UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MECHANICAL PROPERTIES OF HYBRID COMPOSITE CONSIST OF WOOD DUST, COPPER WIRE AND REINFORCED WITH POLYESTER RESIN

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DECLARATION

I declare that this Choose an item. entitled “Mechanical Properties Of Hybrid Composite Consist Of Wood Dust, Copper Wire And Reinforced With Polyester Resin” is the result of my research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature : 

Name : Muhammad Akmal Daniel Bin Rosli

Date : 11/01/2023

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Process and Technology) with Honours.

Signature : .....

Supervisor Name : Ts. Dr. Khairum Bin Hamzah

Date : 25/01/2023

DEDICATION

All thanks are to Allah for providing me with the strength, patience, direction, and knowledge to accomplish this study. I am grateful to God Almighty for allowing me to join this program special award, I dedicate this thesis to my dear parents, Mr. Rosli Bin Abd Razak and Mrs. Sabilah Binti Hussain. My beloved brothers and sisters, particularly my dearest sister, Syamimi , who stands by me when things look bleak. My friends who encourage and support me. Finally, I'd like to thank my supervisor, Ts. Dr. Khairum Bin Hamzah, for all his help, guidance, and advice in completing this thesis.

ABSTRACT

Recently, the furniture industry in Malaysia especially wooden furniture has gained popularity which leads to generating a huge amount of industrial waste such as wood dust, sawdust, and much more. In the present work, a new analysis of wood dust and copper wire mechanical behavior reinforced by polyester resin (WPR) composites were presented. The mixing composites were fabricated using the hand mixing technique to produce three eco-friendly ratios between natural and synthetic materials. These composites were cut according to the size of the specimen of ASTM standard. These composites ratios are 20% of wood dust and 80% of resin (20WPR), 40% of wood dust and 60% of resin (40WPR), 50% of wood dust and 50% of resin (50WPR), 60% of wood dust and 40% of resin (60WPR), and 80% of wood dust and 20% of resin (80WPR), each of the ratios will have 10% of copper wire as filler. The images of the wood dust were captured using Nikon SMZ 745T microscope and their mechanical properties were analyzed using tensile, impact, and flexural testing. The collected data were analyzed using statistical analysis. Numerical computations and graphical demonstrations are carried out to observe the mechanical behavior of the WPR composites according to the three ratios. The different ratios of WPR composites will be affected by their mechanical behavior.

ABSTRAK

Baru-baru ini, industri perabot di Malaysia terutamanya perabot kayu telah mendapat popularity yang membawa kepada menjana sejumlah besar sisa industri seperti habuk kayu, habuk papan, dan banyak lagi. Dalam kerja ini, analisis baharu bagi habuk kayu dan kelakuan mekanikal dawai tembaga yang diperkukuh oleh komposit resin poliester (WPR) telah dibentangkan. Komposit bancuhan telah dibuat menggunakan teknik bancuhan tangan untuk menghasilkan tiga nisbah mesra alam antara bahan semula jadi dan sintetik. Komposit ini dipotong mengikut saiz spesimen piawaian ASTM. Nisbah komposit ini ialah 20% daripada habuk kayu dan 80% daripada resin (20WPR), 40% daripada habuk kayu dan 60% daripada resin (40WPR), 50% daripada habuk kayu dan 50% daripada resin (50WPR), 60% daripada kayu habuk dan 40% resin (60WPR), dan 80% habuk kayu dan 20% resin (80WPR), setiap nisbah akan mempunyai 10% dawai tembaga sebagai pengisi. sifat mekanikal dianalisis menggunakan ujian tegangan, hentaman dan lentur. Data yang dikumpul dianalisis menggunakan analisis statistik. Pengiraan berangka dan tunjuk cara grafik dijalankan untuk memerhati kelakuan mekanikal komposit WPR mengikut tiga nisbah. Nisbah yang berbeza bagi komposit WPR akan dipengaruhi oleh kelakuan mekanikalnya.

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LIST OF SYMBOLS AND ABBREVIATIONS

20WPR		20% of Wood Dust and 80% Polyester resin
40WPR		40% of Wood Dust and 60% Polyester resin
50WPR	-	50% of Wood Dust and 50% Polyester resin
60WPR	-	65% of Wood Dust and 40% Polyester resin
80WPR	-	75% of Wood Dust and 20% Polyester resin
°C	-	Celsius
SEM	-	Scanning Electron Microscope
e-waste	-	Electronic waste
ASTM	-	American Society for Testing and Materials
CNC	-	Computer Numerical Control
N/mm2	-	Newton per Square Millimetre Pressure
GPa	-	Gigapascal
g/cm³	-	Gram per cubic centimeter
vol%	-	Cubic centimeters
TiC %		Titanium Carbide
W/mK	-	Watts per meter-Kelvin
Wt.%	-	Weight
W-2	-	Wood sample 2
W-3	-	Wood sample 3
W-4	-	Wood sample 4
J/K/J	-	Jute/Kenaf/Jute
K/J/K	-	Kenaf/Jute/Kenaf
Rpm	-	Revolution per minute

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CHAPTER 1

INTRODUCTION

This chapter will explain and elaborate the background of the study, characteristics, and mechanical properties of hybrid wood dust and copper wire reinforced with epoxy resin. This study will be based on essential theories and concepts gathered from primary sources such as previous research, books, and journals. All the data and issues are gathered to identify ways to enhance this research.

1.1 Background

Is a blessing that Malaysia, our beloved country is a rich forest resource that can be used in multiple ways to improve productivity and gain profits from all the assets. One of them is the furniture industry, based on an article by Ratnasingam (2009), In 2004, the furniture and furnishings subsector of the Malaysian wood-based industry generated USD 1.7 billion in export earnings. Since 1995, the timber sector in Malaysia has flourished. In Malaysia's tropical rainforest, the variety of tree species determines the development of the timber industry, particularly in the operations of saw timber plywood, which generate large quantities of waste, such as sawdust and wood chips. (Shafie et al., 2017).

Table 1.1 Wood waste generated from different wood industries in Peninsular Malaysia in 2010 (Shafie et al., 2017)

Mills	Production (m^3)	Consumption (m^3)	Waste (m^3)
Sawmill	3,920,570	2,675,384	1,245,186
Plywood mill	681741	459,253	222,488
Moulding mill	290,899	235,500	55,399
Total	4,893,210	3,370,137	1,523,073

The increase in environmental consciousness and the fast growth of the manufacturing industries suggest the need for more economical and biodegradable materials which have better properties such as good mechanical properties, excellent chemical resistance, reduced maintenance, and lower cost (Peretomode, Eboibi, and Fakrogha, 2019).

Hybrid composites are materials created by mixing two or more distinct fiber types inside a single matrix. There are numerous definitions of hybrid composites provided by researchers (Jamir et al., 2018). Thwe and Liao (2003) a reinforcing element put into a variety of matrices to manufacture hybrid composites. On the other hand, Fu (2002) write these composites are considered to be composed of reinforcing material inserted into two or more reinforcing and filler components present in a single matrix. There are many advantages to using hybrid composites over other fiber-supported composites, including a larger range of applications. Prior research on natural-synthetic fiber hybrid composites has mostly centered on the reduction of synthetic fiber usage. Moreover, a recent study showed the potential benefits of hybridization of natural and synthetic fibers (Jamir, Majid, and Khasri, 2018).

From the research of Kumar and Saha (2021) the hybridization of nanofiller with synthetic and plant fiber/fillers has become a significant area of research for producing excellent mechanical, and tensile, thermally, for structural applications that also reduce pollution. In an article produced by Kumar (2014), to improve the physicomechanical properties of epoxy composites, wood dust was added. According to studies, the addition of

sawdust to an epoxy composite boosts the tensile and flexural strengths up to a particular filler concentration, after which the strength declines gradually. The appropriate wood dust content in an epoxy composition is 10 to 15 percent, which brings the highest possible physical and mechanical properties..

Natural fibers are used as reinforcement in composites because they decay. Due to their mechanical properties, they can be used in industries as a substitute at a lower cost and with greater ease of extraction. An attempt is made to study the potential of copper wire reinforced natural fiber. To determine the maximum load, fracture toughness, modulus of elasticity, and modulus of rupture of jute fiber and jute with copper wire composites were investigated.. (Vadivel Vivek et al., 2022).

Many researchers have completed material testing utilizing the tensile strength testing method (Mohapatra, Mishra, and Choudhury 2017; Dinesh et al., 2020). A tensile strength test is done to determine a variety of essential material properties, such as yield strength, modulus elasticity, ultimate tensile strength, area reduction at fracture, and elongation at fracture. From Dash (2018) research data, tensile strength increased with fiber fraction up to 15% then further decreased with fiber loading.

Besides tensile, some researchers are using impact and flexural testing on their composite to test its mechanical properties. Results of the analysis for the flexural characteristics of hybrid composites were in better agreement in the present research work. (Khan et al., 2021)

1.2 Problem Statement

Recently, the growth of the Malaysian furniture industry, especially its wooden furniture sector which accounts for almost 83% of its total production (Ratnasingam et al., 2020). In 2019, the total furniture export from Malaysia amounted to RM 11.38 billion (Annual Report of the Malaysian Wood Industry and MTIB, 2020).

With the growth in the furniture industry, without question, the furniture process will end up creating a wood waste such as wood dust, and wood chirp. As a result of the abscission of materials, garment companies generate a significant volume of garment waste every day. In addition, a significant portion of garbage consists of post-consumer waste, which is a product whose owner no longer needs it and therefore decides to dump it. These items are thrown because they are broken, discolored, torn, or out of style. The waste materials require a large area for disposal. If left unused, these industrial wastes potentially pose a significant threat to the environment. It is vital from an environmental standpoint to manage trash through reuse and recycling. (Islam et al., 2019). In this situation, an investigation on how to recycle this wood dust waste into a new composite.

Currently, the most rapidly expanding waste stream is electrical and electronic waste, sometimes known as e-waste. This condition exists in part due to the absence of laws or enforcement. There are currently acceptable methods for trash disposal, such as the normal waste stream. Most developing nations, such as Bangladesh and Indonesia, have an informal economy, which compels them to recycle and reuse materials using primitive techniques. These are the effects of manufacturing wire rod and wire cable products. Copper metals occupy the third spot in terms of global metal consumption, behind iron and aluminum. In August 2015, scrap imports from Malaysia alone totaled 14,733 tons in Malaysia. The United

States sent the most recyclable materials to Malaysia in August 2015, totaled 5,609 tons, according to the record. Singapore is the second largest importer of scrap metal, with a total of 4,326 tons. Australia ranks third with a total of 1,919 tons (Michael et al., 2020).Composite need to have a good binder such a epoxy resin and a filler such as copper which also facing same problem about waste management. Copper is 100% recyclable. Almost all copper-made products can be recycled. Copper is recycled wherever possible due to its high product value and several environmental concerns. Copper extraction is particularly energy-intensive, hence using recycled copper can save energy (Pargi, Leng, et al., 2015).

Alternatively, to gain a perfect hybrid composite a good ratio of matrix, binder, and filler need to be proposed . From a research of Mishra (2019), epoxy was utilized in the preparation of composites. At two percentages by weight, fiber-reinforced composites were hybridized (20 percent and 30 percent). Samples were evaluated for their qualities, including tensile strength, flexural strength, impact strength, and scanning electron microscope (SEM). Before concluding the weight and volume proportion of the hybrid composite, it is therefore necessary to analyze its mechanical capabilities, such as tensile testing, flexural testing, impact testing, and surface roughness.

1.3 Research Objective

The objectives of this research are as follows:

a) To fabricate wood dust and copper wire hybrid reinforced epoxy using different ratios of material mass.

b) To conduct a cutting procedure of hybrid wood dust and copper into a testing specimen according to ASTM.

c) To observe the mechanical properties of hybrid wood dust and copper using tensile testing, impact testing, and flexural testing.

1.4 Scope of Research

This research will focus on effect of mechanical properties on hybrid composite consist of wood dust, copper wire and epoxy resin. The composite will be fabricated using hand lay-up process and the specimen size will follow the standard by ASTM. The CNC router machine is the process to perform cutting of specimen test to be done. The mechanical properties of the experimental material will be evaluated using tensile test, impact test and flexural test. Then, obtained data will evaluate using statistical analysis such as analysis of variance (ANOVA) to analyze of the experiment specimen and decide the best ratio of this hybrid composite.

1.5 Rational of Research

The rational of this research is as follows:

a) To study and observe the potential of wood dust and copper wire reinforced by epoxy resin as a composite material.

b) To study the potential of the wood dust and copper wire in mechanical properties using tensile, flexural, and impact tests.

c) To understand the behaviour of wood dust and copper wire reinforced with epoxy resin and its ability to resist strength during test.

1.6 Thesis Arrangement

The thesis's first chapter introduces the foundation for the entire research. In Chapter 1, the background of the study, the problem statement, the objective study, the scope of research, and the motivation for the investigation are all discussed to provide a basic understanding of the title. The second chapter delves into specifics and details. This chapter's review shows the theory or foundation of a variety of concerns, as well as historical or recent research on rice husks. Furthermore, the composite material that is made based on rice husk must be studied in terms of its production method and specifications. The approach employed in this research is described in Chapter 3, which describes the methodology of mechanical properties of husk rice reinforced by epoxy resin. This chapter covers raw material preparation, product manufacturing, standard testing procedures for mechanical properties, and suitable methods. Chapter 4 collects data from the tests that were completed and provides a thorough analysis, as well as a commentary based on the findings and give an expected result that will be obtain when the real test is done.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The description of the development of the composition of the natural material from the natural waste material such as wood dust. In addition, waste copper wire is also discussed in this chapter. This study had focused on the result of mechanical properties of natural hybrid composite that reinforced with copper filler and epoxy resin. Then, discussed the ratio of the matrix material and binder that are targeted to be 70 percent of natural fiber and 30 percent of epoxy. The analysis of the study had to observe the tensile strength, impact strength, flexural strength, and surface roughness.

2.2 Hybrid Composite

A hybrid epoxy composite floor reinforced with sal and teak wood was manufactured with varied concentrations of reinforcements while maintaining a concentration of 33 wt. p percent (Dinesh et al., 2020). Changing the reinforcing volume fraction as well as the stacking sequence of hybrid composite now can affect the mechanical properties of the composite.. Hybrid composites may comprise a combination of high modulus fibers, which provide superior load-bearing properties, and low modulus fibers, which increase the material's resistance to damage (Kashyap et al., 2019).

Hybridization presents a new potential to expand the usability of composite materials, particularly for advanced applications. There are three primary criteria that significantly affect the properties of the hybrid composite material. First, there are the