Roller-End Axial Profiling and its Negative Influence on Friction in Thermal Elastohydrodynamic Lubricated Finite Line Contacts

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Roller-end axial profiling in elastohydrodynamic lubricated finite line contacts has often been viewed as a means for improving fatigue damage and wear by enhancing minimum film thickness formation. In this work, through a finite element analysis of thermal elastohydrodynamic lubricated (TEHL) finite line contacts, it is shown that though this is true, the influence on friction is negative. Profiling turns out to increase frictional dissipation in these contacts. The increase is linked to an overall pressure rise within the lubricated conjunction.

Keywords: Thermal Elastohydrodynamic Lubrication; Finite Line Contacts; Friction; Finite Elements;

1. Introduction

From the earliest experimental studies on elastohydrodynamic (EHD) finite line contacts (e.g. Wymer and Cameron [1]), it was revealed that minimum film thickness in these contacts is located at the roller ends and that it is associated with a localized stress concentration in its vicinity. Many numerical studies (e.g. Park and Kim [2]) suggested the application of roller-end axial profiling to enhance minimum film thickness and fatigue damage in such contacts. The influence of this profiling on friction has often been overlooked though. In the current work, it is shown that film thickness enhancement comes at the expense of increased frictional losses. The increased friction is linked to an overall pressure rise within the lubricated conjunction, when roller-end axial profiling is applied.

2. Methods

The full-system finite element approach [3] is extended in this work to the case of TEHL finite line contacts, to investigate the influence of roller-end axial profiling on friction.

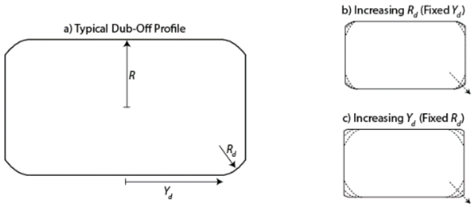

Figure 1: Employed roller-end axial profiling

Typical dub-off profiling [2] is considered, as shown in figure 1. Friction results are compared to the reference straight-roller case, to reveal the influence of roller-end axial profiling on friction.

3. Results and Discussion

Friction curves are reported in figure 2 for different dub-off profiling parameters. These reveal friction coefficient variations with slide-to-roll ratio (SRR), under constant load and mean entrainment speed conditions. As a reference for comparison, the straight-roller friction curves are also provided.

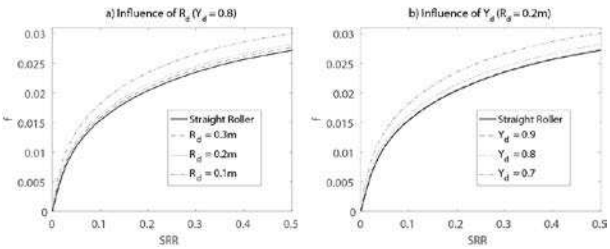

Figure 2: Influence of dub-off profiling on friction

Though roller-end axial profiling enhances minimum film thicknesses, it clearly leads to increased friction as shown in figure 2. The increased friction is directly linked to increased overall pressures within the lubricating conjunction. In fact, roller-end axial profiling leads to increased pressures in the vicinity of the roller ends, that are directly associated with the geometric gradients of the applied profiling. In addition, the latter also induces a reduction in effective contact area, which also leads to increased pressures in the central part of the contact. Also, the more minimum film thickness is enhanced, the more friction is increased. For more details, the reader is referred to [4]. Currently, a comprehensive series of numerical experiments is carried out to compare different types of roller-end profiling (i.e. dub-off, logarithmic, etc.). The objective is to find the profiling parameters that would constitute a good trade-off between surface protection from wear and friction increase.

4. References

[1] Wymer D. G. and Cameron A. – Elastohydrodynamic Lubrication of a Line Contact, *IMechE*, 1974, vol. 188, pp. 221-238.

[2] Park T. J. and Kim K. W. – Elastohydrodynamic Lubrication of a Finite Line Contact, *Wear*, 1998, vol. 223, pp. 102-109.

[3] Habchi W. - Finite Element Modeling of Elastohydrodynamic Lubrication Problems, 2018, *Wiley*, Chichester, UK, ISBN: 978-1-119-22512-6.

[4] Habchi W. - On the Negative Influence of Roller-End Axial Profiling on Friction in Thermal Elastohydrodynamic Lubricated Finite Line Contacts, *ASME Journal of Tribology*, 2020, vol. 142 (11), 111601.