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Nonlinear Prediction of Thermally Induced Instability (Morton Effect)
Dynamic Coefficient Prediction for Tilting/Fixed Pad Bearing with High Fidelity

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Synchronous rotor instability phenomenon, known as the Morton Effect (ME) is caused by the temperature differential across the journal in fluid film bearings. The temperature difference will bend the rotor and cause increased vibrations, which will continue to grow and drive the system unstable in certain conditions. The ME is quite sensitive to operational parameters including oil temperature, bearing clearance, overhung mass, etc. Accurate prediction of the ME instability onset speed requires precise modelling of the rotor dynamics, heat conduction and elastic deformation of the rotor and bearing. The objective is to offer users the capability for transient ME analysis and steady ME analysis. The former predicts the rotor vibration, bearing orbit, rotor & bearing temperature with respect to time, while the latter demonstrates the above information with respect to rotating speeds and evaluates the ME instability onset speed. Moreover, the thermo-elasto-hydro-dynamic analysis can also be applied to accurately predict the dynamic coefficients of various tilting/fixed pad bearing types by taking the flexible pad & pivot, non-uniform oil viscosity, asymmetric bearing clearance due to pad & rotor deformation, etc. into account. The current software packages provides two basic modules for users: the ME prediction module and bearing dynamic coefficient evaluation module. The software adopts the parallel computing and mixing programming with C for computational acceleration. The 3D finite element method is utilized to predict the rotor dynamics with Euler/Timoshenko beam theory and the 3D temperature distribution in both the rotor and bearing. Moreover, the hydrodynamic pressure and 3D temperature of the oil film is obtained by solving the Reynolds equation and energy equation, respectively. Both the ME prediction module and the dynamic coefficient evaluation module have been fully calibrated by published data to ensure accuracy. The future work includes (a) the experiment design to validate the Morton effect simulation, and 20 RTDs have been imbedded across the shaft circumference inside the tilting pad bearing to measure the temperature distribution, (2) remedies for the ME, such as heat barrier sleeve design including geometry optimizing and material selection, and (3) prediction of the ME on other bearing types.

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