French Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes one of the PhD subjects proposed by the French Polytech network. The network is composed of 15 engineering schools/universities. The document also provides information about the supervisor. Please contact the PhD supervisor by email for further information regarding your application.

Supervisor information	
Family name	Amziane
First name	Sofiane
Email	Sofiane.amziane@uca.fr
Web reference	https://www.researchgate.net/profile/Sofiane-Amziane
Lab name	Institut Pascal
Lab web site	http://www.institutpascal.uca.fr/index.php/fr/
Polytech name	Polytech Clermont
University name	Université Clermont Auvergne
Country	France

PhD information	
Title	Mechanical performance of vegetal concrete strengthened with natural FRCM composites
Main topics regards to CSC list (3 topics at maximum)	Materials for environment and ecology Biomaterials and polymer materials

Required skills in science and engineering	Perform experimental tests, perform FE analysis, in-depth knowledge of mechanics of materials, analysing and interpreting data, communication, self-Management.

Subject description (two pages maximum including biblio)

The construction sector now consumes 44% of the nation's energy and emits more than 132 million tons of carbon dioxide each year, not to mention depleting non-renewable resources. This makes this sector one of the key sectors in the fight against global warming and for the energy transition. One solution to adressthis problem is the use of materials with low environmental impact, such as vegetal concretes [1]. In recent decades, these materials have attracted great interest from the civil engineering research community. Besides their low environmental footprint, they have interesting thermal, acoustic and hydric properties [2]. However, their mechanical performance is low compared to materials commonly used in construction (reinforced concrete, wood, etc), which limits the attractiveness of vegetal concretes in construction [3]. The aim of this project is to propose reinforcement solutions using materials with good mechanical properties such as FRCM (Fabric Reinforced Cementitious Matrix) composites.

FRCM materials have been used with great success to reinforce structures made of masonry and reinforced concrete, owing to the multiple advantages they offer: high tensile strength, pseudo-ductile behavior, ease of implementation, non-toxicity and compatibility with different substrates [4,5]. Synthetic fibers (glass, carbon, aramid) are the most commonly used, but unfortunately they have a not-insignificant environmental impact. In this project, they will be replaced by natural fibers such as flax and hemp. These fibers have interesting mechanical properties and a carbon footprint that is consistent with bio-based materials. They are also easily recyclable and easy to process. The combination of a natural FRMC with a vegetal concrete should eventually allow to offer an environmentally friendly product with high mechanical properties.

The main objective of this work is to evaluate the feasibility of reinforcing vegetal concretes with natural FRCM composites. The first phase of the project consists in the development, valorization and experimental and numerical study of a natural FRCM. The composite will be characterized at different scales of analysis to define the key parameters that ensure its mechanical performance.

The second phase is the evaluation of the mechanical behavior of vegetal concretes reinforced with the FRCM developed in the first phase. Different strengthening techniques such as compressive, shear and flexural strengthening will be applied. The effect of strengthening on stiffness, load capacity, ductility, failure mode and cracking of the material will be studied. A parametric study will be conducted to evaluate the effect of the number of reinforcement layers, textile pre-impregnation and addition of short fibers to the FRCM matrix on the mechanical behavior of the composite.

References:

[1] AMZIANE S., COLLET F. Bio-aggregates based building materials, State-of-the-Art Report of the RILEM Technical Committee 236-BBM, Springer, Dordrecht, 2017.
https://www.springer.com/gp/book/9789402410303#aboutBook
[2] S. Amziane, F. Collet, Bio-aggregates Based Building Materials, Springer, Dordrecht, 2017. doi:10.1007/978-94-024-1031-0.
[3] J. Wei, C. Meyer, Degradation mechanisms of natural fiber in the matrix of cement composites, Cem. Concr. Res. 73 (2015) 1–16. doi:10.1016/j.cemconres.2015.02.019.
[4] HOMORO, O., MICHEL, M., et BARANGER, T. N. Dry mineral pre-impregnation for enhancing the properties of glass FRCM composites. Construction and Building Materials, 2020, vol. 263, p. 120597.
[5] Homoro, O., Baranger, T.N., Michel, M. “3D finite element modeling of yarn reinforced mineral matrix: comparison of damage behavior with experimental data”. Composite Structures, 2021, p. 113567.