WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Insulation Capacity of Refined Sawdust and Coconut Coir as Plyboard Wall Cladding

Myrtle Masucol[1], Joanna Lou Lagawan[2], James Matute[3], Marian Ramos[4], Cheerwina D. Puyales[5]

[1,2,3,4]Research Proponent, [5]Research Adviser

[1,2,3,4,5]Carlos P. Garcia Senior High School, Juan Luna Street, Poblacion District, Davao City

ABSTRACT

This study aimed to investigate the insulation capacity of refined sawdust and coconut coir plyboard as wall cladding. The refined sawdust and coconut coir plyboard as well as the commercial plyboard were tested separately before 1 hour exposure to sunlight and after 1 hour exposure to sunlight. The plyboards separately placed inside the prototype room made of galvanized iron and were tested by thermal conductivity meter.

Data were analyzed using mean and Mann-Whitney U Test. Results showed that refined sawdust and coconut coir plyboard can be used as wall claddings of our houses because of its good insulation capacity. Also, refined sawdust and coconut coir can be utilized as interior building material. The refined sawdust and coconut coir plyboard and commercial plyboard have significant differences in temperature after 1-hour of exposure to sunlight, therefore, refined sawdust and coconut coir plyboard have be1er insulation capacity than commercial plyboard and it is environmentally and economically friendly. Explore more uses of refined sawdust and coconut coir plyboard.

Introduction

The planet's ongoing increase in temperature is extremely concerning as it impacts every aspect of life on Earth. Global warming is one of the primary concerns in the Philippines. As temperatures rise, many people with heat-related health issues are more affected by global warming. According to Cabato (2024), the Philippine Atmospheric, Geophysical, and Astronomical Services Administration reported that the heat index in the country recently peaked at a scorching 42 to 48 degrees Celsius. Heat stroke is likely when temperatures reach 52°C or more, which is already regarded as an "extreme danger level." These occurrences have led to numerous human and ecological impacts, including crop failures, wildfires, and damage to infrastructure. According to Acosta (2023), as temperatures continue to rise, the City Health Office urges Dabawenyos to be aware of heat-related illnesses, particularly heat stroke, which has a high potential to be deadly.

According to U.S. Environmental Protection Agency (2024), overall, a total of more than 14,000 Americans had died directly from heat-related causes since 1979, according to death certificates. The report showed that more than 1,300 deaths per year in the United States are due to extreme heat, scientists have learned that excessive heat results to substantially more fatalities caused by the underlying stress brought by a hot weather that elevates the potency of dying from a heart attack, other heart conditions, or respiratory diseases like pneumonia. Such causes of death are far more prevalent in general than dying directly from a heat-related illness which includes heat stroke. As a result, it is probable that this indicator understates the number of deaths brought on by heat exposure. At least 15,000 deaths in Europe were traced to the high temperatures (WHO, 2022). It is crucial for investigating the patterns, causes, and effects of extreme heat because as climate change intensifies, extreme heat events are predicted to continue to rise in scope, intensity, and length. (Chen et. al., 2020: IPCC,2019: Liu et. al.,2019:Russo et. al.,2019).

According to Portugal (2024), over 3.6 million students have been impacted by cancellations of classes due to heatwaves, which have caused heat indices to reach 50 degrees Celsius (122 degrees Fahrenheit) in several parts of the Philippines. El Nino, a weather phenomenon, is intensifying the heatwave that is enveloping the country during the summer months of March through May. Currently, the people in the Country are experiencing heat crisis for each passing year and as time passes, the heatwave becomes hotter. Note that health vulnerabilities brought on by climate change are more common in low- and middle-income nations like the Philippines. Therefore, improving the risk attribution profiling is essential to provide the nation and other low- and middle-income countries with a temperature range that is relatively similar with the knowledge needed to implement preventative measures that can mitigate the risks associated with unfavorable temperature scenarios. Furthermore, risk population-tailored solutions will require the identification of risks in relation to the mortality subgroups (Seposo et. al.,2019).

According to Acosta (2023), as temperatures continue to rise, the City Health Office urges Dabawenyos to be aware of heat-related illnesses, particularly heat stroke, which has a high potential to be deadly. Rubber, plastic, wood, and glass are good electrical insulators. According to Ramzy (2021), they

are used to cover materials that carry electricity. Sawdust, the residue of woodworking operations, is a poor heat conductor because it can impede the flow of heat. Several studies lignocellulosic fiber. Coir is obtained from the husk of coconut, considering coir

fiber has a high lignin content and a low cellulose content, it can be a great choice with regards to this study. This study aims to minimize the increasing number of heats by using sawdust and coconut coir as plyboard wall cladding.

With these, the researcher opted to investigate the insulation capacity of refined sawdust and coconut coir plyboard as alternative wall cladding.

Literature Review

According to Shakir et. al. (2023) research has shown that natural waste fibers exhibit superior thermal performance and insulation behavior, making them a viable raw material for composite insulation panels. When used in composite panels, the formation of an air-void structure results in the unique properties of natural waste fiber, which effectively enhance thermal performance for insulation. Air spaces not only improve thermal performance but also lessen the mechanical and physical characteristics of the composite insulating panel. However, according to Tsalagkas et al. (2021) state that as long as a composite insulating panel has sufficient thermal performance for the heat transmission mechanism, it is not required to have excellent mechanical qualities. These factors explain why most insulating panels on the market today are composed of low-density materials with air-void architectures. It has been noted that its use in insulating applications demanding high durability, curved surfaces, and greater sensitivity to impact damage is limited because of the air void structure and low durability. The mechanical and physical characteristics of standard insulation panels should, in spite of these circumstances, be able to bear the least amount of load feasible during their handling, installation, and maintenance procedures. companies or industries which are sent directly for processing. Through design, the non-metallic and metallic waste is separated. The system is controlled by the microcontroller.

According to Gamiao et. Al. (2023) sawdust is the residue from woodworking operations. It is a poor conductor of heat as it can resist heat flow. Several studies showed that sawdust tends to have low thermal conductivity. If sawdust is properly shaped into facing or wall cladding of sufficient thickness it will act as an effective insulating material. For employing sawdust as an insulating material, it necessarily needs to be in a shape and form that can be installed in the prototype and in actual building structures. For this purpose, wall cladding was made from sawdust. Organic resin was used as a binding material. The organic resin was made by mixing water, flour, vinegar, sugar, and salt in the ratios 1:0.5:0.1:0.05:0.025 respectively by weight. (Qasab and Gul,2019)

Coir is lignocellulosic natural fiber that can be found in the coconut's husk, an abundantly found fruit or nut worldwide. This fiber has some unique characteristics, such as its resistance is seawater, microbial attack, high impact, and many other but its low thermal conductivity and high thermal insulating property serves great potential for being used as insulators in engineering sites. (Mahmud et. Al.,2023)

Sawdust and Coconut Coir

Sawdust cellulose, lignin, hemicelluloses, and 5-10% other materials. Cellulose is a sawdust component that is good for insulation as well as reduction of noise transmission. Lignin is a great component as well. It is characterized by a comparatively high strength, high resilience, and stiffness with regard to UV light. Another good component for insulating against heat and sound is lignin. These components of sawdust carry great potential for the thermal insulation of buildings. Coir is a lignocellulosic fiber. This means that coconut coir has low cellulose percentage but is high on lignin, these properties are what brings the coconut coir a great choice for this study as it is good for insulation capacity as well. According to Ravindrarajah et al. (2001) Sawdust can be utilized to produce load-bearing concrete blocks with compressive strengths more than 12.5 MPa.Given that coconut fiber contains more than 30% lignin, which strengthens the cell wall to protect the carbohydrates from physical or chemical damage while also giving the fiber and tissue compressive strength, coconut fiber is the hardest natural fiber available. Compared to other fibers, coconut fibers can be 4–6 times more strained. Furthermore, the power of coconut fiber is retained when it is stored and exposed to sunlight. The total weight needed for the coconut fiberboard panel is determined in large part by the density of the coconut fiber. As a result, its qualities, coconut fiber is being used more and more in the manufacturing of furniture (Tawasil et al., 2021).

Wall Cladding

Exterior wall cladding serves as a weatherproof barrier that adds extra insulation and shields your home from outside elements. Traditionally made from brick, stone, wood, and tile, contemporary developments offer a variety of materials, such as metal, vinyl, wood-plastic composites (WPC), and glass. These variety of cladding materials ensure that your property is protected while opening up a world of decorative options (Hosung,2023).

Statement of the Problem

This study aimed to investigate the insulation capacity of refined sawdust and coconut coir plyboard as wall cladding. Specifically, the study sought to answer the following questions:

1. What is the temperature before and after using the following treatments:

1.1 Refined sawdust and coconut coir plyboard?

1.2 Commercial plyboard?

2. Is there a significant difference in the temperature before and after using refined sawdust and coconut coir plyboard?

3. Is there a significant difference in the temperature between the refined sawdust and coconut coir plyboard and commercial plyboard?

Research Hypotheses

This study was tested at 0.05 level of significance

Ho - There is no significant difference in the temperature before and after using the refined sawdust and coconut coir plyboard.

Ho - There is no significant difference in the temperature between the refined sawdust and coconut coir plyboard and commercial plyboard.

Significance of the Study

This study will help minimize the global rising of temperature as it affecting earth in every aspect. Using refined sawdust and coconut coir plyboard will give us efficient, low-cost and can benefit urban communities in Davao City.

METHODS

In this section, the researchers presented the research design, gathering and measurement of the materials, experimentation and data gathering procedure used in the study.

Research Design

This study used experimental quantitative research method, specifically a true experimental design, to gather relevant data and information. According to Saigo (2023) generally speaking, an experimental study design focuses on the relationship between two variables: the independent and dependent variables.

Phase I – Gathering of materials for the sawdust and coconut coir wall tiles

The primary material used is coconut coir. Upon searching for the coconut coir, the researchers roamed around the Bunawan on August 27, 2024.Another primary material is wood and thermal conductivity meter. In finding the sawdust, the researchers went to Boulevard Street and bought it in a Lumber Shop. On the other hand, the thermal conductivity meter, was ordered from the Shopee. Conversely, other essential and relevant materials such as pot, ladle, spoon, electric cooker, water, flour ,vinegar, sugar, salt, were produced from the researcher's individual establishments. This approach ensured a prudent management of cost while maintaining the necessary equipment's completeness.

Phase II- Measurement of the ingredients for organic resin

The organic resin was made by mixing water, flour, vinegar, sugar, and salt in the ratios 1:0.5:0.1:0.05:0.025 respectively by weight.

The following procedure was done to create the sawdust and coconut coir wall cladding.

The pot was placed on the fire together with the water and was boiled in the ratio of 1.0 or 1 liter.

The flour was poured flour in the boiling pot with the ratio of 5:0 or 500 grams. After that, the vinegar was placed in the water in the boiling ratio of 1:0 or 10ml together with the sugar in the ratio of 05:0 or 5 grams, salt in the ratio of 025 or 25 grams. The pot was observed while on boil and was boiled below 150 degrees Celsius with a steady temperature.

While the pot was on boil, the mixture was mixed slowly and gently to avoid bubbles. The stirring was continuous until the white gel-like substance was produced.

After cooking, the binding agent was set aside for a while. The sawdust and coconut coir were measured in the weighing scale with the required measurement. After that, the measured sawdust was mixed with coconut coir. The refine wall cladding was produced through mixing the sawdust and coconut coir with the organic resins in its respective measures. The combination was mixed thoroughly.

The sawdust and coconut coir were poured into the molds with pressure applied to compact the sawdust and coconut coir wall cladding to its required shape and size together with the dimensions 20×10×3.5cm.

The sawdust and coconut coir wall tiles was removed from the molds and left to dry in the sun for 4 hours. After 8 hours, the sawdust and coconut coir wall tiles were later placed in the oven for further drying. It was heated on the oven for 2 hours with the strength of only 1 temperature.

After leaving the product for 2 hours, the sawdust and coconut coir wall cladding was removed from the oven and was left under the heat of the sun for 2 hours. After 2 hours, the cladding should attain its sufficient strength to be prepared for its installation and its purpose of insulation.

Phase III. Testing of Parameters Indicators in Testing

All testing indicators were performed inside the school using thermal conductivity meter, prototype room made of galvanized iron (movable roof), improvised wall cladding compressor. The prototype room was tested with temperature after 1 hour, after 1 hour, the refined sawdust and coconut coir plyboard was placed inside the prototype room. For commercial plyboard, same method was performed.

Disposal Procedure

The unused organic resin was diluted with water and disposed safely.

Data Analysis

The following statistical tests were used to analyze the data:

Mean It was utilized to measure the average temperature before 1 hour and after 1 hour of refined sawdust and coconut coir plyboard and commercial plyboard.

Wilcoxon signed rank test: This was used to determine if there is significant difference between the temperature before and after using refined sawdust and coconut coir plyboard.

Mann Whitney U Test: This was used to determine if there is significant difference between the temperature before and after using refined sawdust and coconut coir plyboard and commercial plyboard

RESULTS

In this section, presents the findings based on the data gathered. The presentation is organized into (3) parts. First, is the temperature before and after using sawdust and coconut coir plyboard and commercial plyboard. Second, is the Significant difference in the temperature before and after using the sawdust and coconut coir plyboard. Third, is the significant difference in the temperature between the refined sawdust and coconut coir plyboard and commercial plyboard.

Temperature before and after using the sawdust and coconut coir plyboard and commercial plyboard.

Presented in Table 1 is the result of the temperature before and after using refined sawdust and coconut coir plyboard and commercial plyboard.

Table 1.

Man temperature before and after using refine sawdust and coconut coir plyboard and commercial plyboard.

Parameters	Refined Sawdust and Coconut Coir Plyboard Trials			Mean	Commercial Plyboard	Mean
	Trial 1	Trial 2	Trial 3			
Temperature						
Before 1 hour (⁰C)	39.7	39.0	39.4	39.4	41.7	41.7
After 1 hour (⁰C)	33.7	31.6	29.5	31.6	34.6	34.6

as presented in Table 1, shows the mean temperature before and after using refined sawdust and coconut coir plyboard and commercial plyboard. Before 1 hour exposure to sunlight, the average temperature for refined sawdust and coconut coir plyboard is 39.40C, while the commercial plyboard has a mean of 41.70C. After 1 hour exposure to sunlight, the average temperature for refined sawdust and coconut coir plyboard is 31.60C, while the commercial plyboard has a mean of 34.60C. The results revealed that refined sawdust and coconut coir plyboard has good insulation capacity because it gained lowest temperature after 1 hour exposed to sunlight.

Significant difference in the temperature before and after using the sawdust and coconut coir plyboard.

Presented in Table 2 is the difference in the temperature before and after suing the refined sawdust and coconut coir plyboard.

Table 2.

Significant difference in the temperature before and after using the sawdust and coconut coir plyboard.

Measure 1	Measure 2	W	P	Decision on Ho
Before 1 hour	After 1 hour	15.00	0.03	Reject

As presented in table 2, shows the significant difference in the temperature before and after using the sawdust and coconut coir plyboard. After 1 hour of exposure to sunlight, the result shows that there is a significant difference in the

temperature as detected by the device on the refined sawdust and coconut coir plyboard. The refined sawdust and coconut coir plyboard has the lowest temperature after 1 hour exposure to sunlight. Therefore, the study rejected the null hypothesis. This means that the insulation capacity of refined sawdust and coconut coir plyboard is better than the commercial plyboard.

Significant difference in the temperature before and after using the sawdust and coconut coir plyboard.

Presented in Table 3 is the difference in the temperature between the refined sawdust and coconut coir plyboard and commercial plyboard.

Table 3.

Significant difference in the temperature before and after using the sawdust and coconut coir plyboard.

Parameters	Mean	W	p	Decision on Ho
Temperature (Before)	40.55⁰C	9.00	0.04	Reject
Temperature (After)	33.1⁰C			

Level of significance: 0.05

The table 3 shows the mean temperature of before and after 1 hour exposure to sunlight of refined sawdust and coconut coir plyboard and commercial plyboard. Results show that before 1 hour exposure to sunlight has mean of 40.550C and after 1 hour exposure to sunlight, it has a mean of 33.10C. It also shows that at the level of 0.05 significance, there is significant difference on the temperature after 1 hour exposure to sunlight between refined sawdust and coconut coir plyboard and commercial plyboard. Therefore, the study rejected the null hypothesis. Results show that refined sawdust and coconut coir plyboard has the lowest temperature after 1 hour of exposure. It implies that refined sawdust and coconut coir plyboard has better insulation capacity better than commercial plyboard.

DISCUSSION

After 1 hour exposure to sunlight, the average temperature for refined sawdust and coconut coir plyboard is 31.60C, while the commercial plyboard has a mean of 34.60C. Refined sawdust and coconut coir plyboard can be used as wall claddings of our houses because of its good insulation capacity.

After 1 hour of exposure to sunlight, the result shows that there is a significant difference in the temperature as detected by the device on the refined sawdust and coconut coir plyboard. The refined sawdust and coconut coir plyboard has the lowest temperature after 1 hour exposure to sunlight. Refined sawdust and coconut coir plyboard can be used as interior building material. When compared to the reference sample, the addition of coconut coir dust and sawdust resulted in a decrease of about 26% and 22% in density, as well as 46% and 43% in thermal conductivity, respectively (Jannat, 2022).

Refined sawdust and coconut coir plyboard has better insulation capacity than commercial plyboard and it is environmentally and economically friendly. The coconut coir dust and sawdust sample walls outperformed the reference sample wall in terms of thermal resistance, with an improvement of around 48% and 35%, respectively (Jannat, et al., 2022).

CONCLUSIONS AND RECOMMENDATIONS

Presented in this section is the conclusions and recommendations drawn based on the findings of the study.

1. After 1 hour exposure to sunlight, the average temperature for refined sawdust and coconut coir plyboard is 31.60C, while the commercial plyboard has a mean of 34.60C. Refined sawdust and coconut coir plyboard can be used as wall claddings of our houses because of its good insulation capacity.

2. After 1 hour of exposure to sunlight, the result shows that there is a significant difference in the temperature as detected by the device on the refined sawdust and coconut coir plyboard. The refined sawdust and coconut coir plyboard has the lowest temperature after 1 hour exposure to sunlight. Refined sawdust and coconut coir plyboard can be used as interior building material.

3. Refined sawdust and coconut coir plyboard has better insulation capacity better than commercial plyboard and it is environmentally and economically friendly.

RECOMMENDATIONS

1. Create different proportion combinations of refined sawdust and coconut coir for plyboard production.

2. Use plant-based medium as binders in plyboard production.

3. Use a standardized compressor machine, molding tray, dehydrator/oven, and insulation detector device.

4. Utilize programmed temperature inside the prototype house with standardized devices, applications and software programs.

5. Use refined sawdust and coconut coir plyboard as environment and cost-efficient for house material needs.

6. Explore more uses of refined sawdust and coconut coir plyboard.

REFERENCES

Cabato, L. (2024, May 2). Heat index in PH continues to peak at dangerous levels, Warns Pagasa. INQUIRER.net. https://newsinfo.inquirer.net/1936518/heat-index-in-ph-continues-to-peak-a t-dangerous-levels-warns-pagasa

CEDTyClea. (2024, May 2). DoH: 7 have died in Philippines due to record heat.

BusinessWorld Online. https://www.bworldonline.com/the-nation/2024/05/02/592523/doh-7-have-died-in-philippines-due-to-record-heat/?fbclid=IwY2xjawFsYLZleHRuA2FlbQIxMAABHTGq- 5mCtgD9YEmLNY9zMTHuGEvvihD9WOER9kPS6h0SHz1tE872SIWzKw

_aem_h2ykE50CYcR1rw7HBRYvZQ

Chen et al. (2020). Impact of compound extreme weather events on summer ozone in the Beijing-Tianjin-Hebei Region. *ScienceDirect*. https://www.sciencedirect.com/science/article/abs/pii/S13091042230038 4

Climate change indicators: Heat-Related Deaths | US EPA. (2024, August 16). *US EPA*. https://www.epa.gov/climate-indicators/climate-change-indicators-heat-related-deaths?fbclid=IwY2xjawFsYOFleHRuA2FlbQIxMAABHcSwqVQY0S0cwZgVzOwy5e6vjaPMm2iFlVs66e8p7mn-pMEGMh1yAOWqZA_aem_T1sDR89 KEut6VyPoIpEcTg

Hu, X., Cao, J., Qian, Y., Zhou, W., & Zheng, Z. (2023). Extreme heat events in mainland China from 1981 to 2015: Spatial patterns, temporal trends, and urbanization impacts. *Sustainable Cities and Society, 100*, 104999. https://doi.org/10.1016/j.scs.2023.104999

Jannat, N., Cullen, J., Abdullah, B., Al-Mufti, R. L., & Karyono, K. (2022).

Thermophysical Properties of Sawdust and Coconut Coir Dust Incorporated Unfired Clay Blocks [Review of Thermophysical Properties of Sawdust and Coconut Coir Dust Incorporated Unfired Clay Blocks]. MDPI. https://www.mdpi.com/2673-7108/2/4/16

Khatana, S. a. M., Werner, R. M., & Groeneveld, P. W. (2022). Association of Extreme Heat with All-Cause mortality in the contiguous US, 2008-2017.

JAMA Network Open, 5(5),e2212957. https://doi.org/10.1001/jamanetworkopen.2022.12957

Lakatos, Á. (2020). Investigation of the thermal insulation performance of fibrous aerogel samples under various hygrothermal environment: Laboratory tests completed with calculations and theory. *Energy and Buildings, 214*, 109902. https://doi.org/10.1016/j.enbuild.2020.109902

Estoque, R. C., Ooba, M., Seposo, X. T., Togawa, T., Hijioka, Y., Takahashi, K., & Nakamura, S. (2020). Heat health risk assessment in Philippine cities using remotely sensed data and social-ecological indicators. *Nature Communications, 11*(1). https://doi.org/10.1038/s41467-020-15218-8

Seposo, X. T., Dang, T. N., & Honda, Y. (2016). Effect modification in the temperature extremes by mortality subgroups among the tropical cities of the Philippines. *Global Health Action, 9*(1), 31500. https://doi.org/10.3402/gha.v9.31500

U.S. Environmental Protection Agency. (2024). Climate change indicators: Heat- related deaths. https://www.epa.gov/climate-indicators/climate-change-indicators-heat-rel ated-deaths

Portugal. (2024). Philippine students suffer in wilting heat, thwarting education efforts. *Reuters*.https://www.reuters.com/world/asia-pacific/philippine-students-suffer-wilting-heat-thwarting-education-efforts-2024-04-29