Air Foil Bearings – A Modeling Approach

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Introduction: A first generation air foil bearing (AFB) is shown in Figure 1. Air foil bearings induce, at higher rotating speeds, an air film between the journal and the top foil, which lowers the friction forces.
The goal of the present study is to develop a model to predict the behavior of an AFB.

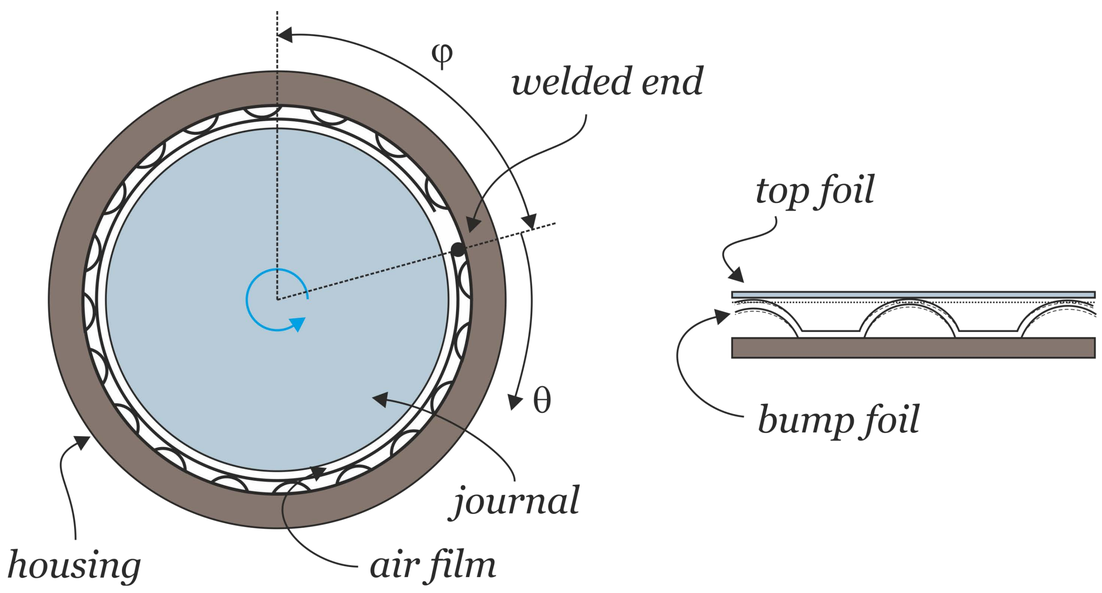

Figure 1. First generation air foil bearing

Computational Methods: The thickness of the air film depends on the clearance, eccentricity and the elastic deformations of the bump structure [1]. The flow in the thin air film between top foil and journal can be described by a Lubrication Shell.
The bump structure is modeled with a nonlinear spring foundation (as shown in Figure 2). The stiffness of the springs is implemented by a Matlab function describing the stiffness of the springs as function of the deformation (dz) and the position of the springs (θ in Figure 1) [2].

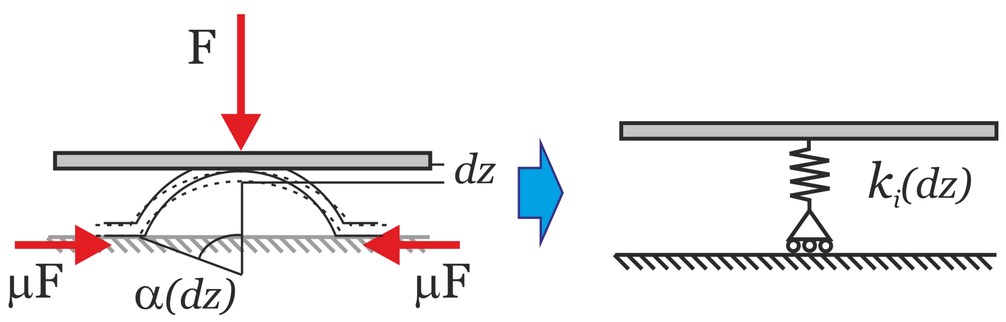

Figure 2. Model of bump structure

Results: Simulations are performed to find the parameters having the largest influence on the performance of the AFB, in this case the load capacity of the bearing.
The load capacity can be determined by computing the forces acting on the journal for a certain eccentricity and orientation of the welded end (φ in Figure 1).
The simulations show that the most important parameters are the geometry of the bump foil and the stiffness of both foils. The fluid pressure for a certain simulation is shown in Figure 3.

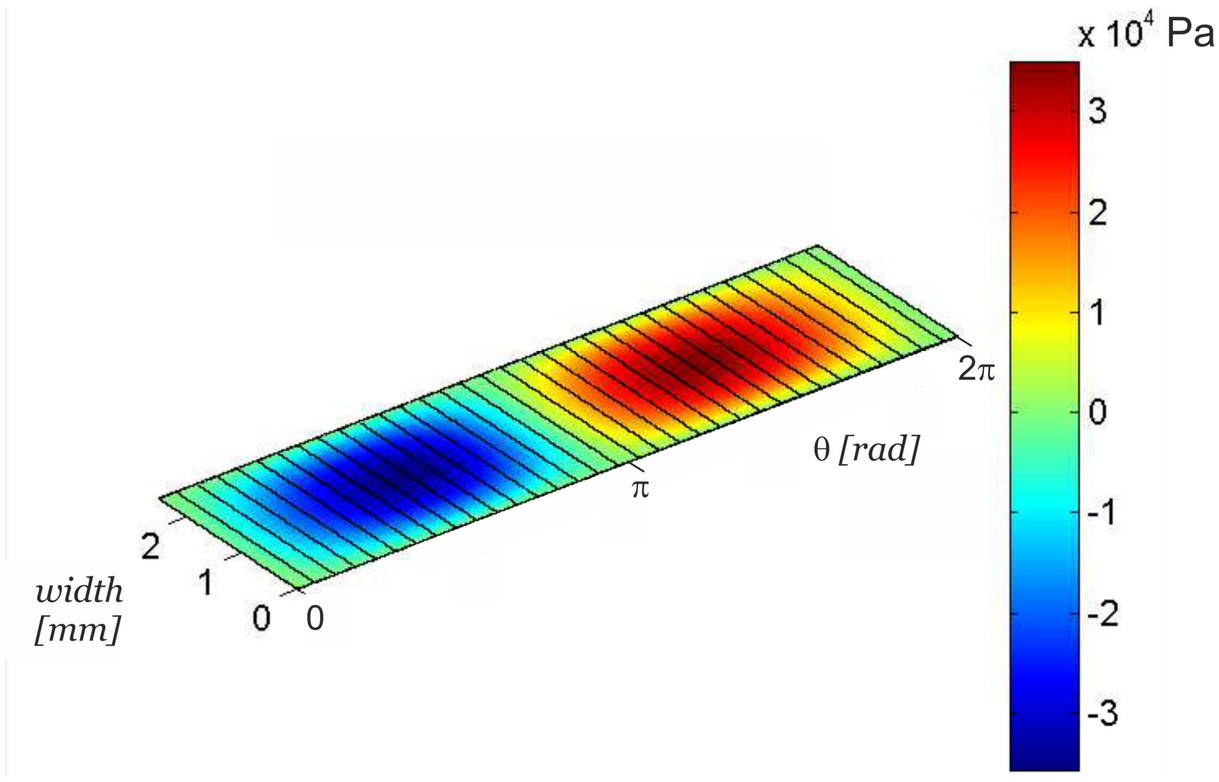

Figure 3. Difference in fluid pressure between total pressure in thin air film and ambient pressure, for φ=0

Conclusions: A computational efficient method is presented here, which yields guidelines for the design of new AFBs. The analytical descriptions combined with FEM will give more accurate results at faster computational times.

References:

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2. I.Iordanoff, Analysis of an Aerodynamic Compliant Foil Thrust Bearing: Method for a Rapid Design, Journal of Tribology, vol. 121, pp. 816–822, (1999)

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