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ENHANCED WAVE PROPAGATION MODELLING CAPABILITIES OF DISCRETE ELEMENT METHOD USING DEFORMABLE ELEMENTS

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It will be shown that the capabilities of discrete element method (DEM) for modelling elastic wave propagation phenomena can be enhanced by using deformable particles. For this purpose, a novel method is used which treats the particle deformability in a simplified way such that the efficiency of the DEM is preserved with only a minor increase in computational cost. This new method is known as the deformable discrete element method (DDEM) [1].

In DDEM, it is assumed that the particle deformation consists of a global and a local deformation mode. The global deformation mode is determined assuming a uniform strain in the particle. The particle strain is instigated by the volume-averaged stress which itself is generated by the contact forces acting on the particle. The inverse constitutive relationship is employed to obtain particle strain from the averaged particle stress. The linear elastic material model is considered 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 assumed at contact zones are represented by the overlaps of the globally deformed particles and the normal contact forces are determined as functions of these overlaps.

It has been shown that the DDEM improves the modelling capabilities of the DEM. Deformability of particle yields a nonlocal contact model in a sense that the contact interaction at one point influences the contact interaction at another point of the particle. It leads to evolution of new contacts, which changes the distribution of contact forces in the particle assembly and consequently affects the macroscopic response of the particulate material. Specifically, it allows to broaden the spectrum of the Poissons ratio which can be reproduced in the DEM, which is an important parameter for instance in problems of wave propagation.

The performance of the DDEM will be demonstrated by simulations of elastic wave propagation phenomena. An elastic solid bar discretized with bonded cylindrical elements of non-uniform particle size will be used. By using various possible combinations microscopic elastic parameters, it will be shown that appropriate consideration for particle deformation can allow to better reproduce the ratio of compressional to shear wave speed, which is dependent on macroscopic Poisson's ratio of the discrete system [2].

References

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