ISCORMA-3, Cleveland, Ohio, 19-23 September 2005

PROBABILISTIC APPROACH FOR ROBUST DESIGN OF GAS-LUBRICATED TILTING-PAD BEARING

Erh-Rong Wu
Mega Research, Inc.
29711 Whitley Collins Drive
Rancho Palos Verdes, CA 90275
E-mail: erwu@megaresearch.com

ABSTRACT

Robust design is meant to facilitate swift selection of optimal parameters/variables in a design process. In the conventional approach, or deterministic approach, design variables are defined as constants for analytical calculations. Then, the statistic method such as regression may be utilized to optimize those variables and obtain a solution close to the design target. The probabilistic approach, contrarily, defines the design parameters as random variables in probability distribution functions based on required conditions. A limit state function is defined as the difference between the design target and the result of a mathematical model that contains all design variables. The limit state function is mathematically regarded as a surface in N-dimensional space represented by N-design variables. Minimization of the gradient of the surface will finally lead to an optimal solution that will almost coincide with the design target. Consequently, all design parameters are determined precisely in the optimization process.

This approach is applied to a tilting-pad bearing, which is known for dynamic stability, with porous materials, e.g. ceramics, coated surfaces for high speed and high temperature operations. As gas bearings are suitable for high-speed rotors, the physical model considers the lubricant to be compressible. For the mathematical model, the bearing geometry including all pads is defined in a global coordinate system. The nonlinear Reynolds equation combined with a thin layer approximation for the porous medium is solved to compute the load capacity of the bearing. In the input, vital bearing parameters are defined as random variables. Computational results in terms of the load capacity are interfaced the probabilistic process to meet the required bearing load capacity and optimize all design variables.

Keywords: Probabilistic approach, deterministic approach, porous tilting-pad bearing, load capacity