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Modelling coupled normal and tangential tractions in adhesive contacts

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Abstract

This paper presents a nanoscale-inspired continuum model to capture the coupling of adhesion and friction in contact-mechanics problems. The method relies on Green's function molecular dynamics to calculate the elastic body fields and on a phenomenological mixed-mode coupled cohesive-zone model to describe the interplay between normal and tangential tractions, i.e., adhesion and friction. While the presented formulation is applicable to linearly elastic solids with generic surface roughness, the focus of our analysis is on the indentation of an array of circular rigid punches into a flat, deformable solid. Our results show that the coupling between adhesion and friction leads to an increase in the contact size and a decrease in the pull-off load.

Keywords: adhesion and friction; tribology; contact area; pull-off load.

1 Introduction

The idea that adhesion and friction affect each other is generally attributed to Desaguliers (1734) [1]. However, it was Bowden and Tabor (1950) [2] who turned this idea into a principal part of their theory of friction. To gain a better understanding of the interplay between adhesion and friction, Savkoor and Briggs [3] applied tangential loading to a rubber hemisphere in an adhesive contact with a glass plate. From this experiment, they concluded that as a result of increasing the tangential force, the adhesive forces be-

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