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The Relation Between Temperature and Time on the Application of Coconut Fiber Cement Panels as Potential for Wall Cover

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Abstract
This research is about coconut fiber material which has the potential to wall cover and the relationship between temperature and time of coconut fiber material in reducing temperature. The wall, as one of the building envelopes, endures high sun radiation. It needs the wall material that can reduce temperature to ensure thermal comfort inside the building. Gaining building thermal comfort requires architecture, knowledge, and skills as well as innovation. Lowering temperature in the room can be done through wall modifications so that it can lessen the use of air-con. Thus, research on the use of natural materials such as coconut fiber for walls is needed. This study is using an experimental approach. The coconut fiber was tested to measure the temperature reduction and study its linear equations from the relation between temperature and time given. The analysis is comparing two materials: (1) the mix of cement and sand without coconut fiber; (2) The mix of cement and coconut fiber material. The tests' procedures are applying heat temperature to the side of the material and measuring the resulting absorbed temperature on the other side of both materials. Both of the material was exposed to 35°C heat temperature for 150 minutes. The materials are set in a box. The tests use 3 thermal sensors are T1, T2 and T3 and one heater. This heater is connected to the power source and a device to control the temperature given called Ts controller. The test shows different results between the temperature of material with coconut fiber and material without coconut fiber. The coconut fiber material has a lower temperature than that of without coconut fiber. The linear equation of the coconut fiber material related to the time and temperature shows the longer time, the lower the temperature is. Thus, it indicates the potential of coconut fiber material used as cover for building walls.

Keywords: material, temperature reduction, coconut fiber, linear equation

1. Introduction

The room receives solar infrared radiation through radiation, conduction, and convection about 83%. The building envelope, namely the roof and walls, must be able to protect and reduce heat radiation transmitted into the building, especially in humid tropical climates. Buildings receive heat from solar radiation through the horizontal covering, namely the roof and the vertical covering by the walls [1]. This air-cooling system is called passive cooling. The

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system mostly relies on the airflow as a heat-transfer medium from morning till evening to reduce the room thermal [2].

As global warming increases the earth's temperature, the need for air conditioning in the room also rises due to the higher demand for room comfort. Higher use of air-con increases the use of the earth's energy and further contributes to global warming, revealed that 50% of the energy used in a building is for cooling equipment, and 30% of the total energy used in a country is usually for housing [3]. It is showing the use of energy in more manageable developed countries, but it will be higher in developing countries. This condition must be handled with strategies. Otherwise, it will have terrible impacts on the sustainability of national development. Thus, building innovations are needed to conserve energy from the environment.

The heat transferred through the walls will increase the room temperature. Walls need heat insulation to keep the room temperature not hot. It is necessary to modify the walls in order to reduce the heat temperature from outside the building. When the room temperature remains low, the use of air conditioning will decrease, thus for save energy, earth, and the environment.

One of the strategies to control solar heat in buildings is the Thermal Insulation Strategy. This strategy control thermal/heat by using materials that can inhibit heat transfer. Reducing heat transfer needs materials with low thermal conductivity. It means the walls need to have higher heat-reflecting ability than their absorbing capability, as presented elsewhere [4].

Using natural materials helps conserve energy and the environment. One of the natural resources is coconut fiber which is mostly wasted and not being used optimally. The amount of coconut fiber produced from coconut harvest every year in Indonesia is quite high since it weighs 35% of the total weight of coconuts.

Therefore, it is necessary to research natural materials that can inhibit heat temperature [5]. This research was conducted to determine the relationship between temperature and time on coconut fiber, which is expected to be potential as a wall covering to reduce the temperature.

2. Methods

There are two different materials in this study: 1). coconut fiber cement panels; 2). Material without coconut fiber. The compacted coconut fiber is coated with cement mix to bind the coconut fiber. The temperature test is done after the mix dries and hardens. The process of making the materials is in figure 1.

Figure 1. Process of making coconut fiber material

The research approach tests related to coconut fiber in reducing heat was following the flowchart in figure 2.

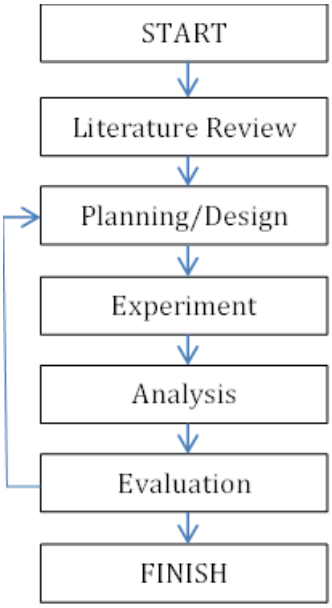

Figure 2. Flowchart of the research process

This research was preceded by reviewing literature and journals related to the modification walls and the ability of natural source material to reduce temperature. The next step is planning and designing material with 1 of centimeter thick coconut fiber panels and material without coconut fiber. The experiment is comparing the ability of coconut fiber panels and material without coconut fiber in reducing temperature. The test is carried out by applying heat temperature to part of the material and measuring the heat absorbed in the other parts of each material. Both of the material was exposed to 35°C heat temperature for 150 minutes. Measuring the temperature is using sensors connected to a computer, and the computer screen will show the temperature detected.

In this test, the materials are set in a box. The tests use 3 thermal sensors and one heater. This

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heater is connected to the power source and a device to control the temperature given called Ts controller. The first sensor or T1 is near the material and connected to the heater to measure its temperature. The second sensor or T2 is outside the box to identify the surrounding temperature. The third sensor or T3 is on the other side of the material to detect the temperature absorbed. The process can be seen in figure 3.

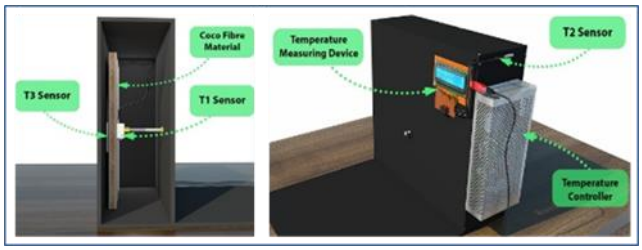

Figure 3. Testing process of coco fiber material

The analysis was to compare the ability between the material with coconut fiber and without coconut fiber. Besides, this analysis aims to figure out the relationship between temperature and time on the material with coconut material in reducing temperature every 30 minutes. The relationship between temperature and time is the linear equation in figure 4. The study ended with an evaluation of the test and the results obtained. The evaluation helps to give input and improvement to this and similar research.

3. Results

The results in both materials show the difference between the amount of temperature exposed and measured. Comparing the two types of material clarifies that coconut fiber material reduces more heat temperature then the material without coconut fiber. The results are in Figure 4.

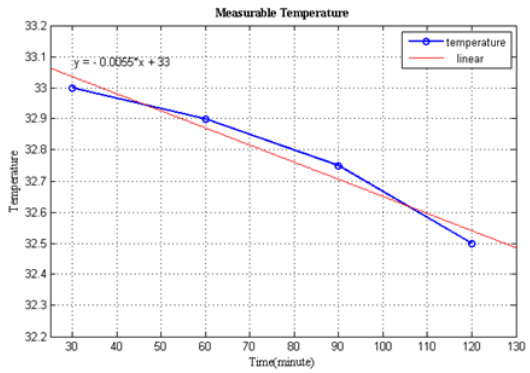

Figure 4. Temperature Measured in the coco material in every 30 minutes

Furthermore, the temperature on the coconut fiber material is reviewed every 30 minutes to get the linear equation from the material. The graph shows a linear equation of the relationship between the temperature on the Y-axis and time on the X-axis, as on equation 1.

$$Y = -0.0055X + 33 \quad (1)$$

Based on this equation, it is found that the longer the time, the lower the temperature. This research is still far from perfect because testing instruments used are still limited. Therefore, further research is needed on the ability of coconut fiber material as a potential for building wall cover.

4. Discussion

Research on the innovations on environmentally friendly buildings to respond the phenomenon of global warming. It has been done by some researchers in research on building materials for walls that can reduce heat among them, as presented by other. The research was conducted on lightweight concrete panels focus on the pearlite as a mixture of concrete panels that can serve as a heat insulator.

Also, Santoso et al. [7] conducted research on mortal mix materials with a focus on the utilization of pumice breksia as the main ingredient of instant mortar as a heat reducer. Other researcher also conducts study on a hot conductivity study between Styrofoam and rice coir, then measuring the heat related to particle board and rice coir particle board composition for heat insulators [8].

Similarly, other studies conducted by Meng et al. [9] on building materials for a wall capable of muffling the heat. Study of the wall of the building that focused on the addition of retroreflective material on the wall, which can improve the temperature of the building by reflecting solar radiation back in the opposite direction has also been studied by other [10]. Omubo-Pepple et al. conducted a study on building walls with a focus on determining the thermal conductivity of cement reinforced by periwinkle shells (sea shells) used as construction materials.

Meanwhile, Samuel et al [11] conducted a study of building walls with a focus on hygrothermal behavior of plant-based insulation products to assess their impact on energy performance in buildings, predict indoor climatic conditions, and prevent unexpected degradation risks.

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Several studies were also conducted on the potential of coconut fiber by Irwan et al. [12] related to the effect of addition of coconut fiber to concrete mixtures as sound absorbers; then Yusril also studied about development of coconut coir fiber for making boards with different types of matrices of cement, gypsum and clay [13].

Research on innovations related to building materials that can reduce heat has been carried out by many researchers but not many have conducted research on the natural material of coconut fiber. Coconut fruit composed of fibers that serve to protect the hard part called the shell, serves to protect the seeds that are only protected by the membrane attached to the inner side of the shell, there is a liquid containing many enzymes called coconut water, and solid phase settles on the wall of the shell along with the growing old fruit called coconut meat.

It can be concluded that the coconut fiber is part of the coconut that protects the inside of the coconut from the outside including from the heat of the sun. Based on this, coconut fiber is estimated to have the potential for heat insulation so, it is necessary to research the coco fiber as building wall coating to reduce heat. The results test can be shown in the graph in the following figure 5.

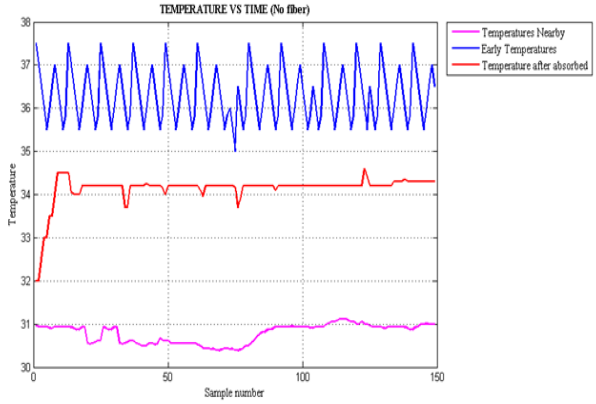

Figure 5. Testing process of coco fiber material

Figure 5 is the result of the material without the coconut fiber. The Y-axis represents the temperatures before and after the material absorbed heat temperature in Celsius. The X-axis illustrates the duration of the test in minutes. The blue line is representing temperature on the material before the heat is absorbed. The red one is after it is absorbed, while the gray line indicates the amount of temperature surrounding the test box.

The results show that when exposed to 35°C of temperature for 150 minutes, the temperature in material without coconut fiber ranges about 34.2°C, as presented on Fig. 6.

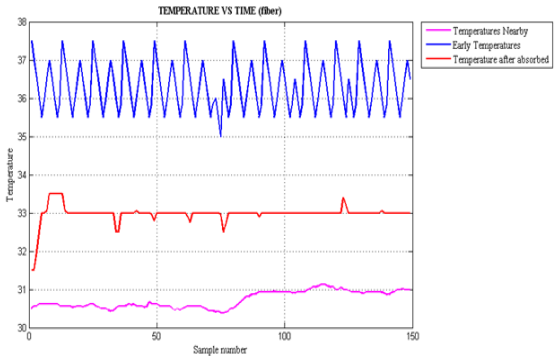

Figure 6. Results of the coconut fiber material

The graph in figure 6 is the result of the material with coconut fiber. The Y-axis expresses the temperatures before and after the material absorbed heat temperature in Celsius. The X-axis is the duration of the test in minutes. The blue line is the temperature on the material before the heat is absorbed, the red one is after it is absorbed, while the gray line shows the amount of temperature surrounding the test box. The results prove that when exposed to35°C of temperature for 150 minutes, the temperature in the material with coconut fiber is about 33°C.

5. Conclusion

Derived from the temperature ratio of the two materials, it can be concluded that coconut fiber has the potential to reduce heat temperature from the outside as to be material on the wall cover of buildings. Based on the linear equation, it shows that the longer the coconut fiber material being used, the lower the measured temperature.

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