Contact between deformable solids with coupled interfacial interactions

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ABSTRACT

The elastic contact between two deformable bodies is usually simplified to rigid body indentation into a deformable body. Nevertheless, this simplification is only valid when lateral displacements are negligible or the analysis is restricted to frictionless contact conditions.

Here, we extend a recently developed modelling technique, Green's function molecular dynamics [1], to study the interplay of normal adhesion and frictional properties in the contact between two deformable bodies. In this technique, the surfaces of the solids are modelled by considering only equi-spaced super-atoms, which interact with each other through effective stiffness. Advantages of this method are its speed, being orders of magnitude faster than the finite element method, and the simplicity with which the contact conditions can be implemented. In order to model the interfacial interactions, the coupled “cohesive zone” relation of McGarry et al. [2] is employed. This method has the advantage that it is able to provide a correct response under conditions of mixed-mode over-closure. However, employing the earlier mixed-mode methods, e.g. Xu and Needleman [3], in indentation-induced problems results in a decrease in the value of tangential traction with increasing over-closure, which is a non-physical behaviour

The effect of friction on the contact area evolution and load carrying capacity is presented. Moreover, the applicability of the JKR model [4] for predicting the pull-off force under frictional contact conditions is studied. Besides, the effect of the interplay between normal adhesive and frictional forces on the relation between pull-off force and work of adhesion is investigated.

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