A MODEL TO PREDICT THE FRICTION FORCES GENERATED DURING SKIING ON ARTIFICIAL SKI MATTING

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KEYWORDS

Friction; Modelling in tribology; Everyday life tribology, skiing

ABSTRACT

Skiing is a popular pastime and competition sport enjoyed by amateurs as well as professionals across the globe. While many people ski, access to snow is limited in many countries. This issue is commonly addressed through the use of specially prepared artificial matting which can provide a skiing surface in warmer climates when it is lubricated with water.

The sliding contact is formed between the ski base and an ensemble of matting fibres in which each individual fibre may operate in one of several contact modes. Each of these modes gives rise to a different contribution to the overall friction force resisting sliding of the ski. Contact modes are considered to be either: dry contacts (leading to contributions to friction due to adhesion or abrasion) or water film lubricated contacts. The ends of the fibres are rounded, as illustrated in figure 1. Consequently, the presence of water precipitates liquid film lubrication on some of the fibre tips leading to contributions to friction due to viscous shear. (An additional contribution to friction is also due to elastic deformation at each fibre to ski interface.) The total friction, F_T, at the interface due to contact at each fibre can, therefore, be represented by a multi term equation of the form:

$$F_T = N\,(Af_{ab} + Bf_{ad} + Cf_{lub} + Df_{\mathrm{def}})$$

Where: *N* is the total number of fibres in the contact, $f_{ab}$and f_{ad}, are the friction forces due to one fibre in either abrasive or adhesive contact, f_{lub} is the friction force due to one fibre in fluid lubricated contact and f_{def} is the friction force due to elastic deformation caused by a single fibre contact. *A*, *B*, *C* and *D* are the proportions of the fibres at the interface operating in each contact mode. A multi-term model, based on this principle has been developed to predict friction at the ski to matting interface.

The model includes the use of appropriate elastohydrodynamic (EHD) equations to allow an estimation of lubricating film thickness and the friction forces arising due to water film shear at lubricated contacts. (Established using an EHD regime map.) It also incorporates equations to describe the adhesive and abrasive contact friction components along with the contribution to power loss arising from the work required to overcome elastic deformation at fibre contacts.

The model is used to predict overall friction between samples of ultra-high molecular weight polyethylene, a material commonly used for ski bases, sliding against typical matting fibres. This data is compared to previously published experimental data for friction at this interface over a range of sliding speeds from about 5 km hr^{-1} to 25 km hr^{-1} [1]. Using this approach, an attempt is made to estimate the likely relative contributions to the overall friction force due to the differing proportions of fibres in fluid lubricated and dry contact, thus permitting friction forces during skiing on artificial matting to be estimated as a function of matting design parameters.

REFERENCES

[1] Ibáñez Campo, J. and Sherrington, I. Tribologica 23 (2004) pp 37 – 44.