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Friction in lubricated soft-on-hard, hard-on-soft and soft-on-soft sliding contacts

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Abstract

Friction in lubricated soft contacts is examined using a ball-on-disc tribometer with the focus on the effect of configuration. In the soft-on-hard and hard-on-soft configurations, one of the contact-pair members is soft while the other one is hard. In the soft-on-soft configuration, both members are soft. For a soft disc, time-dependent viscoelastic deformations contribute to friction. Upon correction for the hysteretic losses, estimated using a theoretical model, the friction coefficient in the full-film regime does not depend on configuration. This holds also for high loads, when the deformations are finite. The combined effect of configuration and surface roughness on the transition from the full-film to the mixed lubrication regime is also examined.

Keywords: soft-EHL, mixed lubrication, surface roughness, finite deformation

1. Introduction

Lubricated contact of soft matter has recently become the topic of active research in engineering and biotribology. The respective engineering applications, such as elastomeric seals [1] and windscreen wipers [2], typically involve polymeric materials that are usually characterized by complex viscoelastic rheology. Even more complex material behaviour is encountered in soft tissues and biomaterials which are the members of biotribological soft contacts, such as synovial joints [3], soft artificial joints [4], eyelid wiping [5], contact lens lubrication [6], human skin contact [7], and others. The biotribological contacts may also involve non-Newtonian fluids, which introduces additional complexity and affects the tribological performance [8]. Lubricated soft contacts constitute thus one of the challenges for the modelling and simulation in tribology [9]. The soft solids themselves also attract a significant interest due to important applications, such as those in soft robotics [10] and stretchable electronics [11], as well as due to the related complex material and structural behaviour [12–14].

When the material is soft, i.e. highly compliant, a relatively small stress may cause large deformation of the solid. The related finite-deformation effects are not included in

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