جامعة عبد المالك السعدي
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Université Abdelmalek Essaadi

Pole for Doctoral Studies
Center for Doctoral Studies
Sciences and Technology and Medical Sciences

ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE

Mr Mohamed EL AABBAS

Will present his research work with the aim of earning a Doctorate

Doctoral program: Engineering Sciences and Techniques
Discipline: Physics
Specialty: Mechanics & Energetics

On 23/07/2025 at 09H30 at the Building F, Conference Room of the Faculty of Sciences and Technology of Tangier.

Centre des Etudes Doctorales Sciences et Techniques et Sciences Medicales

Under the theme

Development of bio-sourced clay bricks using new techniques: Characterization, energy and environmental study.

Front of the jury composed of:

First Name & Last Name	Establishment	Designation
Pr. Mustapha DIANI	FST Tangier, Abdelmalek Essaadi University	President
Pr. Fatima BAHRAOUI	FST Tangier, Abdelmalek Essaadi University	Reviewer
Pr. Rafik BELARBI	University of La Rochelle, France	Reviewer
Pr. Florence COLLET	University of Rennes, France	Reviewer
Pr. Mustapha OUARDOUZ	FST Tangier, Abdelmalek Essaadi University	Examiner
Dr. Brahim MAZIAN	CentraleSupelec, France	Guest
Pr. Mustapha MAHDAOUI	Polytechnic University of Hauts-de-France	Co-Adviser
Pr. Mohammed AHACHAD	FST Tangier, Abdelmalek Essaadi University	Supervisor

Research Laboratory: Materials, Systems and Energy Engineering Laboratory (MaSEEL), UAE/U04FSTTg

Abstract

In the context of global efforts to reduce CO_2 emissions and energy consumption, this research contributes to an innovative approach to sustainable building materials. The study explores the design of lightweight, sustainable fired clay bricks manufactured by 3D printing and enriched with bio-based pore-forming agents, including spent coffee grounds (SCGs) and algae. Furthermore, the integration of phase change materials (PCMs) to enhance thermal regulation has been studied.

The study is structured in several parts. The initial component of the study demonstrated the technical feasibility of 3D printing bricks based on local clay. This was achieved by characterizing the effects of printing and firing parameters on the physical-mechanical properties of the samples. Subsequently, the incorporation of SCGs was analyzed through different proportions (3%, 5%, 10%, 15%), highlighting an optimal balance at 10%, which enabled improved thermal performance while maintaining compressive strength above minimum standards for material construction.

In a subsequent phase, the incorporation of algae, in two distinct granulometries, facilitated a comprehensive analysis of the evolution of porosity, thermal conductivity, and mechanical performance. To this end, advanced tools such as X-ray tomography were employed to visualize the internal microstructure and pore distribution. The results obtained from this study indicate that the distribution of porosity within the material is a crucial factor in determining its thermal insulation properties. However, it is also observed that such distribution tends to concurrently induce a gradual decline in both stiffness and mechanical strength.

Finally, the integration of PCM in hollow brick has shown significant potential for improving summer thermal comfort. A numerical model based on the finite volume method was employed to simulate the thermal behavior of bricks under various scenarios (mass, melting temperature, PCM distribution). The optimized configurations resulted in a 25% reduction in the thermal phase shift factor and a significant improvement in interior comfort.

This thesis demonstrates the potential of pore-forming agents and additive manufacturing for the development of environmentally-friendly, thermally efficient bricks compatible with the requirements of sustainable construction. It paves the way for further research into the optimization of formulations, heat transfer modeling, and the full environmental assessment of these innovative materials.

Keywords: Sustainable Construction Materials, 3D Printed Clay Bricks, Biobased Pore-Forming Agents, Phase-Change Materials, Porosity, Thermal Conductivity.

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