PRESSURE ANALYSIS IN POINT CONTACT FOR ELASTOHYDRODYNAMIC LUBRICATION

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ABSTRACT

The issue of failure in elastohydrodynamic has been investigated by many researches. In this study, numerical approached is used to determine the deformation of the disc and its effect to the pressure distribution. Two numerical software were used is sequential manner. The shear stress on the disc was also found to shift closer to the inlet as the disc deforms, where pressure was observed to be fluctuating in the contact area.

ABSTRAK

Isu kegagalan pada pelincir *elastohydrodynamic* telah dikaji selidik dengan beberapa kajian. Dalam kajian ini, pendekatan penggunaan perisian komputer telah diguna pakai untuk mengenal pasti perubahan pada permukaan cakera dan kesannya terhadap faktor tekanan. Dua perisian telah digunakan secara rangkaian rentetan. Hasil kajian menunjukkan kesan tekanan pada permukaan dan berlakunya perubahan pada permukaan. Tegasan ricih juga didapati berubah ke kawasan berhampiran kawasan masuk, di mana tekanan juga mengalami turun naik di kawasan permukaan cakera tersebut.

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CHAPTER 1

INTRODUCTION

1.1 Background

The purpose of this chapter is to review the elastohydrodynamic lubrication (EHL) throughout twentieth century, to draw attention to topics currently under investigation and finally to consider future its direction. The foundations of fluids-film lubrication theory were established by Osborne Reynolds in 1886, following earlier experimental work on railway axle bearing by Petrov and Tower, 1883. Plain bearing technology developed rapidly in subsequent years, but attempts to explain the effective lubrication of highly stressed counter-formal conjunction, such as those in gears, on the basis of hydrodynamic principles alone remained ineffective throughout most of the first half of the twentieth century. It was recognized that the very high pressures associated with such counter-formal conjunctions would enhance the lubricant viscosity and also causes substantial local elastic deformation and that both effects might contribute to satisfactory film deformation. When such effects were individually incorporated into the analysis by various investigators (see an account of these contributions in reference [1]), both indeed resulted in predictions of enhanced film thickness, but, when considered alone, neither was found to lead to values sufficiently large to be consistent with the experimentally recognized performance of gears.

The quandary was resolved in the middle of the twentieth century for nominal line contacts when the interactive effect of pressure upon both the viscosity and local elastic deformation was found to result in spectacular increases in the predicted film thicknesses in many lubricated, highly stressed machine elements. The subject became known as 'elastohydrodynamic lubrication and it has dominated advances in the field of fluid-film lubrication in the latter half of the twentieth century. Barwell [2] reflected this view in 1970 when he wrote 'the elucidation of the mechanism of elastohydrodynamic lubrication may be regarded as the major event in the development of lubrication science since Reynolds 'own paper'.

Film thickness equations were thus available in the 1980s for the analysis and design of any highly stressed, lubricated machine element, presenting either nominal line or point contact geometries. Emphasis was focused upon film thickness, since it was necessary to ensure adequate separation of the rolling/sliding machine elements if adequate durability was to be ensured. Most of the numerical solutions considered Newtonian fluids and isothermal conditions in those early years, with a few notable exceptions, and the observed agreement between theoretical predictions and experimental measurements of film thickness, recorded principally by electrical capacitance or optical interferometry techniques, made further refinement unnecessary.

In recent years interest in power loss in tribological machine components and the overall performance and efficiency of machines has placed more attention on friction or traction in elastohydrodynamic conjunctions, rather than film thickness alone. Consideration of the influence of high shear rates on lubricant properties has led to the introduction of more realistic, non-Newtonian rheological models of the lubricant at all stages in its transit through the conjunction. Evidence of phase changes within the lubricant, with transition from fluid to glassy solid states, has also enlarged the scope of the analysis. It is now recognized that many elastohydrodynamic conjunctions operate with film thickness of nanometer rather than micrometer proportions. This has introduced further consideration of the influence of surface topography on the performance of realistic elastohydrodynamic conjunctions. Furthermore, the thin film now considered call for the introduction into the model of surface films of molecular proportions under some circumstances.

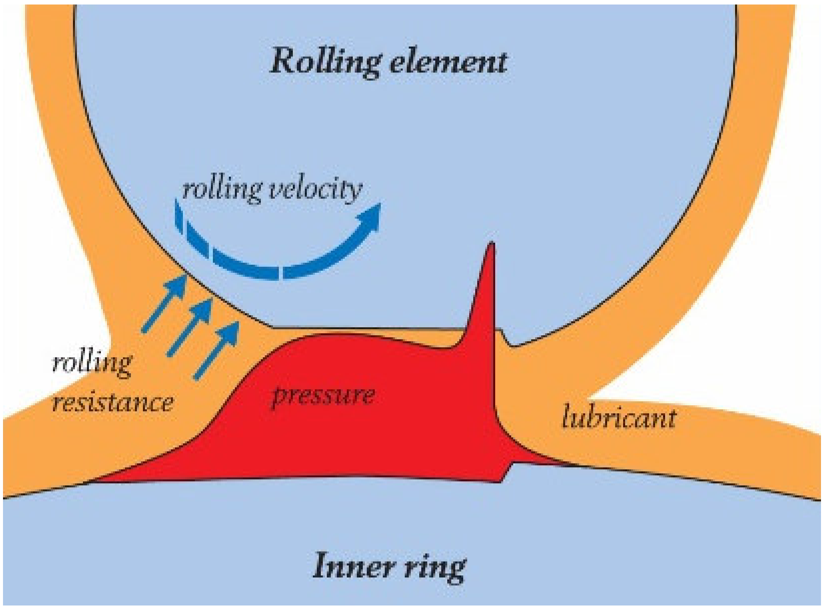

Figure 1.1: Lubricant film thickness and pressure distribution (source: Guillermo Morales Espejal, Tribology and lubrication, SKF Engineering research centre, 2006)

Lubricant film thickness and pressure distribution play an important role towards the correlation of elastohydrodynamic and surface deformation. Figure 1.1 show general ideas of lubricant film thickness and pressure distribution in an elastohydrodynamically lubricated contact. From the figure it shows that the large tail in the pressure at the inlet of the contact produces a resultant moment opposite to the rolling direction.

Continuum mechanics has served to illuminate the essential operating characteristics of many elastohydrodynamic conjunctions, but current consideration of nanometer rather than micrometer thick elastohydrodynamic films is increasingly leading to a consideration of molecular models of the interactions between the lubricant and the solid boundaries. Approaches based upon molecular dynamics and

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