PhD Position

Investigation of interactions between debris flows and obstacles through coupled DEM-SPH modelling

Project summary

Debris flows are fast flowing landslides, i.e., mixtures of coarse grains and mud. They are extremely destructive. Engineers thus regularly seek to stop them with barriers. This involves complex granular and viscoplastic fluid mechanics' interactions. So far, debris flows are modelled either with pure fluid mechanics approaches (e.g., depth-averaged models, SPH - smooth particle hydrodynamics) or with granular approaches e.g., using DEM - discrete elements modelling. This project seek to explore the process of debris flow stopping using advanced numerical models coupling DEM with computational fluid dynamics, likely SPH through the plateform DualSPHysics (https://dual.sphysics.org/).

DEM enable to capture the behaviour of coarse grains, i.e., rocky boulders transported by debris flows, while coupling it with SPH will allow, for the first time, to explore how non-Newtonian properties of interstitial fluid located between coarse grains influences the bulk dynamics of debris flows. The complex interplay between angular coarse grains of various sizes and the viscoplastic interstitial fluid during debris flow propagation and stopping remains generally poorly explored. This work will address a comprehensive exploration of:

1. How do coupled discrete element model–computational flow dynamics perform in computing debris flows propagating under regimes actually observed in the field?
2. How does the interplay between force chains within the granular skeleton and viscoplastic interstitial fluid dynamics drive the fluid–solid transition and thus the flowing and eventual stopping of debris flow surges during impact with an obstacle?

In essence, in the line of Canelas et al. (2017, *Journal of Hydraulic Engineering* 143:6017012) and Wang et al. (2016, *Natural Hazards* 81:1981–1998), this project will seek to improve coupled DEM-CFD models by incorporating non-Newtonian rheology of the fluid phase to study flow before and during impacts of debris flows against obstacles. After rigorous implementation of complex fluid rheology and solid–fluid coupling, it will enable to study in detail the fluid-solid transition at the impact and the flow behaviour near obstacles to finally provide recommendations on ways to compute these phenomena in larger-scale models, e.g., depth-averaged.

Location and practical aspects

The successful applicant will be hosted by the laboratory INRAE, center of Grenoble in the STREAM team. He/she will work under the supervision of Dr Guillaume PITON from INRAE and of Dr Vincent RICHEFEU from Laboratory 3SR.

The contract duration is 36 months, starting September or October 2020. The gross salary will be 1787 euros/months, equivalent to a net salary of 1414 euros/month.

Qualifications of the applicant

The objectives of the thesis require an initial training (engineering degree or master's degree) in mechanics of solids and fluids. In addition, paste experience or training in the field of advanced fluid and solid modelling (e.g., FEM, DEM, SPH, MPM, LBN) and/or in Python programming or equivalent would be appreciated.

Applications

Interested candidates should send their CV and cover letter (plus eventual recommendation letter) to Guillaume Piton (guillaume.piton@inrae.fr) and Vincent Richefeu (Vincent.Richefeu@3sr-grenoble.fr). Deadline for the application: June 30, 2020.

Tec 21
Laboratoire d'Excellence
+33(0)4 56 52 86 50
LEGI Bâtiment K - 1211 rue de la Piscine
Domaine Universitaire - 38 400 Saint Martin d'Hères
www.tec21.fr