PhD position proposal

Transient starvation effects on EHD contacts

In brief:

SKF group together with LaMCoS at INSA de Lyon propose a PhD position to deal the transient aspects of starvation, both numerically and experimentally, i.e. how/when/where full-film lubrication ends due to a failure of oil supply in mechanical systems such as rolling element bearings of helicopter gear boxes. In many other applications, the supply of lubricant is not stationary and this may cause accumulative damage to the surfaces in contact.

Context:

Both experimental and numerical studies of the effect of incomplete lubricant supply to a lubricated contact (classically elastohydrodynamic - EHD - contact in rolling element bearing) have been studied in the literature. Experimentally, it is often difficult to know the exact amount of lubricant a single lubricated contact is subjected to. While not enough lubricant is available at the entrance of the contact, the lubricant film thickness variation in the pressurized zone can be monitored by with white-light interferometry. On the other hand, numerical models are able to predict the contact film thickness as long as the amount in the inlet is known.

In real applications such as rolling element bearings, the available amount of lubricant is not known. In addition, this one could vary drastically depending on the system operating conditions. It can be critical in the case of a problem in the oil supply system, provoking a sudden stop of lubricant delivery, and thus a variable amount of lubricant at the inlet. According to the state-of-the-art, the way the film thickness will vary in the pressurized zone according to this situation is still unknown. If it becomes lower than the average surface roughness, surface damages are expected. In such systems, the lubricated contact life time is often related to the lifetime of the bearing, and consequently to the whole mechanical system.

Approach:

A dual experimental/numerical approach is proposed.

An exploratory experimental study at LaMCoS showed different responses of the EHD lubricated contact to a sudden stop of lubricant supply, depending on the velocities of the surfaces, their nature and roughness, etc. Friction and contact electrical resistance have been measured. Film thickness variation and surfaces analysis would ideally complete this campaign with dedicated tribometers at LaMCoS.

On the other hand, a multiphysics numerical modeling of EHD contacts based on Finite Element Analysis has been extensively used since more than 15 years in LaMCoS, allowing to predict with success film thickness, friction, temperature fields in both solids and lubricant. Recently extended to starved steady-state contacts (with smooth surfaces), it will provide precious information on the impact of transient starvation condition at the inlet on the EHD contact.

Objectives:

The goal of this project is to provide the best indications on how long an EHD lubricated contact could afford to work while a variable amount of lubricant is available at the contact inlet (as, for example, a sudden stop of lubricant supply). This would probably depend on inertial effects, surfaces wettability, and probably other parameters not yet identified. The information provided by the numerical model at the scale of the contact with smooth surfaces (film thickness profile, temperature field, etc.) would provide information to a microscale model implemented by SKF, considering roughness effects.

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