PhD proposal: «Multifunctional behaviour of raw earth and bio-based material in building panel»

Practical conditions

Start: October 1st 2023- October 31st 2026
Duration: 36 months
Location: Université Savoie Mont Blanc (USMB), le Bourget du Lac, Savoie.
Research Laboratory: LabOratoire proCédés énergIe bâtimEnt (LOCIE) - http://www.polytech.univ-smb.fr/index.php?id=2884
Supervised by: Olivier Plé Pr, Noémie Prime McF (LOCIE)
Gross annual salary: 36000€. Possibility to teach at Polytech Annecy-Chambéry and IUT of Chambéry in Energy Buiding Environnemental department and civil engineering department (max 64hEqTD/year).
Consortium: Part of the ANR PACS+ (2022) project in collaboration with "Institut Pascal" (UCA). Head of the consortium Olivier Plé (USMB).

Context and objective

12% of the French national emissions of greenhouse gases are linked to the manufacturing of hydraulic binders (cement, plaster, lime) for the production of construction materials (concrete, mortar, plaster). Consequently, our conventional construction habits, in particular, based on concrete must change within the framework of sustainable development in order to achieve the national objective of carbon neutrality by 2050. In this context, raw earth construction – a traditional, very old and sustainable process – is seeing renewed interest in France due to its low environmental impact and its advantages in terms of hygrothermal and acoustic comfort. On the other hand, raw earth walls are less resistant to uniaxial compression than a wall made of industrial materials, and have rather average insulation properties in winter conditions. In this context, the research project aims at designing and studying an innovative low-carbon envelope wall, based on the combination of rammed earth and bio-based concrete. The geo and bio-based composite thus constructed would constitute a balanced multifunctional hybrid solution combining mechanical compatibility, preserved hygrothermal transfer dynamics and sobriety or even carbon neutrality. The challenge, in terms of multi-physical and technical characterization, is to study the interface between raw earth material and bio-based concrete. The objectives of the thesis, in part of the PACS+ project are:

1. To identify the raw earth material and bio-based material and formulate mixtures adapted to the geo and bio-based hybrid solution,
2. To measure the temperature, humidity and displacement fields on and in the materials constituting the walls,
3. To determine the influence of the implementation of the two-layer wall (raw earth + bio-based panels) on the transitional phase,
4. To understand the multi-physical effects at the rammed earth-vegetal concrete interface,
5. To quantify the overall performance of the rammed earth/vegetal concrete combination from a structural, energy and environmental point of view.

As this PhD proposal is a part of the ANR project PACS+, a similar phD proposal, on "Multi-functional behaviour of complex walls made of geo- and bio-based materials" will be engaged at the Institut Pascal in University Clermont Auvergne by Professor Sofiane Amziane. The two theses will start at the same time. The LOCIE PhD student is asked to work in close collaboration with the PhD student recruited by the Institut Pascal. Mobility between the two laboratories will be mandatory. The thesis work will be done within the ANR PACS+ consortium.

Candidate's profile

The candidate should hold a master degree in civil or mechanical engineering, with strong skills in continuum mechanics and/or geomechanics and/or structures mechanics and/or porous media. The candidate should have a real interest for both experimental and numerical work. Particular skills of communication and autonomy are required.

Contacts

Contact possible until june 30th: **please send a cover letter, a CV, a lists of courses attended (with grades obtained), names and contact details of two references to:**

Olivier Plé (LOCIE) : olivier.ple@univ-smb.fr
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Bibliography

Bio-aggregates based building materials: state-of-the-art report of the RILEM Technical Committee 236-BBM : Amziane, S., Collet, F., (2017); Springer 23.
Lateral load-carrying capacity of hemp concrete as a natural infill material in timber frame walls: Wadi, H., Amziane, S., Toussaint, E., Taazount, M., (2019); Engineering Structures, 180, (1), 264-273.
Impact of moisture content on the elasto-viscoplastic behaviour of rammed earth wall: new findings : T Chitimbo, F Abdul Samad, N Prime, A Revil, O Plé; Construction Materials 2 (4), 1-14.
Drying experiment on rammed earth structure : T Chitimbo, N Prime, O Plé, F Abdul-Samad; European Journal of Environmental and Civil Engineering
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