Journal of Tribology

Discussion

Numerical Simulation of the Overrolling of a Surface Feature in an EHL Line Contact[1]

L. Chang.[2] This discusser would like to point out that one of the authors' introductory statements referring to our earlier work (reference [7]), "...the transient results presented so far have been obtained using a relatively small number of nodes in spatial direction(s) and only a few time steps," is a speculation without a scientific ground. In fact, the time steps taken to solve the moving dent problem reported in reference [7] are a few times more than the time steps that the authors use to solve a similar problem reported in their paper.

In our opinion, the needed number of grid points and time steps depend on the nature and complexity of the problem. For example, it takes a few thousand time steps to simulate EHL contacts between two rough surfaces reported in Chang and Webster (1991) and Chang (1992), and the time steps taken reach fifteen thousands in our latest work on asperity interactions. Furthermore, the grid size and the time step depend on the accuracy of the numerical scheme. For example, if all the spatial derivatives in the Reynolds equation are discretized with a second-order accuracy, the number of grid points can be significantly reduced from the number which should be used when the scheme of discretization is first order, as shown in Chang, Conry and Cusano (1989).

Additional References

Chang, L., Conry, T. F., and Cusano, C., 1989, "An Efficient, Robust, Multi-Level Computational Algorithm for Elastohydrodynamic Lubrication," ASME JOURNAL OF TRIBOLOGY, Vol. 111, No. 2, pp. 193–199.

Chang, L., and Webster, M. N., 1991, "A Study of Elastohydrodynamic Lubrication of Rough Surfaces," ASME JOURNAL OF TRIBOLOGY, Vol. 113, No. 1, pp. 110–115.

Chang, L., 1992, "Traction in Thermal Elastohydrodynamic Lubrication of Rough Surfaces," ASME JOURNAL OF TRIBOLOGY, Vol. 114, No. 1, pp. 186–191.

Authors' Closure

The authors would like to thank the discusser for his careful reading of the paper. As far as the introductory remark referred to by the discusser: "Hence, the transient results....and only a few time steps" the authors would like to point out that it should not be lifted out of its context among which the sentence immediately following it: "Furthermore, most likely....only relatively lightly loaded situations have been studied." Secondly, when referring to Dr. Chang's work, the authors had little choice but to make an educated guess since he neither gives the exact stepsize in time nor space. Even in the present comments he does not give detailed information.

The discusser makes a major point of the number of time steps used in the simulation. The authors, however, would like to emphasize that the accuracy of the results depends on the combination of time step and spatial mesh size. A high accuracy requires both a small time step and a small mesh size and, in most cases, to obtain a small mesh size is much more a computational bottleneck than using a large number of timesteps, particularly when Newton Raphson like global iterative schemes are used.

Therefore, mentioning the use of thousands of time steps without giving details about the number of nodes in spatial direction (and mesh size) is in our opinion a misleading claim to accuracy, particularly in the case of rough surfaces when a dense grid in spatial direction is essential to describe the roughness profile, no matter what order of discretization is used.

Finally, the authors would like to comment on the use of second order discretizations in the simulation. It is a well known fact from basic numerical analysis that the second order accuracy is only obtained for low frequency components, i.e., for those components in the solution that only change on a scale that is large compared to the mesh size and time step. Consequently, to obtain second order accuracy in the case of rough surfaces the spatial mesh size as well as the time step must be sufficiently small compared to the scales in space and time at which variations in the solution (pressure and film thickness) occur. If this can not be ensured or if second order convergence does not clearly show in the results, the authors would be wary of using a second order scheme. The reason for this reservation is that variations in the solution at the scale of one to a few mesh sizes are not only *not represented* as in the case of a first order scheme, but quite often *misrepresented* in the form of numerical artifacts that are in no way related to the physical behavior represented by the continuous integro-differential problem.

Analysis for Incompressible Flow in Annular Pressure Seals[1]

Luis San Andres.[2] The paper contains a detailed analysis of the complete dynamic force and moment response due to shaft translations and angulations for incompressible liquid annular seals. The motion of the fluid in the thin film annular clearance

[1]By C. H. Venner, A. A. Lubrecht, and W. E. ten Napel published in the ASME JOURNAL OF TRIBOLOGY, Vol. 111, No. 4, pp. 777–783.

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[1]By F. Simon and J. Frêne, published in the July 1992 issue of THE JOURNAL OF TRIBOLOGY, Vol. 114, pp. 431–438.

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