Recycled Wood Technology for Wall

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Abstract. The purpose of this research is to discover how to identify the specification of wood wasted wall that can be used to comfortable wall and to determine the potential of wood waste as a building wall and its effects to user comfort. This research used descriptive qualitative method and literary study, it is hoped that this research can provide a picture of the application of wood waste as a wall which is also equipped with phenomena that occur in society, especially in Indonesia. The results are the methods of finding out how wood in general has the ability as an insulator that can inhibit heat transfer, so that it can affect the air temperature of a room and give effect to the comfort of space and improve building performance through passive design. Stressing levels will be different from experiments conducted on participation with various wood waste walls of different thicknesses and various colour of wood. Wood waste is not only can be used as firewood, but can also have added value through its use as a wall that has functional and aesthetic value with good and proper processing.

1. Introduction

This research aims to how to knowing the specification of wood wasted wall that can be used to comfortable wall and to determine the potential of wood waste as a building wall and its effects to user comfort. One of the things that should get more attention when designing a building is comfortability. Comfort is one of the factors that makes a person feel comfortable to do various activities in a room, for example by making the room warmer in winter or making the room cooler in summer. To make a room have an ideal level of comfort, one of the efforts is by using wood waste as wall, it is because there are still many production activities with wood materials in Indonesia and the reprocessing of wood waste is still low.

This research was made based on the potential of wood waste which has the same properties as solid wood as an insulator with further processing wood waste can be a solution to provide thermal comfort for space users with low energy usage levels [1]. Indonesia is an equatorial tropical region with two seasons, namely the rainy season and the dry season with quite high rainfall. Annual temperatures are around 23°C in the rainy season to 38°C in the dry season with relatively low velocity of the winds and high levels of humidity and solar radiation [2]. One material that is easy and inexpensive to use is wood waste which is currently one of the abundant materials in Indonesia. Wood waste is used as an outer wall that functions as an insulator that bring cold air or excess heat can be held by the wooden wall so that the air that enters the building is warmer and more stable ventilation [3]. Wood waste was chosen because it has good weather resistance and sensitivity to low temperature changes. Wood material also has a high degree of flexibility so that it is easily combined with various other types of materials that
can maximize the strength of wood walls [4]. In addition to the comfort of the room temperature, wood waste walls can also provide psychological comfort to building users because wood has the ability to reflect long waves that appear yellow to red so that from the side of human vision wood gives a warm effect on a space [5,6].

For this reason, research on the processing and reuse of wood waste aims to find out the potential for wood waste as building walls and their impact on the comfort of space, considering that wood is one of the natural insulators capable of inhibiting heat transfer so that it can affect the air temperature of a room [7]. The purpose of this research is to discover how to identify the specification of wood wasted wall that can be used to comfortable wall and to determine the potential of wood waste as a building wall and its effects to user comfort. This research used descriptive qualitative method and literary study, it is hoped that this research can provide a picture of the application of wood waste as a wall which is also equipped with phenomena that occur in society, especially in Indonesia.

2. Method
The methods used in this study are descriptive qualitative method and the literary study by examining journals related to research on the use of wood as building walls. The results of this literature analysis are then used to find out what kind of impact of the use of wood waste as walls on comfort and what factors that support the potential ability of wood waste as building walls.

3. Results and Discussion
Wood is one of the materials produced by nature. Wood is a material consisting of cells. The structure consisting of cells gives wood many unique characteristics and characteristics [8]. Indonesia is one of the countries with the largest timber industry. Generally, wood is used as material for building construction or furniture such as chairs, tables, window sills, doors, fences, to handicrafts with increasingly sophisticated production processes. From each of these production activities, of course it will always produce waste that will cause various environmental problems, for example such as river water pollution or if burned will cause air pollution. Wood production in Indonesia reached 2.6 million m$^3$/year and assuming the waste generated was 54.24%, the resulting waste reached 1.4 million m$^3$/year [9].

For this reason, one of the efforts to reduce waste arising from production results is to process and reuse wood waste as one of them as a wooden wall [10-12]. This utilization is an effort of implementing sustainable architecture with energy saving that is environmentally friendly so that people from various circles can participate in making this effort because of the low cost. Wood is a natural insulator that has the ability to inhibit heat transfer so that it is good to be used as an intermediate material because it has a high cell density [13]. Therefore, wood waste has the potential to be used as a wall material that can inhibit the transfer of temperature from the outside into buildings that aim to provide thermal comfort in a space or psychological comfort. The strength of wood based on SNI 03-6848-2002 is influenced by:

1. Weight type
2. Moisture content
3. Wet condition
4. Dry oven condition
5. Dry air condition
6. Fiber saturation point

The climate approach is carried out as part of the passive design response of the building to the potential of the micro climate in Indonesia. Passive design of buildings one of which is to use a material approach that aims to maximize the performance of the building so that it impacts on the comfort of the occupants and users of the building [11]. Waste wood walls can be used as a timber-cladding material that can filter changes in temperature from outside into the room. Comfort becomes an important thing
in a building because comfort can have an impact on one's productivity in the room. Wood waste is used as a natural thermal comfort provider which will inhibit the transfer of temperature from the outside and stabilize the temperature entering the room so that the incoming temperature is neither too hot nor too cold which can have an impact on human physical comfort.

Impacts of using wood waste as wall:
1. Minimizing the heat gain (heat gain) of solar radiation into a room
2. Provides the effect of cold at high temperatures (passive cooling)
3. Give a warm effect at low temperature

Various studies related to comfortable temperatures to conduct various activities in humid tropical climates, such as Mom and Wiesebron in Bandung, Webb, Ellis, de Dear in Singapore, Busch in Bangkok, Ballantyne in Port Moresby, then Karyono in Jakarta, showing that the temperature range between 24°C to 30°C is considered comfortable for humans who live in these climate regions. In addition, the ability of wood to reflect long waves so as to create colour vision from yellow to red gives a warm impression to the room. As research conducted by Satoshi Sakuragawa, Yoshifumi Miyazaki, Tomoyuki Kaneko, and Teruo Makita where a room with wooden walls can have an effect that is a decrease in blood pressure from participants significantly and heart rate becomes slower which means participants become more relaxed. This is slightly contrary to participants who have to face the closed curtain which over time there is an increase in blood pressure. So that it can be seen the impact of the use of wood waste material not only has the technical ability that can stabilize the temperature from the outside, but also the aesthetic value through the unique forms of fiber and the resulting colour impression can affect the psychological condition of humans with an experiment by using a room in Figure 1 [6].

![Figure 1. Model of a wooden wall design](image-url)

Experiments were carried out on various aspects to modified of the wall, as in Figure 2, participants were surrounded by walls covered with white curtains. It can be seen that participants are allowed to sit facing the wall and an analysis of how long participants experience will stress when continuing to look at the wall.
Different participant in Figure 3 showing the experiments to analysed stressing level on participant are allowed to sit facing the wall using steel walls with white paint.

Figure 4 shows the experiments on participants sitting on chair and facing the wall using the Hinoki wood walls with natural colour.
Figure 4. Wooden wall

The results of the experiment show on graphic in figure 5, when the participant using room as show in Figure 4 with Hinoki wooden wall, showed that participants facing a wooden wall had the lowest level of stress.

Figure 5. Mood level of the first participant

Contrary to the results in the Figure 3, who participant sitting on chair and facing up with the steel white wall, in the analyze diagram figure 6 shows the stress level of the second participant who was facing white steel is high.
4. Conclusion
The conclusion this research is that wood waste has the same characteristics as log which through a certain process can be used as one of the solutions to solve thermal problems in architectural designs in tropical climates through the recycling process. The aesthetic potential of wood waste in the form of colour and wood fiber give psychological impact to the users while in a room. In its utilization, wood waste is no longer a waste that damages the environment, but can provide room comfort and has high economic value, by making it for wooden wall.

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