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Recent Advances in Modeling and Simulation of Rotors in Oil Film Bearings

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In addition to synchronous oscillations due to unbalance, rotors in oil film bearings are prone to show "oil whirl" and "oil whip" oscillations which are also denoted by subsynchronous oscillations [2,3]. In the design process of oil film bearings in rotordynamic applications, advanced modeling and simulation are essential to minimize or to even avoid oscillations. The main goal is to establish reliable and time-efficient computational methods which have to consider both the oil film bearing and the stability analysis of the rotor oscillations. Furthermore, the investigations should improve the physical understanding of the multiphysical system.

The bearing model usually involves the sole solution of the Reynolds equation if thermodynamic effects are neglected. Semi-analytical methods are derived for instance by look-up tables or by Fourier-Galerkin methods [5,7] which allow time-efficient run-up simulations of turbocharger rotors for parameter and sensitivity studies [5] as well as a detailed stability analysis by using the methods of numerical continuation [3]. In such lightly-loaded, high-speed rotating systems, either floating ring bearings or ball bearings in combination with a squeeze film damper are usually preferred. However, they exhibit "oil whirl/whip" instabilities due to the inner and/or outer oil films [2,3]. An extension of the mechanical model considers the interaction of the turbocharger housing and the rotor bearing system to reveal the acoustic phenomena mainly excited by subsynchronous oscillations [4]. Since porous journal bearings are often favored due to their self-lubricating properties, they have an essential role in nowadays research and industry application [7]. A further research area is the nonlinear oscillatory behavior of systems with elastohydrodynamic line contacts [6,8] as they occur for instance in lubricated ball bearings. Additionally, recent publications (e.g. [1]) demonstrate promising results of the application of piezoelectric actuators in oil film bearings which provide an active damping to suppress the synchronous and subsynchronous oscillations.

[1] Becker, K., and Seemann, W., 2016, "A Journal Bearing With Actively Modified Geometry for Extending the Parameter-Based Stability Range of Rotor-Dynamic Systems," In *Proc. of ISROMAC 2016.*, Hawaii, Honolulu, USA.

[2] Boyaci, A., Hetzler, H., Seemann, W., Proppe, C., and Wauer, J., 2009, "Analytical Bifurcation Analysis of a Rotor Supported by Floating Ring Bearings," *Nonlinear Dynamics.*, **57**(4), pp. 497-507.

[3] Boyaci, A., Seemann, W., and Proppe C., 2011, "Bifurcation Analysis of a Turbocharger Rotor Supported by Floating Ring Bearings," In *Proc. of the IUTAM Symposium.*, Springer Netherlands, pp. 335-347.

[4] Boyaci, A., and Seemann, W., 2017, "Vibro-Acoustical Behavior of a Turbocharger Housing Excited by Oil-Film-Induced Rotor Oscillations," In *Proceedings of the SIRM 2017.*, Graz, Austria.

[5] Knoll, G., Seemann, W., Proppe, C., Koch, R., Backhaus, K., and Boyaci, A., 2010, "Run-Up of Turbocharger Rotors in Nonlinearly Modelled Floating Bush Bearings," *MTZ Worldwide.*, **71**(4), pp. 280-285.

[6] Maier D., Hager, C., Hetzler, H., Fillot, N., Vergne, P., Dureisseix, D., and Seemann, W., 2015, "A Nonlinear Model Order Reduction Approach to the Elastohydrodynamic Problem," *Tribology International.*, **82**, pp. 484-492.

[7] van Buuren, S.W., Hetzler, H., Hinterkausen, M., and Seemann, W., 2012, "Novel Approach to Solve the Dynamical Porous Journal Bearing Problem," *Tribology International.*, **46**, pp. 30-40.

[8] Wiegert, B., Hetzler, H., and Seemann, W., 2013, "A Simplified Elastohydrodynamic Contact Model Capturing the Nonlinear Vibration Behaviour," *Tribology International.*, **59**, pp. 79-89.