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Sandwich Panel Board Using Coconut Fibre and Fiberglass

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Abstract : This study focus on the coconut fibre wasted in our daily life. Therefore, recycling is a suitable way to reduce coconut fibre waste. Based on the previous study, coconut fibre waste is also suitable for production of panel boards apart from for agricultural purposes. The production of panel boards from coconut fibre is not suitable as an outer layer due to its non-waterproof properties. Then, it should be produced in the form of sandwiches. Therefore, to make the outer layer of the panel board, the material chosen must have a high density that is material does not absorb water. The most suitable material is fiberglass panel board. The objectives of this study are to produce sandwich panel board using coconut fibre panel board and fiberglass panel board by layering method. Next, to test Modulus Of Rupture (MOR), Water Absorption (WA) and Thickness Swelling (TS) of two design sample of sandwich panel board then compare it mechanical and water resistance properties with conventional panel board. Process involved in sandwich panel board manufacture are manufacture of coconut fibre panel board and fiberglass panel board. Next, the manufacturing of the sandwich panel board using layering method. Finally, testing of sandwich panel board sample which are Modulus Of Rupture (MOR), Water Absorption (WA) and Thickness Swelling (TS). As result, non-reinforced sandwich panel board has MOR of 3.179MPa, WA of 46.5% and TS of 4.5%. For reinforced sandwich panel board, it has MOR of 7.096MPa, WA of 47.2% and TS of 8.3%. As comparison, the conventional panel board has MOR of 3.117MPa, WA of 61.3% and TS of 21.3%. In the nutshell, the result analyze that the non-reinforced sandwich panel board has the better result compared to conventional panel board and reinforced panel board that may be the best alternative for replacing traditional panel boards because it have a lot of economical potential.

Keywords: Panel board, Fiberglass, Coconut Fibre, Sandwich panel board, Layering, Combination

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1. Introduction

In general, panel board is the main material in construction but in recent years, the economy of the country's construction industry has declined and resulted in an increase in the value of building supplies as well as an increase in the price of materials in construction. To solve the problem, the construction industry needs to find a way out by using renewable resources in the manufacture of panel boards. Previous studies have stated that panel board manufacturing that uses renewable resources such as agricultural waste is becoming increasingly popular in the industry [1]. So, coconut fibre was chosen as one of the main materials to produce sandwich panel boards in this project because coconut fibre is a renewable material. Apart from coconut fibre, fiberglass is also the main material in the manufacture of sandwich panel boards. All the mechanical properties of these two materials have been studied through past studies through research done by [2]. Knowing the mechanical properties of a material is important because it can help in understanding how it can withstand loads and how long it will last in use [3].

Next, the aim of this study is to combine between coconut fibre panel board and fiberglass panel board to produce sandwich panel board. This aim was chosen because the panel board made only of coconut fibre is very easy to absorb water, while the panel board made only of fiberglass is very heavy and difficult to handle. Therefore, the combination of these two materials is very suitable to overcome their respective shortcomings. There are two types of sandwich panel boards produced in this project, which are non-reinforced sandwich panel boards and reinforced sandwich panel boards. Non-reinforced sandwich panel board has two layers of fiberglass and one layer of coconut fibre, while reinforced sandwich panel board consist of three layers of fiberglass and two layers of coconut fibre. Based on previous studies, all laminate layers are better than laminate bottom layers and the more laminate layers are used, the more strength is required to break the laminated board panels [3]. Therefore, according to the tests have been done, reinforced sandwich panel board is the best choice as it is able to withstand heavy loads and less in water absorption.

2. Materials and Methods

Based on **Figure 1**, it shows two different types of recommended Sandwich Panel Board designs. The first design has no reinforcement in the middle layer while the second design has a reinforcement layer. Therefore, this Sandwich Panel Boards have a similarity which fiberglass panel boards as the outer layer and coconut fiber panel boards in the middle. In addition, the size of the design is the same for both designs.

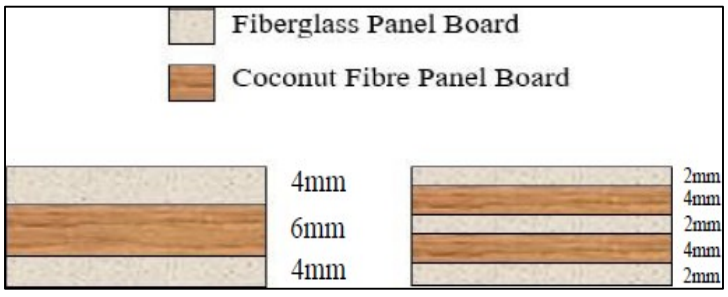

Figure 1: Layer size and recommended Sandwich Panel Board design

According to the flow chart in **Figure 2** has shown the whole process of creating sandwich panel boards from coconut fibre and fiberglass, from the preparation of raw materials, the creation of molds to the sample testing of Sandwich Panel Boards. More specifically, the project process is divided into four stages, the first phase covers the preparation of coconut fibre panel boards and fiberglass panel boards. Also, for the second phase is about the process of making Sandwich Panel Boards. In addition,

the third phase is a testing process, which is divided into two categories: mechanical strength testing and water resistance testing. Furthermore, for the last phase covers about analyzing the experimental results.

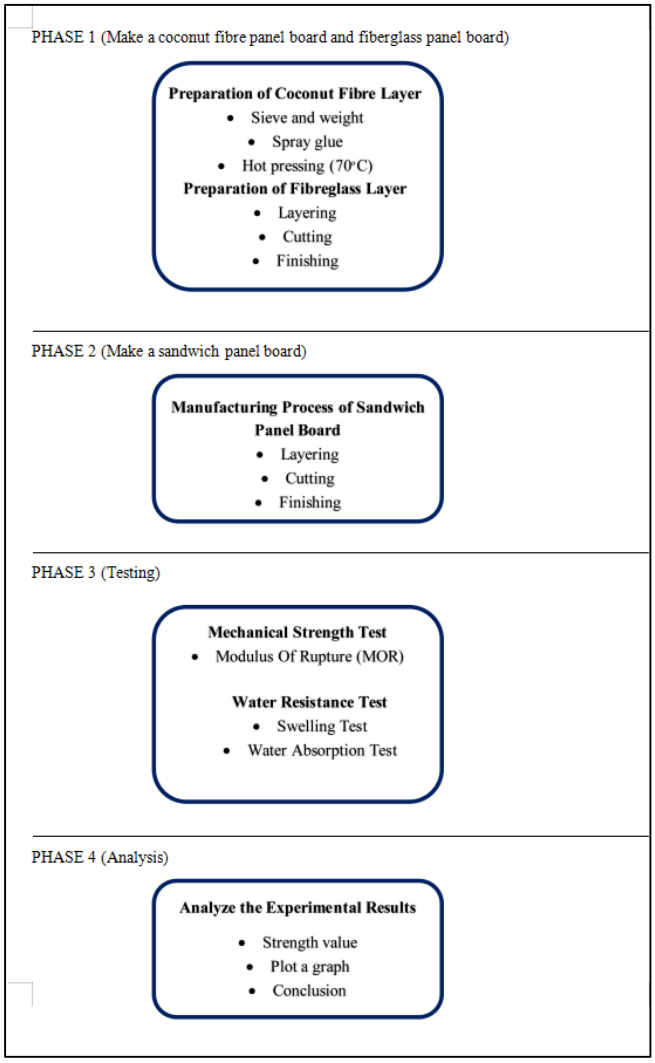

Figure 2: **The flow of Sandwich Panel Board Process**

The first phase is the preparation of coconut fibre panel boards and the preparation of fiberglass panel boards. The coconut fibre used for the preparation of panel boards is processed coconut fibre. Before the coconut fibre is sprayed with glue and put into a hot and cold pressing machine, the coconut fibre is sifted first. Then, the coconut husks are separated slightly and placed in a mold so that they do not knot with each other. After the process, a mold filled with coconut fibre that has been sprayed with glue is put into a hot and cold pressing machine at the appropriate temperature. After it is done, allow it for a few minutes to cool before removing it from the machine.

The process of preparing a fiberglass panel board has several steps, initially, several sheets of fiberglass that have been cut from fiberglass mats have been prepared according to the required size as shown in **Figure 3**. Then, a mixture of unsaturated resin and catalyst hardener is prepared mixed in a container. Tiles are used as the basis for the process of sweeping a mixture of resin and catalyst hardener on the fiberglass sheets that have been cut. Also, to prevent fiberglass from sticking to the tile, clean it with a mirror glaze. Using a brush, apply the resin mixture evenly to the entire surface of the fiberglass

as shown in **Figure 4**. Continue with the same procedure for the remaining layers. Allow about a few hours for the fiberglass to dry before moving on to the next layer. Finally, separate the tiles from the fiberglass panel boards. Fiberglass panel boards usually take about a few hours to dry.

Figure 3: **The process of cutting fiberglass mats**

Figure 4: **The process of coating a resin mixture on glass fibers**

Following is the second phase of the process which is the making of sandwich panel boards. Sandwich panel boards are produced using coconut fibre panel boards and fiberglass panel boards that have been made before. In order to create a sandwich panel board, fibreglass and coconut fibre panel boards were combined using a combination process. First, the sandwich panel board design uses fiberglass panel board as the first layer then spread the glue on its surface. Thenceforth, place the coconut fibre panel board as the second layer. After a few minutes, the coconut fibre panel board and the last layer of fiberglass panel board are combined together. Then, wait a few minutes to make sure all the layers stick together and become a perfect combination. Furthermore, for the second design, all methods and ways of layering are the same as for the first design, but for the second design, fiberglass panel boards are used as reinforcement with the total number of layers being five layers. After finishing combining the two types of panel boards, the sandwich panel boards were cut according to the sample size for testing.

Alongside, the testing is held as the third phase. There are two types of tests carried out in this project which is testing for mechanical strength and testing for water resistance properties. The degree of flexibility and durability could be seen between the reinforced sandwich panel samples, non-reinforced sandwich panel boards, and standard panel boards during the Modulus of Rupture (MOR) test. Thereafter test is the water resistance test. This test is divided into two tests, the first is the Water Absorption test. This Water Absorption test determines how much water is absorbed under a given condition. The panel samples Water Absorption (WA) were assessed by soaking them in distilled water for two and twenty-four hours, respectively [4]. Water Absorption test is also commonly used as a key indicator of the waterproofing ability of wood composite panels (ASTM D 1037-49T). The water immersion method accelerates water absorption and is frequently used in laboratory tests.The second test for water resistance is the swelling test. Swelling test is to test in the size of each sample of expanded panel board after the sample is soaked in 24 hours. Then, from the observations seen from the sample from each design is a comparison of its thickness.

Thereafter, for the fourth phase is to analyze the experimental results. All experimental results are recorded, for example, the results of the strength values for each sample of sandwich panel boards. Then, the results are also shown in the form of a graph.

3. Results and Discussion

3.1 Modulus Of Rupture (MOR)

From the Modulus of Rupture (MOR) test result shows in **Figure 5** below, there is very notable difference between the conventional panel board and reinforced sandwich panel board. MOR value is a measure of a specimen's ultimate strength before it breaks or ruptures. Based on **Figure 5**, the average value of the conventional panel board is 3.116 MPa, non-reinforced sandwich panel board is 3.179 MPa and reinforced sandwich panel board is 7.096 MPa. For that, this means that the average value of reinforced sandwich panel board is higher than the average value of non-reinforced sandwich panel board and at the same time, it is a good panel board of the three panel boards because it can withstand high loads. This is because the particles contained in the reinforced sandwich panel board are smaller than that of other panel boards. In the previous studies, they found that smaller particles improved the qualities of the board with a superior internal bond strength [5]. This is due to the fact that smaller particles were more compressed and had fewer overlapping regions, resulting in homogeneous, uniform cells with fewer voids [6].

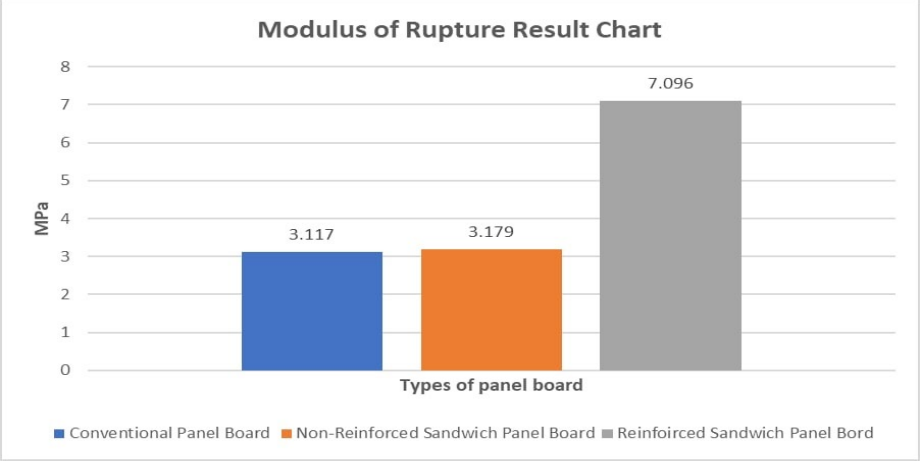

Figure 5: **Modulus of Rupture Test Result Chart**

3.2 Water Absorption (WA)

The difference between the conventional panel board, non-reinforced sandwich panel board, and reinforced sandwich panel board may be seen in the Water Absorption (WA) test result chart displayed in **Figure 6**. The conventional panel board has the highest WA value (60.3%), followed by the non-reinforced sandwich panel board (46.5%) and the reinforced sandwich panel board (47.2%). Besides, when panel boards are exposed to or immersed in water, the WA value is stated in percentages and refers to the property of water absorption. A higher WA number implies that the panel board has a higher water absorption rate and will absorb a larger volume of water than those with a lower WA value. A lower WA value is better to a higher WA value for panel boards because it indicates that the panel board is more waterproof (resistant to water) when exposed to or immersed in water. In the nutshell , after compared three different types of panel boards, it can be determined that non-reinforced sandwich panel board is the greatest, waterproof panel board due to it lowest water absorption percentage when compared to conventional panel board and reinforced sandwich panel board.

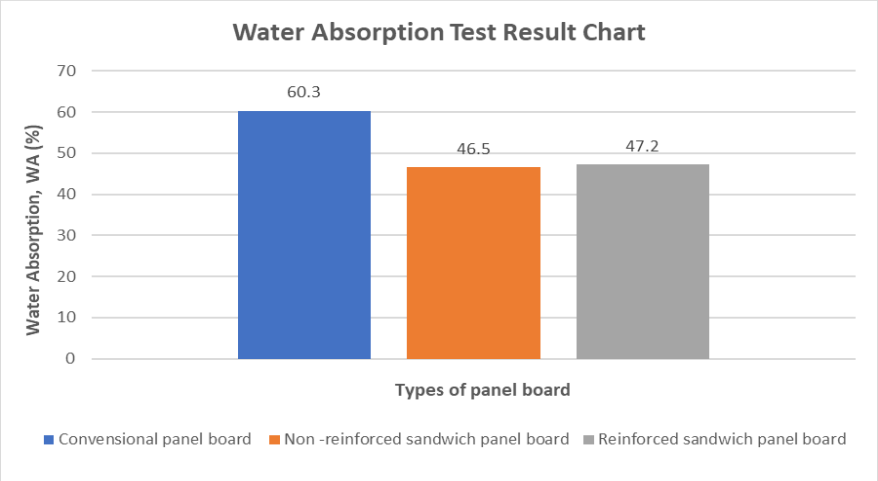

Figure 6: Water Absorption test result chart

3.3 Thickness Swelling (TS)

The Swelling test (%) result chart shown in **Figure 7** below, shows the differences between the three panel board samples. Reinforced sandwich panel board had a percentage average of 8.3% thickness difference while Non-Reinforced sandwich panel board was 4.5% and Conventional panel boards have a percentage of 21.3%. Higher percentage values indicate higher thickness compared to lower values. In terms of panel boards, the average value of the lower percentage difference in thickness is better than the average value of the higher percentage difference in thickness. Overall for this Swelling test, the Non-Reinforced sandwich panel board was the least increased panel board in thickness making it the best panel board out of the three panel board samples that have been compared.

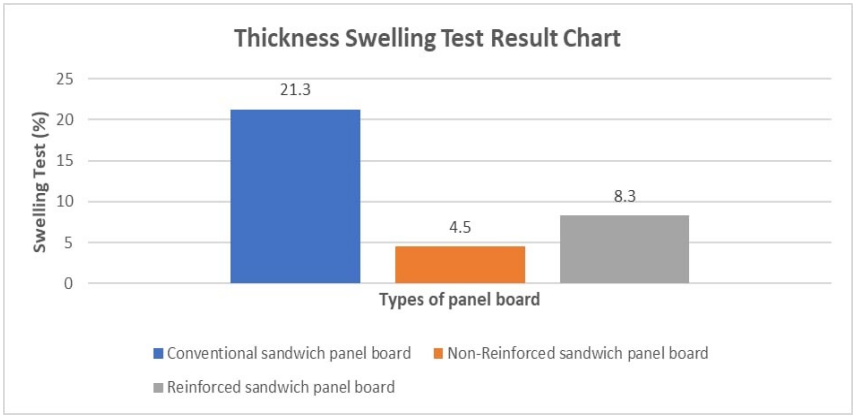

Figure 7: Thickness Swelling test (%) result chart

Observations made based on the results of the three standard tests that have been made, it shows that in the test Modulu of Rupture (MOR), Reinforced Sandwich panel board is the best because when the test is carried out on it, it achieves a very high load value from other panel boards while the second strongest is Non-Reinforced panel boards. Thenceforth, for the Water Absorption and Swelling tests, it has been seen that the Non-Reinforced Sandwich panel board is the best sample for these two tests. This is because these Non-Reinforced Sandwich panel boards have the lowest level of water absorption and produce a lower average thickness value than the others. This Non -Reinforced Sandwich panel board has reached the panel board standard where the percentage of Swelling thickness for Non -Reinforced Sandwich panel board is 4.5% less than 12% because usually the maximum allowable Swelling of thickness is 12 percent, resulting in, panel board with TS more than 12 percent does not comply with such requirements [4]. If observed on both Reinforced and Non-Reinforced Sandwich panel boards, it

produces a lower average value of water absorption than Conventional panel boards but the nature should be that it does not absorb water because its material source is made of waterproof material. This may be because during the manufacture of Reinforced Sandwich panel boards there is still coconut fibre powder in the coconut fibre which causes water absorption to occur on the Sandwich panel board. Coconut fibre powder has an absorption capacity of 1.5% which can increase the absorption capacity of coconut fibre [7]. So if Non-Reinforced Sandwich panel board can absorb even a little water, then Reinforced Sandwich panel board will have more water absorption percentage rate because it has two layers of Coconut Fibre panel board.

This is also the reason that Reinforced Sandwich panel boards have a heavier mass as they have more water absorption weight and have reinforcement in the middle layer compared to Non-Reinforced Sandwich panel boards. Moreover, for its average value in the Swelling test for Reinforced Sandwich panel boards, it also got second place in less thickness than conventional panel boards, after Non - Reinforced Sandwich panel boards. It is possible that the Reinforced Sandwich panel board has a cavity in the layer between the coconut fibre panel board and the fiberglass because it is likely that the time of combining the two panel boards is not firmly clamped after digam which causes the coconut fibre to decompose unknowingly in water after soaking. Usually it depends on the temperature and brand, the clamping period is usually around 6 hours. Urea-formaldehyde has an excellent opening time of 20–30 minutes depending on the formulation, and it does not grip like some other wood glues [8]. This prevents the Reinforced Sandwich panel board from being the best panel board among the three panel boards.Thus, after being analyzed as a whole, Non-Reinforced Sandwich panel board is the best panel board in comparison with reinforced Sandwich panel board and Conventional panel board. This is because Non-Reinforced Sandwich panel boards are lighter in weight and are able to withstand larger loads than Conventional panel boards available in the market today.

4. Conclusion

Coconut fibre is a natural fibre that is known as a waste material in the countries that cultivate it. This happens because in the old days there is no further knowledges and researches on how to develop the waste material into a useful product. But nowadays, with the help of technological development, natural fibres are widely used in a wide range of application such as filler of panel board.

Among the three panel boards that have been tested, the non-reinforced panel board are among the best of the other panel boards based on the analayze of three test and also according to the Standard Test Method for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials, (ASTM D1037). Furthermore, the objective of this study was achieved, where coconut fibre was used as a filler for panel board and fiberglass as the outer layer of panel board. This is because its own strengths and weaknesses can be overcome.

Thus, panel boards that have aesthetic value can replace the conventional panel board in the market and solve the issue of environmental pollution in the country. The product of this study can also be commercial with low cost and more advantages than conventional panel boards. There is a possibility that these coconut fibre panel boards have a lower cost than regular panel boards because they use recycled waste materials and do not require any chemical treatment to process the raw materials.

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