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FINITE ELEMENT MODEL OF GRAINS/FLUID FLOWS

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We present a model to solve grains/fluid flows. Mixtures of grains and fluids occur in a large number of industrial and geophysical applications like fluidised beds, mixing, mudflows, landslides, submarine avalanches, etc.

The granular phase is solved by a contact dynamics method at the particle scales. For the hydrodynamic part, we solve the incompressible Navier-Stokes-Brinkman equations in a porous media by a finite element method. Those equations represent in a single model a continuous transition between the Darcy regime at high particle concentration and a classical Navier-Stokes flow at low concentration. At high Reynolds number, the term of Forchheimer is used to take the particle shapes into account. This approach allows the simulation of a granular phase with a large number of particles with different size, shape, and compactness.

The interactions between the grains and the fluid mixture occurs at a mesoscopic scale. The mesoscopic scale is chosen independently of the mesh resolution of the hydrodynamic problem so that the flexibility of the unstructured mesh is fully preserved. A mesh convergence analysis is performed and, thanks to a proper treatment of the coarse-graining and projection operations, the order of precision of the finite-element method is preserved.

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