DISCUSSION

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This is an interesting paper as it uses the stream function formulation for the mean flow. But the treatment is somewhat terse and I would like to ask for some clarification of the analysis. (1) The pressure enters the equations through first derivative only, yet there are two boundary conditions specified in pressure. (2) There seem to be no boundary conditions in Ψ, though Ψ is a dependent variable of the PDE's. (3) I would like also to know the ratio of magnitudes of the largest neglected term to the smallest term retained during simplification of the equations. I happen to be of the opinion that convective inertia terms cannot be neglected—at least not via a strict order of magnitude analysis—when modeling turbulence (Szeri, 1987).

Additional Reference

Szeri, A. Z., 1987, "Some Extensions of the Lubrication Theory of Osborne Reynolds," Journal of Tribology, Vol. 109, pp. 21–36.

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Author's Closure

The author would like to thank Professor Szeri for his important discussion.

(1),(2): In this analysis, the author assumed that the lubricant flows on the boundary lines of a bearing pad, and then one of the momentum equations and the prescribed pressure value were used as the boundary conditions. As pointed out by Professor Szeri, in the governing equations only the gradient of stream function, $\partial\psi/\partial\theta$, $\partial\psi/\partial R$, has the physical meaning and the stream function itself is meaningless. Therefore, in the numerical analysis an arbitrary value of stream function was set at any one grid point on the bearing pad and the values of stream function on the other grid points, including the points on the boundary lines, were determined iteratively based on the Newton-Raphson iterative scheme under the prescribed four pressure boundary conditions, in which two pressure boundary conditions were used for the check on a convergence of stream function. In the inertialess case, which corresponds to the case of $Re^*=0$ in the momentum equations, the numerical results by the present method agree with the results from the conventional turbulent Reynolds equation with four pressure boundary condition.

(3): Unfortunately, the author did not examine strictly the ratio of magnitudes of each term, including the inertia force term of momentum equations. However, the author guesses from the numerical analysis of film pressure that none of the terms in the inertia force term can be neglected at large value of inertia parameter, Re^*, even under laminar condition, and certainly under turbulent condition, which was already presented by Professor Szeri via an order of magnitude analysis. In the future, the author would like to check the magnitude of each term in the inertia force term of momentum equations based on the present numerical analysis procedure.