PhD Subject – Université Grenoble Alpes

Research Institutions Involved

Laboratoire 3SR, Grenoble

Subject

"A micro-mechanical approach to cemented granular materials"

Project description:

This doctoral work pivots around the underlying hypothesis that the **mechanical response of cemented granular materials** (*i.e.,* materials comprising a granular skeleton connected by a network of cement bridges) is driven, at the engineering scale, by the **collective response of the individual grains and cement bridges.** While this observation is generally regarded as self-evident, this is a fact **normally neglected** in the formulation of the models describing their behavior, which rely on **phenomenological** hypotheses to formulate their stress-strain relationships. While this was virtually the only viable approach when only macroscopical (sample-scale) observations were available, a number of full-field techniques, spear-headed by **x-ray imaging** have in recent times provided an unprecedented insight into the micro-(grain-)scale mechanisms driving the behavior. This wealth of data has only very recently started to be exploited in granular materials and is virtually untapped in cemented granular materials. This thesis will **acquire a unique datset** also thanks to the combined use **of neutron and x-ray** data and cast it within **numerical models** (DEM or MPM) to gather information about the inter-granular forces at play and the dissipation. This wealth of information will then be used to improve and/or **reformulate an existing micro-mechanics based constitutive model.**

In brief, this thesis will take advantage of this approach and recently available potential to:

Work package 1 – experimental (Year 1 and 2)

1) Gather a 4D x-ray (and potentially neutron) dataset on cemented granular materials under load, aimed at the quantification of the dominant processes.
2) Adopt and adapt image processing algorithms to quantify these processes. For points 1 and 2 it will be possible to start from the developments of one of the supervisors (Tengattini)

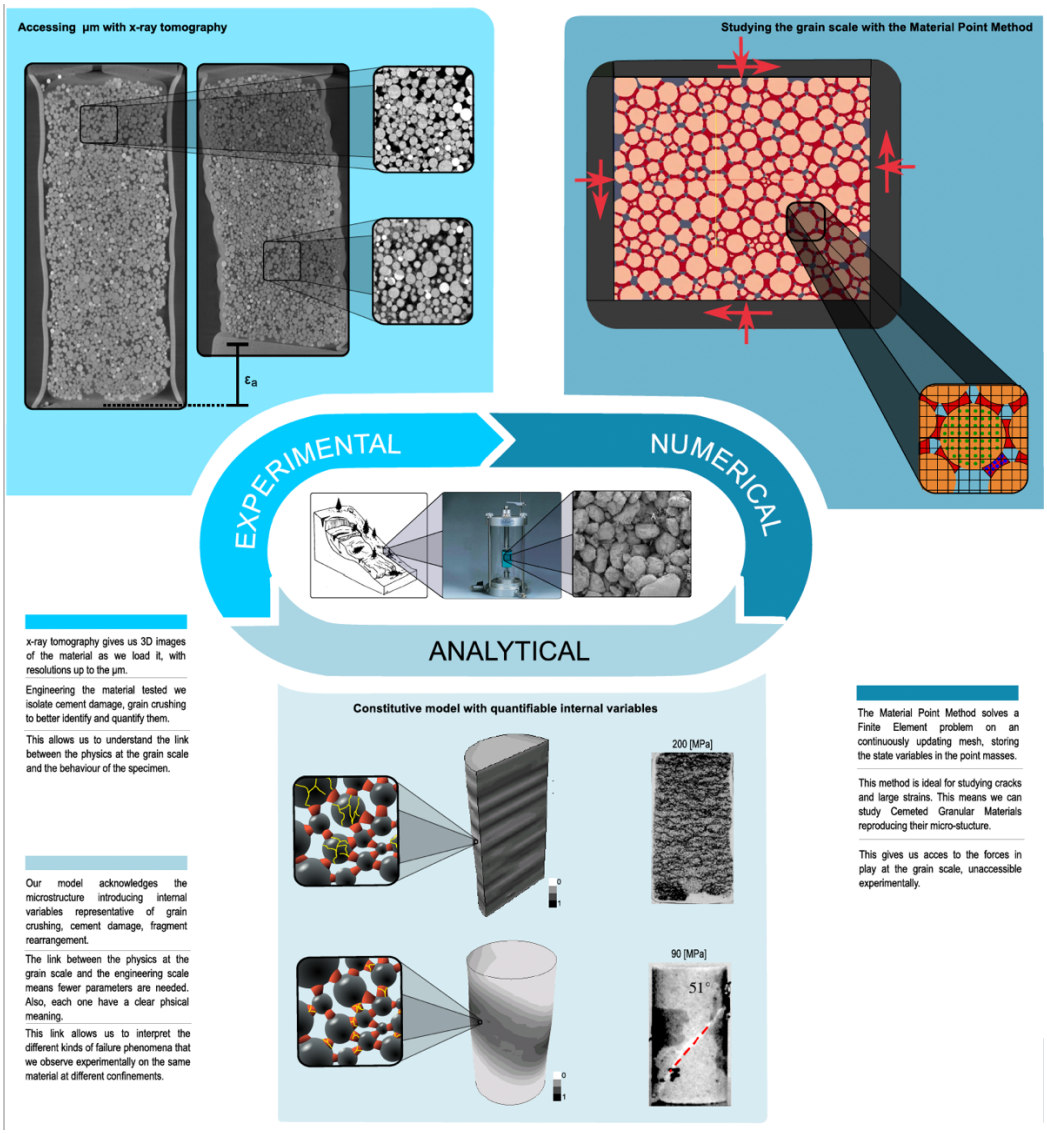
Work Package 2 – numerical (Year 2 and 3)

3) Cast this data within a numerical model (DEM or MPM) to extract the grain forces at play at the representative elementary volume scale.
4) Simulate the sample response either through numerical upscaling (DEMxFEM) or homogeneisation

Work Package 3 -- analytical (Year 1, 2 and 3)

5) Use this data to improve an existing micro-mechanics based constitutive model

Given the multiple possible axes of development (experimental, numerical and analytical) this project can lean more towards one of these directions (while maintaining the overall structure) based on the profile and interests of the candidate



Required skills

- Good knowledge of continuum mechanics, constitutive modelling
- Good knowledge of Python programming

Desired skills

- Some exposure to numerical modelling (FEM and/or DEM)
- Some exposure to with to image analysis

Calendar of the recruitment process

Step	Date
Application deadline	31st May
Interviews	1st-14th June
Announcement of the decision	15th June
Indicative start date	December 2020

Supervision team

- Alessandro Tengattini (alessandro.tengattini@3sr-grenoble.fr)
- Cino Viggiani (cino.viggiani@3sr-grenoble.fr)
- Pierre Bésuelle (pierre.besuelle@3sr-grenoble.fr)

Application

Please send a detailed CV and a letter of motivation to all three emails above.