi-active. The active method seeks to exert direct forces to restrict the motion of the rotor itself, and electromagnetic actuator is the mostly used device [1–3]. The magnetic forces generated by the actuator are usually modeled as tunable equivalent stiffness. This supplemental stiffness helps reduce vibration amplitudes and raise instability thresholds. Without feedback, the passive way for rotor vibration control generally seeks to adjust or simply increase the damping property of the rotor system. One intuitive means is to use high damping materials [4–6], such as rubber, polymers and other viscoelastic materials, to support the rotor system. Another way is to rely on fluid film to provide additional damping. Applications include using squeeze film damper for roller bearing to provide damping [7–10] and taking advantage of the extra lubricant fluid film in the floating ring bearings for more bearing damping [11–14].

1.1 Semi-active way of rotor vibration control

The semi-active method of rotor vibration control generally focuses on affecting the rotor behavior