A Coupled FEM-DEM procedure for nonlinear analysis of structural interaction with particles

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ABSTRACT

The contact problem where particles and solids are involved is of great interest in the industry with many possible applications. A good approach to address these problems is the use of the Finite Element Method, which is used for the solution of the solids, and the Discrete Element Method, which turns to be a powerful tool to simulate the particles. These two methods are combined in order to inspect the effects of the contact i.e. the deformation or the wear due to friction occurring at the solids in contact with particles.

In many simulations using classical DEM the granular media has been modelled with the classical spheres which are the cheapest and most efficient element for simulating a large amount of particles [1]. Alternatives to it are the superquadrics, which permit a wide range of symmetric convex shapes [2], the Granular Element Method, which uses NURBS to represent the particles, or the use of clusters [3] or agglomeration of spheres. The last is chosen in this work since it provides great balance between shape accuracy and efficiency in terms of computational cost. Furthermore, it is the most versatile method in terms of particle shape and can naturally include angularities. The particles are treated as rigid bodies which contact detection and characterization is solved element-wise with a sphere discretization of the surfaces or overlapping in the interior of the clusters.

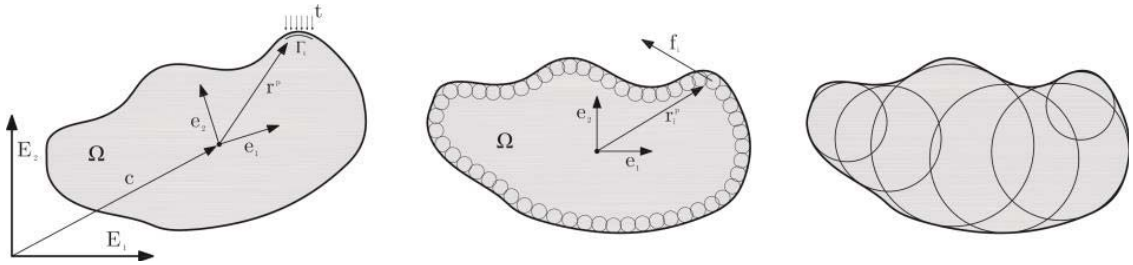

Figure 1: A generic rigid body and its discretization using a cluster approach on the surface or in the interior.

An algorithm has been developed in the open-source platform Kratos (http://www.cimne.com/kratos) that solves the contact between the Finite and Discrete Elements and calls subsequently the solid mechanics FEM based solver and the explicit rigid body dynamics solver adapted for the DEM cluster. The contact is solved in a direct way between the spheres of the rigid clusters and the triangles/quadrilaterals on the surface of the tire FEM model. The contact strategy permits having contacts of several particles with a finite element and vice versa, taking into account the non-smooth contact with edges and vertices. The approach for the contact detection used as well as the integration of the nonlinear equations of motion of the clusters treated as rigid bodies will be presented.

REFERENCES

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