THE PERFORMANCE OF TALAHIB (SACCHARUM SPONTANEUM) GRASS WITH POLYESTER RESIN PARTICLE BOARD

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By

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APPROVAL SHEET

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In partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering, this thesis entitled **-The Performance of Talahib (Saccharum Spontaneum) Grass with Polyester Resin Particle Board** prepared and submitted by Catherin P. Cifra, Kris Aple Mae M. Daguman, and Romarc G. Vergara, hereby recommended for the oral examination, acceptance, and approval.

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The Performance of Talahib (Saccharum Spontaneum) Grass with Polyester Resin Particle Board

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***Abstract*— — This research evaluated the performance of a particle board made from talahib grass (Saccharum spontaneum) and polyester resin as a binding agent. Following the guidelines established by the American Society for Testing and Materials (ASTM), the board's physical (density, water absorption, thickness swelling, and flammability) and mechanical (modulus of rupture and modulus of elasticity) qualities were evaluated. This research also compared the results to the existing particle board in the market and performed a cost analysis. According to the results, the talahib grass particle board is 19% more expensive than the market price of medium-density particle board. The physical properties of the board revealed that the density and water absorption were significantly higher than the typical medium-density board, with an optimum value of 1204.44 kg/m3 and 1.47%, respectively. While the thickness swelling test results show no significant change, the flammability test results show that the board was less susceptible to re due to the lower weight loss. In terms of mechanical properties, the board's Modulus of Rupture (MOR) is much higher than that of a typical medium-density board, with an optimum value of 52.02Mpa. At the same time, the Modulus of Elasticity (MOE) does not meet any particle board standards. Conclusively, as the study shows that the talahib grass significantly impacts the board's physical and mechanical quality, it was also suitable for manufacturing the particle board.**

***Index Terms*— Polyester resin, talahib grass, particle board**

I. Introduction

Due to the rapid population growth, the construction industry is one of the fastest-growing sectors in the Philippines today. The increase in housing construction activities and growing demand for wood composites and wood-based materials have increased as the resources for timber decreased [1]. Illegal logging and typhoons affected wood production in the country, disabling it from producing a large quantity of wood for construction purposes in future years. The demand for wood-based particle boards has increased greatly due to population growth, while timber resources are alarmingly depleted [2]. As a result, there needs to be more concern about fulfilling the need for increasing demand for timber products without deteriorating the world's forest resources [3].

Particle boards are developed to replace traditional materials with economical rates and varieties of applications. As the Philippines is known to be abundant in natural resources, especially in vegetation and agriculture, the exploration of different plants, their particles, and fibers helps researchers innovate and improve materials in the construction industry. Studies involving biomass materials such as Khimp Plant, bamboo, cogon grass, dried leaves, and other industrial waste as the main resource to make a new construction material led the researchers to make this study.

Perennial grasses, specifically Kans Grass (Saccharum spontaneum) or Talahib Grass, are unwanted plants that grow abundantly in some parts of the country. Talahib grass is a perennial grass that has grown for more than two years. Even in low-fertility environments, perennial grasses have the benefit of producing significantly more biomass than most annual species [4]. Traditionally, it was used to make hats, brooms, baskets, walls, and furniture. Other studies on talahib grass use it as medicine and some other scientific research. The compositional analysis of Talahib Grass was carried out to determine principal components (43.78% cellulose, 28.06% hemicellulose, 72.86% holocellulose, 33.2% α-cellulose, 6.71% lignin, and 2.25% ash) [5]. These properties show that Talahib grass has the potential for conversion into useful products.

As it grows abundantly, researchers in the country have utilized and taken advantage of the things that most people think a waste but utilized for future improvements in construction. Previous research about Talahib Grass proved that this grass was useful in many ways. Aside from the grass information, the binding agent was analyzed and conceptualized. The improvement of the quality of the particle board in terms of its moisture resistance, flammability, and strength is the focus of this study. Research and experimentation in this grass further increased the data and knowledge attained for the basic objectives of the study.

This research aimed to make a particle board out of talahib grass. The researchers determined physical parameters like density, water absorption, thickness swelling, and flammability. The mechanical properties of the generated particle board, such as the Modulus of Rupture (MOR) and Modulus of Elasticity (MOE), were compared to the existing standard particle board in the Philippines, and a cost analysis was conducted.

Governments are concerned about the deterioration of the global environment, particularly the global depletion of forest resources. As a result, various treaties have been established to prevent biodiversity and habitat degradation. One way to help was to create high-quality, non-wood building materials that met the demand for low-cost, environmentally friendly building materials. This research could help many countries deal with current and future challenges.

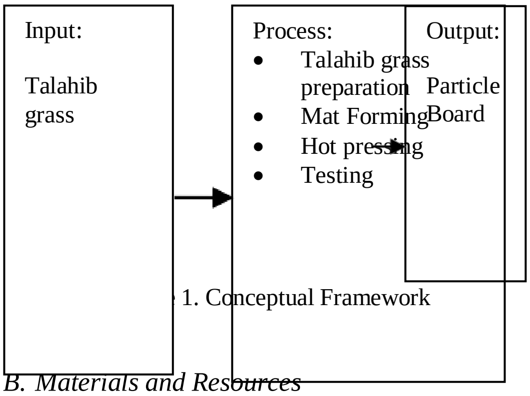
In this study, the researcher concentrates solely on the performance of Talahib grass mixed with Polyester resin particle board that satisfies the potential and capabilities of Talahib grass particle board as a substitute to the existing particle board in the market through experiment and testing of and physical properties.

II. MATERIALS AND METHODS

A. *Conceptual Framework*

The researcher used the input-process-output (IPO) model, as shown in Fig.1; hence the particle board using Talahib grass was produced as output. The input contains the raw material Talahib grass. The research process includes Talahib grass preparation, mat-forming, hot pressing, and testing.

The talahib grass was divided into two parts, coarse and ground. A 0.04kg of talahib grass composed of coarse and ground with ratios of 25 percent coarse and 75 percent ground, 75 percent coarse and 25 percent ground, and 50 percent coarse and 50 percent ground were mixed with 250ml and 300ml of polyester resin to form a mat. After forming, it was hot compressed using a slab with loads above it. The testing came after it was hot pressed. There, the talahib grass particle board was made.



1. Conceptual Framework

B. *Materials and Resources*

Talahib (Saccharum spontaneum) grass was collected at Kaputian, Island Garden City of Samal, for this study's materials and resources. Dust particles were removed by washing the plant material with water and drying it with air. The talahib grass and stalks were cut into 2.5 cm lengths, while other samples were processed in a blender to make them finer and used in particle board manufacturing. The fiber cell length was 1.10 millimeters, and the fiber cell width was 12.38 micrometers, according to FIDA analytical reports for the morphological parameters of untreated Saccharum spontaneum fibers cut for 1-2 inches or 2.5 to 5 cm in length. The reports also indicate that an individual fiber has a tensile strength of 14.6 MPa and an elongation of 3.33% [5].

The binding agent used was ClearcastPolyester resin purchased online at Delsum Online Shop. Every bottle contained 1000 ml polyester resin and was mixed with a 5 ml hardener. Polyester is a versatile thermoplastic/thermoset polymer with extensive commercial use renowned for its biodegradability and superior thermal, mechanical, and chemical characteristics [6]. Strength and other specific qualities vary among the many diverse kinds. In general, the material offers good electrical qualities, heat and age resistance, minimal creep, good color retention, and wear resistance.

A at steel bar with dimensions of 15x15x1.5cm was also fabricated by the researchers and used as a molder for the board. The raw materials and samples are meticulously weighed to verify that the correct mass and weight are obtained. As a result, the researchers employed a digitalweighing scale to obtain precise mass and weight measurements.

The data needed to evaluate the water absorption and thickness swelling was obtained when the samples were submerged in a container filled with fresh water.

The data needed to estimate the samples' modulus of rupture and modulus of elasticity was obtained using compression test equipment accessible at a testing center.

C. Methods and Procedures

The physical and mechanical properties of the talahib grass employed in this investigation were considered. Tensile strength, Tensile Modulus, and Elongation are 278-618 MPa, 8.1-11.1 MPa, and 1.7-2.8 percent, respectively, with a density of 400 kg/m3 and a diameter of 250-780 µm [7].

The 15 x 15 x 1.3 cm particle board was made by manually combining the talahib grass particles with Polyester resin as an adhesive. To acquire more data for this investigation, the researchers comprise various mixing ratios of coarse and ne talahib grass with varying volumes of Polyester resin. The percentage ratio for the Polyester resin to the Talahib grass can be 60%-90% per the amount or weight [8]. Thus, the 250 ml and 300 ml of Polyester were 65% and 75% of the volume percentage for the 0.04kg Talahib grass.

Table I below shows the mixing ratio for the 300 ml and 250 ml resin and the varying weight of the grass with the respective number of samples that were made and used for the test procedures. It states that 40g of grass of varying lengths, such as coarse talahib grass and ground talahib grass, will be mixed with the resin. During the study, 30 samples were made.

The mixture was molded uniformly into the fabricated steel mold to form a mat and was manually compressed for 24 hours. A load of 2.045kg was put on top of the molding to solidify the adhesive while sun-drying. Then, the formed mixture was air-dried for three days.

The researchers produced particle boards as test samples for water absorption and thickness swelling for 2 hrs, 12 hrs, and 24 hrs, and flammability test-1 sample per mixture for every varying amount of Polyester resin in every test. For the data used in the Modulus of Rupture and Modulus of Elasticity, a cube sample with a dimension of 3x3x2.5 inches was produced for the compression test tested at the testing center. The physical properties, such as density, water absorption, thickness swelling, flammability, and the mechanical properties, such as modulus of elasticity and modulus of rupture of the board samples that were tested, shown in Fig.2. Figure 2 also illustrates the designated terms for themixing ratios, such as T1 for 1Coarse:1Fine/Grind, T2 for 0.25Coarse:0.75Fine/Grind, and T3 for 0.75Coarse:0.25Fine/Grind talahib grass.

Table I. Mixing Ratio and No. of Samples Made

Talahib Grass	Polyester Resin	No. of Samples
20g Coarse: 20g Grind	300 ml	5
10g Coarse: 30g Grind	300 ml	5
30g Coarse: 10g Grind	300 ml	5
20g Coarse: 20g Grind	250 ml	5
10g Coarse: 30g Grind	250 ml	5
30g Coarse: 10g Grind	250 ml	5

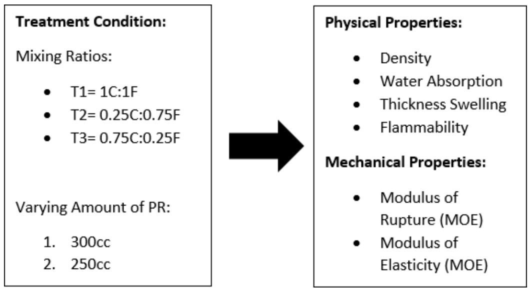


Figure 2. Mixing Ratio and Properties to be Tested

D. Testing Procedures

Before being tested, the completed particle board was exposed to the atmosphere of a well-ventilated room for at least 48 hours. It was evaluated for physical, mechanical, and flammability properties.

1. Physical Properties of Talahib Grass with Polyester Resin Particle Board

The physical properties of the particleboards, such as density, water absorption, and thickness swelling, were determined by test procedures.

a. Density of Talahib Grass with Polyester Resin Particle Board

The weight of the samples was determined by using the weighing scale. The dimensions at different treatments were measured using a ruler. For the volume of the particle board, the length, width, and thickness of each sample will be multiplied. The density of the composite board was calculated using the standard equation by dividing its actual mass by its measured volume.

b. Water Absorption & Thickness Swelling of Talahib Grass with Polyester Resin Particle Board

The water absorption and thickness swelling tests were performed following ASTM D 1037-99 guidelines (Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials) [9]. Before being submerged in water for two hours, three (3) samples for each mixing ratio were weighed (Wdry) and measured for thickness (t1). After being soaked, it was weighed (Wsat) and patted dry with a towel. After 2 hours, 12 hours, and 24 hours, it was weighed once more. After being removed from the water, the thickness (t2) of all the submerged samples was measured.

Another set of samples was weighted (Wdry) and measured for thickness for each mixing ratio (t1). It was also soaked for 12 hours before patting dry with a towel. After 2 hours, 12 hours, and 24 hours, the weight (Wsat) and thickness (t2) were also measured. Another batch of samples was submerged in water for 24 hours, and the same approach was used.

Finally, the water absorption and the corresponding expansion ratio of the thickness were calculated based on the standard formula for water absorption. The saturated weight was removed from the dry weight and divided by the dry weight of the sample to determine the water absorption for the sample board. It is multiplied by 100% to convert the answer from decimal to percentage. As for the thickness swelling, the measured thickness after the submersion of the samples was subtracted from the initial thickness and was divided by the initial thickness, and will be multiplied by 100% to make it in a percentage form.

c. Flammability of Talahib Grass with Polyester Resin Particle Board

There are various methods for evaluating re resistance. Small, medium, and large-scale flammability testing was conducted in academic and commercial laboratories [10]. The flammability of the samples was determined by exposing them to heat or flame. The flammability tests were carried out in line with the standards defined in ASTM D3675-22 test method ASTM E-162 (Standard Test Methods for Evaluating Properties of Materials Using A Radiant Heat Energy Source) [11]. A small amount of gas was poured on one side of each specimen to start a re and then exposed to re for a maximum of 5 minutes. The weight loss (WL %) was calculated from the weight before and after the ember was completely extinguished. The width of the burnt area was then measured with a ruler.

The standard equation for weight loss was used to solve the board sample's flammability.The measured weight before the flammability testwas subtracted by the weight after the test and then multiplied by 100% to get its weight loss.

2. Mechanical Properties of Talahib Grass with Polyester Resin Particle Board

The mechanical properties of the Talahib grass particle board were determined by the six pieces of 3x3x2.5 inches samples that underwent a compression test. The findings of this test were used to calculate the sample's Modulus of Rupture. At the same time, samples with a dimension of 15x15x1 cm were tested to compute the Modulus of Elasticity of the particle board.

a. Modulus of Rupture of Talahib Grass with Polyester Resin Particle Board

The compressive test results were utilized to calculate the Modulus of Rupture for talahib grass with a polyester resin particle board. The maximum load was derived from the compression test results after each test piece failed.

Diameter of the plate = 165 mm
Width of the test piece = 63.5
The thickness of the test piece = 76.2

ASTM standard formula was used to calculate the modulus of rupture of a sample under a load in a three-point bending set-up by multiplying the maximum load and length of the sample by three and dividing it by the product of the width of the test piece times the thickness of the test piecetimes two. Substituting the values given above in the formula gave us the modulus of rupture of each sample.

b. Modulus of Elasticity of Talahib Grass with Polyester Resin Particle Board

Using the 15x15x1 cm sample, the researcher conducted a separate Modulus of Elasticity test. The loading bar, which had a section of 50.8 mm, was fixed on top of the specimen's center, and a load increment of 4.5kg was given at a minute interval until the sample failed.

A standard ASTM method formula was also used to calculate the modulus of elasticity of wood fibers. It was calculated by multiplying the proportional load limit and the length of the sample and dividing it by four times the width, the thickness of the test piece, and the center deflection of the proportional limit. The direct substitution was performed using the given valuesrepresented by each sample to solve the MOE.

III. RESULTS AND DISCUSSIONS

A. Density of Talahib Grass with Polyester Resin Particle Board

The raw talahib grass that was processed and cut into 2.5cm lengths and divided into two parts, namely the coarse and Grind, was used in manufacturing the particle board. Figure 3 andFig. 4 shows the coarse and ground particle of talahib grass that was mixed with polyester resin to make a particle board. It significantly affects the performance of the talahib grass with polyester resin particle board in terms of its density, water absorption, thickness swelling, flammability, modulus of rupture, and modulus of elasticity.

Figure 3. Coarse Talahib grass

Figure 4. Fine/Grind Talahib grass

The most significant parameter of particle board is its density, which influences all properties. The board density was classified into three categories by the ANSI (D1037-99, ASTM D1554, 2016) standard for particleboard [12]. Thefirst type is low-density particleboard, which hasa density of 610-640 kg/m3. It is potentially useful in insulation, door core, and anything requiring minimal strength. On the other hand, the Intermediate-density particleboard has a density range of 640-800 kg/m3 and is undergoingongoing research to improve its strength. It is potentially useful for furniture, cabinets, shelving, and paneling [12]. Figure 5 and Fig. 6 (Refer to Appendix B) provides the data to classify the particle board as medium-density particle board (MDF) or high-density particle board (HDF). The talahib grass particle board met the requirements to be classified as MDF and HDF particle board. The talahib grass particle board has a minimum density of 957.5758, and based on Fig. 6 (Refer to Appendix B), it passed the required density of 900kg/m3.

Finally, there is high-density particleboard, which has an 800 kg/m3 or higher density. It is potentially useful in interior furniture applications where a large form is required [13]. The data obtained for the density of all the particleboards made from talahib grass with 300 ml and 250 ml concentration are shown in Fig. 7 and Fig. 8, which contains 300 ml and 250 ml concentration, respectively. It shows that the data are compacted due to the short box plot. Figure 7 of 300 ml concentration shows that the density ranges from 840 to 1139.9317. The 1C:1F mixture shows the minimum value to be 872.781, the first quartile is 891.667, the median is 980.9254, the thirdquartile is 1083.333, and the maximum value is 1139.9317. The 0.75C:0.25F mixture shows the minimum value to be 840; the first quartile is 891.852, the median is 933.33, the third quartile is 968.254, and the maximum value is 986.348. In the 0.25C:0.75F mixture, the minimum value is 863.889, the first quartile is 885.9259, the median is 982.935, the third quartile is 1010.2389, and the maximum value is 1066.667. Based on the results, the minimum and maximum values are taken from mixtures 0.75C:0.25F and 1C:1F, respectively.

Figure 8, of 250 ml concentration, shows that the density ranges from 823.932 to 1204.444. In the 1C:1F mixture, the minimum value is 823.932,the first quartile is 861.5385, the median is 940.7407, the third quartile is 973.037, and the maximum value is 1204.444. In the 0.75C:0.25F mixture, the minimum value is 907.4074, the first quartile is 918.5185, the median is 1002.0202, the third quartile is 1035.5556, and the maximum value is 1128.8889. In the 0.25C:0.75F mixture, the minimum value is 957.5758, the first quartile is 1010.101, the median is 1106.6667, the third quartile is 1120, and the maximum value is 1146.667. Based on the results, the minimum and maximum values are taken from the 1C:1F mixture.

Therefore, the 250 ml concentration has a higher density than the 300 ml concentration. Therange of their densities is from 823.932 to 1204.444. Moreover, the results showed that the densities of the particle board sample with 250 ml concentration were much denser than those with 300 ml concentration.

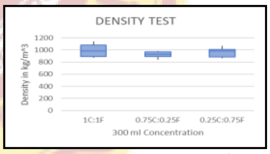
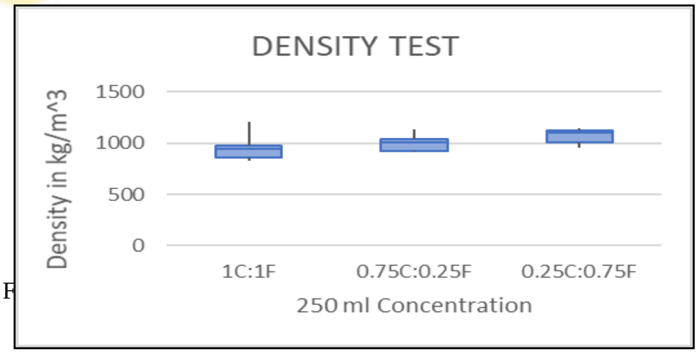


Figure 7. The density of Talahib grass with Polyester resin particle board



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B. Water Absorption of Talahib Grass with Polyester Resin Particle Board

Absorption and thickness swelling tests evaluated particleboard dimensional stability. Figures 9 and 10 show the water absorption values of particle boards made from talahib grass with 300 ml and 250 ml concentrations. Subsequently, the water absorption increased with the increased soaking time of 2 hours, 12 hours, and 24 hours. The boxplots are short; therefore, the data are compacted. In Fig. 9 of 300 ml concentration, the absorption percentage for 1C:1F has a minimum value of 1.47% and a maximum value of 4.907%. The 0.75F:0.25C mixing ratio has a minimum value of 4.013 and a maximum value of 10.8, and the 0.25F:0.75C has a minimum value of 1.993% and a maximum value of 3.741%.

In Fig. 10, which contains 250 ml concentration, it was observed that the 0.75F:0.25C mixing ratio has the greater water absorption value with a maximum value of 14.768% and a minimum value of 3.968%. The 0.25F:0.75C mixing ratio has a maximum value of 9.055% and a minimum value of 4.292%, while the 1C:1F mixing ratio has a maximum value of 8.696% and a minimum value of 3.968%. The water absorption and board density are highly correlated base on the previous study of 24 hours soak test. It has been reported that the higher-density boards have a slow water entry due to decreased porosity and increased woodmaterial [13]. Also, the results clearly show that the water absorption of the talahib grass with polyester resin boards with 300 ml concentration was much lower than those with 250 ml concentration.

The results in Fig. 9 and 10 clearly show that the talahib grass particleboards produced with 300ml concentration were less prone to water permeation. The ability to resist the permeation of water observed in the case of the boards with 300 ml concentration is an indication of dimensional stability.

Figure 11 depicts the particle board's condition prior to any testing procedures. Figures 12 and 13 show the state of the board after submersion. Figure 12 shows that after 2 hours of immersion, the board has no visible damage to its physical appearance and only its weight changes as it absorbs water during the immersion. Figure 13 depicts the state of the particle board after 24hours of immersion. Because the resin had been soaked for a long time, a visible white discoloration was present. It should also be noted that the board returns to its original state after drying up.

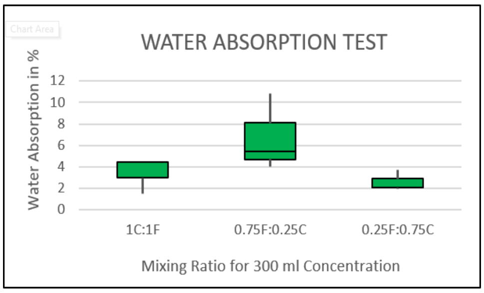

Figure 9. Water Absorption of Talahib grass with Polyester resin particle board for 300 ml concentration

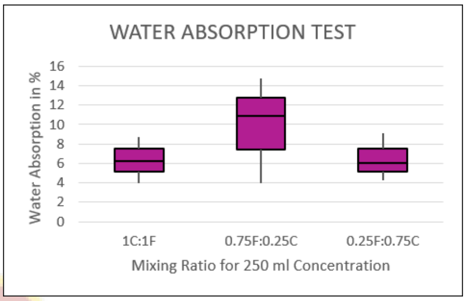

Figure 10. Water Absorption of Talahib grass with Polyester resin particle board when immersed in water for 250 ml concentration

Figure 11. Talahib grass with Polyester resin particle board before submerging in water

Figure 1
board a

Figure 13. Talahib grass with Polyester resin particle board after water absorption test (24hrs immersion)

C. Thickness Swelling of Talahib Grass with Polyester Resin Particle Board

The thickness swelling of the particleboards after the immersed samples resulted in zeropercent thickness swelling for all the sample boards. When the sample is submerged in water, the thickness of the sample does not change significantly, as indicated. It just absorbed water during the trial but did not influence its thickness. When the swelling thickness has a minimal value, it indicates dimensional stability. Thepresence of voids affects thickness swelling in thesame manner as voids affect water absorption.According to a prior study, these voids enhance water permeation, which finally leads to thickness swelling [14]. The American National Standard Institute (ANSI/A208.1-2016) species an 8 percent maximum thickness swelling for general-purpose particle boards [12]. The findings of this investigation show that all the created particleboards met the American National Standard Institute's (ANSI/A208.1-2016) general-use board standard. In addition, the standardstable in Fig. 5 and 6 (see Appendix B) also metthe standard in thickness swelling, which is 14-20 percent.

D. Flammability of Talahib Grass with Polyester Resin Particle Board

The re combustion determined the weight loss for the board specimens. Various factors contributed to the outcomes during the testing method; the results reported varied. The amount of binding agent and the number of talahib grass particles helped spread the re when it came into touch with the grass.

The results presented in Fig.14 show various concentrations used in testing flammability. The variable sizes of box plots are based on a similar duration of five minutes for both concentrations. Focused on weight loss, the talahib grass mixtures with 250 ml concentration (1C:1F, 0.75F:0.25C, 0.25F0.75C) have a higher level than the talahib grass mixtures with 300 ml concentration (1C:1F, 0.75F:0.25C, 0.25F0.75C). This means talahib grass mixtures with 250 ml have higher weight loss than talahib grass mixtures with 300 ml concentration.

The 300ml concentration shows a short boxplot that indicates a little comparison of the percentage of different ratio samples. The datareveals that the minimum and first values of weight loss are 0% and 7%, respectively. They were followed by the first to the median value of 7%-14%. Lastly, the third and maximum value is 14.5% and 15%, considering samples with 1C:1F,0.75F:0.25C, 0.25F, 0.75C ratio.

In contrast, 250 ml concentration shows a long box plot that indicates a considerable percentage of each ratio sample. The weight loss percentage of this sample based on the box plot starts with a minimum of 3% and the first value of 10%. They were followed by a median of 17% and a third percentage of 20%. Lastly, the maximum percentage result is 23%, considering samples with 1C:1F, 0.75F0.25C, 0.25F:0.75C ratio.

Therefore, samples with 300 ml concentration are less susceptible to re and are harder to combust than the other samples.

Figure 15 depicts the condition of the talahib grass with polyester resin particle board before any testing procedures. Figure 16 captures the particle board's state following its re exposure for the flammability test. It should be noted that the lower the amount of resin in the mixture, the moreprone to re and the greater the weight loss compared to the board with a higher amount of resin.

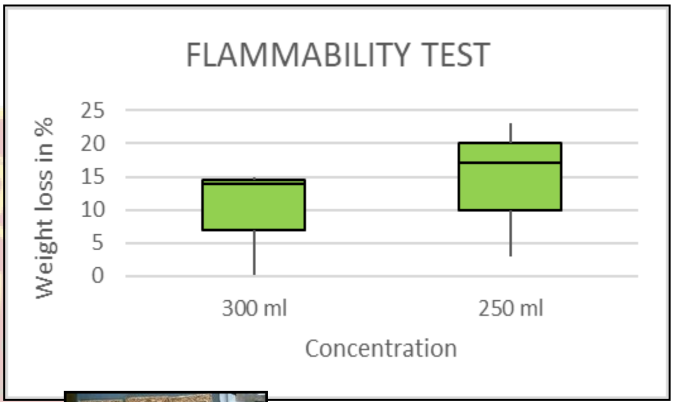

Figure 15. Talahib grass with Polyester resin particle board before the flammability test

Figure

E. Modulus of Rupture (MOR) of Talahib Grass with Polyester Resin Particle Board

The values of the Talahib Grass particle board's Modulus of Rupture are shown in the boxplot below, which reveals that the data are compact because the boxplot is quite short. The MOR for the two different amounts of resin ranges from 41 MPa to 52 MPa. The Talahib grass particle board with 300 ml concentration is lopsided dataskewed to the left, as shown in the graph below. The values of the lower quartile and the lower whiskers have the same amount of distance as the upper and upper quartile. It is also observed that the MOR for the 0.75C:0.25F and 0.25C:0.75F mixture, which are 52.02MPa and 50.88Mpa respectively, was higher than the 45.31 MPa of the 1C:1F mixture.

The boxplot was skewed to the right for the 250 ml resin concentration, with a subtle variationin the distance between the upper and lower quartiles. The data for this boxplot was more compact than the other, with values of 43.5649MPa, 41.1483MPa, and 45.8471MPa for the ratios of 1C:1F, 0.75C:0.25F, and 0.25C:0.75F, respectively. However, there was little difference in MOR between the varied mixing ratios. Furthermore, there was a difference of more than 7MPa in the median for both concentrations, indicating that the higher the resin concentration, the higher the Modulus of Rupture. The boxplot was skewed to the right for the 250 ml resin concentration, with a subtle variationin the distance between the upper and lower quartiles. The data for this boxplot was more compact than the other, with values of 43.5649MPa, 41.1483MPa, and 45.8471MPa for the ratios of 1C:1F, 0.75C:0.25F, and 0.25C:0.75F, respectively. However, there was little difference in MOR between the varied mixing ratios. Furthermore, there was a difference of more than 7MPa in the median for both concentrations, indicating that the higher the resin concentration, the higher the Modulus of Rupture. The MOR and MOE increased as the resin content increased [15]. The results revealed that the Talahib grass particleboard with 300 ml of Polyester resin has a greater strength value than the Talahib grass particleboard with only 250 ml of resin. The low MOR value was presumably because of the insufficient amount of resin in the mixture, as the different mixing ratios all contain the same mass of talahib grass.

The higher amount of resin in the mixture strengthened the board's adhesive bonding, increasing the Talahib particle board's strength. The grass length also affected the strength of the board. As indicated in the results, the Talahibgrass particle with a 0.75C:0.25F ratio has thehighest strength value because it is more compact because the ne particles of the grass cover the gapbetween the coarse particles in the mixture. The binding agent also helps to coat the outside of the sample to make it more resistant to loads.

Figure 18 depicts the condition of the talahib grass with polyester resin particle board cube samples before any testing procedures. Figure 19 depicts the condition following the compression tests. There are no visible physical changes because the compression tests only cause a minor crack in the samples.

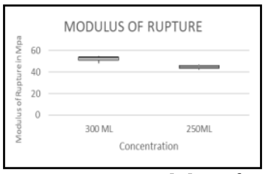

Figure 17. Modulus of Rupture of Talahib Grass with Polyester resin Particle board samples

Figure 18. Talahib grass with Polyester resin particle board cube samples before compression test

Figure 19. Talahib grass with Polyester resin particle board cube samples after compression test

F. Modulus of Elasticity (MOE) of Talahib Grass with Polyester Resin Particle Board

The boxplot in Fig.20 shows the considerable variance in the values of the Modulus of Elasticity of the two different resin concentrations. The data for the 300ml resin concentration has a long boxplot with a long upper whisker indicating data of mixed results. The upper whisker and the upper quartile have the same distance of 115.304MPa, while the lower quartile and the lower whisker also have the same distance of 9.1255MPa. As observed on the graph, the talahib and polyester resin particle board mix ratio of 0.25C:0.75F has a maximum value of 271.48 MPa, and for the 0.75C:0.25F mixing ratio, it is represented by the minimum value of 22.624MPa.

For the 250 ml resin concentration, the boxplot shows a compact result with a median of 49.663MPa, which has a closer value to the upper quartile, which has 55.9255MPa. The results show that the mixing ratio of 1C:1F is the minimum, with a MOE of 14.37MPa. While the mixing ratio of 0.75C:0.25F has a maximum MOE of 62.188MPa, and the 0.25C:0.75F mixingratio has a MOE of 49.663MPa.

It was also worth noting that the MOE values for both concentrations are different and that the amount of resin significantly impacts these results. The higher the modulus of elasticity, the denser the material or particleboard, and the more it could absorb significant loads compared to other samples. However, the more likely it is to distort permanently. Because the sample was more compacted, it only covered the sample's outside, which increased its durability. For the sample with the ratio of 0.75F:0.25C and 1F:1C of grass particles, the binding agent helps the talahib grass particle board with polyester resin to be more elastic as the finer grass particle makes the sample have a low density that also makes the particle board versatile to any deformation.

However, based on the MOE of the samples, they all made particleboards assessed fulfilled the minimal standard criteria provided by the American National Standards Institute for intermediate-density and high-density boards.

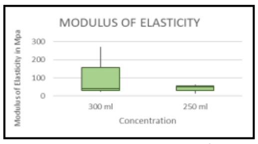

Figure 20. Modulus of Elasticity of Talahib Grass with Polyester resin particle board


Figure 21. Talahib grass with Polyester resin particle board samples before Modulus of Elasticity tests

Figure 21 depicts the condition of the talahib grass with polyester resin particle board samples before any testing procedures. Figures 22 and 23 show the state of the board after it has been tested to determine its deflection to solve for itselasticity. The figures show that there are cracks visible in the board because of the tests.


Figure 22. Talahib grass with Polyester resin particle board samples after Modulus of Elasticity tests


Figure 23 Talahib grass with Polyester resin particle board samples after Modulus of Elasticity tests

G. Cost Analysis of Talahib Grass with Polyester Resin Particle Board

This section primarily focused on a cost comparison of Talahib grass mixed with Polyester Particle Board to the market's current particle board price. Time, cost, and quality are all important considerations while making these boards, as they are tools that greatly impact the country's construction sector.

Table II. Cost Analysis of Existing Particle Board over Talahib with Polyester Resin Particle Board

	Ex Pa Boa the I (E
Price per unit of	P

Table III (refer to appendix A Table III) indicates the pricing of particle board in the Philippines based on market prices with dimensions of 1220 mm x 2440 mm x 12 mm, which was then compared to manufactured talahib grass particle board with dimensions of 1220 mm 2440 mm x 12 mm to make cost comparisons. The researchers calculated the amount of resin and grass to be used for the larger dimension particle board using ratio and proportion. Thisdata was used to do a cost analysis for two different products.

The cost of the talahib grass particle board was also calculated and presented in Table IV (see appendix A, Table IV) based on the dimensions stated above. To make a board with dimensions of 1220mm x 2440mm x12mm, 4 gallons of resin and 4250g of talahib grass are required. The comparison was based on the wholesale price of polyester resin at SEA Olympus Marketing, which is 655 pesos per gallon (3.65 kg). For ten (10) sacks of talahibgrass, which cost 5 pesos per sack, it can produce approximately 4500g of talahib grass particle that was cut to 2.5cm, and some will be ground to fill the voids in the sample board. The cost of the talahib grass particle board was calculated by dividing the cost of the particle board on the market by the cost of the existing particle board (EPB). As per Table III (see Appendix A), the total cost would be approximately P2670.00, which was 1.19 times more expensive than the particle board on the market (refer to table II), as the particle board with the same size on the market that was used in the comparison was P2250.00.

The higher material cost was clearly due to the amount of resin used, as the talahib grass, which has high fiber content and can absorb a significant amount of liquid, also consumes a significant amount of resin. However, compared to other boards that used wood chips, sawdust, and wood shavings, the quality of the board was more durable and water-absorbent. It also degrades more slowly because it becomes more durablewhen dry. Talahib grass was also widely obtainable because it is a biomass material and can be easily cultivated. As a result, mass production of the board will be feasible. The researchers also discovered that the grass does not decay easily. During the water absorption test, it was also discovered that it simply returned to its original state after submerging the board. As a result, it can withstand moisture longer than other particle boards. Because the study was justcompleted, the researchers have yet to determine how long it will take to deteriorate.

After learning about the other features of this Talahib grass particle board, such as the savings in natural resources since there was a minimal cost for the grass, sustainability, board durability, and a Modulus of Rupture that was much higher than the average particle board, it was implied that these features would counterbalance the other costs for the Talahib grass particle board's production.

IV. CONCLUSIONS AND FUTURE WORKS

The presence of talahib grass in the particle board has significantly improved both the physical and mechanical properties of the board. It met the high-density particle board category criteria in terms of density, water absorption, and thickness swelling. Regarding re resistance, the samples with 300 ml of resin concentration have lower weight loss. On the other hand, the MOR ofthe sample boards matched the standards of the high-density board for the mechanical qualities of the talahib grass since the talahib grass with the binding agent makes it more durable. Due to the factors that influence the results, the modulus of elasticity may not satisfy the criteria of a typical particle board. Thus, among all the tests performed, the 0.75F:0.25C ratio with 250 ml concentration was the optimum. For the cost analysis of Talahib particle board, the initial results indicate that it was feasible to use Talahib grass as a particle board material to use renewablebiomass while reducing the use of wood.

It is recommended that further research be conducted on talahib grass particle boards to develop a better-quality board in terms of its Modulus of Elasticity. The researcher must also locate a bulk resin supplier to keep the board's cost low. Despite the need for more research on the cost-effectiveness of Talahib grass particle board, it could be recommended as a newconstruction material for use in construction.

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APPENDIX A

COST ANALYSIS

Table III. Cost of Particle Board in the Philippines	
Cost of Particle Board in the Philippines (12x1220x2440 mm)	P2250.00

Table IV. Unit cost of material in the production of Talahib grass with Polyester resin particle board(12x1220x2440mm)			
Cost of Materials			
Type of Cost	Value Php/unit	Quantity	Total
Talahib grass(per sack)	5.00	10 sacks	50
Resin (1 gallon/3.65 kg)	655.00	4 gallons	2620.00
Total Cost			**P2670.00**

APPENDIX B

Physical and Mechanical Property Requirements for MDF When Determined in Accordance with ASTM D 1037-96a Part A [1,2]

Grades	Physical and Mechanical Properties [3]											
	Modulus of Rupture (MOR)		Modulus of Elasticity (MOE)		Internal Bond (IB)		Screw-holding [4]				Thickness Swell (TS)	
											Panel Thickness	
							Face		Edge		≤15 mm	>15mm
	N/mm^2	(psi)	N/mm^2	(psi)	N/mm^2	(psi)	N	(pounds)	N	(pounds)	mm (inch)	percent
110	14.0	2030	1400	203100	0.30	44	780	175	670	151	1.5 (0.059)	10%
120	14.0	2030	1400	203100	0.50	73	875	197	775	174	1.5 (0.059)	10%
130	24.0	3481	2400	348100	0.60	87	1100	247	875	197	1.5 (0.059)	10%
140	24.0	3481	2400	348100	0.75	109	1325	298	1000	225	1.5 (0.059)	10%
150	31.0	4496	3100	449600	0.90	131	1400	315	1200	270	1.5 (0.059)	10%
160	31.0	4496	3100	449600	1.05	152	1555	350	1335	300	1.5 (0.059)	10%

Figure 5. Physical & Mechanical Properties of Medium Density Particle Board [12]

Mechanical and physical properties of hardboards

Type	Nominal thickness, mm	Density, Kg/m^3	Modulus of rupture, MPa	Water absorption, % by mass		Thickness swelling, %		Screw holding, N	Nail Head Pull-Through, N	Tensile strength parallel to surface, MPa
				21±2 °C	30±2 °C	21±2 °C	30±2 °C			
Standard	2.5	900	35	30	-	20	-	-	195	18
	3.2	900	35	30	53	18	29	195	345	18
	4.8	900	35	25	49	16	26	290	440	18
	6.4	950	35	20	34	14	23	490	590	18
Tempered	3.2	950	44	25	45	16	25	245	490	22
	4.8	950	44	16	35	14	23	390	590	22
	6.4	950	44	16	27	14	17	490	685	24

Figure 6. Physical & Mechanical Properties of High- Density Particle Board [12]

APPENDIX C

RESEARCH DATA

Density Test of the Talahib Grass Particle Board

1C:1F MIXING RATIO (300 ML)				
Test No.	**Mass (kg)**	**Thickness (m)**	**Volume (m^3)**	**Density (kg/ m^3)**
T6	0.39	0.016	0.00036	1083.333
T9	0.334	0.013	0.000293	1139.9317
T10	0.295	0.015	0.000338	872.781
T11	0.321	0.016	0.00036	891.6667
T12	0.309	0.0140	0.000315	980.9524
AVERAGE	**0.3298 kg**	**0.0148**	**0.000333 m^3**	**993.733 kg/ m^3**
0.75F:0.25C MIXING RATIO (300 ML)				
Test No.	**Mass (kg)**	**Thickness (m)**	**Volume (m^3)**	**Density (kg/ m^3)**
T7	0.311	0.016	0.00036	863.8889
T13	0.288	0.013	0.000293	982.935
T14	0.296	0.013	0.000293	1010.2389
T15	0.299	0.015	0.0003375	885.9259
T16	0.288	0.012	0.00027	1066.6667
AVERAGE	**0.2964 kg**	**0.0138**	**0.0003107 m^3**	**961.9311 kg/ m^3**

0.25F:0.75C MIXING RATIO (300 ML)				
Test No.	**Mass (kg)**	**Thickness (m)**	**Volume (m^3)**	**Density (kg/ m^3)**
T8	0.315	0.015	0.0003375	840
T17	0.294	0.014	0.000315	933.333
T18	0.289	0.013	0.000293	986.348
T19	0.301	0.015	0.0003375	891.852

T20	0.305	0.014	0.000315	968.254
AVERAGE	**0.3008 kg**	**0.0142**	**0.0003196 m^3**	**923.9574 kg/ m^3**

1C:1F MIXING RATIO (250 ML)				
Test No.	**Mass (kg)**	**Thickness (m)**	**Volume (m^3)**	**Density (kg/ m^3)**
T21	0.241	0.013	0.0002925	823.932
T22	0.271	0.01	0.000225	1204.444
T23	0.252	0.013	0.0002925	861.5385
T24	0.254	0.012	0.00027	940.7407
T25	0.253	0.012	0.00027	937.037
AVERAGE	**0.2542 kg**	**0.012 m**	**0.00027m^3**	**953.5384 kg/ m^3**

0.75C:0.25F MIXING RATIO (250 ML)				
Test No.	**Mass (kg)**	**Thickness (m)**	**Volume (m^3)**	**Density (kg/ m^3)**
T26	0.248	0.011	0.0002475	1002.0202
T27	0.248	0.012	0.00027	918.5185
T28	0.254	0.01	0.000225	1128.8889
T29	0.245	0.012	0.00027	907.4074
T30	0.233	0.01	0.000225	1035.5556
AVERAGE	**0.2456 kg**	**0.011 m**	**0.0002475 m^3**	**998.4781 kg/ m^3**

0.25C:0.75F MIXING RATIO (250 ML)				
Test No.	**Mass (kg)**	**Thickness (m)**	**Volume (m^3)**	**Density (kg/ m^3)**
T31	0.252	0.01	0.000225	1120

T32	0.250	0.011	0.0002475	1010.1010
T33	0.237	0.011	0.0002475	957.5758
T34	0.258	0.01	0.000225	1146.6667
T35	0.249	0.01	0.000225	1106.6667
AVERAGE	**0.2492 kg**	**0.0104 m**	**0.000234 m^3**	**1068.20204 kg/m^3**

WATER ABSORPTION TEST

Water Absorption and Thickness Swelling Test of the FR Samples

Water Absorption & Thickness Swelling (immersed in water for 2 hrs)									
Test No.	**Mass dry (kg)**	**T_1 (m)**	**Mass Sat. (kg)**	**Mass after 2 hrs immersion**	**Mass after 12 hrs immersion**	**Mass after 24 hrs immersion**	**T_2 (m)**	**Water Absorption (%)**	**Thickness Swelling**
T9	**0.334**	**0.013**	**0.339**	**0.335**	**0.335**	**0.334**	**0.013**	**1.497**	**0**
T15	**0.299**	**0.015**	**0.311**	**0.307**	**0.301**	**0.300**	**0.015**	**4.013**	**0**
T18	**0.289**	**0.013**	**0.295**	**0.291**	**0.290**	**0.289**	**0.013**	**2.076**	**0**
T23	**0.252**	**0.013**	**0.262**	**0.260**	**0.255**	**0.251**	**0.013**	**3.968**	**0**
T30	**0.233**	**0.01**	**0.243**	**0.241**	**0.237**	**0.233**	**0.01**	**4.292**	**0**
T31	**0.252**	**0.01**	**0.264**	**0.262**	**0.254**	**0.249**	**0.01**	**3.968**	**0**

Water Absorption (immersed in water for 12 hrs)									
Test No.	**Mass dry (kg)**	**T_1 (m)**	**Mass Sat. (kg)**	**Mass after 2 hrs immersion**	**Mass after 12 hrs immersion**	**Mass after 24 hrs immersion**	**T_2 (m)**	**Water Absorption (%)**	**Thickness Swelling**
T10	**0.295**	**0.015**	**0.308**	**0.306**	**0.300**	**0.298**	**0.015**	**4.407**	**0**
T14	**0.296**	**0.013**	**0.328**	**0.325**	**0.316**	**0.312**	**0.013**	**10.811**	**0**
T19	**0.301**	**0.015**	**0.307**	**0.301**	**0.302**	**0.302**	**0.015**	**1.993**	**0**
T25	**0.253**	**0.012**	**0.275**	**0.271**	**0.262**	**0.257**	**0.012**	**8.696**	**0**
T26	**0.248**	**0.012**	**0.263**	**0.260**	**0.253**	**0.251**	**0.012**	**6.048**	**0**
T35	**0.249**	**0.01**	**0.276**	**0.271**	**0.257**	**0.252**	**0.01**	**10.843**	**0**

Water Absorption (immersed in water for 24 hrs)									
Test No.	**Mass dry (kg)**	**T_1 (m)**	**Mass Sat. (kg)**	**Mass after 2 hrs immersion**	**Mass after 12 hrs immersion**	**Mass after 24 hrs immersion**	**T_2 (m)**	**Water Absorption (%)**	**Thickness Swelling**
T12	**0.309**	**0.014**	**0.331**	**0.329**	**0.325**	**0.315**	**0.014**	**4.407**	**0**
T13	**0.296**	**0.013**	**0.312**	**0.303**	**0.300**	**0.298**	**0.013**	**5.405**	**0**
T17	**0.294**	**0.014**	**0.305**	**0.303**	**0.301**	**0.300**	**0.014**	**3.741**	**0**
T22	**0.271**	**0.01**	**0.288**	**0.284**	**0.280**	**0.257**	**0.01**	**6.273**	**0**
T28	**0.254**	**0.01**	**0.277**	**0.271**	**0.268**	**0.251**	**0.01**	**9.055**	**0**
T33	**0.237**	**0.011**	**0.272**	**0.263**	**0.259**	**0.25**	**0.011**	**14.768**	**0**

FLAMMABILITY TEST

TEST NO.	$MASS_1$ (kg)	WIDTH OF THE BURNED AREA (SIDE) (cm)	WIDTH OF THE BURNED AREA (DIAGONAL TO THE CENTER) (cm)	$MASS_2$ (kg)	Weight Loss (kg)
T6	0.390	6	11	0.375	0.015
T7	0.311	4	4	0.297	0.014
T20	0.305	2	2	0.305	0
T21	0.241	8	3.5	0.238	0.003
T27	0.248	9	11	0.231	0.017
T32	0.250	15	19	0.227	0.023

COMPRESSION TEST FOR TALAHIB GRASS PARTICLE BOARD (CUBE SAMPLE)

Dimension: 3x3x2.5 inches (0.0762x0.0762x0.0635 m) = 3.6871x10^{-4} m^3

TEST NO.	**Mass (kg)**	**Density (kg/m^3)**	Load Applied (Readings) (kN)	Compressive Test Strength (psi)	Type of Failure
T36	0.294	797.377	67.5	1768.6	Splitting
T37	0.304	824.499	77.5	2030.6	Splitting
T38	0.311	843.484	75.8	1986.1	Splitting
T39	0.269	729.573	64.9	1700.5	Splitting
T40	0.274	743.134	61.3	1606.2	Splitting
T41	0.275	745.846	68.3	1789.6	Splitting

Modulus of Rupture Test of the Samples

TEST NO.	Load Applied (N)	**Span (mm)**	**Width of test piece (mm)**	**Thickness of test piece (mm)**	**MOR (MPa)**
T36	67500	165	63.5	76.2	45.3101
T37	77500	165	63.5	76.2	52.0227
T38	75800	165	63.5	76.2	50.8816
T39	64900	165	63.5	76.2	43.5649
T40	61300	165	63.5	76.2	41.1483
T41	68300	165	63.5	76.2	45.8471

Modulus of Elasticity Test of the FR Samples

Deflection of Talahib Grass with Polyester resin Particle board samples from the MOE Test

TEST NO.	Area (m2)	Force Applied (N)	Thickness (m)	Elongation (m)	MOE (MPa)
T11	0.0225	927.045	0.150	0.009	0.6867
T16	0.0225	309.015	0.140	0.008	0.2409
T8	0.0225	971.19	0.140	0.002	3.083
T24	0.0225	397.305	0.120	0.010	0.2127
T29	0.0225	220.725	0.110	0.006	0.1784
T34	0.0225	220.725	0.100	0.005	0.1962

APPENDIX D

DOCUMENTATION

Appendix D-1: Preparation of materials

Appendix D-2: Board and cube samples

Appendix D-3: Testing samples

Appendix D-4: Testing at QSTI

APPENDIX E

COMPRESSIVE STRENGTH LABORATORY RESULT

QSTI
QUALITEST SOLUTIONS & TECHNOLOGIES, INC.
DPWH-BRS ACCREDITED TESTING LAB
B&L Bldg., Beside Ma-a Bridge, Diversion Road, Davao City
Tel# (082) 241-2886 and (082) 241-2924

PROJECT: THE PERFORMANCE OF TALAHIB GRASS WITH POLYESTER RESIN PARTICLE BOARD

DATE: February 23, 2021

LOCATION: UNIVERSITY OF MINDANAO, MATINA

REPORT NO. MC 21 - 0352 A

CLIENT: CATHERIN CIFRA / ROMARC VERGARA / KRIS APLE DAGUMAN

TYPE OF TEST CONDUCTED: COMPRESSION TEST FOR CUBE   TEST DATE: 23-Feb-21

TYPE OF SAMPLE: -
SOURCE OF MIXTURE: -
SAMPLED BY: CATHERIN CIFRA
TYPE OF TEST: COMPRESSION TEST
SUBMITTED BY: CATHERIN CIFRA

SAMPLE I.D. NO	PART OF STRUCTURE OR STATION REPRESENTED	DESIGN STRENGTH (PSI)	DATE SAMPLED	AGE IN DAYS	TYPE OF FAILURE	READINGS (KN)	COMPRESSIVE TEST STRENGTH (PSI)
T1	250 CC	-	8-Feb-21	15	3	64.9	1700.5
T2	250 CC	-	8-Feb-21	15	3	61.3	1606.2
T3	250 CC	-	8-Feb-21	15	3	68.3	1789.6
T4	300 CC	-	8-Feb-21	15	3	67.5	1768.6
T5	300 CC	-	8-Feb-21	15	3	77.5	2030.6
T6	300 CC	-	8-Feb-21	15	3	75.8	1986.1

****NOTHING FOLLOWS***

TYPE OF FAILURE :

1. SHEAR -   2. CONIC -   3. SPLITTING -

WITNESSED BY:

Catherin Cifra, UM - Matina
Romarc Vergara, UM - Matina
Kris Aple Daguman, UM - Matina

REMARKS: SAMPLE TESTED USING NEOPRENE PADS, TEST TIME: 3:40 PM - 3:45 PM

TEST CONDUCTED BY:
Kleig R. Dumdum
Laboratory Engineer

CERTIFIED CORRECT:
Engr. Shang Feng L. Liu
Operations Manager

NOTE: THIS TEST REPORT SHALL NOT BE REPRODUCED WITHOUT THE APPROVAL OF THE TESTING LABORATORY.
DPWH - BRS ACCREDITED AS PER D.O. NO. 173, SERIES OF 2002: JANUARY 29,2022 (FORMERLY QSTS)

THIS REPORT IS NOT VALID WITHOUT DRY SEAL

APPENDIX F

RESEARCH DOCUMENTS

The University of Mindanao

RESEARCH AND PUBLICATION CENTER

[✓] Main [ ] Branch ______________

ASSIGNMENT OF RESEARCH PERSONNEL

Course Code: CE 501

Program: BSCE

This is to acknowledge acceptance of assignment as Research Personnel for the thesis entitled:

The Performance of Talahib (Saccharum Spontaneum) Grass with Polyester Resin Particle Board

	Name	Signature	Date
Adviser	Engr. Michelle A. Daarol	[signature]	Sept. 16, 2019
Statistician/Data Analyst	Engr. Cresencio Genobiagon Jr.	[signature]	Sept. 16, 2019
Editor	Engr. Michelle A. Daarol	[signature]	Sept. 16, 2019
Panel Members	Engr. Jetron J. Adtoon	[signature]	Sept. 16, 2019
	Engr. Noroddin V. Melog	[signature]	Sept. 16, 2019

Endorsed by: Engr. Jetron J. Adtoon
Research Coordinator/Asst. Research Coordinator

Approved by: Dr. Charito L. Cañesares
Dean of College

F-13100-019 / Rev. # 0 / Effectivity: January 25, 2018

The University of Mindanao

College of Engineering Education
2nd Floor, BE Building
Matina Campus, Davao City
Telefax: (082)296-1084
Phone No.: (082)300-5456/300-0647 Local 131

ENDORSEMENT FOR FINAL DEFENSE

August 9, 2022

This is to endorse the research manuscript entitled **"The Performance of Talahib (Saccharum Spontaneum) Grass with Polyester Resin Particle Board"** prepared and submitted by **Catherin Cifra, Kris Aple Mae Daguman** and **Romarc Vergara** for final defense. The paper has been evaluated by the research personnel listed below and was found to be compliant to the quality standards as provided by the UM Research Manual.

Endorsed by:

ENGR. Michelle A. Daarol Date: 08/09/2022
Adviser

ENGR. Cresencio Genobiagon Jr. Date: 08/09/2022
Statistician

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UNDERGRADUATE THESIS / RESEARCH / CAPSTONE APPROVAL OF FINAL MANUSCRIPT

Date : October 24, 2022

Title : **The Performance of Talahib (Saccharum Spontaneum) Grass with Polyester Resin Particle Board**

Student-Proponents	Program
1. Cifra, Catherin P.	BSCE
2. Daguman, Kris Aple Mae M.	BSCE
3. Vergara, Romarc G.	BSCE

Panel Comments/ Recommendations	Previous Status	Actions Taken / Revisions	Page Reflected
1. Improve the cost analysis and add statistical analysis. Consult the statistician.	The cost analysis is lacking in data and should be improved.	To improve the cost analysis of the particle board, the researchers consulted with their statistician. They added more details about the costs of the material used.	9
2. Improve the abstract. It must stand alone, short, and compact. Mention the methods done in the study.	The abstract lacks details about the tests that were performed.	The methods used to conduct the tests were discussed. The researchers also included information about the board with the best data.	1
3. Remove the citation in the significance of the study. It should be based on common knowledge.	There was a citation in the significance of the study.	The citation-containing paragraph was replaced with a paragraph from common knowledge.	1
4. Put discussion for the conceptual framework. (Fig.1)	The conceptual framework is not being discussed.	The researchers included discussion about the conceptual framework.	2
5. Figure 4 has also no discussion.	There is also no discussion of figure 4, which contains the mixing ratio and board properties to be tested.	Discussion about figure 4 was added.	3
6. Fig. 2 and 3 must be in methods and procedure.	Figures 2 and 3 were found in the materials and resources section.	The figures 2 and 3 were transferred to the methos and procedures.	3
7. In methods and procedure, remove the "Preparation of Samples.	Under methods and procedure, there was a subtitle "Preparation of Samples."	The "Preparation of Samples" was removed.	2
8. The details about the talahib grass and resin must also be discussed.	The details about the resin and talahib grass were lacking.	The researchers added more details about the materials.	2
9. The subtopics "A", "B", and "C" must be removed or can be replaced with "a", "b", and "c".	The testing procedures for the physical and mechanical tests were labeled A, B, and C.	The subtopics were replaced with small letters a, b, and c.	3-4
10. Put the table captions at the top of the tables and include discussion about the table.	Table and figure captions were placed beneath the tables and figures and there were no discussions.	The captions were put at the top of the tables and figures and discussions were added.	3,5-9
11. The formulas must have an equation number and put explanation/ discussion about the formula.	There were no equation number for the formulas used.	The formulas now have an equation number, as well as an explanation.	3-4
12. Put images/figures in the Discussion of Results and compare the results with the	There were no images in the results discussion.	Images were added to compare the before and after results of the tests performed.	6-9

Date Effective: September 3, 2022

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UNDERGRADUATE THESIS / RESEARCH / CAPSTONE APPROVAL OF FINAL MANUSCRIPT

Panel Comments/ Recommendations	Previous Status	Actions Taken / Revisions	Page Reflected
before and after the test procedures.			
13. Remove the table for the results of the thickness swelling.	There was a table for the thickness swelling.	The table was removed.	6-7
14. Conclusion and Recommendation for future works must be one paragraph each.	The conclusion has 3 paragraphs and the recommendation for future works was not thoroughly discussed.	It has been reduced to one paragraph each.	10
15. Change the font size of the references to size 8.	The font size for the references was size 9.	It has been reduced to size 8.	10
16. In methods and procedures add the process flow.	The process flow for the study was not thoroughly discussed.	The researchers added more details about the process flow.	2-3

**You may add more columns if necessary*

APPROVALS:

C Complied NC Not Complied	Thesis Adviser / Editor	Signature	Date
C	Engr. Michelle A. Daarol	[signature]	Nov. 17 2022

C Complied NC Not Complied	Statistician	Signature	Date
C	Engr. Cresencio P. Genobiagon Jr.	[signature]	Nov. 18, 2022

C Complied NC Not Complied	Panel Members	Signature	Date
C	Engr. Jetron J. Adtoon	[signature]	DEC 01 2022
C	Eng. Noroddin V. Melog	[signature]	Nov. 22, 2022

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Research and Publication Center
Room H1B, DPT Building
Matina Campus, Davao City
Phone No.: (082)300-0640 loc. 111

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- [ ] Doctoral thesis

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The Performance of Talahib (Saccharum Spontaneum) Grass with Polyester Resin Particle Board

Name of author/s:

Romarc G. Vergara, Catherin P. Cifra, Kris Aple Mae M. Dagunan

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The Performance of Talahib (Saccharum Spontaneum) Grass with Polyester Resin Particle Board

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CERTIFICATION

This is to certify that the undergraduate thesis output of Romarc Vergara, Catherin Cifra and Kris Aple Mae Daguman entitled "**The Performance of Talahib (Saccharum Spontaneum) Grass with Polyester Resin Particle Board**" in partial fulfillment of the requirements for the Degree of Bachelor of Science in Civil Engineering has been properly reviewed and statistically analyzed/data analyzed.

Respectfully yours,

ENGR. CRESENCIO GENOBIAGON JR.
Thesis Statistician

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CERTIFICATION

This is to certify that the undergraduate thesis output of Romarc Vergara, Catherin Cifra, and Kris Aple Mae Daguman entitled "**The Performance of Talahib (Saccharum Spontaneum) Grass with Polyester Resin Particle Board**" in partial fulfillment of the requirements for the Degree of Bachelor of Science in Civil Engineering has been properly reviewed to be aligned with the set of structural rules that govern the composition of sentences, phrases and word in the English Language.

Respectfully yours,

ENGR. MICHELLE A. DAAROL
Grammarian

The Performance Of Talahib Grass With Polyester Resin Particle Board-Manuscript

by Michelle Daarol

General metrics

37,778	6,047	306	24 min 11 sec	46 min 30 sec
characters	words	sentences	reading time	speaking time

Writing Issues

✓ No issues found

Plagiarism

This text hasn't been checked for plagiarism

Unique Words Measures vocabulary diversity by calculating the percentage of words used only once in your document	**15%** unique words
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Word Length Measures average word length	**4.7** characters per word
Sentence Length Measures average sentence length	**19.8** words per sentence

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Date: February 2, 2023

AUTHORIZATION LETTER

This is to authorize the University of Mindanao and adviser/co-author, **ENGR. MICHELLE A. DAAROL,** of the study entitled **THE PERFORMANCE OF TALAHIB (SACCHARUM SPONTANEUM) GRASS WITH POLYESTER RESIN PARTICLE BOARD** to present the paper in local, national or international research conferences; publish the paper in local, national or international research journals; and/or submit the paper for national or international intellectual property protection. It is therefore the responsibility of the adviser to ensure that the primary authors/inventors/makers/designers are given due recognition.

The Researchers

Romark G. Vergara

Catherin R. Cifra

Kris Aple Mae M. Daguman

APPENDIX G

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	Kidapawan City, North Cotabato
	2011-2015

APPENDIX H

ROUTING FORM

The University of Mindanao

RESEARCH AND PUBLICATION CENTER

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Title: The Performance of Talahib (Saccharum spontaneum) Grass with Polyester Resin Particle Board

Proponents: Vergara, Romarc G.
Cifra, Catherin P.
Daguman, Kris Aple Mae M.

Program: BSCE
Course Code: CE 50a (10157)
Semester/SY: ____________

Name	Date Received	Signature	Date Released	Signature	Remarks
Adviser Engr. Michelle A. Daarol	Feb. 03, 2023		Feb. 03, 2023		
Statistician Engr. Cresencio P. Genobiagon Jr.	Feb. 07, 2023		Feb. 07, 2023		
Panel 1 Engr. Noroddin V. Melog	Feb. 08, 2023		Feb. 08, 2023		
Panel 2					
Panel 3 (RC/ARC) Engr. Jetron Adtoon	Dec. 1, 2022 FEB 10 2023		Dec. 1, 2022 FEB 11 2023		Approved for binding
Plagiarism Check Engr. Jetron Adtoon	Dec. 2, 2022		Dec. 5, 2022		Compliant
Editor Engr. Michelle A. Daarol	Feb. 03, 2023		Feb. 03, 2023		
Dean Engr. Charlito L. Cañesares					

F-13100-018 / Rev. # 0 / Effectivity: January 25, 2018