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Experimental Evaluation of Thermal Insulations Materials Used in Building Sector to Achieve the Objectives of the National Determined Contribution

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ABSTRACT

The use of thermal insulation proves to be a highly effective strategy for energy conservation in building structures. Thermal insulators play a crucial role in both the construction of new buildings and the renovation of existing ones, enhancing their energy efficiency and ensuring better thermal comfort. In Algeria, a significant challenge persists owing to the limited availability of companies and specialists dedicated to the execution of thermal insulation. To address this issue, it is essential to augment the number of thermal insulation companies and enhance production capacity. This expansion is pivotal for realizing the goal of improved energy efficiency by 2030. This study is dedicated to the investigation of the thermal properties of three distinct thermal insulation systems: lightweight foam concrete (LFC), expanded polystyrene (EPS), and polyurethane (PU). The primary objective is to comprehend and integrate these materials into new building programs for housing and the renovation of older structures.

Keywords: Thermal insulation, foam concrete, polystyrene, polyurethane, thermal conductivity.

1. Introduction

The significant increase in heating costs is caused by multiple factors. Carbon dioxide emission fees or geopolitical tensions that impact fossil fuel prices are among them [1]. To mitigate the impact of escalating utility expenses, it becomes imperative to undertake thermal modernization for both existing and new buildings [2]. Thermal modernization encompasses a set of procedures specifically designed to minimize heat losses [3]. By reducing heat losses in winter and minimizing heat gains in summer, thermal insulators significantly contribute to energy savings and help reduce the environmental impact of buildings. Various types of thermal insulators are available in the Algerian market, ranging from natural options such as cork, cotton, and wool to synthetic materials like expanded polystyrene and polyurethane. Additionally, insulators derived from animals and minerals, such as rock wool and foam concrete, are also prevalent. Different insulation methods are applied based on the specific structural requirements of walls and roofs. Energy efficiency in the building sector is projected based on the properties of thermal insulation used in the building envelope.

2. Experimental

The measurements are conducted utilizing the TORUS 300 heat flux apparatus. The TCA 300 thermal conductivity measuring instrument employs the heat flow meter principle to accurately determine the thermal conductivity and heat transmission resistance of various materials such as building insulation.

3. Results and Discussion

From a thermal perspective, the tested insulators demonstrate commendable thermal insulation properties. Thermal characterization conducted at the National Center for Integrated Building Studies and Research (CNERIB) unveiled diverse thermal conductivities and densities. In the case of lightweight concrete, the thermal conductivities ranged from 0.09 to 0.105 W/m.K. For polystyrene, the measured thermal conductivity was 0.032 W/m.K, while polyurethane exhibited a thermal conductivity of 0.022 W/m.K. These measurements were obtained using a flux meter apparatus at an average temperature of 20 °C.

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The consistency of these results with measurements from reputable international laboratories, such as the Scientific and Technical Center for Building (CSTB) and the CERIB laboratory, validates the thermal performance of foam concrete. The significant findings presented in this work can serve as a basis for improving the thermal rehabilitation of buildings and contributing to Algeria's national housing program.

4. Conclusions

This work focuses are dedicated to the selection of optimal thermal insulation materials and systems, emphasizing their thermal and mechanical properties to implement energy efficiency measures. The objective is to contribute to the realization of national determined contributions (NDC) within the building sector by effectively reducing greenhouse gas emissions. Some of the actions and research results related to materials insulations in the building sector are published in the third communication TNC and biennial update report BUR, accessible on the UNFCCC website. The revision of the CDN will continue to ensure submission before 2025. We will utilize our materials research results to formulate new policies between 2025 and 2030, aiming to enhance energy efficiency in the building sector.

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