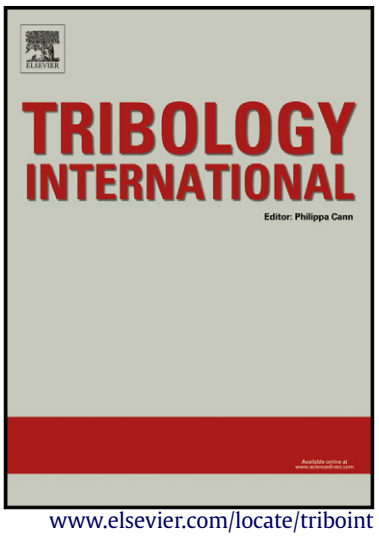

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On the elastic stress field of tilting roller pairs considering thermal elastohydrodynamic lubrication

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Abstract: A numerical solution of thermal elastohydrodynamic lubrication (TEHL) of finite line contacts for axially profiled and tilted cylindrical roller is presented. The effects of tilting angle, entrainment velocity and slide-roll ratio on the lubricating performance and the subsurface stress field have been investigated specifically from the point of view of the von Mises stress as it provides a better criterion for rolling contact failure and material damage. The results show that tilting angle, entrainment velocity and slide-roll ratio influence the pressure, temperature and von Mises stress distributions. As tilting angle increases, the maximum von Mises stress becomes larger. As entrainment velocity and slide-roll ratio change, the maximum von Mises stress changes in different routes.

Keywords: thermal elastohydrodynamic lubrication, finite line contact, tilting, von Mises stress

1. Introduction

All the rollers of cylindrical roller bearings are axially profiled to relieve high edge stress concentrations caused by their finite length and axial tilting. It is well known that the rollers and races are separated by lubricating oil films and the oil pressure distributions are entirely different from those of simple elastic contact. This difference influences the subsurface stress field and bearing fatigue life.

Since Dowson and Higginson[1] obtained the first numerical solution for the infinitely long line contact problem, elastohydrodynamic lubrication (EHL) problems of finite line contacts have been studied extensively for about five decades. Mostofi and Gohar[2] were the first to analyze numerically an EHL problem for axially profiled cylindrical rollers, but their numerical procedure was not systematic and the results near the position where the profiling starts were physically inconsistent. Park and Kim[3] successfully analyzed the same problem using a finite difference method and the Newton-Raphson method. Their numerical procedure was fully systematic and the results were physically consistent. Liu and Yang[4] and Yang and Yang[5]studied the TEHL problems for axially profiled cylindrical rollers. Recently, Park [6] and Liu et al.[7] studied the effect of roller axial profiles and tilting angle on the EHL of finite line contacts under moderate load. The results showed that the effect of tilting angle on the EHL pressure distribution is much higher than the film shapes. Liu and Yang[8] studied the effect of tilting angle and end profile radius on the pressure distribution, temperature distribution, and film thickness in TEHL problems. However, a better indicator for rolling contact failure and material damage[9-11] is the effect on the von Mises stress and its distribution, which have not been investigated. Dong et al.[12] presented a pitting life prediction model based on the subsurface von Mises stress of a three-dimensional line contact mixed EHL, which essentially is an infinite line contact; the effects of roller profile and tilting angle were not investigated. For now, most of the research on TEHL of finite line contacts for axially profiled and