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Surface mechanics induced stress disturbances in an elastic half-space subjected to tangential surface loads

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Abstract

To better understand the impact of surface stress effects on frictional contact mechanics, a three-dimensional stress analysis is presented for an elastic half-space subjected to arbitrarily distributed shear tractions in a circular portion of its plane boundary. The method of Boussinesq displacement potentials is used to address the problem, where local elastic field including displacements and stresses right on the loading surface is semi-analytically determined by solving a set of integral equations. Numerical results are presented to examine effects and the stress disturbances caused by the coupling of surface loads and surface mechanics. The results show that a metallic layer with properly designed mechanical behavior coated on the free surface of a half-space substrate of even the same material can function as a stiffener and stress reliever. Surface stress effects also result in unexpected rise of adhesive forces near the loading perimeter, although the traction loads are purely tangential. The results suggest a means of optimizing the local displacements, strains and stresses by controlling the material properties of the half-space boundary.

Keywords: Surface mechanics, Half-space, Surface load, Stress analysis, Cerruti's problem

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