PLASTIC DEFORMATIONS AND WEAR OF REAL CONTACT SURFACES IN HIGH PERFORMANCE MACHINES

Sören Andersson
Department of Machine Design, KTH,
SE 100 44 Stockholm, Sweden

Keywords: Plastic deformations, real surfaces, initial contact, wear, high performance machines.

ABSTRACT

Real surfaces of high performance machines are always somewhat rough, although they may seem very smooth. When such surfaces are brought together, they become first elastically and then plastically deformed and thereafter elastically deformed and worn. The main difficulty today is to predict the initial plastic deformations, since we at KTH Machine Elements in Stockholm have a long experience of mild wear predictions or simulations.

Previous experiments at KTH Machine Elements in Stockholm [1] and Imperial College in London [2] indicate that the initial plastic deformation of rough contact surfaces is mainly determined by the macro form of the contact bodies. As the initial plastic deformation may be strongly dependent on the shear in the contact, some contact surfaces were subjected to complementary sliding deformation testing [3]. The plastic deformation of the asperities remained marginal as long as the running conditions were mild; the plastic deformation of the whole contact, however, was as noticeable as in the case of a pure normal load even if the surfaces were rather hard (case hardened). The contact situations were also analyzed. Loaded contacts were namely simulated using nonlinear elastic surface elements in a commercial FE program [4]. The simulated and experimental results were compared. The final contact stresses can after the FE simulation be determined by BE simulation using a previously developed program [5] and data or form of the contacting bodies from the FE simulation. The contact stress distribution can then be used in the subsequent wear simulation [6]. By this approach we can predict the initial deformations as well as the mild wear of the contact surfaces in most high performance machines.

References

1. Björklund S., Salas-Russo E. (1991) The influence of surface roughness on the plastic deformation of a ball indentation. In: Andersson S. (ed),Surface Mechanics. TRITA MAE 1991-5.
2. Lee-Prudhoe I., Sayles R.S., Kaderic A. (1999) Investigations into asperity persistence in heavy loaded contacts. ASME Journal of Tribology, 21, 441–448.
3. Sjöberg S., Sundh J. (2009) Scuffing resistance of gear surfaces: influence of manganese phosphate and lubricants. Proceedings of ECOTRIB 2009, 2nd European Conference on Tribology, 7–10 June 2009, Pisa, Italy.
4. Sellgren U., Björklund S., Andersson S. (2002) A finite-element model of normal contact between rough surfaces. Wear, 254, 1180–1188.
5. Björklund S., Andersson S. (1994) A numerical method for real elastic contacts subjected to normal and tangential loading. Wear, 179, 117–122.
6. Andersson S. (2008) Wear simulation with a focus on mild wear in rolling and sliding contacts. Friction, wear and wear prediction, 9-11 April 2008, Aachen, Germany.