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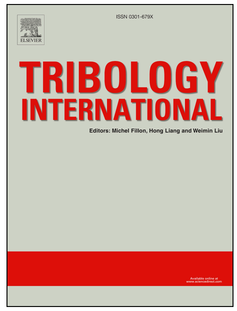

On the modelling of mixed lubrication of conformal contacts

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On the modelling of mixed lubrication of conformal contacts

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Abstract

When it comes to the numerical evaluation of tribological contacts operated in the boundary and mixed lubrication regime, the estimation of the asperity contact based on statistical methods is widespread. We have studied the effects and expressiveness of major aspects of statistical contact modelling including the choice of contact model, surface evaluation method and magnification in the process of surface acquisition. To this, friction experiments including two material combinations were conducted and compared with numerical results retrieved from a newly developed numerical framework in a commercial simulation software. The results point out the relevance of the numerical framework and visualize the effect of inappropriate surface acquisition respectively the expressiveness of the investigated evaluation methods and contact models.

Keywords: Journal bearing, Mixed lubrication, Friction measurement, Simulation

1. Introduction

The identification of journal bearings' lubrication regimes is commonly connected with the first investigations conducted by Stribeck [1] in 1902. By investigating the behaviour of journal bearings under varying load and sliding speed the author was able to correlate the measured frictional losses with the regimes of boundary, mixed and fluid lubrication. Herein, the fluid lubrication regime represents the regime of preferred operation wherefore the mathematical background was developed by Reynolds [2] in 1886 based on preceding experiments by Tower [3, 4]. Reynolds applied several simplifications on the Navier-Stokes equations and developed a differential equation which describes the hydrodynamic behaviour within a thin lubrication gap. The use of this equation has been engineering standard in the dimensioning process of journal bearings ever since. Reynolds' mathematical description holds for a fluid film thickness which exceeds the surface roughness significantly. However, when the fluid film thickness drops, the surface roughness increasingly alters the fluid flow which consequently violates a basic assumptions within this mathematical framework, namely the consideration of smooth surfaces. Addressing this circumstance Patir and Cheng [5, 6] developed the Reynolds equation further allowing the consideration of the fluid film altering effects of surface roughness by introducing the theory of pressure and shear flow respectively shear stress factors. The authors provided empirical relations for these factors based on numerical investigations on small scale which subsequently allows the transfer on large scale problems. With increasing computer power it was possible to compare the statistical approach by Patir and Cheng with deterministic numerical results [7]. A very good agreement between the two approaches was shown which confirms the widespread use of the theory by Patir and Cheng. The application of the theory by Patir and Cheng comes increasingly to fruition due to the constantly increasing demands driven by environment, law and market. Following the aim of

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