Simulation of granular flow problems with an implicit Material Point Method

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ABSTRACT

An implicit version of the Material Point Method (MPM)[1, 2], implemented in the Kratos Multiphysics platform [3, 4], is presented. The Material Point Method (MPM) is a particle-based technique that combines the use of a Lagrangian description of the continuum, represented by the material points, with a discretization of the computational domain, given by an Eularian grid, which in the current work is considered fixed. A formulation, which takes into account large displacement and large deformation regime, is implemented, such that non-linear problems can be tackled and accurate results can be obtained.

Unlike the Discrete Element Method (DEM), where particles represent the physical particles that compose the bulk, the material points in MPM are representative volumes of the continuum. On each material point it is possible to store the information of the material and the historical variables, characterizing the material response, without committing mapping information errors, typical of methods, which make use of remeshing techniques.

This feature of MPM makes the method particularly attractive for the resolution of problems, where more than one material is involved and where complex constitutive laws are used.

In the current work, the Material Point Method is applied to practical engineering problems, involving granular flows. Several plastic constitutive laws, defined within the soil mechanics framework, are validated with simple test cases and used for the study of granular flow in industrial and environmental problems. The numerical results are compared with available results found in the literature.

In conclusion, it is demonstrated that, if accurate constitutive laws are used, the Material Point Method is an appropriate and valid numerical tool both for the simulation of real scale cases and for the analysis and design of granular processes.

REFERENCES

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