PhD project proposal

Quantifying Degradation in Cemented Granular Materials using X-ray and Neutron Tomography

Context: Cemented granular materials, ranging from sandstones to grouted sands, are ubiquitous in natural and engineered environments. The three main micro-mechanical processes governing the degradation of these highly heterogeneous materials are commonly identified as (i) cement damage, (ii) grain crushing and (iii) fragment rearrangement. The two latter mechanisms have been, to some extent, well documented in the recent literature by means of well-established experimental methods. However, a quantitative characterization of cement damage processes and its evolution in time and space has not yet been achieved. The use of X-ray tomography, perhaps the most used non-destructive technique in geomechanics, does provide meaningful but incomplete information, since it cannot clearly distinguish the cement from other solid material present in granular materials.

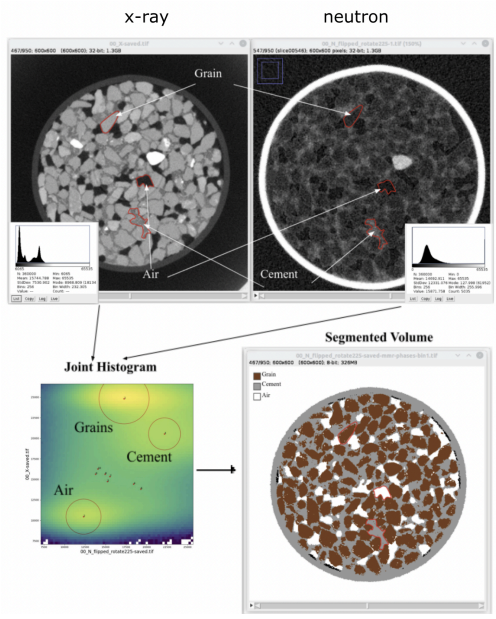

Fig.1 Horizontal slice of X-ray and neutron tomographies of a Cemented Granular Material, highlighting the high complementarity of information that allows to segment the individual phases.

Project Proposal: A novel approach to this problem consists in complementing the use of X-ray imaging with Neutron tomography. Neutron flux attenuation is sensitive to different properties of the material and can therefore reveal highly complementary and rich information about the degradation at the cement bridge sites. This project will focus on the development, performance, and analysis of experimental campaigns where triaxial loading of an artificial sandstone is performed while acquiring X-ray and neutron tomographies simultaneously, to compare different types of cement, grain surface bonding effect and grain properties will be explored and their effect on microscopic damage and resulting macroscopic response will be analyzed. The candidate will further conduct a complementary numerical study using a mutliscale implementation combining the discrete element method (DEM) and finite element method (FEM).

Skills: The candidate should have a background in civil/mechanical engineering, physics, or applied mathematics. The ideal candidate has experience and can be autonomous in generating/analyzing experimental data (imaging methods, instrumentation, sample preparation, …). Good programming skills in Matlab/Python are also required, as well as familiarity with other languages (e.g. Fortran, C, C++). Additionally, modeling skills in a finite element framework and development of constitutive models are highly desirable. Strong oral and written English communication skills are required.

Location: 3SR laboratory, Université Grenoble Alpes (UGA) , Grenoble, France.
Salary: Net salary of approximately 1716€ per month.
Start date: 1st of October 2024 (the start date can be slightly delayed if necessary).

Contact: To apply please send an email to Alessandro Tengattini (alessandro.tengattini@3sr-grenoble.fr), Cyrille Couture (cyrille.couture@3sr-grenoble.fr) and Cino Viggiani (cino.viggiani@3sr-grenoble.fr).