

**Internship offer :** Particle breakage during shear of granular materials

**Lieux du stage :** Université Gustave Eiffel, IFSTTAR, Campus de Nantes, laboratoire MAST/GPEM, Allée des Ponts et Chaussées, 44344 Bouguenais, France

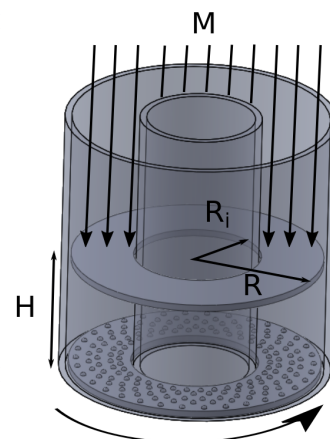
**Supervisors :** Riccardo Artoni, Patrick Richard

**Context :** Granular materials may be subject to changes in particle size distribution during transport, storage, mixing, etc. Among the different size-changing mechanisms, particle surface wear, or attrition, can be a major problem for controlling processes and applications involving these materials. In this project, we want to study from a quantitative point of view the relation between rheology and attrition in a wide range of flows, from dense to rapid, with particular attention to two aspects: (1). the effect of flow on attrition: interactions between grains (collisions, friction) if sufficiently energetic can detach small fragments; (2). the effect of fines on the flow: the presence of fines can change the flow pattern, for example by lubrication phenomena, or by damping collisions between grains.

**Project :** To do this, an experimental device aimed at studying the attrition of materials with controlled shear in a wide range of shear rates has been realized. This device is an annular shear cell where the bottom plate rotates at a controlled speed. It is developed from a previous setup (<https://doi.org/10.1017/jfm.2018.407>). A load is imposed on the upper wall. The torque needed to shear the particles is measured.

Model granular materials (glued beads, agglomerated particles) will be analysed with the shear cell. Different parameters will be varied, such as the speed of rotation, the imposed load, the height of the flow, the moisture or pre-saturation of the grains. The evolution of the particle size distribution in time and space will be evaluated by recovering the material at different levels after testing and by sieving. will be connected to the evolution of the rheology characterized by the measurements of torque and normal force, and by parallel PIV measurements via a high speed camera. The goal is to develop breakage laws and rheological constitutive laws that take into account particle breakage.

Sketch of the shear cell principle.



The internship will be carried ideally from March to August 2020 out at the Aggregates and Materials Processing Laboratory (GPEM), located in Nantes, France. GPEM is a research laboratory and is part of Université Gustave Eiffel. GPEM is a laboratory which performs fundamental and applied research on processes involving granular materials. The intern will receive a compensation of the order of 500 €/ month. Application to programs such as Erasmus+ for Traineeship is possible.

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