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AN AVERAGED APPROACH TO ASPERITY CONTACT INTERACTIONS FOR NON-GAUSSIAN LUBRICATED SURFACES

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ABSTRACT

The contiguous surfaces of tribological contacts are often subjected to a period of embedding during the initial stages of operation commonly referred to as the running-in period. Asperity interactions and increased frictional losses are often prevalent during this period. After the transience of the surface roughness during the initial running-in phase, the resultant surface contributes to the tribological behaviour of the contact throughout the majority of its remaining usable life.

The analysis of the surface roughness as a number of spherical Hertzian contacts was provided by the work of Greenwood and Williamsons [1]. Later Greenwood and Tripp [2, 3] adapted the model provided for the probability of asperity interaction between two surfaces. The aforementioned asperity contact models are adapted in the current study to model the asperity interactions throughout a contact's running-in phase. The adapted model considers non-Gaussian surface roughness distributions and account for the significant change of geometry of the highest summits by considering the mean asperity radius of curvature as a function of the peak height.

A mixed regime of lubrication model is developed in which the Patir and Cheng [4, 5] Average Reynolds model accounts for the surface roughness effect on the generated hydrodynamic pressure. The model relies on the use of statistical sampling assuming that the surface topographical regions are repeatable in nature in a similar way to Greenwood and Williamson [1]. The asperity interactions are considered using the modified Greenwood and Tripp model described previously.

The frictional losses predicted by the numerical model are compared with the experimental results. The tests are conducted under such conditions that the contact resides in the mixed regime of lubrication and experiences wear during the early stages of running. The surface is periodically measured using an Infinite Focus Microscope until such point as the surface roughness sufficiently stabilises (signifying the end of the running-in process). The measured roughness data is used as the input data for the numerical model.

The paper presents an adapted asperity contact model capable of considering the effect of roughness interactions on frictional losses during the formative embedding process. The numerical results are compared with experimental test results. The combined numerical and experimental approach allows for an improved understanding of the frictional losses during the running-in.

REFERENCES

[1] Greenwood, J. A., & Williamson, J. B. P. (1966). Contact of nominally flat surfaces. Proceedings of the Royal Society of London. Series A. Mathematical and Physical Sciences, 295(1442), 300-319.

[2] Greenwood, J. A., & Tripp, J. H. (1967). The elastic contact of rough spheres. Journal of Applied Mechanics, 34(1), 153-159.

[3] Greenwood, J. A., & Tripp, J. H. (1970). The contact of two nominally flat rough surfaces. Proceedings of the institution of mechanical engineers, 185(1), 625-633.

[4] Patir, N., & Cheng, H. S. (1978). An average flow model for determining effects of three-dimensional roughness on partial hydrodynamic lubrication. Journal of Tribology, 100(1), 12-17.

[5] Patir, N., & Cheng, H. S. (1979). Application of average flow model to lubrication between rough sliding surfaces. Transactions of the ASME, 101, 202-230.