DESIGN AND NUMERICAL SIMULATION OF HYBRID-SYSTEM OF BEARINGS

Abstract submitted by

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ABSTRACT

This thesis investigates methods to improve the performance of shaft-disc systems by focusing on their bearings. It explores two main bearing types: oil film and permanent magnet bearings (PMBs). The research introduces a new approach that combines finite element analysis (FEM) with semi-analytical methods to analyze these bearings and determine their stiffness and other vital characteristics. Additionally, it delves into hybrid systems that combine oil film and PMBs, providing valuable insights for designers of such systems. The first part of the thesis establishes the research motivations and objectives. These include reviewing past research for the load capacity of bearings in shaft-disc systems and studying both oil film and PMBs. It also explores various computational methods for estimating the forces acting on a short cylindrical journal bearing with an oil film. It compares the accuracy and efficiency of these methods, helping designers choose the most suitable approach based on their specific needs. It further presents a method using FEM to estimate the characteristic parameters of hydrodynamic journal bearings under static conditions. This method offers improved accuracy compared to traditional methods.

Further, the research introduces a basic non-dimensional model for a PMB configuration. While this model exhibits axial instability, it can be stabilized by implementing specific design features. This chapter focuses on non-dimensional parameters, which allow for broader application compared to analyzing specific dimensional values. In persuasion of PMB simulation, it presents a novel semi-analytical FEM approach for analyzing PMBs. This method offers advantages over existing methods by providing a more complete picture of the bearing's stiffness characteristics, including angular stiffness. It also offers guidance for designers in optimizing PMB parameters. Finally, it presents a detailed analytical model for a hybrid system combining oil film and PMB technologies. This model allows designers to assess the suitability of such hybrid systems for their specific applications. It highlights potential benefits like improved stability, increased ranges of operational speeds, and enhanced load capacity compared to traditional oil film bearings. In conclusion, this thesis offers a comprehensive simulation study of hybrid systems of bearings, providing valuable approach and knowledge for designers working with oil film bearings, PMBs,

and hybrid systems. It introduces novel methods for analyzing these bearings, explores their behaviors, and provides insights for characterizing their performance for various applications.

LIST OF PUBLICATIONS:

I. M. Karmakar and S. Sarkar, "Non-dimensional analysis of axially polarized passive magnetic bearings," SN Appl. Sci., vol. 2, p. 987, 2020. http://dx.doi.org/10.1007/s42452-020-2809-x.

II. M. Karmakar and S. Sarkar, "Semi-Analytical Finite Element Approach for 6-DOF Characterizations of PMB Load," in IEEE Transactions on Magnetics, vol. 58, no. 7, pp. 1-10, July 2022, Art no. 8001510. http://dx.doi.org/10.1109/tmag.2022.3174449.

III. M. Karmakar, S. Tudu, S. Sarkar, and S. C. Mondal, "Comparison of errors in calculating the journal force of a short cylindrical oil film bearing," presented at the 1st International Conference on Contemporary Issues in Computing, July 25, 2020. http://dx.doi.org/10.26480/cic.01.2020.59.63.

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