Experimental injection of fine grains and subsequent impacts on granular materials stability

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The research unit RECOVER from INRAE is pleased to invite applications for a postdoc position on the experimental investigation of the impact of fine grain injection on the mechanical stability of granular materials. This PhD project is part of the project ClapMeca supported by the Carnot Institute for Water and Environment. The postdoc duration is 18 months.

Context and motivations

Granular materials are fascinating in the sense that they can fail before the plastic limit is reached, which is a consequence of the fact that they behave as non-associated plastic materials. Such failure modes are responsible for static liquefaction/ mechanical instability of earthen structure such as the impressive collapse of Brumadinho dam in 2019 in Brazil. Recent research results have shown that the presence of weakly loaded grains in granular materials has a positive impact on the material mechanical stability [6, 5], and the subsequent risk of liquefaction. The research project ClapMeca aims to explore to what extent these results can be valued by considering a reinforcement technique by injection of fines into materials that are sensitive to liquefaction. In the field, the technique can be implemented by simply pouring fine materials on degraded earthen hydraulic structures and by taking advantage of water infiltration to tansport and clog the fine materials inside the hydraulic structure [1] as illustrated in Figure 1.

Project work

The present postdoctoral offer consists in i) reproducing in the laboratory the process of hydraulic injection of fine materials into a coarser and loose material, ii) characterizing the induced changes in microstructure and iii) quantifying their impact on the mechanical stability of treated materials.

The project is mostly experimental and will use a test device developed in the research team for the study of suffusion phenomenon (suffusion permeameter device SEPT) [2, 3].

At the end of the hydraulic test, the samples will be recovered and mechanically tested via triaxial tests on various stress paths [4, 2]. We will focus on paths with i) constant deviatoric loading (reproducing the change in the stress state in earthen structures subjected to a rapid rise

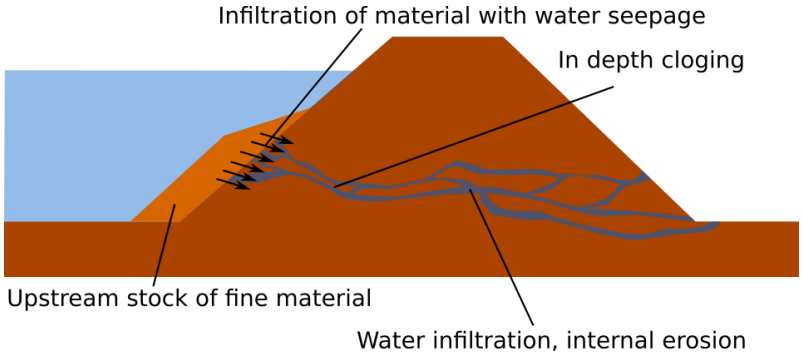

Figure 1: Field technique to inject fine material into a degraded earthen hydraulic structure.

in the water level) and ii) triaxial extension (mimicking the change in the stress state resulting from wave impact on earthen structures). The results will help conclude whether the presence of filtered grains improves the mechanical stability of the material.

In addition, X-ray tomography images before and after testing may be acquired to characterize the induced changes in the microstructure [3].

Required knowledge and skills

The candidate should have a PhD in geomechanics, civil engineering or mechanical engineering and should have a previous experience in experimental work. A theoretical background in continuum mechanics and soil mechanics will be appreciated. A previous experience with advance imaging techniques would be a bonus. A good level of scientific English (speaking and writing) is mandatory.

Application

In order to apply for this position, CV and cover letter (in English or French) must be sent by e-mail to all members of the supervising team (antoine.wautier@inrae.fr and nadia.benahmed@inrae.fr).

Terms and contract

The postdoc candidate will benefit from an INRAE contract that is scheduled to start in spring 2022 (with some flexibility) for a period of 18 months. The gross salary is expected to be between 2,500 and 2,900 €/month depending on past experience. The postdoc candidate will also benefit from 48 days of holidays per year.

References

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[3] Cong Doan Nguyen, Nadia Benahmed, Edward Andò, Luc Sibille, and Pierre Philippe. Experimental investigation of microstructural changes in soils eroded by suffusion using x-ray tomography. *Acta Geotechnica*, 14(3):749–765, 2019.

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