Ecole Doctorale I-MEP2

PhD project
"Influence of grain properties on jumps during free-surface granular flows"

Project summary

A great number of industrial and geophysical processes involve flows of granular materials and the occurrence of discontinuities in height, velocity and density within the flows. The impact of natural granular flows on protection barriers for instance produces such discontinuities, called granular jumps by analogy to the canonical case in hydraulics. The granular jump is also regarded as a key process in the interpretation of deposits lefts by pyroclastic flows in vulcanology. Granular jumps are also observed in industrial applications that imply the transport of particles during silo discharge problems or in a pneumatic conveying system. Recent search studies demonstrated the complexity of this physical process that appears during the transition, over a finite length, from a supercritical (rapid and fast) flow to a subcritical (thick and slow) flow. Traditional equations of hydraulics to describe those jumps do not take into account the compressibility nor the energy dissipation via friction, and thus show their limits for a range of granular jump patterns. A new theoretical framework that accounts for the finite length of the jumps and their internal kinematics needs to be developed. However, the internal kinematics of jumps and their geometry, beyond the fact that they are driven by input conditions (mass discharge, slope angle), are both very dependent on the physical and mechanical properties of grains. For instance, it has been recently shown that a water-like roller appears in granular jumps when the interparticle friction is decreased below a threshold and that the particle orientation of elongated grains changes drastically across the jump. The relation between grain properties and jump features still remains poorly known. Investigating this challenging question will allow to advance the state of the art on the rheology of granular flows under well-controlled but highly non-uniform (standing jump) and transient (traveling jump) flow states. This will have a strong impact for geophysical and industrial applications where steady and uniform flows are barely encountered in practice.

Location and practical aspects

3 years PhD fellowship project, start: 1st October 2020

The successful applicant will be mainly hosted by the laboratory INRAE Grenoble in the ETNA team (Research Unit on Torrential Erosion, Snow & Avalanches). He/she will work under the joint-supervision of Dr Thierry Faug from Laboratory INRAE & Univ. Grenoble Alpes (UGA, France) and Prof. Itai Einav from the School of Civil Engineering of the Univ. of Sydney (USyd, Australia). A one year mobility of the applicant to the School of Civil Engineering will be considered under the frame of a PhD cotutelle agreement between UGA and USyd, which is a requirement to be awarded the double doctoral degree from UGA and USyd.

Qualifications of the applicant

The applicant should have preferably a formation in fluid and/or solid mechanics. It is desirable that the applicant has solid experience in experimental fluid mechanics and/or mechanical numerical modelling. More specific skills in granular physics will be beneficial but not compulsory. The applicant should feel comfortable in learning or deepening laboratory techniques using X-ray dynamic radiography applied to granular materials and numerical methods based on discrete element modelling. Finally, the applicant should be fluent in scientific English.

Applications

Interested candidates should send their CV and cover letter to:

- Dr. Thierry Faug, thierry.faug@inrae.fr (+33 4 76 76 28 28 / +33 7 88 14 54 74)
- Prof. Itai Einav, itai.einav@sydney.edu.au (+61 2 93 51 20 69)