The Applications of Thermal Insulation from Rice Husk

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Abstract

The Northeastern region of Thailand located in hot and humid climate which average temperature and average relative humidity were quite high all year round. Heat and humidity have been transferred from outside into the building through its envelopes like roofs and walls then, human discomfort condition has been created. Moreover, if the air conditioning system was used to drain heat and humidity out, it consumed more energy for its operation. The research objective is to represent two example applications of thermal insulation from the residual material as rice husk in order to minimize the heat transferring from outside into the building. The first is 'the loose fill application' by filling dried rice husk into external cavity of walls and the second is 'the knock down application' by filling dried rice husk into used milk containers, then installed inside the building by attached to inner side of wall. By experimental methodology, these applications could minimize the heat transferring to reduce cooling energy and to enhance thermal comfort in building by utilization of residual material with local labor.

Keywords: Building Insulation, Thermal Behavior, Residual Material, Rice Husk

1. Introduction

Architectures are not only shelter to protect human from danger, but also climatic modifier for human to live [1]. In hot and humid climate like The Northeastern region of Thailand, average temperature ranged between 27-35°C and average relative humidity ranged between 65-80% in daytime [2]. Heat and humidity from the outside of the building always transfer through the building envelopes cause human discomfort. Because the human comfort condition ranged between 22-27°C and 20-75% of relative humidity [3][4] that lower than climatic condition, the thermal insulation must be used to minimize the heat transferring by installed with the building envelopes.

'Rice husk' is the residual material that can be found in many areas in Thailand, especially in the Northeastern region area. The main inspiration of these researches came from an ice factory where workers have been used rice husk to decrease melting rate of the ice by spreading on its surface. From this usage, this granular material would possibly apply as building's thermal insulation to enhance the thermal comfort condition and to decrease cooling energy demand which cause recent global warming problem [5].

2. Methodology

The two example applications of the thermal Insulation from rice husk derived from two different ideas, the first came from 'the loose fill concept' by filling the dried rice husk into the external cavity of the brick walls at 3.2 lb/ft^3[6] (Figure 1). This tested wall was installed in double-floored simulated building that made from general construction as, reinforced concrete floor, brick wall, and asphaltic shingle roof (Figure 2) then collected the data like: the outside air temperature, the outside and inside surface temperature of the wall, and air temperature inside the simulated building. The data logger and temperature sensors were used to collect the data in local area in summer through a week.

Figure 1. The external wall cavity of the simulated building filled with dried rice husk.

Figure 2. The physical character of simulated building that installed with the insulation from rice husk at its external wall.

The second application came from 'the knock down concept' by filling dried rice husk into used milk containers at the same density like the first one (Figure 3) to reduce emissivity value by using the qualification of aluminum foil inside the used milk containers. The containers with rice husk were installed inside the tested wall, made from 4 inches brick wall (Figure 4) and placed perpendicular to the south side of tested cell which made from 6 inches polystyrene foam (Figure 5). The temperature data such as: outside air temperature, surface temperature, and inside air temperature of tested cells were collected by data logger and sensors through a week in summer and they were compared with the temperatures of general wall without any insulation. The test area has been located in the department of building technology, Faculty of Architecture, Khon Kaen University.

Figure 3. The panel of used milk containers filled with rice husk.

Figure 4. The tested wall was installed with the panel of used milk containers filled with rice husk.

Figure 5. The tested cells placed with tested walls.

3. Results

In the first part, temperature in simulated building is quite constant at 25-27°C while the outside air temperature is 27-37°C in daytime and 22-27°C in nighttime (Figure 6). The outside surface temperature of the insulated wall is quite high (40°C at peak in daytime) because of the resistance qualification of the external insulation method. The inside surface temperature of wall is conform to the air temperature inside simulated building.

In the second part, the air temperature inside test cell installed with the rice husk insulation is range between 25-30°C, lower than the air temperature inside the test cell without insulation around 2-3°C at peak during daytime (Picture 7). However, the temperature in tested cell which placed with the insulation inside the wall is higher than outside air temperature in 24:00-12:00 because the heat is hard to drain out of tested cell.

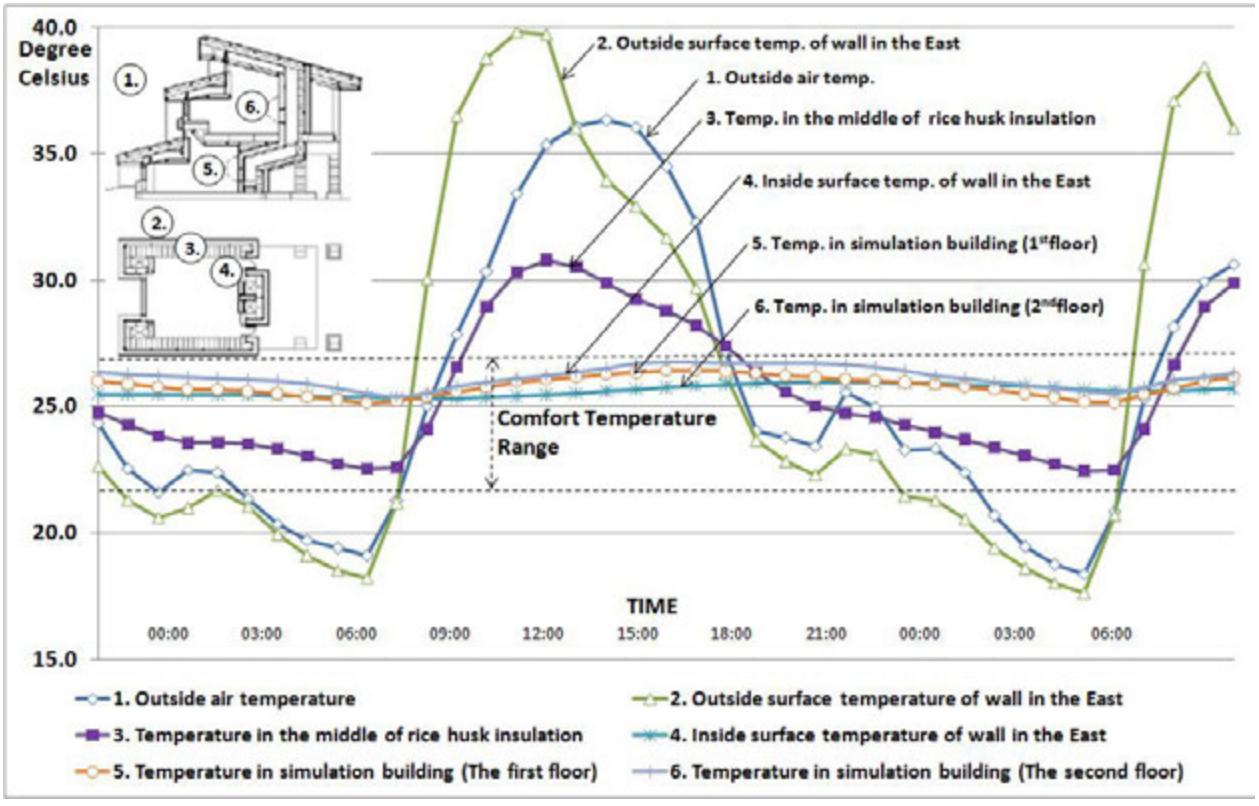

Figure 6. The temperature of each positions of the simulated building compared with the outside air temperature.

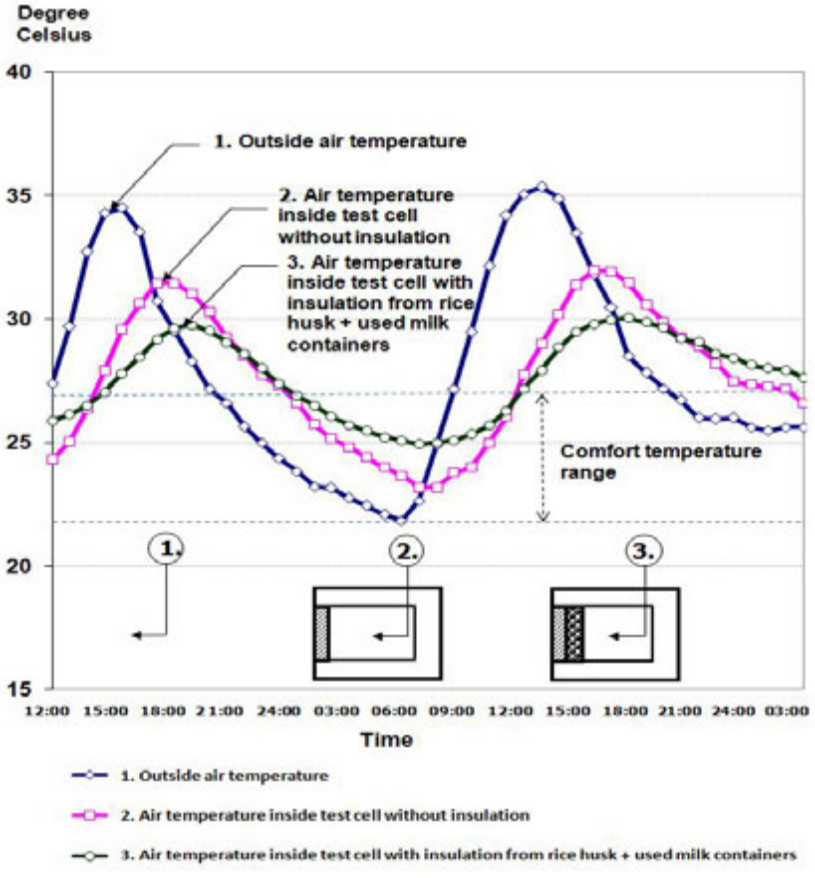

Figure 7. Air temperature in tested cell placed with the rice husk insulated wall and temperature in test cell placed with general brick wall without any insulation compared with outside air temperature.

5. Discussion

From figure 6, inside air temperature in the first floor and the second floor of simulated building are stay in the human comfort range all the time. The reasons why the air temperature in the simulation buildings are quite constant are, the thermal qualification of rice husk and the external insulated method, notice by the harmony between inside surface temperature and inside air temperature of the simulated building. During nighttime, the air temperatures in simulated building are higher than the outside air temperature due to the external insulation's resistance qualification.

Harmony with figure 6, in the second part of research (Figure 7.), the reason why the temperature in test cell placed with the wall insulated by milk container with rice husk is lower than temperature in test cell placed with the wall without insulation is thermal resistance of this insulation like the first part. However, the temperatures in all test cells are higher than comfort range in 12:00-24:00, stay in comfort temperature range in 24:00-12:00. The main influential factor that makes the different among these two parts is the thermal behavior difference between external and internal insulation method. The external insulation concept is the method to use the insulation outside of main wall. By this idea, the insulated wall can resist the heat transfer from outside more efficient than the internal insulation method because the insulation can shade the main wall (always made with high density materials) from direct sun light. Furthermore, this external insulation also minimizes the harshness of diurnal swing temperature between daytime and nighttime by protection main wall from sunlight and outside temperature.

6. Conclusion

From the results of these researches, the rice husk will be used for the building as a thermal insulation at least in two applications. If these applications will be used in the future, the pest controlling and humidity protection will be considered. Furthermore, many residual materials can be found in our local area and can be applied as the building insulation like rice husk. The applications of local materials or residual materials will be an appropriate choice for human to environmental awareness because they can reduce the transportation energy that used to convey them from one place (production area) to another (construction area), and we can add the value of residual materials by applying them in order to reduce our energy demand and enhance human thermal comfort in our buildings.

7. References

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