EFFECT OF PARTICLE ROUGHNESS ON THE BULK DEFORMATION USING COUPLED BOUNDARY ELEMENT AND DISCRETE ELEMENT METHODS

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Abstract

Particles slide and roll on each other when a granular material is sheared. Consequently, the tribological properties such as inter-particle friction and adhesion play a major role in influencing their bulk failure and rheology. Although the influence of roughness on adhesion and friction of contacting surfaces is studied in the tribology community, there are still big unanswered questions about their effect on friction and wear, particularly for non-conforming contacts as relevant to particulate solids in this work. Numerical modelling of particulate systems by Discrete Element Method (DEM) has been developed extensively in the last few years with more focus on the numerical efficiency and incorporation of accurate contact laws, whilst less attention has been given to the effect of roughness on the particle-particle interactions. In this work, a novel coupling scheme has been used in which two modelling frameworks of Boundary Element Method (BEM) and DEM are combined to model the interactions of rough non-conforming surfaces. A BEM code, developed in-house, is employed to calculate the normal force-displacement for rough contacts, based on which a semi-analytical contact model is proposed. This is an efficient and relatively fast method of calculating the contact mechanics of rough surfaces. The resulting model is then implemented in the simulations by DEM to determine the effect of micro-scale surface roughness on the bulk compression of granular materials. This study highlights the importance of the effect of surface characteristics on contact behaviour of particles for the case of penetration of a footing into a granular system and provides an efficient approach for modelling the flow behaviour of a large number of rough particles.

Keywords: Contact mechanics, Numerical modelling, Discrete Element Method, Boundary Element Method.

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