Discrete and finite element co-simulations

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ABSTRACT

The possibility of coupling discrete element method (DEM) and finite element analysis (FEA) simulations is particularly attractive in order to model contact between granular matter and soft bodies. The coupling takes place at the surface of a body which is in contact with the granular material. The nodes of the surface mesh are shared by the DEM and the FEA code. In the simplest scheme, both codes use the same integration time step. The DEM code sends node forces to the FEA software which sends node displacements back in return. The displacement affects the granular material in contact which again causes changes of the node forces.

The representation of the contact surface within the DEM software can be done in two generic ways. On the one hand, a spherical DEM particle can be placed on every node of the surface. This requires a surface mesh with very little variation in element edge length. The particles representing the surface interact with the freely moving DEM particles using the defined force laws. The only difference between both kinds of particles is that the surface particles are moved according to the displacements received from the FEA software while the other particles are propagated according to the integration of Newton's equation of motion within the DEM code. Two types of artifacts are inherent to this surface representation method. The surface has a certain geometrical roughness and holes in the surface appear if the distance between neighboring nodes becomes larger than the particle diameter.

On the other hand, a surface triangulation can be used within the discrete element code which does not suffer from the aforementioned artifacts [1]. For this approach, the force laws have to be modified in order to capture the correct physics of a collision between a sphere and a plane (or edge or corner, respectively).

The implementation of such a co-simulation scheme has been realized using the DEM code SimPARTIX [2], the FEA software Abaqus and the multiphysics code coupling interface MpCCI [3]. In this presentation an overview of the coupling scheme will be given. On the basis of application examples the benefit of DEM/FEA co-simulations will be demonstrated.

REFERENCES

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