Advances in Tribology
Volume 2008 (2008), Article ID 214894, 17 pages
doi:10.1155/2008/214894

Research Article

A Model of the Transient Behavior of Tractive Rolling Contacts

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Received 19 September 2007; Accepted 6 February 2008

Recommended by Mihai Arghir

Abstract

When an elastic body of revolution rolls tractively over another, the period from commencement of rolling until gross rolling ensues is termed the prerolling regime. The resultant tractions in this regime are characterized by rate-independent hysteresis behavior with nonlocal memory in function of the traversed displacement. This paper is dedicated to the theoretical characterization of traction during prerolling. Firstly, a theory is developed to calculate the traction field during prerolling in function of the instantaneous rolling displacement, the imposed longitudinal, lateral and spin creepages, and the elastic contact parameters. Secondly, the theory is implemented in a numerical scheme to calculate the resulting traction forces and moments on the tractive rolling of a ball. Thirdly, the basic hysteresis characteristics are systematically established by means of influence-parameters simulations using dimensionless forms of the problem parameters. The results obtained are consistent with the limiting cases available in literature and they confirm experimental prerolling hysteresis observations. Furthermore, in a second paper, this theory is validated experimentally for the case of V-grooved track.