Investigation of the Thermal Insulation Walls of Coconut Fiber Mixed with Cement.

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Abstract

This paper aimed to conduct an experimental study of the thermal insulation entering the building compared to the simulated houses installed. Smart Board Wall Type (A), Coconut Fiber Cement Wall Type (B) and Coconut Fiber Cement Wall Type (C) ware the insulation example in this research. Testing of 3 simulated houses, roof facing south. The dimensions of the model house are: 1.20x1.20x1.20 m. The model house was raised with a steel stand 0.20 m from the floor to compare the thermal performance of the house between the smart board wall (A) with air gap and the coconut fiber cement wall. Type (B) with air gap with coconut fiber cement-clad wall (C) with air gaps and vents that have the effect of reducing heat in the room of the experimental house under the climate of Suphanburi Province The results of the experimental study showed that the coconut fiber cement-infused wall (C) with air voids and vents has a lower room temperature. Type (B) Coconut Fiber Cement Wall and Type (A) Smart Board Wall Type (C) Coconut Fiber Cement Wall with air gaps and vents reduces heat more than no installation. Heat vent and the use of natural materials to be beneficial and environmentally friendly.

Keywords: Coconut fiber wall mixed with cement, coconut fiber, natural materials

Introduction

Due to the current organic waste in agriculture sector in 2017, organic waste in Thailand accounted for 64% of the total waste in the country. (Ministry of Science technology and environment ,2020; Notification of the Ministry of Energy,2020) Normally, organic waste disposal is focused on incineration. or discarded in rivers and canals in various public places by any means that cause the waste, leaves, branches to disappear causing problems for the ecosystem and the environment Architectural attention has been paid to the reuse of organic waste and to play more roles in architecture, which is an architecture that takes into account the environment. And it is designed with the sustainability of nature in mind. and energy saving with the goal of energy-saving design and the least impact on the environment. (Hancharoen, K., & Chotikaprakhan, S. , 2016; Jarawae, R., 2016) conducted an experiment on insulation made from natural fibers, which consist of khao grass. Coconut fibers, banana sheaths, rice straw and betel nut sheaths and use para rubber as a binder for the material. The insulation was a flat sheet size 15 x 15 x 3 cm by testing. The maximum tensile strength water absorption In summary, the results of the research found that All 5 natural materials can be used to produce insulation. Later, (Phutakot, N., & Thongsamut, Ch., 2010) studied the wall of the building from waste materials consisting of waste husk materials. and leftover milk cartons were tested by building a test cell from 6" thick polystyrene foam. Three tests were performed: Regular masonry walls, masonry walls with milk cartons installed inside. and masonry walls with milk cartons containing rice husks installed inside. By facing the test wall to the south that receives sunlight all day. Data was collected using a Fluke HydraLogger thermometer to measure air temperature. external skin temperature internal skin temperature The results of the experiment made the indoor air temperature closer to the comfortable condition. (Putpirotjana, Ph., 2010) studied the energy consumption in air conditioning between

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single- and two-storey aerated concrete walls. The experiment was carried out using a real building, room size 8. 2 rooms with different exterior walls. between one and two layers of aerated concrete In a simulation of energy consumption by the EnergyPlus program to compare the results between the two methods, two layers of aerated concrete were more energy-efficient in air conditioning than single-layer aerated concrete. The simulation results at night showed that two-layer aerated concrete can save relatively little energy, a double-wall consumes 0.118 kWh of energy per hour, and a single-layer wall consumes 0.119 kWh of energy. (Puraprom, W. , 2019) The design of high-performance wall should add materials with higher heat resistance between wood structure. Using insulation and gypsum can help to reduce heat transfer equivalent to air conditioners by 7,522 Btu/hr. Indoor air temperature reached reach the human comfort zone and cooling load decreased by 87%.

Methodology

The design of the cement-coconut fiber siding using natural ventilation was conducted in small-size houses to compare thermal performance. The test is in the summer. The model house for the test is shown in Figure 1. The details are as follows. The table1 Different styles of walls and roofs of 3 model houses.

Table 1. Different styles of walls and roofs of 3 model houses.

Model House	Wall type
Model 1	Smart Board Wall Type (A)
Model 2	Coconut Fiber Wall With Cement Type (B)
Model 3	Coconut Fiber Wall With Cement Type (C)

South facing wall and roof testing the size of the room is 1.20 x 1.20 x 1.20 meters, as shown in Figure 2 - 4 The walls are using smart board 6 mm thick. The small test room is raised by a steel stand 0.20 meters from the floor, located at Rajamangala University of Technology Suvarnabhumi Suphanburi Campus on the rooftop of the building 10, 3rd floor. South facing wall and roof testing The size of the room is 1.20 x 1.20 x 1.20 meters, as shown in Figure 2 - 4 The walls are using smart board 6 mm thick. The small test room is raised by a steel stand 0.20 meters from the floor, located at Rajamangala University of Technology Suvarnabhumi Suphanburi Campus on the rooftop of the building 10, 3rd floor.

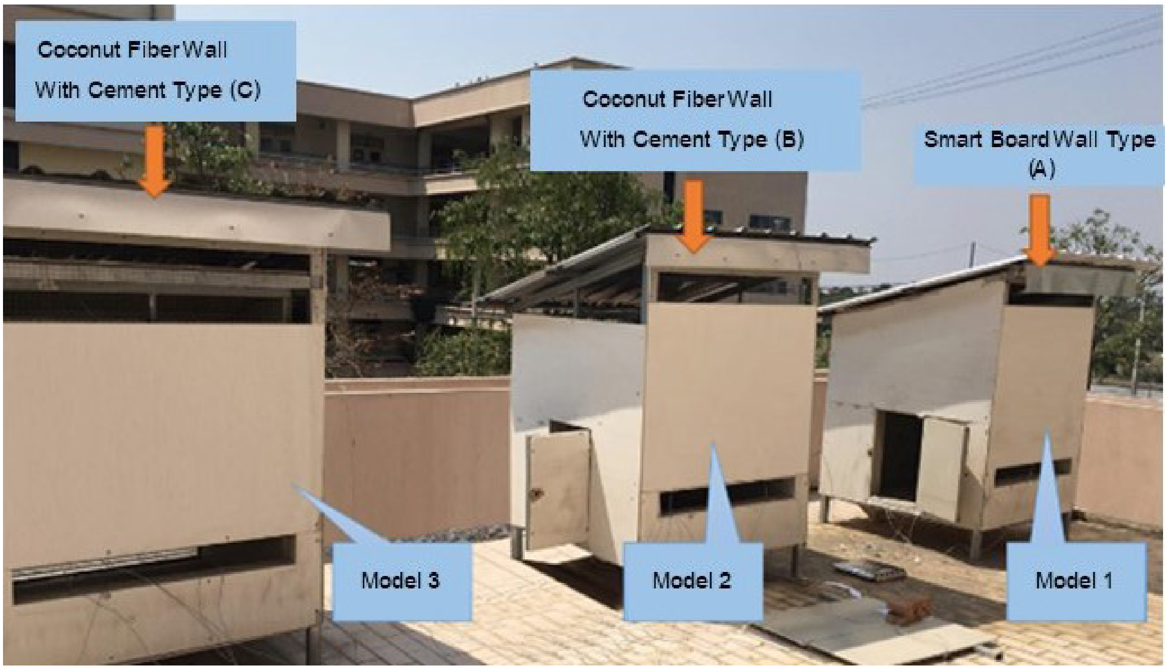

Figure 1. The model house for the test.

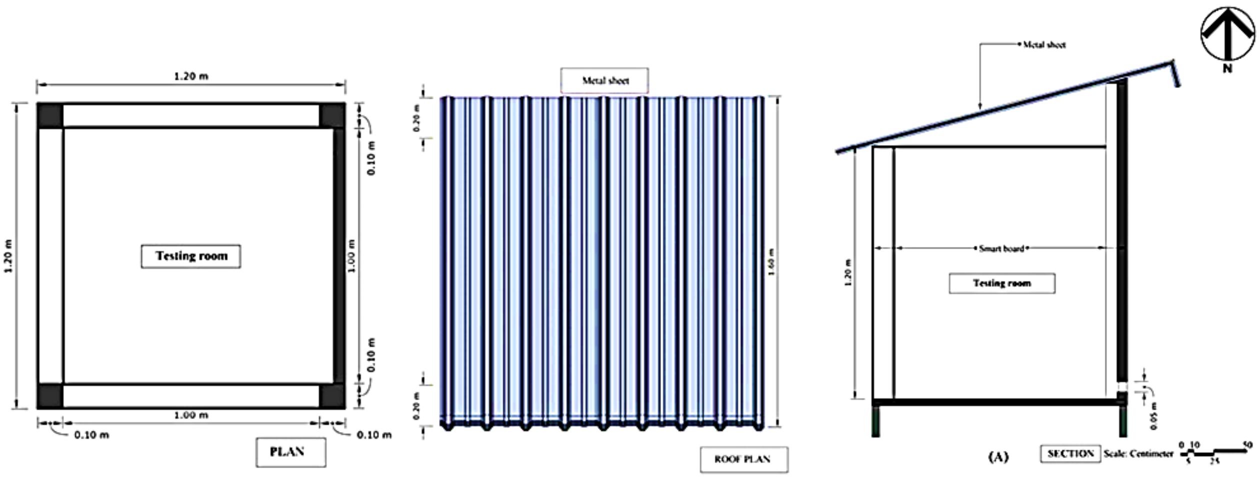

Figure 2. Model of the first house model, smart board wall type (A)

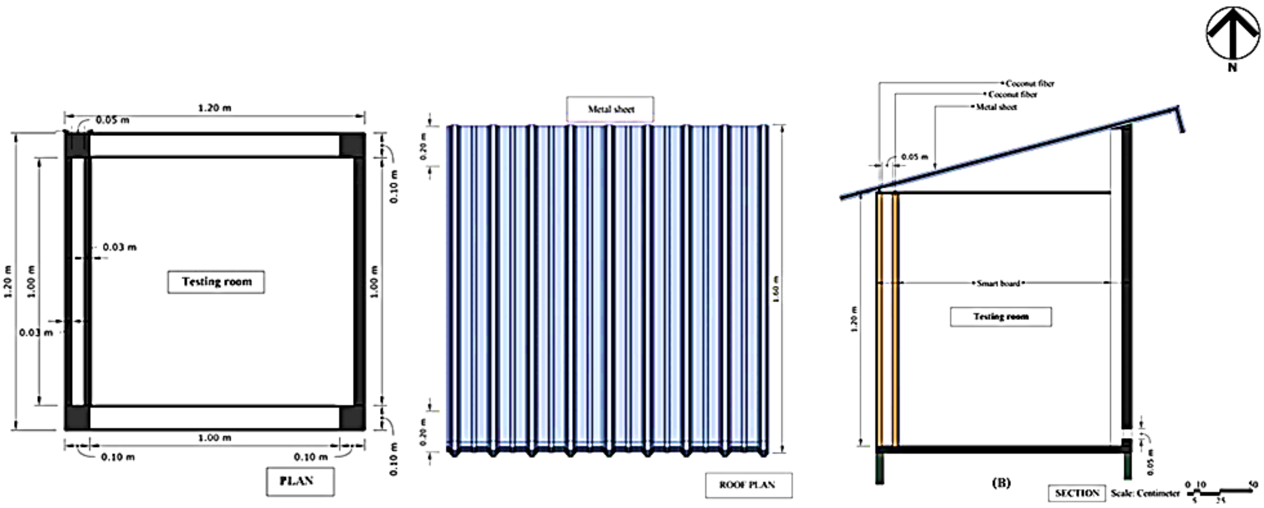

Figure 3 Model of the second house with coconut fiber-cement wall type (B)

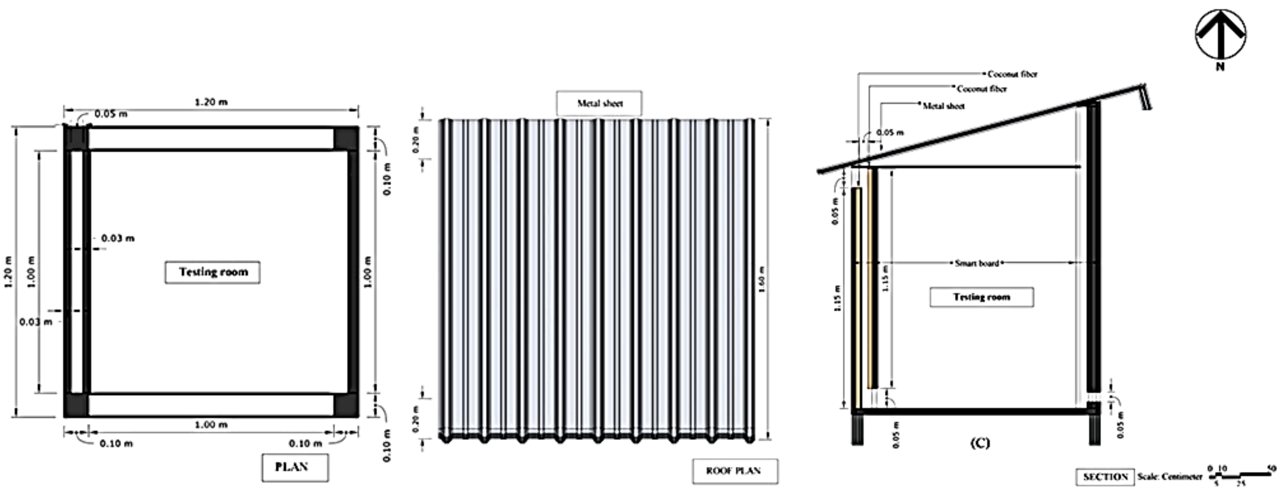

Figure 4 Model of the 3rd house model with coconut fiber-cement wall (C)

All Model House testing by Thermocouples (Type K) are installed for temperature testing in different locations. Smart Board Wall Type (A) Coconut Fiber Cement Wall Type (B) Coconut Fiber Cement Wall Type (C) The different installation locations are as follows.

Smart Board Wall Type (A)

T_{wall1} = Outside the smartboard wall

T_{wall2} = Inside the smartboard wall

T_{room} = Center of the room

Coconut Fiber Wall With Cement Type (B)

T_{wall1} = Outside the smartboard wall

T_{wall2} = Inside the smartboard wall

T_{room} = Center of the room

Coconut Fiber Wall With Cement Type (C)

T_{wall1} = Outside the smartboard

T_{wall2} = Inside the smartboard

$T_{f\text{-}wall\ 1}$ = Center inside the wall chimney

$T_{f\text{-}wall\ 2}$ = Centered inside the chimney with the outer wall.

$T_{f\text{-}wall\ 3}$ = Centered inside the chimney with the inner wall.

T_{Room} = Center of the room

T_{in1} = Center of the air intake chamber

T_{in2} = Center of the air inlet into the wall chimney.

T_{in3} = Center of the air intake into the roof chimney

While, The experiment started at 6:00 AM and ended at 6:00 PM, recording data every 15 minutes.

Results and discussion

1.wall temperature details

The temperatures at different measurement locations of the cement-coconut fiber wall (A), (B) and (C) are shown in Fig. 5 - 8 respectively, due to the continually increased heat transfer from the heat radiation. Heat from the sun through the cement-coconut fiber wall.

Figure 5 shows the temperature of the inner surface of (T wall 2) of (A) is higher compared to (T wall 2) (B) and (T wall 2) (C), respectively. 0.05 m and the vents thus cause air exchange inside the wall, thus the temperature of the inner surface of the wall (C) is lower than (B) , (A) respectively.

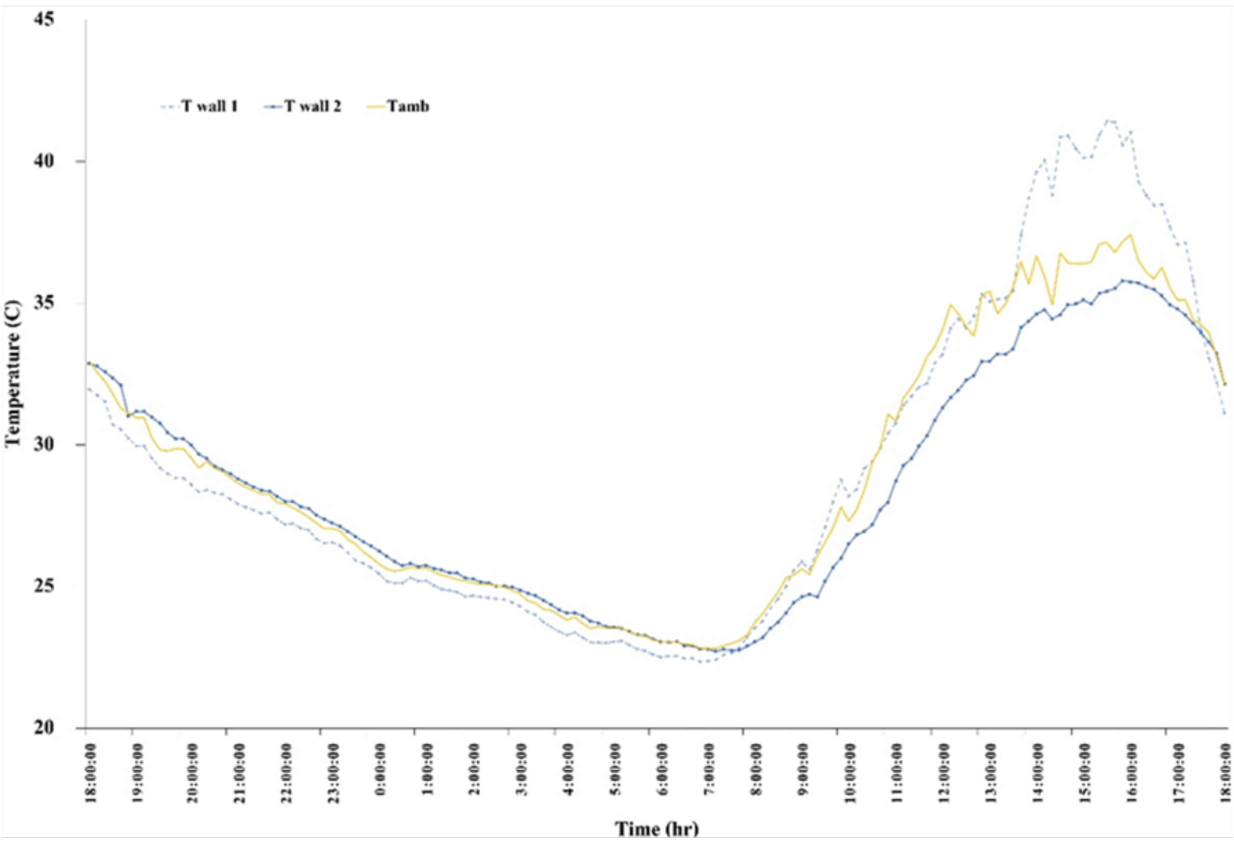

Figure 5. The Different temperature changes of smart board wall type (A).

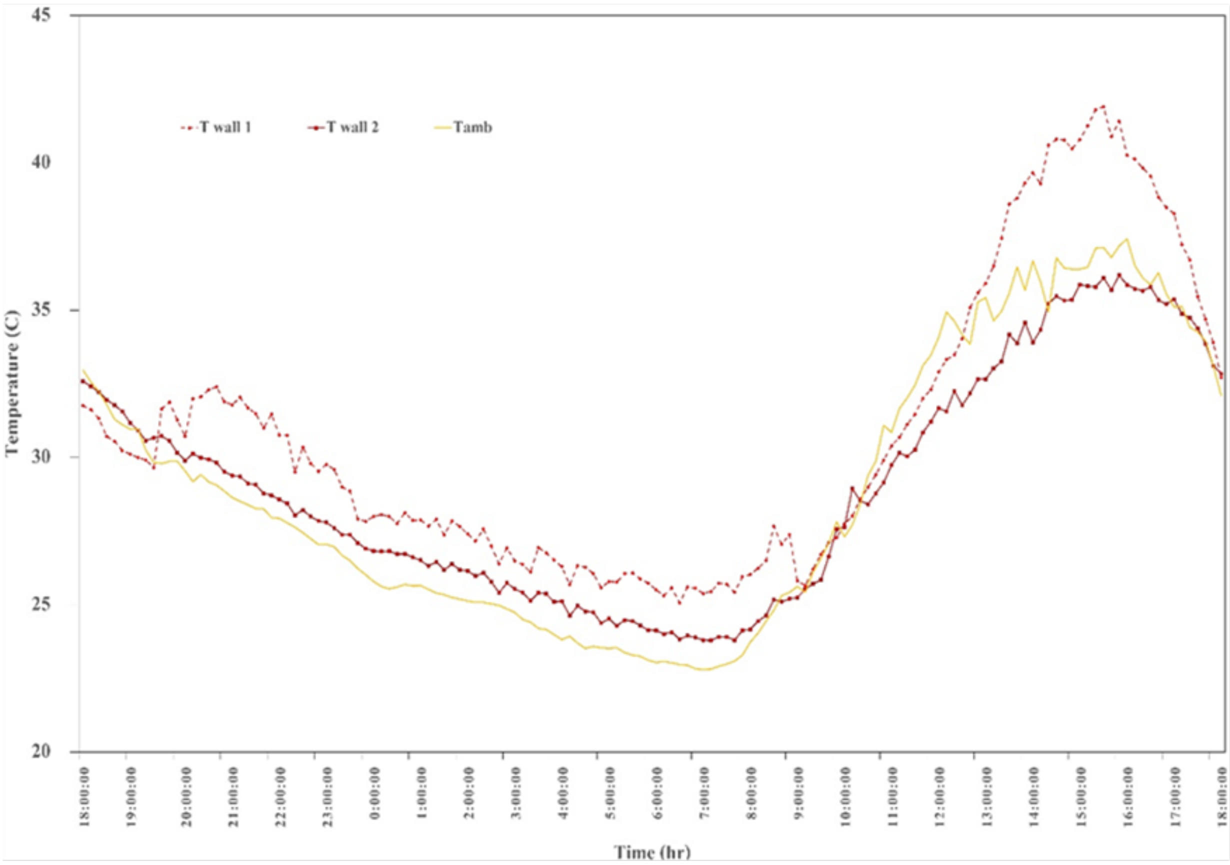

Figure 6 The Different temperature changes of the coconut fiber cement wall (B)

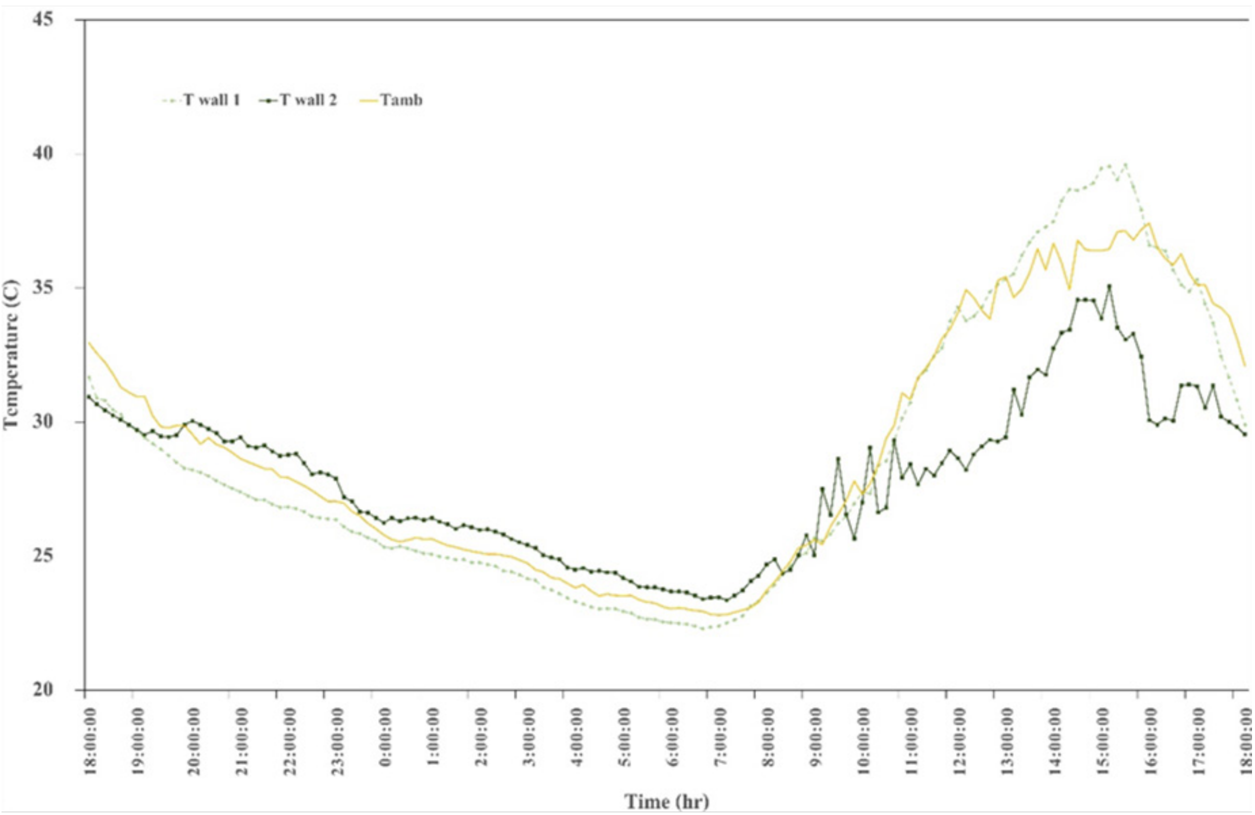

Figure 7 The different temperature changes of the cement-fused coconut fiber wall (C)

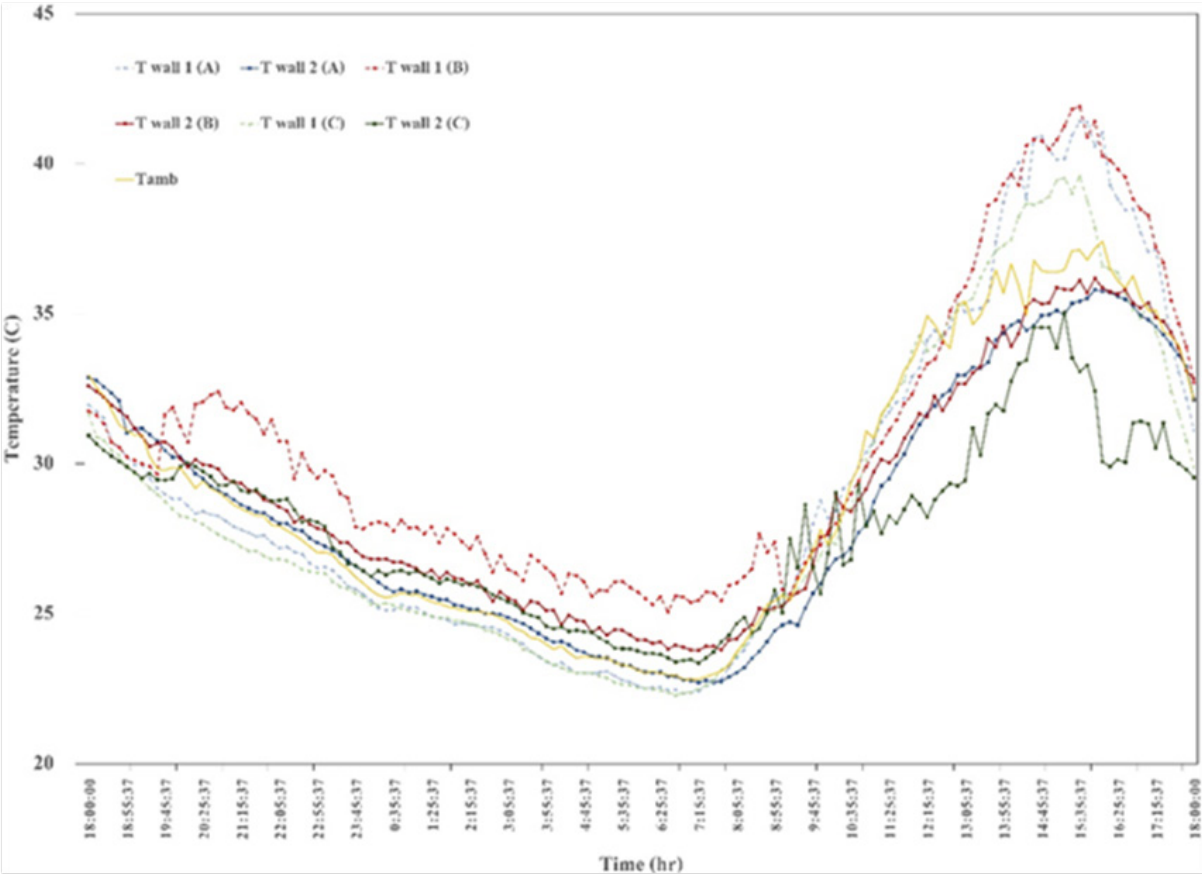

Figure 8 The different temperature changes of the coir-cement fiber wall of the forms (A), (B) and (C).

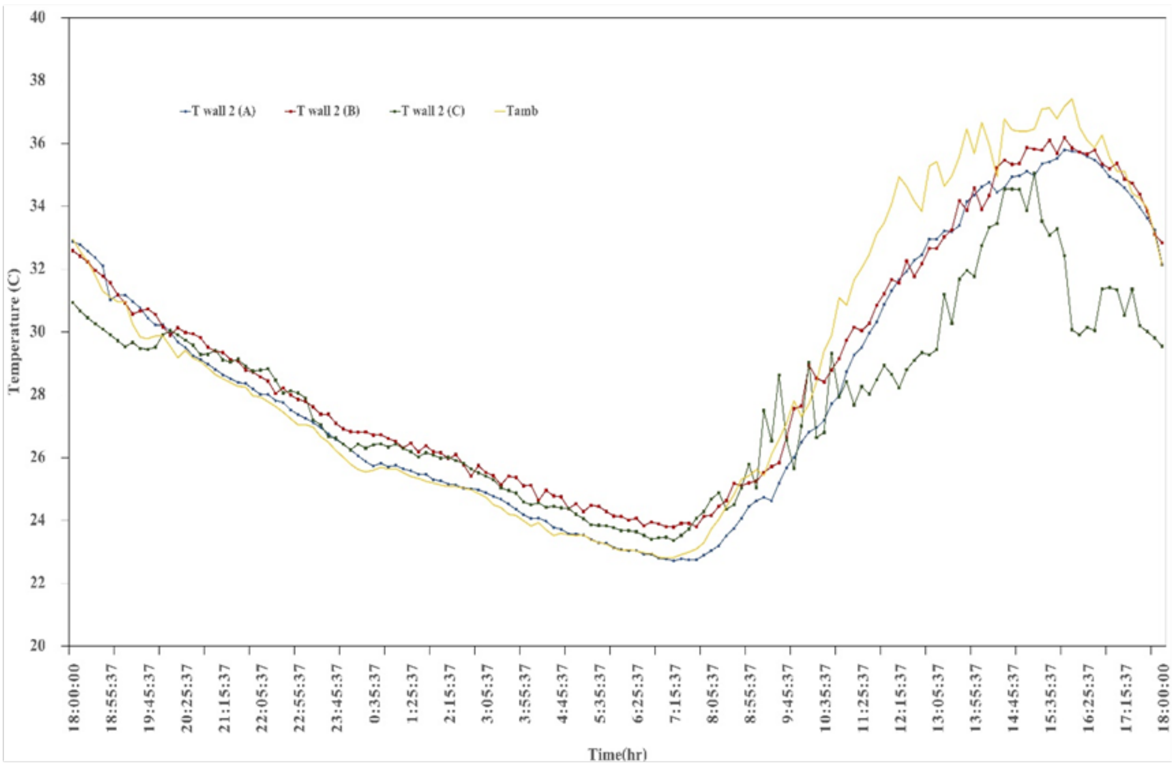

Figure 9 Shows Different temperature the temperature of the inner surface of the wall (A), (B) and (C).

The comparison of temperature differences of (A), (B) and (C) coir-cement fiber walls with the inner surface temperature of (T wall2) of (C) was lower compared to (T. wall2) (B) and (T wall2) (A), respectively, because the coconut fiber cement-cemented wall (C) has a chimney and vent of 0.05 m in size, resulting in air retardation, ventilation and air exchange. The temperature of the inner surface of the wall (C) is therefore lower than (B) , (A) respectively during the period of 2:00 PM - 3:00 PM.

2. Temperature measurement inside the test room

The figure 10 shows the temperature in the center of the room. This resulted from the reduction of heat passing through the cement-coconut fiber wall and ventilation shafts. The effect of heat radiation entering the test room is reduced. The test room temperature of (C) is lower than (B) , (A). It is noticeable that the test room temperature of (A) & (B) is higher than (C) because the test room of (B) , (A) does not. The vent thus prevents air exchange inside the wall causing the test room temperature of (C) to be lower than (B), (A), respectively, as shown in figure 10. While, (Watchrodom, N., 2018.) the insulation Coconut fiber walls reduce the temperature below ambient temperature, resulting energy consumption from the air conditioner in the room.

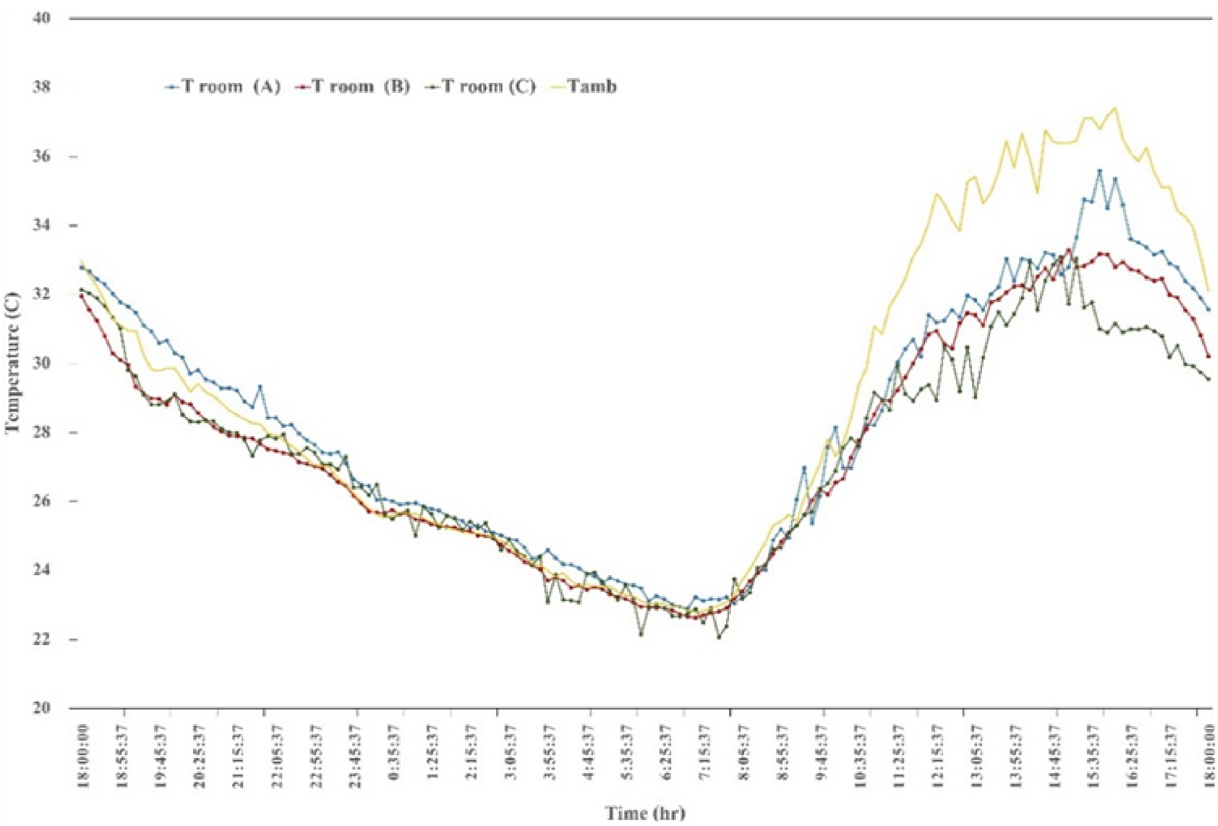

Figure 10 Comparison of temperature inside the test room of the cement-bonded coconut fiber wall (A), (B) and (C).

Conclusion

The heat transfer test through the cement-coconut fiber wall In the third model house, the coconut fiber cement-cemented wall (C) is installed with a wall chimney and a vent that allows air exchange. The coconut fiber wall mixed with cement type (C) in this research experiment has best performance. Compared to the second model house, the coconut fiber cement mixed wall (B) was installed with the coconut fiber cement mixed wall and the chimney wall alone. The 1st model house, smart board wall type (A) that has only installed smart board wall and chimney.

The 3rd model house, field tests showed that no overheating was observed at room temperature. It is usually near or below room temperature, which is of great interest. The corresponding ventilation and temperature variations caused by air were relatively high with a difference of between 1.14 and 4 °C of the third model house.

Acknowledgement

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