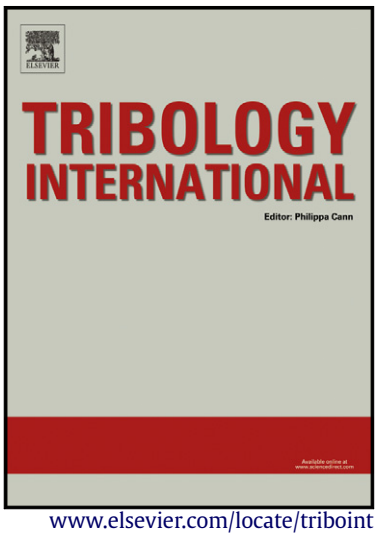

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COMPUTATIONAL MODEL FOR FRICTION FORCE ESTIMATION IN SLIDING MOTION AT TRANSVERSE TANGENTIAL VIBRATIONS OF ELASTIC CONTACT SUPPORT

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Abstract

The main purpose of this work has been to develop a dynamic computational model for analysing the influence of transverse tangential vibrations on friction and driving forces in a sliding motion in the case when vibrations are imposed not directly onto the sliding body but are transferred to it from a vibrating support. This model is applicable to perfectly elastic contacts. For the friction force description, the dynamic friction models were used. Considered also was compliance of the drive system. The outcomes of simulating analyses carried out with the use of this model, implemented in Matlab/Simulink environment, were compared with results of experimental investigations conducted on a novel, in-house designed test rig. Excellent consistency of experimental results with those from simulating analyses was achieved. The mechanism of friction force reduction in sliding motion under the influence of transverse tangential vibrations was explained.

Keywords: transverse vibrations, friction force reduction, modelling

1. Introduction

The phenomenon of friction force reduction under the influence of vibrations is known and utilized by human for years. However, its mechanisms at both, micro- and macro-scale are not yet fully known and described. A relatively ample body of publications can be found in literature describing theoretical analyses and experimental investigations on the influence of longitudinal tangential vibrations and those normal to the sliding surface on the friction force at a macro-scale. It has been found there that longitudinal tangential vibrations exert significantly greater influence on the friction force than the normal ones. [1]. Relatively poor, however, is the literature on the influence of transverse tangential vibrations on the friction force. With regard to these vibrations a thought prevails (Matunaga and Onoda [2], Storck, Littmann, Wallaschek and Mracek [3], Kumar and Hutchings [4], Tsai and Tseng [5]) that the reduction of friction resistance arises from cyclic changes of friction force vector under the influence of vibrations. According to these thoughts, a variable vector of relative velocity of sliding causes oscillations of the friction force vector around the sliding direction resulting in a sub-division of this force into two components one of which is parallel whilst the other, perpendicular, to the direction of motion. Consequently, only a portion of friction force is acting in the direction of motion. Hence, the observed reduction in the driving force acting in this direction, taking place after the occurrence of transverse tangential vibrations in the area of contact of the sliding body and support.