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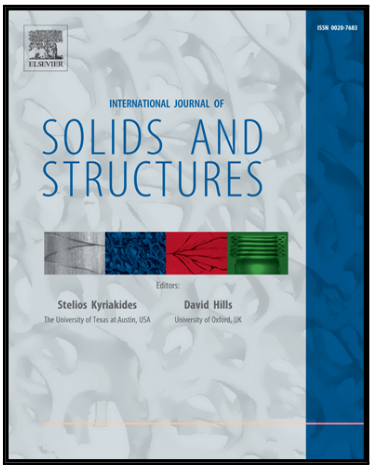

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Friction of Extensible Strips: An Extended Shear Lag Model with Experimental Evaluation

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Abstract

The role of effective axial compliance on the frictional response of extensible strips is investigated, both experimentally and theoretically. A translational actuator pulled a steel sled resting on top of an elastic strip on a glass substrate, while the strip was only bonded to the leading edge of the sled. The friction force and local deformation along the length of the strips were measured using a force sensor and a camera, respectively. By increasing the effective axial compliance of the strip, the static friction force was found to decrease dramatically, while the kinetic friction force increased significantly. For sufficiently soft strips, there was no observable static peak, although there was a slope change in the force-displacement curve at the point where progressive slippage initiated at the leading edge. Possible mechanisms for permanent increase in the kinetic friction are discussed that could be implemented in the systems where the kinetic friction is of significant importance. A theoretical model, somewhat analogous to an extension of the classical shear lag model to incorporate elastic-plastic interlayers, is proposed to predict the friction response as a function of effective compliance. The results obtained from the theoretical model are compared with experimental results and shown to be in good agreement. This study provides a better understanding of the effect of axial compliance on the frictional response of materials, paving the way for design and optimization of systems where the static and kinetic friction forces play an important role.

Introduction

Friction is ubiquitous in daily life, playing an important and often essential role in many natural processes as well as engineered technologies such as tires, brakes, rubber seals, conveyer belts, and footwear. The coefficient of friction (COF) of a pair of materials has often been considered as a constant, according to Coulomb's friction law. However, more detailed studies have shown that the COF of a pair of materials depends on roughness [1-3], normal load [4-8], sliding