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Discussion

A Fast Method for Calculating Dynamic Coefficients of Finite Width Journal Bearings With Quasi Reynolds Boundary Condition[1]

Z. Zhang.[2] The authors are to be congratulated for their valuable contribution to the efficient and practical method of solving the Reynolds equation. In journal bearing calculation, especially those concerned with dynamic properties and stability behavior, the time of computation is chiefly consumed in solving the Reynolds equation and its various differentiated forms. Therefore, every effective effort in developing mathematical methods which can save time of computation and improve accuracy of calculation should be beneficial to all who are engaged in bearing analysis and calculation.

In the discusser's opinion, the authors' method falls in the category of Galerkin's method, which is used to find the solution of a differential equation by using a chosen series of base functions to express the unknown solution. This kind of method is equivalent to using the Rayleigh-Ritz method to arrive at a stationary functional related to the differential equation, namely the Reynolds equation in the present case. An extensive discussion on the principle and various possibilities of applying Galerkin's and similar methods to solve the Reynolds equation can be found in the early published book [A1]. When combined with electronic computers, these methods can be very efficient and accurate, especially when applied to problems with simple boundary contours such as journal bearings whose boundary of film rupture can be very well approximated by a straight line. For example, [A2] has also successfully treated journal bearings, using essentially the mathematical formulation similar to that in the present paper. But it is worthwhile to point out that the authors of the present paper have derived their concrete formulation from a more generalized viewpoint, and expressed their treatment in a very compact form. They have evidently tested their method very carefully, gained much experience of fixing their convergence criteria and way of discretization, and moulded their method into a very efficient computer program.

The very short time of computation (about 1/100 of that required by the "classical method") is truly impressive. But, after Lund published his method of calculation of bearing dynamic coefficients, only a few researchers still use positive and negative finite perturbations to obtain these coefficients. If the later method is meant by the authors as the "classical method," would it be better to make comparison to the currently used methods comprising four infinitesimal perturbations instead of eight finite ones?

Have the authors considered the pros and cons of performing a Vogelpohl transformation prior to introducing the serial expression, and what is their conclusion?

Have they investigated the errors in the calculated oil flow and friction, brought forth by using quasi Reynolds boundary condition, and how great are they?

Additional References

A1 Korovtschinsky, M. B., "Theoretical Working Principles of Sliding Bearings" (in Russian), *Maschgiz*, 1959, pp. 247–294.

A2 Sinhasen et al., "Design Data for Offset-Halves Journal Bearings in Laminar and Turbulent Regimes," *ASLE Trans.*, Vol. 25, No. 1, Jan. 1982, pp. 133–140.

Authors' Closure

The authors thank Professor Z. Zhang for his kind and constructive comments and questions.

In the present study, calculation time was compared to the "classical method" since it is still sometimes used, to the authors' knowledge, in creating database of dynamic coefficients. However, it will be meaningful to compare the calculation time to the method of four infinitesimal perturbations.

Rapidity of calculation depends on the possibility of an analytical integration of $R_{n\mu\nu}$ (see equation (25)) and it is easy to do this when the equation consists of terms having only coefficients of h^m, where m is an integral number, like equation (13*a*). The authors have also considered the Vogelpohl transformation by which the Reynolds equation is transformed to a standard form by eliminating first order differentiation terms such as $dp/d\theta$. The transformed equation, however, has terms with coefficients h^a, where a is not an integral number, and an analytical integration can not be done easily. Thus the transformation was not used.

Oil flow and friction were not calculated in the present study, but the errors owing to the use of the quasi Reynolds boundary condition are considered to be small because the quasi Reynolds boundary line locates very close to the boundary line obtained in the calculation under the Reynolds condition, e.g., the difference between two lines was only a few degrees in bearing angle (see discussions in reference [10]).

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[1] By T. Kato and Y. Hori published in the July 1988 issue of the JOURNAL OF TRIBOLOGY, Vol. 110, pp. 387–393.

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