Formulation and modelling capabilities of the discrete element method with deformable particles

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ABSTRACT

An original formulation of the discrete element method with deformable cylindrical or spherical particles will be presented. The concept of the new method, called the deformable discrete element method (DDEM) has been introduced by the authors in [1]. It is assumed that the particle deformation is composed of the global and local deformation modes. The global deformation mode is evaluated assuming a uniform strain and stress in the particles. The stress is evaluated in terms of the contact forces acting on the particle using the averaging procedure over the particle volume. The particle strains are obtained via the inverse constitutive relationship from the averaged particle stress. The linear elastic material model is assumed for the particle global deformation mode. The deformed shape (global deformation) of the particle is obtained by an integration of the particle strain. The local deformation modes are assumed at contact zones, and they are represented by the overlaps of the globally deformed particles. The normal contact forces are determined as functions of the overlaps.

The particle deformability leads to formation of new contacts and yields a nonlocal contact model. An accurate computation of the contact forces would require an iterative solution of the implicit relationship between the contact forces and particle displacements. In order to preserve efficiency of the DEM, the new formulation has been adapted to the explicit time integration. Numerical properties of the solution algorithm has been studied extensively in [2].

It will be shown that the proposed method enhances modelling capabilities of the discrete element method. The nonlocal contact allows us to better represent interaction of particles, it changes the distribution of contact forces in the particle assembly and gives more flexibility in reproducing a macroscopic response of the particulate material. It has been shown in [1] that the DDEM allows to extend the range of the Poissons ratio which can be reproduced in the DEM.

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