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Consequences of a defect of lubricant supply on the EHL contact

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This paper is the presentation of a coming study dealing with the effect of the loss of lubricant on an elastohydrodynamic lubricated contact. Explanation of the goal of this research is given as well as a short state of the art regarding film thickness decay. A numerical model is briefly presented together with the short-term objectives. Comparisons with experimental work should be considered during the study.

Keywords: Elastohydrodynamic lubrication; lubrication failure, transient starvation.

1. Introduction

This study is motivated by the need for industrial designers to be able to predict how long a lubricated system (such as an aero drive trains) will work with an oil shortage. Thus, the focus of this work is on lubricant supply shortages for an EHL contact. Therefore, the goal is to determine a critical time where lubricated contacts will stop working properly, i.e. when very high friction or very thin film thickness occur, leading to tribological failures.

A shortage of lubricant supply in a mechanical component will appear in the contact as a transient (time dependent) starvation process. The modeling of a transient starved Elastohydrodynamically Lubricated (EHL) contact is proposed in this research, where the oil feeding conditions are varying with time. Film thickness decay has been studied assuming a supply layer decay resulting from several successive overrollings [1,2] or oscillatory lubricant supply to simulate surface waviness [3]. But to the best of the authors' knowledge, the problem of a transient starved EHL contact is not properly addressed in the literature.

2. Numerical model

A numerical model has been built. It solves the transient Reynolds equation fully-coupled to the linear elasticity equation and the force balance equation. To do so, the Finite Element method is used. Pure rolling conditions are assumed, so the lubricant is considered as Newtonian (film shearing is assumed to be negligible, as well as thermal effects).

The key element of the numerical model is the way of handling the transient lubricant supply layer decay with an accurate model of starvation. Starvation can be generated by different manners, using the widely used JFO algorithm [2,3], a two phases flow model [4], etc.. An attempt with a three phases flow model is done in order to consider air, liquid oil and vapor oil (in the cavitation zone).

The aim here is to start from a steady state solution with a determined amount of lubricant on the raceway. Following this initial computation, a film supply layer decay is applied at the inlet of the domain versus time until a critical time where film thickness is so thin that the lubrication regime changes and becomes mixed lubrication (see Figure 1; $H_m < \bar{H}_{roughness}$).

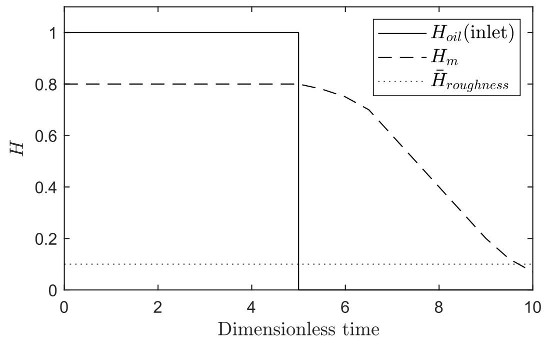

Figure 1: Schematic evolution of the dimensionless minimum film thickness H_m versus dimensionless time when a Heaviside function is applied to the lubricant supply layer (diagram)

3. Discussion

The interest is set on the minimum film thickness evolution versus time. The dimensionless form of the Reynolds equation reduces the number of parameters but a parametrical study remains essential. Furthermore, different behaviors for the oil supply shortage are tested to analyze their consequences. This numerical work is then compared to an experimental investigation on a PCS MTM2 test rig (Ball-On-Disk tribometer with traction measurement).

4. References

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