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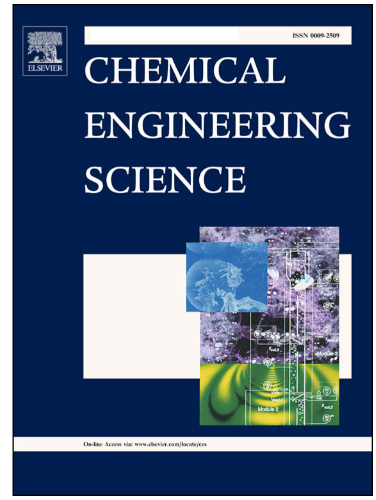

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Evaluation of contact force models for discrete modelling of ellipsoidal particles

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Abstract

Discrete element method (DEM) has been widely used to study granular materials. However, how to model non-spherical particles is still challenging. Ellipsoidal particles are a typical kind of non-spherical particles in DEM simulations. There are three common methods to calculate the overlap and contact force between two ellipsoidal particles, namely, geometric potential (GP), common normal (CN) and overlap region (OR) methods. These methods are based on different physical concepts and hence will give different results. However, the comprehensive evaluation of these methods is still lacking, leaving DEM users no solid reference for selecting algorithms. In this paper, we conduct detailed comparisons on the penetration depth, contact plane and contact point predicted by the three methods. Particularly, using the orientation discretization method, the results are compared in all orientations quantitatively. It is shown that the difference between GP and CN is the largest whereas OR is always in between. The difference in contact point is relatively small when overlap ratio is small, whereas the difference in contact plane can always be large. Further, the results are directly compared to those obtained from sub-particle scale finite element analyses, which reveals that CN can always accurately predict contact plane and most times contact point, while GP are relatively better in predicting force magnitude. This study not only gives a more clear and comprehensive evaluation of different contact force models for ellipsoidal particles but also establishes an effective framework for comparing and verifying contact force models for general non-spherical particles.

Keywords: discrete element method; finite element method; computational powder technology; non-spherical particles; contact force.