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Bifurcations of a System of Rotor-Ball Bearings with Waviness and Squeeze Film Dampers

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Abstract : Squeeze film damper systems (SFD) are often used in machines with high rotational speed to reduce non-periodic behavior by creating external damping. These types of systems are frequently used in aircraft gas turbine engines. There are some structural parameters which are of great importance in designing these kinds of systems, such as oil film thickness, C, and outer race mass, mo. Moreover, there is a crucial parameter associated with manufacturing process, under the title of waviness. Geometric imperfections are often called waviness if its wavelength is much longer than Hertzian contact width which is a considerable source of vibration in ball bearings. In this paper, a system of a flexible rotor and two ball bearings with floating ring squeeze film dampers and consideration of waviness has been modeled and solved by a numerical integration method, namely Runge-Kutta method to investigate the dynamic response of the system. The results show that by increasing the number of wave lobes, which is due to inappropriate manufacturing, non- periodic and chaotic behavior increases. This result reveals the importance of manufacturing accuracy. Moreover, as long as C< 1.5×10-4 m, by increasing the oil film thickness, unwanted vibrations and non-periodic behavior of the system have been reduced, On the other hand, when C>1.5×10-4 m, increasing the outer oil film thickness results in the increasing chaotic and non-periodic responses. This result shows that although the presence of oil film results in reduction the non-periodic and chaotic behaviors, but the oil film has an optimal thickness. In addition, with increasing mo, the disc displacement amplitude increases. This result reveals the importance of utilizing light materials in manufacturing the squeeze film dampers.

Keywords : squeeze-film damper, waviness, ball bearing, bifurcation
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