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Thermal lag and decrement factor of a coconut-ferrocement roofing system

R. Alavez-Ramirez [a], F. Chiñas-Castillo [b,*], V. Morales-Dominguez [a], M. Ortiz-Guzman [a], J. Lara-Romero [c]

[a] Research Center for Interdisciplinary Regional Development, IPN, Oaxaca, Oax. C.P. 71230, Mexico
[b] Department of Mechanical Engineering, Instituto Tecnológico de Oaxaca, Calz. Tecnológico No. 125, Oaxaca, Oax. C.P. 68030, Mexico
[c] Faculty of Chemistry, Universidad Michoacana de San Nicolás de Hidalgo, Morelia C.P. 58060, Michoacán, Mexico

HIGHLIGHTS

- A real-scale prototype house was built.
- Coconut fibre filled ferrocement precast channel roof components present a thermal offset of 210 min (3½ h).
- A lower thermal damping of 43% compared to ferrocement-only precast channel roof.
- Coconut fibre limits the flow of heat at peak times where temperatures reach their highest values.
- Ferrocement fibre filled precast channel roof components can bring thermal comfort.

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ABSTRACT

In this paper, coconut fibre filled precast ferrocement roofing channel components were developed, their thermal behaviour was characterized and its performance was compared to precast ferrocement-only roofing channel components in a real-scale prototype house built at CIIDIR facilities in Oaxaca, Mexico. The experimental analysis performed in this study was based on dynamic climatology. A solar orientation chart of the place was constructed to identify the solar radiation intensity acting on the house. Measurements of roof surface temperatures were conducted to determine temperature damping and temperature wave lag. Monthly average temperature and direct solar radiation data of the site was considered. Coconut fibre filled precast ferrocement roofing performance was compared to a ferrocement-only roofing and to a traditional concrete slab roofing. Results indicate that, coconut fibre filled precast ferrocement roofing channel components experience higher solar radiation intensity but its thermal damping is 40% and its thermal lag of about three and a half hours. Precast ferrocement-only roofing channel showed no thermal lag or damping and traditional concrete slab roofing exhibit a thermal damping of only 13% and its thermal lag of zero. Thus it is concluded that coconut fibre filled precast ferrocement roofing channel components are an ecological alternative for energy saving and thermal comfort.

1. Introduction

Ferrocement construction buildings are an economical option for low-income families mainly because of the associated cost compared to conventional materials. It is a kind of material made of cement mortar reinforced with layers of a continuous mesh grid. However its main drawback is the high-energy transfer in roofs and walls during winter and summer. These gains and losses of energy cause conditions of discomfort and sometimes provoke health problems to users. Conditions inside a ferrocement-made house present temperatures around 7 °C higher with respect to conventional materials [1]. On the other hand, the roof is a covering component on the uppermost part of a dwelling and is critical to shelter from climatic elements, provide thermal comfort and privacy. Important elements to be considered in the design of a roof are material, construction and durability. In developing countries, most roofs are constructed from local materials such as banana leaves, wheaten straw, and seagrass. Other roofing materials such as corrugated galvanized iron, ceramic tiles, aluminum sheeting and precast concrete have some advantages such as low maintenance, durability and easy installation but in hot-tropical climates they do not provide thermal insulation. Because the aim of a roof is protection from climatic elements, insulating properties are important in the choice of material. Researchers aim to reduce energetic costs caused by solar radiation making roof components of

* Corresponding author. Tel.: +52 9515015016x232; fax: +52 9515167211.
E-mail address: fernandochinas@gmail.com (F. Chiñas-Castillo).

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