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Quantifying errors due to the Hertzian contact model in multi-sphere Discrete Element Modelling simulations

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In Discrete Element Modelling (DEM), non-spherical particles are often emulated using clusters of rigidly connected spheres that can be either overlapping or not. Within this multi-spherical approach, two sources of error can be identified. One is due to the difference between the true particle shape and the multi-spherical approximation; the other arises from the contact model used in the DEM simulations. The potential for inaccuracy in multi-sphere DEM simulations is well known [1, 2]. However, for a DEM simulator it remains unclear what error might be expected when multi-sphere particles are adopted. This contribution focuses on the role of the contact model as a source of error for the special case of two-sphere particles.

Considering a single multi-spherical rod consisting of two identical spheres and quasi-statically compressing it until a total of 5% strain has been applied, the force response obtained through Finite Element Analysis (FEA) was compared against the Hertzian contact model. The process was repeated for spheres with varying degrees of overlap, ranging from 0 to 100%, and the relative errors of the FEA models against the Hertzian contact model were calculated.

Up to a 60% sphere overlap, Hertz underpredicts the normal contact forces beyond 0.5% strain, where the disparity between the FEA model and Hertz forces is increasing monotonically with strain. However, beyond an overlap of 70%, Hertz overpredicts the normal contact forces with the sphere overlap being the main driver of this deviation. Future research will involve comparing these errors with the 'shape' source of error by compressing perfect spherocylinders, considering rods composed of more spheres, and investigating how the error is affected by the relative orientation of two contacting particles.

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