On the nonlinear dynamics of two types of backup bearings - Theoretical and experimental aspects - DTU Orbit (29/12/2018)

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The possible contact between rotor and stator can for some cases be considered a serious malfunction that may lead to catastrophic failure. Rotor rub is considered a secondary phenomenon caused by a primary source that leads to a disruption of the normal operational condition. It arises from sudden mass unbalance, instabilities generated by aerodynamic and hydrodynamic forces in seals and bearings among others. The contact event gives rise to normal and friction forces exerted on the rotor at impact events. The friction force plays a significant role by transferring some rotational energy of the rotor to lateral motion, impacting the stator. This event results in persistent coupled lateral vibration of the rotor and stator. This paper proposes a new unconventional backup bearing design in order to reduce the rub related severity in friction. The idea is to utilize pin connections that center the rotor during impacts. In this way, the rotor is forced to the center and the lateral motion is mitigated. The four pins are passively adjustable, which allows the clearance to be customized. A mathematical model has been developed to capture phenomena arising from impact for the conventional backup bearing (annular guide) and for the new disk-pin backup bearing. For the conventional annular guide setup, it is reasonable to superpose an impact condition to the rub, where the rotor spin energy can be fully transformed into rotor lateral movements. Using a nonideal drive, i.e., an electric motor without any kind of velocity feedback control, it is even possible to almost stop the rotor spin under rubbing conditions. All the rotational energy will be transformed in a kind of self-excited rotor lateral vibration with repeated impacts against the housing. The vibration of the housing is coupled through the interaction force. The experimental and numerical analysis shows that for the conventional annular guide setup, the rotational energy is fully transformed into lateral motion and the rotor spin is stopped. However, by employing the new disk-pin design the analysis shows that the rotor at impact is forced to the center of the backup bearing and the lateral motion is mitigated. As a result of this, the rotor spin is kept constant. © 2012 American Society of Mechanical Engineers.

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