A PROPOSAL OF A GRANULAR FLOW CONSTITUTIVE MODEL FOR MODELING THE SOLID/GRANULAR MATERIAL INTERACTION

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ABSTRACT

The behavior of granular flows is a function not only of the direct interaction of the granular particles themselves, but also it has a complete dependency of the boundary conditions. In order to fulfill this requirement on modeling these phenomena, it is necessary to define a proper solid-granular material interaction.

Classic contact methods for modeling this interaction – e.g. node-to-segment, segment-to-segment, mortar – require an extensive analysis of the projection of the nodes and/or segments in order to establish the potential contact between domains. Due to the large displacements and large deformations present at the boundaries during granular flows, these methodologies do not manifest robustness during the phenomena.

The contact method proposed in this work emerges in a natural manner from the Particle Finite Element Method, PFEM. This proposal has been proved robust for performing large deformation problems. The confinement boundaries and granular material interaction allows the coupling of both domains in terms of an intermediate region connecting the potential contact surfaces by a domain of the same dimension than the contacting bodies. Similar treatment is defined by the Contact Domain Method but it considers this interface as fictitious and it is solved in terms of Lagrange multipliers which present the same problems of robustness than previous methods for these simulations; in our proposal, the interface has size, *h*, and the contact conditions, normal and friction forces, are supplied via a constitutive model similar than the given for dense granular flows [1]. Taking into account the frictional and incompressible response of the proposed constitutive model for granular flow the method defines a correct representation of the wall friction angle.

A set of examples are presented herein in order to demonstrate the potential of the method. A first example allows correlating the internal friction angle of the constitutive model with the Coulomb friction coefficient. Finally, a set of numerical examples demonstrate the variability of the granular material flow behavior due to the variation of the wall friction angle between the solid, where it interacts, and the material.

References

[1] 1. Dávalos, C., et al., On the numerical modeling of granular material flows via the Particle Finite Element Method (PFEM). International Journal of Solids and Structures, 2015. 71: p. 99-125.