SIMULATION OF VERTICAL ROTORS BY 3D-FINITE ELEMENT MODELLING

Simon Pääjärvi[1]

[1]*Department of Engineering Sciences and Mathematics, Division of Product and Production Development, Luleå University of Technology, Luleå, Sweden*

Rotor dynamic analysis encompasses the study of several components in a rotor assembly; the rotor itself, its connections, and its supporting structure, which all contribute to the system's dynamic characteristics. 3D-finite element analysis provides an approach for estimating dynamic contributions from the supporting structure.

Using the analysis capabilities in the transient solver of Simcenter Nastran, a finite element model was created and analysed, including two tilting journal bearings, a rotor, and its surrounding frame, illustrated in Figure 1.

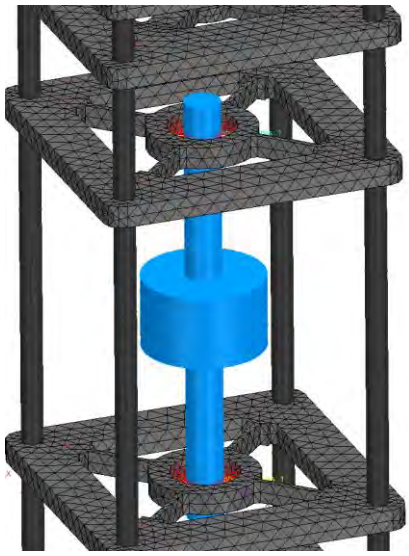

Figure 1*:* The discretised rotor rig in Simcenter Nastran, based on the experimental setup in Vattenfall's facilities in Älvkarleby.

The bearing coefficients for damping and stiffness are determined by solving Navier-Stokes' equations. These coefficients are condensed into 2D-polynomials of rotor eccentricity and rotor speed using the approach of Benti et al. [1], which effectively reduces the computational complexity of describing the fluid-film behavior. These polynomials are implemented into a Fortran-based subroutine, compiled as system file. This file interacts with the solver during the simulation and outputs a load vector corresponding to the bearing forces for each time step.

The forces of the upper bearing are shown in Figure 2. for a constant rotor speed of 2000 rev/min and unbalance 0.0056 kgm. The results are compared with measurements made in Vattenfall's laboratory in Älvkarleby. A maximum deviation of 20.8 % is observed for the forces in the *y*-direction and a maximum of 9.8 % in the *x*-direction, with respect to the measured average.

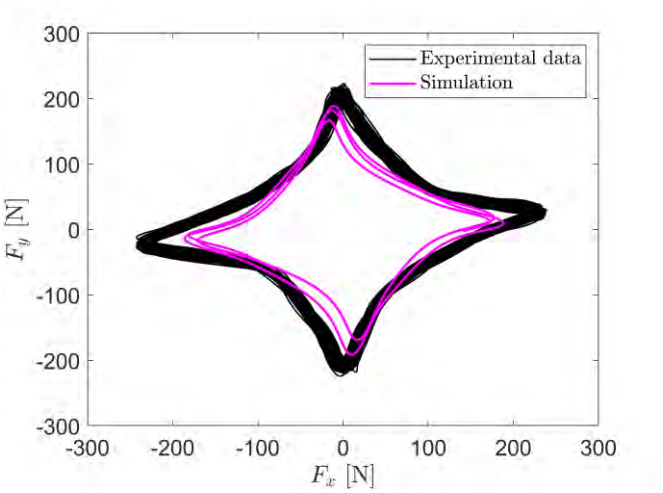

Figure 1*:* Forces for the upper bearing for simulation and measurement.

The finite element model captures the bearings' dynamics and approximates the bearing forces. It showcases possibilities for rotor dynamic analysis by 3D-finite element modelling, as the whole rotor assembly can be incorporated, allowing the study of dynamic contributions from potentially complex structures. Furthermore, the case of implementing custom bearing functions into 3D-finite element analysis underlines the potential for simulating intricate bearing models together with complex geometries.

References

[1] Benti, G., Rondon, D., Gustavsson, R., and J. Aidanpää, 2021, Numerical and experimental study on the dynamic bearing properties of a four-pad and eight-pad tilting pad journal bearings in a vertical rotor, p. 35 – 38

Corresponding author email: simpjr-6@student.ltu.se