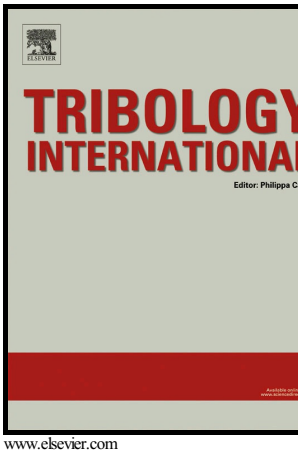

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A Comprehensive Study of the Elasto-Plastic Contact of a Sphere and a Flat

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Abstract

In this paper the frictionless contact of an elasto-plastic sphere with an elasto-plastic flat has been studied. Previously, elasto-plastic contact has been studied mostly for either the isolated flattening or indentation cases. This work analyzes the case in between these, where both surfaces deform elasto-plastically. It has been shown that the deformation on both objects has a significant effect on the real area of contact and the contact force. The ratio between the yield strengths of the sphere and the flat has been defined as a major governing factor. FEM analysis has been performed for more than 400 cases, and a comprehensive formulation has been developed based on the FEM results in order to predict the contact parameters.

Keywords: Elasto-Plastic Contact, Contact Area, Contact Force, Yield Strength Ratio.

1. Introduction

Contact between two objects is one of the most important mechanical problems that has been studied. Many analytical, experimental and numerical studies have been performed in the past in order to simulate and predict the contact properties, such as the real radius of contact, average pressure (i.e. hardness) and contact force; however, because of its complexity no closed-form solution has been provided for elasto-plastic contacts.

Hertzian theory [1] can be used for elastic contacts, but in most cases there are plastic deformations. Hertzian theory approximates the spherical surface by a parabolic one. When the contact force reaches a critical value, the stress state will start to cause yielding within the sphere. Many numerical analyses have been performed to develop suitable models for the elasto-plastic contact, but each of the models is accurate only in a small range of material properties or initial conditions. To simplify the problem, in most of the models the contact between a sphere and a flat has been modeled. Contact models can be divided into two main groups [2], the indentation models and the flattening models. In the flattening models, the flat has

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