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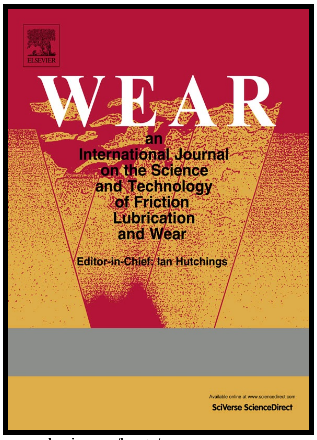

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Anisotropic friction and wear rules with account for contact state evolution

Z.Mróz[1)], S.Kucharski[1)], I.Páczelt[2)]
1) Institute of Fundamental Technological Research, Warsaw, Poland
2) University of Miskolc, 3515 Miskolc Egyetemváros, Hungary

Abstract. The present study is related to analysis of coupled friction and wear process in sliding along, the rough surface with an anisotropic asperity pattern characterized by single or mutually orthogonal striations. Due to wear process the initial anisotropic response evolves with the variation of asperity distribution, tending to a steady-state pattern. The orthotropic friction sliding model and the related wear rule are analytically formulated assuming evolution of contact anisotropy to its steady state. The orthotropic frictional sliding model and the related wear rule are analytically formulated assuming evolution of contact anisotropy to its steady state. The experimental study is next presented for orthotropic asperity patterns induced on steel plate surface. The transient and steady states are characterized and the respective evolution parameters calibrated. The numerical finite element wear analysis aimed at validation of model-predictions and wear parameter calibration is presented at the end of paper.

Keywords: anisotropic contact, friction sliding and wear rules, evolution of contact anisotropy, experimental study, numerical wear analysis.

1. Introduction

Modelling and prediction of wear in sliding or fretting contact conditions is fundamental for assessment of service life of machine or structural elements. The extensive research has been conducted in formulating wear models for different contact conditions and in developing effective numerical procedures within finite element and boundary element formulations. The extensive literature review was presented in the recent paper by Rodriguez-Tembleque et al [5] with emphasis put on the boundary element method applied to wear modeling for both isotropic and anisotropic contact conditions, cf. [6,7]. Similarly, the finite element method was applied in numerous papers, cf. for instance [4, 8, 10, 13, 15, 18], where the reference to literature can be found.

The Holm-Archard wear rule $V_w = \tilde{k}_w P_n s / H$ relating wear volume V_w to normal load P_n, sliding distance *s*, hardness of contacting surfaces H, $(1/H = 1/H_1 + 1/H_2)$ and the non-dimensional wear coefficient $\tilde{k}_w$ was usually applied in the wear analysis. An alternative form applicable to both transient and steady state processes relates the local rate of wear depth h_w to contact pressure p_n and relative sliding velocity v_r, thus $\dot{h}_w = k_w p_n v_r$, where $k_w = \tilde{k}_w / H$. To account for friction effect, the wear rate is related to the friction shear stress $\tau_n = \mu p_n$ developed in sliding condition, so we can write

$$\dot{h}_w = k_f \tau_n v_r = k_f \dot{D}_f = k_f \mu p_n v_r = k_w p_n v_r \qquad (1)$$

where $\dot{D}_f$ is the frictional dissipation rate, μ denotes the friction coefficient and k_f is the dimensional wear coefficient, $k_w = k_f \mu$. The form (1) is convenient for generalization of wear rule to the case of anisotropic friction. Let us note that contact parameters were usually assumed as fixed in the analysis wear processes. The non-linear dependence of wear rate on contact pressure and sliding velocity was assumed in some papers, cf. [4,8].

The anisotropic friction effects occur in many cases important for engineering applications. The surface roughness of metal elements after most machining operations