The potential utilization of natural materials as a wall covering of the building in heat reduction

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The potential utilization of natural materials as a wall covering of the building in heat reduction

K Jeumpa[1,*]
Doctoral Study Program of Technology and Vocational Education, Faculty of Engineering, Padang State University, Indonesia

E-mail: ipajeumpa@gmail.com

Abstract. This paper aims to examine the potential of natural coco fibre to be utilized as a wall covering in building construction for sun radiation protection. Engineering innovation in building construction to control the building's temperature is important. Lowering the building's room temperature can be carried out by modifying the wall construction materials. Thus, the usage of an air conditioner which is not environmentally friendly can be reduced. The wall modification can give more protection and dampen the sun's heat, hence the thermal comfort can be obtained. Natural materials, moreover, can be used in the wall modification to reduce the room temperature. In this study, a comparative analysis was carried out between two materials: (1) the coco fibre coated with cement mixture; (2) the mixture of cement and sand, both were used as materials to plaster the wall. The cement mixture acted to bind the compacted coco fibre sheets. The material was evaluated after the cement mixture had been hardened. The test was carried out by providing heat on one side and measuring the temperature on the other side of the material. The results were significant between the two materials. This indicates the potential of coco fibre as a heat insulation in the wall construction materials that can minimize solar thermal radiation into the room.

1. Introduction

Sunlight is the main source of heat in the building, the heat of sunlight mainly enters the room through roofs and walls. About 83% of the sun's infrared rays going through from the roof and building walls are absorbed and emitted into the room by radiation, conduction and convection. In humid tropical climates, building coating is important to protect the occupants from the sun's heat, also reducing the radiant heat forwarded into the building. Therefore, one of the functions of the building coating is to control or to reduce the heat load from solar radiation into the building (transmission). The entry of solar radiation into the building can be through a vertical cover that is a wall or a horizontal or sloping cover that is roof. Cooling the space in this way is classified as passive cooling system that relies heavily on air movement as a hot carrier medium in the morning to late afternoon to reduce room's temperature, (Cook, 1985; Giovani, 1994) in [1].

The rise of earth's temperature due to global warming has increased the usage of air conditioner as the demand of comfortable room's temperature has increased as well. This increases the energy use thus further worsen the global warming. Bourdeau, 1999 revealed the fact that 50% of the energy absorbed in a building is only for refrigerators, and at least, 30% of a country's total energy is used in housing. This figure is only applicable in developed countries that are more manageable. Hence in developing countries, the figure will be bigger. If this is not handled strategically, it will devastate the sustainability of the national development. Based on these factors, innovations in building construction are desired to conserve energy and environment.

The heat absorbed in the wall propagates into the room and increases the room's temperature. Walls can be made to dampen the sun's heat and protect the indoor space from the heat. Therefore, one way to inhibit heat from the outside is through the wall modification.

* Corresponding author: ipajeumpa@gmail.com

Non-heated rooms can reduce the usage of air conditioner. The reduced usage of air conditioner means to save energy and also save the earth and the environment.

Some researchers had studied on environmentally friendly innovation of building construction materials to combat global warming. For instance [3] had conducted a research on lightweight concrete panels focused on the pearlite as a concrete panel mixture as a heat insulator. Likewise, [4] had conducted research on mortal mix materials focused on the utilization of pumice breksia as the main ingredient of instant mortar as a heat reducer. While Hary Wibowo had conducted a hot conductivity study between styrofoam and rice coir, focusing on the comparison between styrofoam particleboard and rice coir particleboard as heat insulators. Similarly, foreign researchers had studied building materials for heat muffling. For instance, [5] had studied the addition of retro-reflective materials on the wall, which was found to be capable to improve the building's temperature control by reflecting solar radiation back in the opposite direction. Furthermore, [6] conducted a study determining the thermal conductivity of periwinkle shells (seashells) reinforced cement as the building wall construction materials. Meanwhile, [7] conducted a study on assessing the impact of energy performance of hygrothermal behavior of plant-based insulation products in buildings, predicting indoor climatic conditions, and preventing unexpected degradation risks.

Environmental awareness can be realized with the use of materials derived from nature as a form of energy conservation and environmental protection. For example, coconut coir (coco fibre) is minimally utilized in Indonesia, for the most part it is considered as a mere waste. Coco fibres are widely available in Indonesia, as they can be obtained from the coconut harvest each year. Not to mention, 35% of the coconut total weight is consisted of coco fibres.

In this regard, this research is urgently important to evaluate the potential of coco fibre, as a natural material, to reducing heat in the building. The main question of this research is how potential is the coco fibres to act as a heat insulator. This research was conducted with the aim to evaluate the potential of coconut coir, which later can serve as a the building wall coating to reduce heat from the external environment.

2. Materials And Methods

The materials of this research included: (1) coir reinforced cement; and (2) a mixture of cement and sand (commonly used wall plaster material). A compacted coconut fibre sheet was coated with a cement mixture that also acted to bind the coir. The process of the material preparation can be observed in Figure 1 below.

Figure 1. The process of making coir test material

This research is experimental in nature to study the potential of coconut coir as heat insulator. In this research, the two materials were compared by their ability to inhibit the heat propagation. The test was carried out after the mixture had dried and hardened. The test was carried out by providing heat on one side and measuring the temperature on the other side of the materials respectively. The heat applied to the material surface was 60 ˚C for 2 hours.

3. Results And Discussion

Environmental awareness can be realized with the use of materials derived from nature as a form of energy conservation and environmental protection. Coconut fruit consists of fibres (coir), shell (the hard layer), coconut water, and coconut meat. The fibres can be found on the outer layer of the coconut protecting the shell. Meanwhile the shell and the membrane attached in the inner side, serve to protect the seeds. Inside the coconut, there is liquid containing many enzymes known as coconut water. The solid phase, attached on the inner shell which keeps growing as the coconut getting ripe, called coconut meat. Coconut coir provides protection for the coconut from the external interference including from the heat of sun. Based on this fact, coconut coir is considered to be potential for heat insulation, hence this research to evaluate the application of coconut coir application as a building wall coating is necessary.

This study compared the materials with and without the coir. The test results can be observed in the graph in Figure 2 and Figure 3 below.

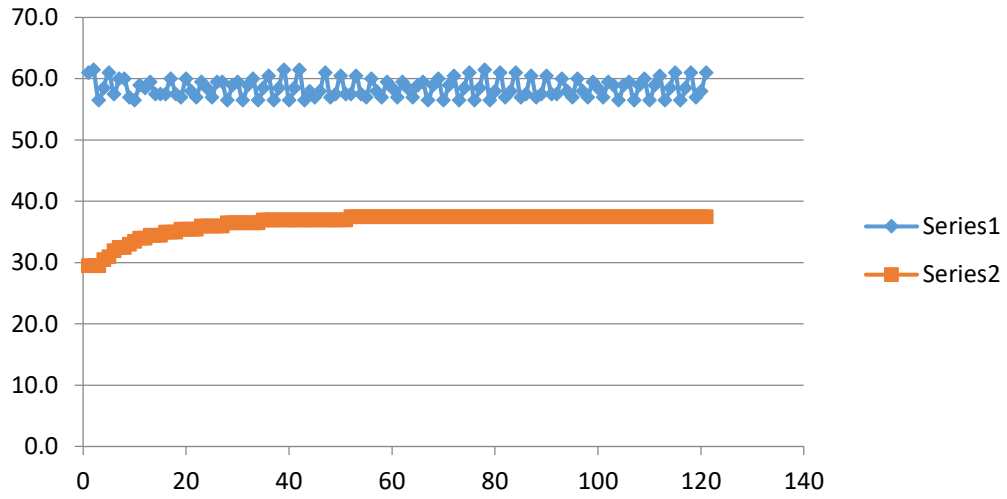

Figure 2. The test result of the material without coir

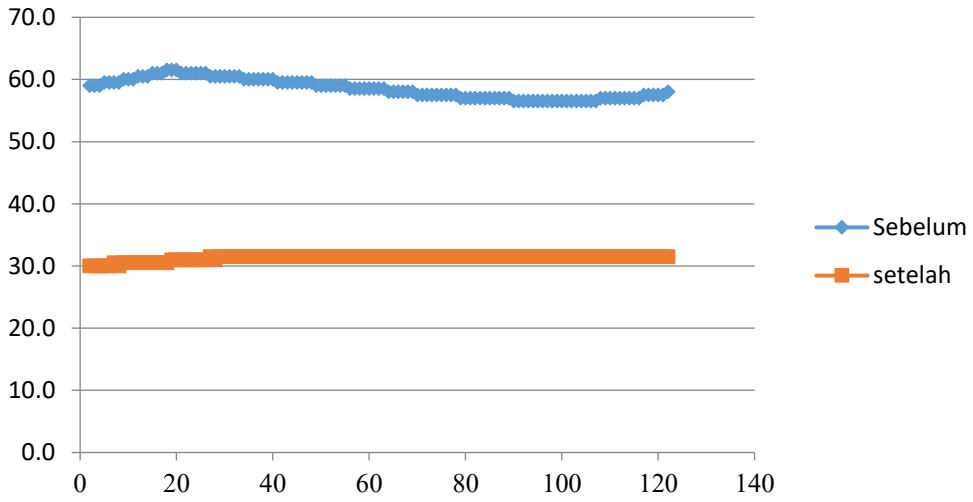

Figure 3. The test results of the material with coir

The graph in Figure 2 shows the result of the test material without coir. The y axis shows the temperature on the material surface expressed in degree Celcius. The x-axis shows the length of time the heat is applied during the test, expressed in minutes. Series 1 exhibits the amount of heat applied on one side of the material expressed, while the series 2 indicates the amount of heat measured on the other side of the material. The graph explains, when the given heat was 60 ˚C, the temperature measured on the other side was initially around 30 ºC. Within the 40th minute, the heat increased rapidly on the other side, indicates a quick heat transmission. A constant heat reached around 39 ˚C at the 120th minute.

The graph in Figure 3 shows the test results of the coir reinforced material. The y axis shows the temperature on the material surface expressed in degree Celcius. The x-axis shows the length of time the heat is applied during the test, expressed in minutes. Series 1 exhibits the amount of heat applied on one side of the material expressed, while the series 2 indicates the amount of heat measured on the other side of the material. As opposed to the material without coir, the material with coir exhibits no rapid increase of the temperature on the other side at the first 40 minutes (30-31 ˚C). This indicates a good insulation properties reinforced by the coir towards the material. The constant temperature of 31 ˚C reached under 40 minutes of the treatment. A significant difference of the heat applied and transmitted can be observed in the test results. However the coir reinforced material is more capable to reduce the heat as opposed to one without coir reinforcement.

This study may still be far from perfection because the test equipment required is still limited. The heat given is still too high (60 ˚C) because it is rather difficult to set the tool to produce heat near the temperature of the actual environment. Therefore further study is required to measure the effectiveness of coir reinforced material in heat insulation.

4. Conclusion

From the measured temperature compared with the two materials, it can be concluded that, the coir material has the potential to be utilized as a building coating insulation material which serves to reduce heat transmission from the outside environment.

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