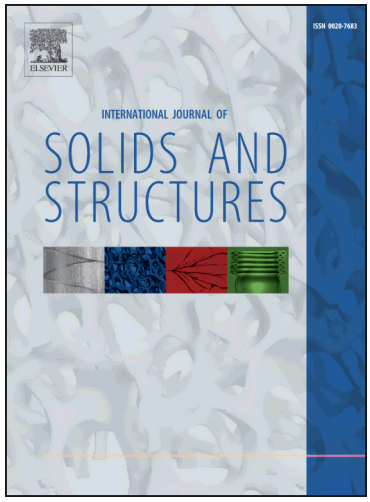

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An Analytical Elastic Plastic Contact Model with Strain Hardening and Frictional Effects for Normal and Oblique Impacts

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Abstract

Impact between metallic surfaces is a phenomenon that is ubiquitous in the design and analysis of mechanical systems. To model this phenomenon, a new formulation for frictional elastic-plastic contact between two surfaces is developed. The formulation is developed to consider both frictional, oblique contact (of which normal, frictionless contact is a limiting case) and strain hardening effects. The constitutive model for normal contact is developed as two contiguous loading domains: the elastic regime and a transitionary region in which the plastic response of the materials develops and the elastic response abates. For unloading, the constitutive model is based on an elastic process. The normal contact model is assumed to only couple one-way with the frictional/tangential contact model, which results in the normal contact model being independent of the frictional effects. Frictional, tangential contact is modeled using a microslip model that is developed to consider the pressure distribution that develops from the elastic-plastic normal contact. The model is validated through comparisons with experimental results reported in the literature, and is demonstrated to be significantly more accurate than 10 other normal contact models and three other tangential contact models found in the literature.

Keywords: Contact Mechanics, Constitutive Behavior, Elastic Plastic Material, Indentation and Hardness, Friction

1. Introduction

Contact between features with moving parts is a phenomenon pervasive in most mechanical designs. Impact phenomena are particularly salient in applications involving chatter (Cusumano

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