Postdoctoral position at 3SR lab, Grenoble, France

Study of the early-age behavior of earth masonry structures

Supervision:

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Period:

around june 2024 to may 2025

Funding:

CNRS ingénierie

Candidate profile:

PhD Degree in Civil Engineering, Geotechnical Engineering, knowledge of the French language

Application form:

The application file must include cover letter, CV, grade transcripts. Contact florent.vieux-champagne@univ-grenoble-alpes.fr.

Keywords:

Interface, raw earth, transport in porous media, x-ray and neutron tomography, multimodal registration, multi-scale approach.

Skills:

Experience in the mechanical characterization of masonry, raw earth materials, and/or imaging (X-ray, neutron, DIC) would be appreciated.

Post-doctoral project

Structures designed using load-bearing eco-friendly materials, such as raw earth masonry (where "earth" denotes a mixture of gravels, sand, silt, and clay), represent potential alternatives to mitigate the carbon footprint of the construction industry [5]. Earth masonry implies the use of earth bricks joint by an earth mortar, with the bonding layer playing a key role in shear and tension behavior of the overall structure. However, this (re)emerging sector faces various challenges typical of new technologies, including a lack of scientific studies hindering the establishment, a shortage of expertise as well as a limited number of professionals formed to meet the growing demand.

One major scientific challenge involves the hydro-mechanical early-age behavior, which is a key priority for optimizing on-site structure implementation. Unravelling the role of water in such materials is a key factor for identifying, among others, the minimum drying time required for the material to attain the necessary strength during construction and ensuring the structure's long-term performance in terms of mechanical performances and durability.

In the framework of the post-doctoral position, the drying process of masonry structures will be analysed at the scale of the block/mortar interface taking into account the type of block and the vertical stress applied to the assembly during the drying. The main objectives are to better understand the phenomenology, depending on confining pressure and intrinsic permeability, and to furnish a case study to validate a numerical model [2] using materials properties already available in the literature [1, 3]. Indeed, to avoid a time consuming identification process, the same materials than in [1, 3] will be used for this post-doc project. To achieve these objectives, a multiscale approach will be used.

At the macroscopic scale, controlled THM drying test will be performed in a climatic chamber. Image analysis [6, 7] will be used to track the moisture cloud during the early-age drying phase. To assess the influence of the intrinsic permeability of the block and of the confining force different configurations will be setup under constant and controlled relative humidity and temperature. The water content will be tracked by dedicated embedded sensors. The knowledge of the material already studied in literature, will allow to deduce the suction from this measurements. Filter paper will also be used to validate this approach from the "mortar alone" configuration. Finally triplets will be tested to obtain their shear strength.

At the mesoscale, the study will consist in the analysis of the migration of the moisture clog, at the early-age block-mortar-block assembly, from neutron/X-Ray tomography using the experimental platform NeXT [8]. The equipment whose feasibility has already been assessed in [4] will be employed. This test will give a measurement of the moisture content spreading in the granular stacking that constitute the mortar joint. It will also allow analysing shrinkage and cracks development, and assess the phenomenology involved at the interface brick-mortar. The experimental results will serve as a benchmark for a THM numerical model based on [2].

Bibliography

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[4] Murilo Henrique Moreira et al. "Experimental proof of moisture clog through neutron tomography in a porous medium under truly one-directional drying". In: *Journal of the American Ceramic Society* 105.5 (2022), pp. 3534–3543.

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[7] Marilyn Sarkis et al. "Tensile strength measurement of the calcite bond between bio-cemented sand grains". In: *Acta Geotechnica* (2023), pp. 1–16.

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