SVENSKT CENTRUM
FÖR HÅLLBAR VATTENKRAFT

# Development of components for increased damping in hydropower units

## Objectives and Goals

### Main objectives

- Development of squeeze film bearings
- Define Method for validation of natural frequencies in vertical rotors (OMA).
- Increased damping through offset bearing halves

### How the project supports sustainable hydropower

Damping is essential to avoid high vibrations and failures of hydropower units. The aim of the project is to develop techniques to increase damping.

### Impact or innovation

The project has demonstrated a cost-effective method to modify sleeve bearings to increase damping. Simplified bearing models are developed for fast simulations and to predict damping properties. Knowledge of bearing properties is essential to predict system damping.

### Research Question

How can damping be increased in hydropower units?

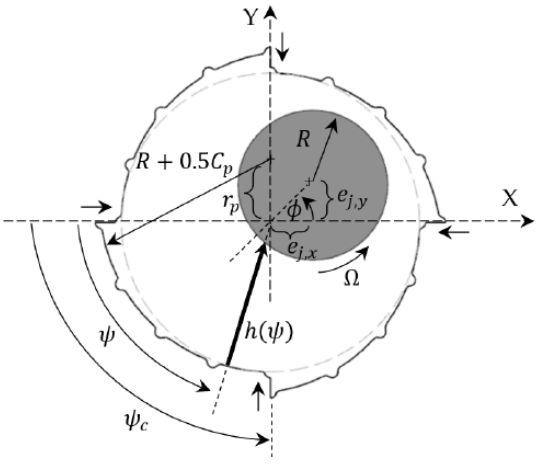


Figure 1 Modified sleeve bearing into a four lobe bearing.

## Key Results

- Result 1: A cost-effective method to modify sleeve bearings to increase damping. The guide bearing was found to have too large clearance which resulted in low damping properties. By offsetting two halves, the system damping was increased and vibration levels significantly reduced.

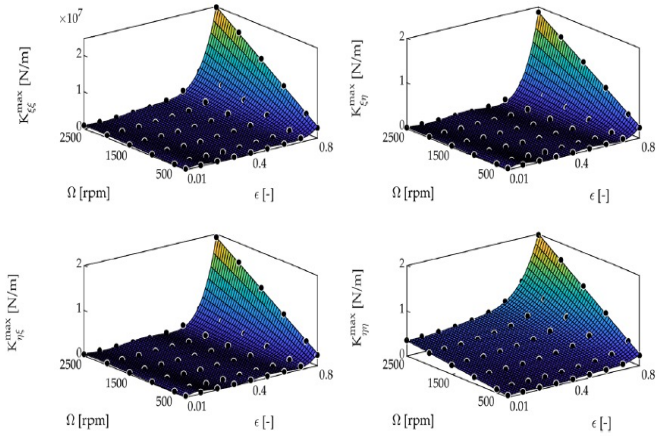


Figure 2 Speed and excentricity dependent stiffness model of tilting pad journal bearing.

- Result 2: An analytical speed dependent bearing model was created which facilitates start up simulations of vertical rotors. The model was later simplified to make the simulations faster.

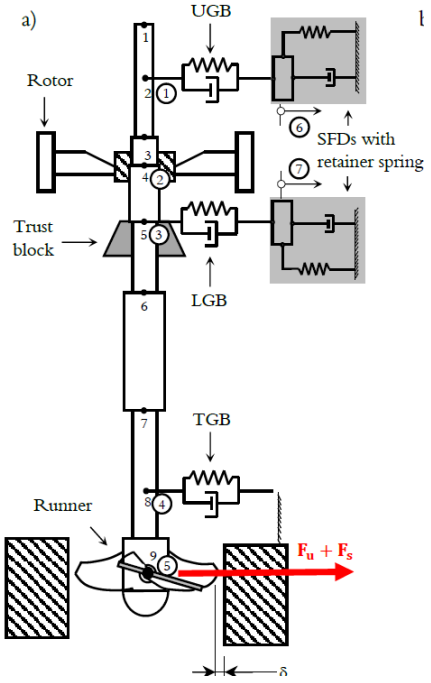


Figure 3 including squeeze film dampers in upper and lower generator bearings.

- Result 3: Numerical model of squeeze film damper for vertical rotors. It was shown that a squeeze film damper could increase damping in a hydropower unit and also reduce the risk for turbine contact.

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## Publications / Outputs

**In a previous project**

Numerical and experimental study on the dynamic bearing properties of a four-pad and eight-pad tilting pad journal bearings in a vertical rotor. Gudeta Berhanu Benti, David Rondon, Rolf Gustavsson, Jan-Olov Aidanpää: Journal of Energy Resource Technology (2022)

A Rotordynamic Characterization of Tilting-Pad Bearings With Eight Pads in Vertical Rotors. Authors: David Rondon, Gudeta Berhanu Benti, Jan-Olov Aidanpää and Rolf Gustavsson. Journal of Energy Resource Technology (2022)

Speed Dependent Bearing Models for Dynamic Simulations of Vertical Rotors. Gudeta Berhanu Benti, Jan-Olov Aidanpää, Rolf Gustavsson: published in Machines (2022)

**In this project**

Simplified transformation matrices of journal bearings in vertical application. Gudeta Berhanu Benti, Jan-Olov Aidanpää, Rolf Gustavsson: published in Applications in Engineering Science (2023)

Cost-Effective Design Modification of a Sleeve Bearing with Large Bearing Clearance. Gudeta Berhanu Benti, Jan-Olov Aidanpää, Rolf Gustavsson: published in Applied Sciences (2024)

Rotor-stator contact in a hydropower machine with squeeze-film damper. Gudeta Berhanu Benti, Jan-Olov Aidanpää, Rolf Gustavsson: Published in a book,16th Chaotic Modeling and Simulation International Conference / [ed] Christos H. Skiadas; Yiannis Dimotikalis, Springer Nature, 2024, p. 57-74.

## Future work

• The project is finished but we need to solve unanswered questions in new projects.

## Training/capacity development

• Presentations in SVC reference group
• One PhD student
• Presentation at two scientific conferences.
• Presentation at SVC hydropower day.
• Presentation at "Svenska Mekanikdagarna" 2022.

## Project

Development of components for increased damping in hydropower units
Duration of project: 2023(January)-2024(June)

## Project Leader

Project Leader: Professor, Jan-Olov Aidanpää, Chair professor Machine Design, Luleå University of Technology, tel 070 2592531, E-mail joa@ltu.se

## Team Members

Addjunct Professor Rolf Gustavsson Vattenfall VRD

## Partners

Vattenfall VRD, LTU



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