



On the tribo-dynamics of lubricated point contacts: modeling and experiment

S. Li · A. Kolivand · Z. Shi · A. Anisetti

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Abstract This study proposes a modeling methodology for the description of tribo-dynamic behavior of generic point contacts, considering surface defect/failure type of excitation. A twin-disk contact set-up is developed to experimentally determine the acceleration induced by lab-controlled groove surface feature present on one of the mating surfaces. The periodic passage of this artificial surface defect through lubricated contact zone leads to contact force fluctuation, and consequently normal direction dynamic relative displacement and relative velocity of the contact bodies. These dynamic responses impact the lubrication film thickness and flow, altering the tribological performance that governs the contact force. Implementing this interaction loop between dynamics and tribology, the computational simulations are shown to be able to yield fairly accurate predictions in comparison to the measured acceleration signals.

Keywords Point contact · Dynamics · Tribology · Surface defect · Surface failure

S. Li (✉) · A. Kolivand · A. Anisetti
Department of Mechanical and Materials Engineering,
Wright State University, 3640 Colonel Glenn Highway,
Dayton, OH 45435, USA
e-mail: sheng.li@wright.edu

Z. Shi
Department of Mechanical Engineering, University of
Cincinnati, 2600 Clifton Ave., Cincinnati,
OH 45221, USA

1 Introduction

Dynamic responses, such as noise and vibration, are common in applications of high-speed rolling mechanical elements (gears and bearings for instance), whose cyclic contact actions are deemed to be the main sources of excitations [1–7]. From an interdisciplinary point of view, dynamic vibration has been shown to have large influence on tribological performance occurring at the interface of contacting components, including fluctuating normal force and lubricant viscosity [8, 9]. Although the physical interactions between tribology and dynamics are evident and substantial [9], a majority of works in the literature focused on only one way of impact. In the early 80s of last century, Wang and Cheng [10] numerically evaluated the thermal elastohydrodynamic lubrication (EHL) solutions of spur gear contacts subject to dynamic tooth force. Considering both normal and tangential vibrations, Yang et al. [11] investigated the responses in terms of lubrication film thickness, pressure, and temperature of a line contact. Both studies assumed perfectly smooth surfaces. Including surface roughness effects, Mohammadpour et al. [12] examined friction and efficiency of planetary gear systems through mixed thermal EHL analyses under dynamic condition. Joining a lumped parameter vibratory model to EHL governing equations, Li and Kahraman [8] demonstrated the unique transient gear EHL behavior under nonlinear dynamic

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