

# EFFECT OF MACHINING PERFORMANCE ON RECYCLE PALM OIL WASTE BASED MATERIAL



# BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY WITH HONOURS

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## Faculty of Mechanical and Manufacturing Engineering Technology



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**Bachelor of Manufacturing Engineering Technology with Honours** 

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## EFFECT OF MACHINING PERFORMANCE ON RECYCLE PALM OIL WASTE BASED MATERIAL

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## UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

#### **DECLARATION**

I declare that this Choose an item. entitled "Effect Of Machining Performance On Recycle Palm Oil Waste Based Material". The oil palm fruit bunches as raw material is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



## 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 with Honours.

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#### DEDICATION

All the praises and thanks to be to Allah S.W.T for His Love. Im would love to dedicate this final report of my project to my late father, Abu Samah Bin Yip and my late mother, Norzabah Binti Sahar. The two persons that give me strength to be here during my sutudies. Special thanks to my supervisor and co-supervisor, Dr. Khairum Bin Hamzah and Dr. Fariza Binti Ab Wahab for the encouragement, constructive guidance and patient in fulfilling my aspirations in completing this project. To my brothers, groupmates and entire friends, will never archieve without all of you.

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#### ABSTRACT

The effect of machining performance on recycle palm oil based epoxy is not a new idea, but there have been very few studies about reinforcing oil palm fiber with epoxy composite. In this study, to analyze the machine performance and mechanical properties on recycle palm oil fibers using tensile testing, surface roughness and impact testing. The oil palm fiber were used and will be mix with epoxy resin composite to improve the mechanical properties of oil palm fiber. For this experiment, three ratios are available: 55Natural 45Epoxy (55N45E), 60Natural 40Epoxy (60N40E), and 65Natural 35Epoxy (65N35E). Following the process, the cutting procedure is carried out using a machine which is a CNC router machine. The collected data were analyzed using statistical analysis. Numerical computation and graphical demostration are carried out to observe the effect of machining and mechanical properties on recycle palm oil with epoxy resins. The results were obtained from the ratio of materials and parameter of machine will be effect on the result strength of materials.



#### ABSTRAK

Kesan prestasi pemesinan pada epoksi berasaskan minyak sawit kitar semula bukanlah idea baharu, tetapi terdapat sangat sedikit kajian mengenai pengukuhan gentian kelapa sawit dengan komposit epoksi. Dalam kajian ini, untuk menganalisis prestasi mesin dan sifat mekanikal pada gentian minyak sawit kitar semula menggunakan ujian tegangan, kekasaran permukaan dan ujian impak. Gentian kelapa sawit telah digunakan dan akan dicampur dengan komposit resin epoksi untuk meningkatkan sifat mekanikal gentian kelapa sawit. Untuk eksperimen ini, tiga nisbah tersedia: 55Natural 45Epoxy (55N45E), 60Natural 40Epoxy (60N40E) dan 65Natural 35Epoxy (65N35E). Mengikut proses tersebut, prosedur pemotongan dijalankan menggunakan mesin iaitu mesin penghala CNC. Data yang dikumpul dianalisis menggunakan analisis statistik. Pengiraan berangka dan demostrasi grafik dijalankan untuk melihat kesan pemesinan dan sifat mekanikal ke atas minyak sawit kitar semula dengan resin epoksi. Keputusan diperoleh daripada nisbah bahan dan parameter mesin akan memberi kesan kepada hasil kekuatan bahan tersebut.



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## LIST OF SYMBOLS AND ABBREVIATIONS

CAD/CAM	-	Computer-Aided Design/Computer-Aided Manufacturing	
CNC	-	Computer Numerical Control	
CO2	-	Carbon Dioxide	
EOPF	-	Empty Oil Palm Fruit	
FFB	-	Fresh Fruit Bunches	
HAZ	-	Heat Affected Zone	
MDF	-	Medium Density Fibreboard	
NaOH	-	Sodium Hydroxidesodium Hydroxide	
OPEFB	- 14	Oil Palm Empty Fruit Bunches	
OPF	A. A.	Oil Palm Fruit	
YAG	<u>-</u>	Yttrium Aluminium Gamet	
55N45E	-	55 natural 45epoxy	
60N40E	"aya	60 natural 40 epoxy	
65N45E	- 101	65 natural 45 epoxy	
	ملاك	اونيومرسيتي تيكنيكل مليسيا	

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#### **CHAPTER 1**

#### **INTRODUCTION**

#### 1.1 Introduction

This chapter discuss about the problem statements, the objectives and project scope. The tittle of this project is the Effect of Machining Performance on Recycle Palm oil wastebased material. The material is Empty Oil Palm Fruit (EOPF) bunches as raw material and Epoxy Resin.

#### 1.2 Background

In the Eco-products Directory 2010, "Eco Materials" refer to "Materials" (or material technologies) which are capable of producing, using, recycling or disposing of highperformance characteristics that have little impact on the environment, but also have a human friendliness." The range of environmental-friendly materials includes recyclables, hazardous substances-free materials, low energy-consumption materials and clean conditions, water and air-contaminated materials, highly efficient and resource-efficient materials and much more.

Malaysia is the world's largest supplier of palm oil, and the major source of lignocellulos is palm oil waste in the form of empty palm fruit oil bunches. At the moment, only a limited amount of equipment has been created to remove this trash, and there is a severe shortage of disposal space for it. As a result, many palm oil refineries burn these residues to eliminate them. The results of this combustion might lead to environmental contamination. Numerous research on the conversion of discarded palm fruit bunches into a range of value-added goods have been undertaken.

The aim of this task is to explore, in several factors like physical and mechanical properties, the structure of the oil palm fibre composite with epoxy resin. The palm oil fibres are a build-up of the agro-business, usually produced on a high level. The use of characteristic fibre to promote research has been an enormous advantage. This has developed an important source of unlimited lignocellulosic biomass with considerable effort and an eagerly acquired result.

The elastic and tensile characteristics of these composites were investigated, and it was shown that high-quality composites made of oil palm fibre may be effectively produced. Natural fibres such as pulp, bamboo, wood, hemp, bagasse, and cotton, as well as plant fibres (for example, jute, lime, two ramies, and sisal), are found in a variety of diverse environments. Natural features of carbon fibres and glass fibres give a number of compensations, including suppleness by minimising machine wear and its lower causes; minimum hazards to human health; and vital fibre phase proportions (Cerqueira, Baptista and Mulinari, 2011).

There are two different types of cutting machines that are used to test the surface roughness on the specimen which is Computer Numerical Control (CNC) router machine after the materials had cut. Due to its precision and high intensity, router machining has a large application in fine composite cuttings. Loser-aided cutting has revolved around a range of materials, including wood, glass and plastic, in the manufacturing industry.

#### **1.3 Problem Statement**

ALAYSIA

Material and energy consumption are causing a rapid global environmental deterioration. Our safety is threatened by an increase in ageing systems, installations and machinery. Since the Earth's capacity is limited from both the input (resources) and output (disposal) aspects, environmental load minimization, and the most efficient use of energy and resources are essential for sustainable international development. "Eco materials" are suggested as a key concept in material technology which harmonises with the environment, in other words, to minimise environmental stress in a whole lifetime (Nowosielski, Kania and Spilka, 2007)

It claims that because the usage of synthetic plastic materials in the environment cannot be abolished, an unending buildup of waste on the ground and serious pollution might occur. It consisted of fine fibres embedded in a variety of plastics (polymers) that have dominated the market for synthetic composites for the last 40 to 50 years (Kindo, 2010). Although worldwide research is shifting its focus to another synthetic fibre option as a result of the accumulated global energy crisis and ecological risk. Although significant advancements in the elastic and flexural characteristics of these composites have been made, high-quality composites may be manufactured efficiently utilising natural fibre as their component.

However, sample preparation may be extremely challenging when mechanical characteristics are used to detect vacuums, fractures, and other flaws, as damage can readily be induced during preparation (Cerqueira, Baptista and Mulinari, 2011). To resolve this concern, this study proposes that further research be conducted on the influence of machining

performance on palm fruit bunch-based epoxy resin in terms of physical and mechanical characteristics.

#### **1.4 Research Objective**

The objectives of the current study are:

- a) To fabricate on recycle oil palm oil palm fruit bunches waste.
- b) To perform the different process of cutting recycle palm oil fruit bunches waste into the testing specimen.
- c) To analyze the machine performance and mechanical properties on recycle palm oil fibers using tensile testing, surface roughness and impact testing.

#### 1.5 Scope of Research

This project will be focus on the effect of machining performance on recycle palm oil fruit bunches waste based on materia and its mechanical properties. This project involves the materials from palm oil waste to be used in industry. This product will consist of palm oil waste and epoxy resin. To create the composite, the fabrication process of alkalinizing, drying, and milling must be considered. To carry out the distinct process of cutting palm oil into the testing specimen, a router machine will be needed. The test that involve are a tensile testing, surface roughness testing and impact testing will be use to analysis the product. The result will be selected from the analysis and will be decide from the three different process for better quality of specimen material. All the results will be analyze using statistical analysis.

#### **CHAPTER 2**

#### LITERATURE REVIEW

#### 2.1 Introduction

In the cutting machine sector today, many various materials generate variable quality, which normally must prevent or make the cutting processes less complicated. This chapter identified a process for cutting performance which is CNC router machine been utilized or used in the industry. Tensile, surface roughness and impact quality knowledge of workpieces or products cut would assist in the evaluation of the CNC router machine which are better

for each ratio.

#### 2.2 Work Material



#### 2.2.1 Oil Palm Fruit Bunches



Figure 2.1 (a) Oil Palm Fruits Bunches, and (b) Oil Palm Tree

Palm oil fibers originate from the empty fruit bunch that is one of the oil palm residues. The fibers used in the present study are shown in Figure 2.1. The wastes of Palm Oil are made from large amounts of lignocellulosic substances, such as empty fruit bunches, oil palm fronds and trunks, which contribute to enhance the binding of construction material. These residues help the country to transform its large supply of by-products from the oil palm industry into value-added products that optimise its utilisation of these residues and totally neutralise the idea of burning those residues, which frequently cause environmental problems through the generation of severe air pollulation, which is opposite to environment law (Ismail and Hashim, 2008).

After three years in the plantation, fresh fruit bunches (FFB) were generally harvested from oil palm trees. After removing the fruitlets, scientists dried the Empty Fruit Bunch (EFB) to a moisture level of 10% and crushed it into 1 mm particles using an IKAE grinder (German) (Hamzah, Idris and Shuan, 2011). Oil palm empty fruit bunch (OPEFB) fibres are biodegradable, natural reinforcing fibres. The quantity of biomass wastes that may be utilised as reinforcing components in the polymer composite provides a natural source of fibres. It is a non-toxic, renewable, and economically viable industrial interest (Ewulonu and Igwe, 2011).

#### 2.2.1.1 Oil Palm Fruit Material Properties

The primary elements of lignocellulose are cellulose, hemicellulose, and lignin, and fresh EFB from the mill typically includes 30.5 percent lignocellulose, 2.5 percent oil, and 67 percent water. Physically, their elements are tough and powerful. As a result, the EFB possesses properties that are promising for future applications (Gunawan et al., 2009).

Property	Mean Value ( ±standard deviation )		
rioperty	Dura Variety	Tenera Variety	
Length, mm	30.5 ( ±5.07 )	35.96 ( ±4.08 )	
Width, mm	19.94 ( ±2.64 )	20.15 (±3.79)	
Thickness, mm	15.66 ( ±2.25 )	17.11 ( ±1.91 )	
Sphericity, %	70.67 ( ±9.27 )	64.23 ( ±6.58 )	
Aspect Ratio, %	67.78 (±15.29)	56.77 ( ±9.47 )	
Fruit mass, %	7.66 ( ±2.04 )	8.50 ( ±2.00 )	
True density, kg/m^3	1112.50 ( ±52.60 )	995.70 ( ±26.99 )	
Bulk Density, kg/m^3	659.40 (±21.74) <b>YSI</b>	A 611.04 (±27.79)	
Density ratio, %	59.33 ( ±2.21 )	61.45 ( ±4.01 )	
Porosity, %	40.67 ( ±2.21 )	38.55 ( ±4.01 )	

Table 2.1 Summary of some properties of palm fruit with standard deviation

Table 2.1, the dura sphericity and aspect ratio of the dura are 70.67 percent and 67.78 percent, respectively. The high sphericity of the palm fruit implies that its form is prone to become spherical. When paired with the high aspect ratio of 67.78 percent (the ratio of the fruit's breadth to its length), it's simple to see why palm fruits roll rather than glide on their smooth surfaces. The tenera variety's average fruit mass was 8.50 g, whereas the dura variety's average fruit mass was 7.65 g. The tenera's average fruit mass is more than that of

the dura. This may be related to the tenera's size, as the dura is smaller (Owolarafe, Olabige and Faborode, 2007).

#### 2.2.2 Epoxy Resin

It Epoxy resins are a significant family of polymeric materials distinguished by the presence of more than one three-membered ring, known as the epoxy, epoxide, oxirane, or ethoxyline group. Epoxy resins are used in a variety of applications. Epoxies are one of the most versatile groups of polymers, with a wide range of uses including metal can coatings, automobile primers, printed circuit boards, semiconductor encapsulants, adhesives, and aerospace composites, to name a few examples. Upon curing, most cured epoxy resins produce amorphous thermosets with exceptional mechanical strength and toughness, as well as excellent chemical, moisture, and corrosion resistance, as well as good thermal, adhesive, and electrical properties; no volatiles are released and there is little shrinkage; and excellent dimensional stability – a unique combination of properties that is not found in any other plastic material on the market. Epoxy resins have acquired widespread acceptance as the material of choice for a wide range of bonding, structural, and protective coating applications because of their high performance features, as well as their outstanding formulation versatility and reasonable pricing (Riemenschneider and Bolt 2005). Figure 2.2 shown the example of epoxy resins in industry.



Figure 2.2 Epoxy Resin and Epoxy Hardener

## 2.2.2.1 Epoxy Resin Material Properties

This raw material has been used as a matrix phase in particle composites for a long time, particularly in laminated composites of glass fibre, aramid fibre, and carbon fibre, among other materials. Due to the outstanding relationship between mechanical strength and weight of the latter composite material, it has been widely used in the aircraft industry (density). However, because of the mechanical properties of both the matrix and the dispersion phase, the mechanical behaviour of this composite is quite brittle compared to other composites. As a result, it is feasible to apply the mechanical concepts of linear elastic fracture to different damage numerical models that are available on a finite element solver and then evaluate the results (Luis Christoforo et al. 2016). Table 2.2 summarises the information available in the literature regarding the mechanical behaviour of commercial epoxy resins.

Modulus of Elasticity E	35.9 GPa
Ultimate Strength (Su)	33.7 MPa
Critical Intensity Factor (Kic)	1.33 MPa√m
Poisson's Coefficient (v)	0.389
Vomuletric Density [g/cm <sup>3</sup> ]	1.152
Bulk Density [g/cm <sup>3</sup> ]	1.168
Porosity (%)	1.601

Table 2.2Mechanical Properties of Epoxy Resin

#### 2.3 Cutting Process Machine

Machining is a generic term for a multitude of industrial technologies and processes. It is the process of removing material from a workpiece to shape it into the desired design using power-driven machine tools. Most metal components and parts require some form of machining throughout the production process. Other materials, such as plastics, rubber, and paper products, are commonly created using machining processes.

## 2.3.1 CNC Router Machine

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The CNC router is a computer controlled cutting equipment for the gravure of wood, composites, aluminum, steel, plastics, and foam materials and other types of materials. A CNC router enables the cutter to be positioned simultaneously at any spot, using 3 movement axes. This means that the cutter can be moved from left to right or down simultaneously. In terms of design a CNC router is fairly similar to a CNC frinder. The tool route can control via the numerical computer control (Dhruv et al., 2014).

For the first time, the aerospace industry used the CNC routers to reduce intricate patterns from aluminium sheets. This technology was then applied in a number of machinery types in the secondary woodworking industry in the early 1980s. Today CNC is increasingly

taking an expanding role in the success of the wood processing sector. New features have been developed with increased performance (Sütcü and Karagöz, 2012).

Working with mechanical automatic equipment necessitates precision, accuracy, speed, consistency, and flexibility. In this instance, embedded computer applications are required to complete the task. A CNC machine (Computer Numerically Controlled) is a piece of mechanical equipment that has been widely utilized in combination with a microcomputer. CNC machines are used to do mechanical operations including cutting, engraving, and drilling. The computer technology that is used to run, control, and parse programmes (Rocha, Silva and Lima, 2010).

For all these production systems, it is very important to find the optimum production settings in order to get the maximum quality, because the setup can be very exact and reproducible. In contrast, there would appear to be unanimity on traditional techniques for machining that spindle rotational rates are normally between 10,000 and 100,000 rpm, although some framing procedures allow rotational rates that reach up to 5,000 rpm. Higher rotational speeds are usually coupled with large feed rates for the table and contour processing usually takes place within 15–60 range (Gordon and Hillery, 2005).



Figure 2.3CNC Router Machine

Figure 2.3 illustrates a CNC Router Machine in use in industry. These CNC machines drill, bore, rotate, and correct a variety of materials, including cement, plastics, composition, solid bodies, and wood-based materials. CNC machinery has been used in recent years to provide businesses with the equipment necessary to treat solid wood and wood panels via a variety of processes such as cutting, turning, and milling. Medium Density Fiberboard (MDF) is a material that is commonly used in furniture production. Following CNC processing of the MDF, the surface is painted or coated with a PVC film. The toughness of the MDF surface is determined by the CNC unit's cutting settings (Yuan, Guo and Liu, 2014).

The advantages of speed machining include increased removal rates, less tool wear, improved surface finish, the machine's capacity to manufacture thin walled components, and the ability to process hard materials. High-speed tools are more expensive to manufacture because they must be more robust than ordinary CNC machines and meet stricter standards. CNC controls the machine's complicated shapes, which are frequently encountered during high-speed cavity mould and die operations (Dewes, Aspinwall and Wise, 1995).



Figure 2.4 Router Machine 3-axis



Figure 2.5Router Machine 5-axis

There are two types of CNC router machine used in manufacturing industry which is router machine 3-axis and router machine 5-axis as shown in Figure 2.4 and Figure 2.5. Most machines router 3-axis for cutting flat steel plate have a gantry design because the Z-X coordination system is an easy way for moving cutting instruments. On one axis, usually the Z-axis is the rail system that runs through the portal. The terminals are the other axis, usually the Y axis the ports. The X-axis also includes a portable cutting machine that is attached to the bridge structure itself. The guidance system of X-axis is usually less than the Z-axis rails because only a small carrier and cutting tool, not all of the door, must bear the weight (Krishna, Khan and Reddy, 2014).

For the automation of cutting, boiling and shaping, CNC is widely implemented in the wood industries. A particular type of CNC router has grown in popularity in the furniture manufacturing industry, where it is used for grinding, side milling, and patterning furniture material. This technology offers numerous benefits in terms of production, quality of the surface and provides greater productivity improvements (Costes and Larricq, 2002)

#### 2.3.1.1 Process of CNC Router Machine

The routing process begins with the unfinished sheet product being fitted to the cutting table (wood, splinted wood or fiberboard). This sheeting material is connected to the cutting table through a suction hole in the table. Computer-Aided Design/Computer-Aided

Manufacturing (CAD/CAM) software is then used to send the finalized items to a CNC router. The CNC router cuts the unfinished components using its high-speed spindle in accordance with these CAD/CAM designs (Camci, Temur and Beskese, 2018). Figure 2.6 show the CNC router machine process.



Figure 2.6 CNC Router Machine Process

#### 2.3.1.2 CNC Router Machine Parameters

There are hundreds of studies in the literature using the experimental Taguchi Method of design to achieve optimum conditions of output . The quality of a machined composite product such as deamination, cracking, pull-out fibre and burned matrices may potentially result from machining. The abrasive nature of the reinforcing fibres and the need for their smooth shearing make the selection of the optimal materials, shape and cutting parameters more demanding and constraining (Sundi et al., 2019). Table 2.3 show the CNC router machine specification.

PARAMETERS	SPECIFICATION
Max Spindle Speed	10 000 rpm
Horsepower of the Spindle	15 hp
Max Feed Rate	53.3 m/min
Maximum X-axis travel distance	3073 mm
Maximum Y-axis travel distance	1549 mm
Maximum Z-axis travel distance	279 mm
Work Surface/Table	3099 mm x 1346 mm

 Table 2.3
 CNC Router Machine Specification

Both machining parameters are based on the present practise of the local composite producers, namely speed of spin and feed rate. Table 2.4 shows machining parameters.

	Spindle Speed, N (RPM)	Feed, Vf (mm/min)
R1	7000	1750
R2	10000	1500
R3	7000	1500
R4	10000	1750

Table 2.4Machining Parameters

#### 2.4 Machine Testing Operation

Test machines use variable loads of such loads in voltage, compression, torsion, torsion or combinations, and specimen failure cycles are recorded (Ogata and Takahashi, 2006). Composites can be tested in a number of methods. Adequate consideration must be given to factors such as efficiency and protection while deciding the appropriate method. In addition, the method adopted should cut operational costs (Nanduri, Taggart and Kim, 2002). Operational testing is a testing method that ensures that the product, system, service and process complies with the operational requirements. The operating criteria are efficiency, dependability, longevity, interoperability, connectivity, backup and recovery. It is a mechanism for confirming that acceptance is not functioning. Operational testing is required during operational set-ups and operational support when components are combined. It detects functional or structural improvements to apps in a functional and non-functional environment. This investigates if software is designed without interrupting the business process. Operational research is based on these items.

Measurement is an integral part of an operational definition. The assignment of numbers to a variable that is interested is a basic and exact definition of measurement. These

are the number for statistical analysis, submit the raw material (Jane, 2016). Data tested in detail are actuality as a first step in researching how the process is adapted to different contextual elements (Nanduri, Taggart and Kim, 2002).

#### 2.4.1 Surface Roughness

The surface roughness of materials is a critical criterion for determining their surface smoothness. The roughness of the surface has a significant role in determining the quality of wood-based interior and exterior ornamental components, and the fact that the qualities of these elements are of low value affect not only the appearance of the finished product but also the effect on both top surface and glue adhesion requirements (Aslan, Coşkun and Kiliç, 2008). Surface roughness is a primary measure of uniformity for cutting and coating procedures. Different crude methods are available to analyse the surface content of wood and wood products include pneumatic, laser and light dispersing. Stylus Profilometer types are commonly utilised to deliver dependable numerical results for their uses and benefits. Laser system also provides advantages such as infinite scan, curved surfaces and integrated automation. Due to the study feed rate, MDF surface roughness was revealed to be the most beneficial component (Ananthakumar et al., 2019). Figure 2.7 show the surface roughness machine.



Figure 2.7 Surface Roughness Machine

Surface roughness variances obviously contribute to aesthetic disparities, but they also affect a range of other features. For example is the wear capacity, ability to create a stick when a component contacts another surface, and paint thickness required to cover a part. The method of measuring every material surface after production was conducted by the surface ruggedness machine has been shown using Figure 2.7 above. Surface approach is a model-building and analysis methodology. The objective is to achieve the optimal values based on various independent variables. The most important testing method for correctly measuring the specimen is surface roughness.



Figure 2.8 Method Surface Roughness Measured

#### 2.4.1.1 Parameter of Surface Roughness

The evaluation of surface roughness is critical for a variety of basic concerns, including friction, contact deformation, heat and electric current conduction, contact joint tightness, and positional accuracy. Increase the number of parameters utilised to achieve a more precise description (Gadelmawla et al., 2002).

Users recognised measurement requirements in a variety of other fields, and apparatus was created to satisfy these requirements. In contrast, for many years, the technical expertise of instrument makers considerably exceeded the complexity of users, allowing the former to impose parameters on the latter that were established more for their own convenience than for the customers' real requirements (Thomas, 1981).

#### 2.4.2 Tensile Testing

Tensile tests provide information on the strength, yield strength and ductility of the metal material as a destructive test technique. It quantifies the force needed to break a plastic or composite specimen and the amount to which the specimen extends or extends to this break-point. Composite tensile tests are usually performed by basic or flat-sandwich tension tests, as per ISO 527-4, ISO 527-5, ASTM D 638, ASTM D 3039, and ASTM C 297 standards (Saba, Jawaid and Sultan, 2018). The test samples were created with emery paper and the sample bands were polished according to ASTM D3039 tensile test standards. The measurement equipment was loaded with a tensile test sample and the load was applied until the sample collapsed. Five repeated measurements were made and the average findings are presented below. The ASTM tensile testing recommendations (Ramesh, Palanikumar and Hemachandra Reddy, 2016).

The tensile test machine was utilised to measure the tensile test specimen strain with the relative shift of the fastening medium, which results in the fastening of the tensile test specimen independently of the tensile test strength used. This equipment enables the machine strain and friction forces measures to be compensated and the drawing speed controlled throughout the tensile testing procedure at the same time. Figure 2.9 show the tensile testing machine.



The test specimens are prepared first with the mould manufacturing. The dog's bone is adapted to the ASTM D3039 Type I standard for tensil testing purposes. In addition, before the test specimens can be made, the experiment must first be correctly conceived. The right quantity and type of material samples required for testing is vital to be known. Proper experimental preparation is vital to ensure that the results are meaningful and adequate for post-factorial analysis. Figure 2.10 shows the test sample dimension for tensile testing.


Figure 2.10 The test sample dimension for tensile testing

## 2.4.2.1 Parametes of Tensile Testing

PARAMETER	VALUE
Maximum test force	100 KN
Maximum test stroke	1000 mm
Accuracy of force	1 Ň
Accuracy of displacement	0.001 mm
Acquisition frequency	1000 Hz

 Table 2.5
 Parameters of the tensile testing machine

Table 2.5 show the parameters of the tensile testing machine. Proportional specimens

are said when the length of the gauge L0, relates to the original cross sections, A0, expressed in L0=k, to the original cross sectional area. The constant k in the EN and 5 in the ASME regulations is 5.65. These measurements have a diameter of about 5x and a diameter of 4x correspondingly, although this discrepancy may not be technically crucial for asserting that the specimen conforms to standards.

#### 2.4.3 Impact Testing

Due to strong impact loads, it is the material's ability to sustain bending without breaking. When a substance is heated, its toughness diminishes. This quantity is also known as the area under the stress-strain curve, and it represents the amount of energy a unit volume of the material has absorbed after being stressed to failure. To the opposite of brittleness, the ability of a material is to resist fracture under shock loading. Basically, two basic impact tests for determining the hardness of material in Joule are available notably Izod and Charpy test. Figure 2.11 depicts the three types of Notches utilised for fracture investigation. U type notch specimens can also be utilised for testing. In case of ductile materials, when the material is stressed, it plastically deforms by absorbing high energy and eventually the material breaks. But in the case of brittle materials, the cohesive strength of the material exceeds before getting plastically deformed and consequently absorbs less energy before getting shattered. There are factors responsible for brittle behaviour; they are notch, low temperature, thickness and microstructure. When temperature dropping, the breakdown mode of some materials changes from ductile to brittle (Murugan, 2020).



Figure 2.11 Different types of notch

Impact testing is depicted in Figure 2.12. The potential energy is stored in the pivoting arm, which is elevated to a certain height before being released. The specimen is

broken when the arm swings down and hits a notched sample on the specimen holding vise. This measurement is based on the height of the sample's arm swing after it hits the sample. The hammer's swing-up and swing-down angles are used to calculate the fracture energy (Joule). Impact energy and notch sensitivity are commonly determined using a notched sample. ASTM D6110, ASTM E23, and ASTM D256 are just a few of the test standards that are widely used around the world (Murugan, 2020).



2.4.3.1 Parameter of Tensile Testing

UNIVERSITable 2.6 Impact Test Parameters

Specified Impact	Falling Height	Impact Velocity	Specimen Quantity
energy (J)	(mm)	(m/s)	
12	227	2.11	18
18	345	2.60	18
24	453	2.98	18
30	569	3.34	18

Table 2.6 shows the parameters for impact testing (Yudhanto et al. 2019). A pneumatic clamping system with a circular cutout (76 mm in diameter) at the upper and lower clamps compressed the specimen to 5.5 bar. In order to produce an impact energy range of 12-30 J, the impactor was dropped from a height of 227 mm to 569 mm before being hit. 25 degrees Celsius were used for the test (Yudhanto et al. 2019).

## **CHAPTER 3**

#### METHODOLOGY

## 3.1 Introduction

The methodology is a rule method to enhance and observing this project. The project is composed of the information, formula and data are gathered from journals, sites, books and research articles. This chapter provides specific information about the output parameter of the cutting processes. This research focuses on this machines' output parameters. In general, a number of machines are utilized to develop the trimming process and the output analysis.

# 3.2 Project Experiment Process

To cut the material in this project, CNC router machine are used. A substance of such relevance must be manufactured prior to doing the experiment. The fabrication used empty oil palm fruit and resin epoxy. After the material had been laminated, vacuum bagging was used to cure it. Following the acquisition of the material, the substance will be used to carry out the experiment. To cut the specimen, CNC router machine will be needed. The input parameters employed define the feed rate and thickness of the experimental specimen. Following the conclusion of the cutting process, the output parameters of the cutting process will be checked to obtain the result. Table 3.1 shows a block diagram for parameter analysis affecting the cutting process with two separate machines

Machine	Process	Input parameters	Output	Feed Rate
			parameter	
CNC Router	<b>Cutting Process</b>	Specimen	Surface	Heat
		Thickness	Rouhness	Effected
				Zone

 Table 3.1
 Analysis parameter effect of cutting process

# 3.3 Flow Chart

The process of this project is partitioned into two section which is there are a literature review and case study. At first, the literature review means to study or archieving any concentrates that have been finished by researcher and explored the study should hav a lot common with the case study now that is not out of the genuine track. The point of the journal review process is to get motivation and guide. The more journals read and contemplate the more information accessible to finish this study. Figure denotes flow chart of a methodology for this project.

Flowcharts are used in a variety of fields for the analysis, planning, documentation, and administration of a process or programme. Flowcharts are used to develop and document a simple system process. The flowchart for this section depicts the complete procedure of an experimental for a research effect on cutting performance with a certain parameter action. A flowchart can help you comprehend each stage of a process and how it is carried out.

To fabricate the material, empty oil fruit bunches and rasin epoxy must went to hand mixing process method. To stick the empty oil fruit bunches and epoxy and hardener were added. Then, vacuum bagging technique were used for cure the empty oil fruit bunches and raisin epoxy. If the material are good, then proceed to cutting process. For testing, the size of specimen is 25 mm x 25 mm. After done the cutting process, proceed to testing the material. If the result not good, the material will be go to cutting process again or take again the result for find a better result.





Figure 3.1 Flowchart Process

# 3.4 Design of Material Specimen

Tests in sample form are conducted for the experimental material. Multiple specimens will be available. Examples of empty fruit oil bunches is 210 mm x 297 mm. Then the material will be cut into 250 mm x 250 mm for tensile testing. The another will be cut into size 25 mm x 25 mm. The specimen was constructed to fulfil the test requirements for the find better quality of cutting process. The specimen has a thickness of 3 mm, 5 mm, and 9 mm. The specimen was manufactured entirely by "sandwiches" process. Products from recycled products will be reuse. The design is shown in Figure 3.2 and Figure 3.3 below.



Figure 3.2 Dimension of specimen



Figure 3.3 Combination "sandwiches" of Empty Oil Fruit Bunches and Epoxy Resin

#### 3.5 Experimental Procedure

This study's experimental approach is a step-by-step procedure for each stream. These processes are crucial to ensuring that the procedures and operations run smoothly. Each operation requires the existence of a focus point in order to get effective and precise results. This section will next look into numerous phases, such as the laser cutting process and the CNC router cutting process. The method includes tensile testing, surface roughness testing.

# 3.5.1 Fabricate Material

At first, initially, the material needs to be dried first to be mixed with epoxy. Then, it is necessary to provide an empty and clean container as well as a scale to weigh the amount of material and epoxy. Other utensils such as spoons, clean containers and gloves are also required. The first step is to weigh the empty and clean containers to get the right amount or quantity. Material and epoxy need to be weighed in a certain amount at three different ratios. After getting the desired amount, the epoxy needs to be mixed thoroughly to get good results. After that, the material and epoxy need to be mixed and mixed carefully so that the material and epoxy blend with each other. Next, the material needs to be compressed on a compress machine and left for approximately 24 hours. Figure 3.4 shows that the oil palm fibre has been dried before mixed with epoxy later.



Figure 3.4 Dried the Oil Palm Fibre

Next, after drying the material will be crushed to become the desired powder before starting fabrication. A crusher machine is used to convert the material to the desired powder as shown in Figure 3.5 and Figure 3.6 shown the crusher machine that had been used.



Figure 3.5 Process crush the material to the powder



Figure 3.6 Crusher Machine

Next, for more details on the fabrication of this specimen is with the preparation the equipments and tools. Firstly, need to weigh the empty container to get an accurate amount of the oil palm fibre and epoxy. Figure 3.7 shows that weigh the empty container using electronic scales. Then, weigh the coconut coir material with three different ratios which is 65% of nature and 35% of epoxy, 60% of nature and 40% of epoxy, and 55% of nature and 45% of epoxy. These three ratios have different quantity of cocnut coir. This activity requires precision and accuracy. Figure 3.8 shows that weigh the oil palm fibre with a predetermined amount.



Figure 3.7 Weight the empty container



Figure 3.8 Weigh the oil palm fibre with a predetermined amount

Other than that, the use of epoxy serves to harden the material so as to allow the execution of testing the material to be done properly. For this fabrication, epoxy have two type which is epoxy and resin. Both of epoxy and resin need to be mixed in one clean and empty container. Before that, the epoxy and resin need to be weighed with different amount. Figure 3.9, Figure 3.10 and Figure 3.11 shows that the procedure of weigh and mixed for epoxy and resin.



Figure 3.9 Weigh the epoxy and resin



Figure 3.10 Put the epoxy and resin together



Figure 3.11 Mixed the Epoxy and Resin

After mixed the epoxy and resin, need to put them with the oil palm fibre and done by mixing until the material and epoxy are well blended before performing the next process. Figure 3.12 shows that the activity of mixed the epoxy and resin with oil palm fibre. Figure 3.13 shows that the spciment need to make a round shape for making the process of compression completely done. Figure 3.14 shows that the shape of specimen after the compression process at the compression machine. The specimen need to be dried and left for approximately 24 hours. The specimen need to be cut into specific shape and dimension before testing process.



Figure 3.12 Mixed the Epoxy Resin with Oil Palm fibre



Figure 3.13 Mix well before the compressed the mixture composite



Figure 3.14 Shape the specimen after compression process

# 3.5.2 CNC Router Machine

The next is that the test material needs to be placed on the vice to hold the test material. Next, the computer control panel needs to confirm the position or coordinate axis to a value of zero point. Once the coordinates are confirmed in the form of NC codes, the cutting tool should be in the same position. The spindle speeds used are 400 rpm, 600 rpm and 800 rpm. Figure 3.15 shows that specimen in the position and Figure 3.16 shown the cutting process on the specimen using CNC Router machine.



Figure 3.15 Specimen composite in the centre



Figure 3.16 Cutting Process on specimen

# 3.5.3 Tensile Testing Process

After the cutting process, the test material needs to make tensile testing in tensile machine. Before that, the specimen needs to mark the size that has been determined to clamp on the tensile machine to hold the specimen well. The test material must be in good condition to perform the tensile process. Figure 3.17 shows that the display before starting tensile testing. The next step, is to fill in complete and accurate information into the computer which includes the thickness of the test material, the length of the test and related. After the tensile process is completed, the results of the tensile test will appear on the computer.



Figure 3.17 Computer display before start the tensile testing

After set the parameter at the computer display, grip the specimen at the tensile machine as shown in figure 3.18 and figure 3.19 shown the specimen had been grip at the machine. The result as shown in figure 3.20 after the specimen cracking.



Figure 3.19 The specimen had been grip at the tensile machine



Figure 3.20 The specimen after the tensile testing

# 3.5.4 Surface Roughness Process

Test material needs to be done to test the surface roughness after the test material is cut using CNC Router machine. After that, it is necessary to turn on the machine and place the nozzle on the surface of the test material that has been cut. Upon completion of the process, it is necessary to record to all the data and it is necessary to find which surface is the best among to all the test material. Figure 3.21 shows that the test material should be placed on clay to hold the test material during the testing process. Figure 3.22 shows that the surface roughness process carried out in the laboratory. Figure 3.23 shows that example result surface roughness for this specimen.



Figure 3.21 Placed Clay to hold the specimen



Figure 3.22 Surface Roughness process



Figure 3.23 Example result for Surface Roughness 50

## 3.5.5 Impact Testing Process

Impact testing is done because they want to test the durability of the material whether it is strong or weak. Before the impact process is performed, it is necessary to mark the norch on the specimen as shown as Figure 3.24. The depth is 2mm. This activity is done after the specimen has been completed perfectly and the result of cutting using machines namely CNC router machine. Figure 3.25 shows that list of impact testing results. This impact test will produce results in the form of energy (Joules). Figure 3.26 shows that the specimen results after impact.



Figure 3.24 Process of making the norch on the specimen

Current lot results										
Brk	▼Width [mm]	Abs.en. [%]	▼Re [kJ/m²]	▼Energy [J]	1					
C-	6.21	0.61	7.85	0.303	A					
C	6.21	0.07	0.92	0.035	1					
C	6.21	0.51	6.57	0.253						
C	6.21	0.56	7.21	0.278						
C	- 6.21	0.68	8.81	0.340	1					
					00					
	Accept	100		Don't accept						

Figure 3.25 List of impact testing results



Figure 3.26 The result of specimen after impact testing

# 3.6 Summary of Methadology

What can be concluded from this chapter is that each process must be done in a careful and safe manner to further facilitate the process to run smoothly and perfectly. Every plan done needs to reach the desired level in order to get good results. Lastly, every process done should be made in a focused state and not taken lightly as it will ruin the results.

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## **CHAPTER 4**

## **RESULT AND DISCUSSIONS**

## 4.1 Introduction

In this chapter, we will focus on discussing the effect process using CNC router on empty oil palm fruit composite on tensile testing, capture image testing using microscope, surface roughness testing, and impact testing. A description of the result, out of several tests performed and the calculation used will be discussed and explained through this chapter.

#### 4.2 Tensile Strength on Oil Palm Fiber

For various ratios of oil palm fibre, the variation in tensile strength and elasticity are shown in Figures 4.1 and 4.2, respectively, as a function of the ratio of oil palm fibre. The results revealed that the tensile strength of oil palm fibre with a 55N45E ratio is greater than the value obtained with the other ratio. In terms of tensile strength, the strongest epoxy had the highest value when compared to the others. It appears from this observation that the tensile strength of the oil palm fibre increases as the amount of epoxy used in the experiment increases.



Figure 4.1 Tensile strength for three different ratio of oil palm fiber



Figure 4.2 Elasticity for three different ratio of oil palm fiber

Source of						
Variation	SS	df	MS	F	P-value	F crit
Between Groups	18.7589	2	9.37945	2.883	0.13261	5.14325
Within Groups	19.5202	6	3.25336			
Total	38.2791	8				

Table 4.1 ANOVA of tensile strength for oil palm fiber with three different ratios.

Table 4.2 ANOVA of elasticity for oil palm fiber with three different for ratios.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	202828	2	101414	10.2567	0.01159	5.14325
Within Groups	59325.3	6	9887.54			
Total	262153	8				

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Table 4.1 and 4.2 show analysis of variance (ANOVA) for tensile strength and and elasticity of oil palm fiber with three ratios, respectively. The results for Table 4.1 indicated that the tensile strength for all different ratios is not significant since the P-value is larger than the significant cut-off level ( $\alpha = 0.05$ ). This observation indicated that all the tensile strength oil palm fibre composite with epoxy resin have equal average and this condition is applied to all different ratios. The results for Table 4.2 indicated that the tensile strength for all different ratios is statiscally significant since the P-value is smaller than the significant cut-off level ( $\alpha = 0.05$ ). This observation indicated that all the tensile strength for all different ratios is statiscally significant since the P-value is smaller than the significant cut-off level ( $\alpha = 0.05$ ). This observation indicated that all the tensile strength oil palm fibre composite with epoxy resin do not have equal average and this condition is applied to all different ratios

Figures 4.3, 4.4, and 4.5 depict the point of maximal stroke, which is a brittle fracture and a necking fracture for oil palm fibre with three different ratios, as well as the point of maximal stroke for a brittle fracture and a necking fracture. It is the sudden, very rapid cracking of a fabric under stress in which there is little or no evidence of ductility or plastic degradation before the fracture occurs that is referred to as brittle fracture. Instead, this damage mechanism frequently results in sudden cracking of the equipment, which can result in the equipment being shattered into many pieces. The phenomenon of necking occurs when an instability within the material causes the material's cross-section to decrease by a greater proportion than the strain hardens when the material is deformed tensile. If the hardening of the fabric occurs at a rate that is less than the rate of decrease in cross-sectional area, strain is concentrated at the point where the highest stress or lowest hardness is experienced.



Figure 4.3 The point of maximal stroke for oil palm fiber with ratio of 55N45E



Figure 4.4 The point of maximal stroke for oil palm fiber with ratio of 60N40E



Figure 4.5 The point of maximal stroke for oil palm fiber with ratio of 65N35E

## 4.3 Surface Roughness on Oil Palm Fiber

Three different cutting speed parameters for the CNC Router machine were used as shown in Table 4.3. The one-way ANOVA was used to examine the surface roughness of oil palm fibres cut at three different feed rates for three different ratios such as (65N35E), (60N40E), and (55N45E).

Table 4.3 Parameter for Feed Rate, Tool diameter, and Spindle Speed

Parameter	Level 1	Level 2	Level 3
Feed rate (mm/min)	400	600	800
Tool diameter (mm)	4	4	4
Spindle speed (rpm)	8000	8000	8000

Table 4.4 ANOVA of surface roughness for oil palm fibers with three different feed rates parameters for ratio.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	34.4553	2	17.2277	12.1361	0.00779	5.14325
Within Groups	8.5172	6	1.41953			



Figure 4.6 Surface roughness for three average different ratio of oil palm fiber

When comparing all different oil palm fibre ratios, the results showed that the CNC Router machine cutting speed parameters were statistically significant because the P-value was lower than the statistically significant cut-off level (0.05). These observations indicated that all the CNC Router machine cutting speed parameters are different and this condition can not be applied to all different types of ratios as shown in Table 4.3 and Table 4.4 respectively. The results in Table 4.4 indicated that the CNC router cut machine feed rates parameters for all different oil palm fiber ratios were statistically significant since the P-value is smaller than the significant cut-off level ( $\alpha = 0.05$ ). This observation indicated that all the surface roughness oil palm fibers composites do not have equal average even though the CNC router machine feed rates parameters are different, and this condition is applied to all different types of ratios. Figure 4.6 shows that the average of surface roughness of three different ratio oil palm fibers.

#### 4.4 Impact Testing on Oil Palm Fiber

The variation of impact testing for various ratio of oil palm fiber is shown in figure 4.7. The results showed that the value of impact testing for oil palm fiber with 60N40E is greater energy formed than the ratio as shown as Figure 4.7. The results indicated that the impact for oil palm for all different oil palm fiber ratio were statistically significant since the P-value is lower than the significant cut-off level ( $\alpha = 0.05$ ). Table 4.5 shows that the ANOVA of impact for oil palm fiber with three different cutting speed parameters for ratio and the P-value is smaller than significant cut-off level.

Table 4.5 ANOVA of impact for oil palm fiber with three different ratios.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.15558	2	0.07779	23.5156	0.001448	5.1432528
Within Groups	0.01985	6	0.00331			



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#### **CHAPTER 5**

## CONCLUSION AND RECOMMENDATION

#### 5.1 Introduction

This chapter summarize about conclusion and recommendation for future work in this observation to improve the data of how to achieve a good quality of surface roughness on oil palm fiber by three different ratio and three different cutting speed on CNC Router machine.

#### 5.2 Conclusions

As previously stated in the previous chapter, there are three objectives that must be met in order for this project to be considered a success. Considering that the research on testing the strength oil palm fibre was a success, all of the objectives listed above have been met for this particular experiment.

There are three different ratios in this experiment, each of which is determined by the process that will be performed. Using three different amounts of oil palm and epoxy, the designer came up with the final design to see here. In order to ensure that the specimen's dimensions match perfectly with the machine and that it is also tested, the design of this experiment was chosen based on a procedure that would be followed. In the following step, the specimen was constructed out of a mixture of oil palm fiber and epoxy and compressed with the help of a compression machine. Maintaining the highest level of quality control during the specimen's manufacturing is critical. With 55N35E, 60N40E, and 65N35E, there are three different types of ratios. Tensile testing will be carried out in order to determine the mechanical properties of the experimental material. Because of this, the greater the amount of epoxy used, the greater the elasticity and strength of the specimen. When performing the procedure, there are issues that must be addressed in order to avoid slippage during the tensile test. Whenever the specimen's grips 68 are held tightly, it will break the specimen and become slippery. After that, in order to prevent the specimen from becoming slippery, the correct clamp was used to clamp it.

Surface roughness testing, tensile testing, impact testing, and image capture will all be used to investigate the differences between these three different rations. The purpose of this thesis is to investigate the quality of the composites through the use of the ANOVA method. The ANOVA method will be used to examine the relationship between surface roughness, tensile strength, and impact data. This approach can be easily evaluated by the Pvalue in any results of the difference of the input parameter, which is the cutting speed, and it is simple to implement and understand.

# 5.3 Recommendation for future work \_\_ MALAYSIA MELAKA

There are recommendations that could help in this study. Study of the composition of the oil palm fiber composite and different thickness from this research. From this research, more natural fiber, less tensile strength. It proved the 55N45E was high tensile strength. It will recommend another ratio such as above than 45% epoxy to find which ratio are more strength. After that, add an extra testical method like density testing, Scanning Electron Microscope (SEM) and Thermogravimetric analysis (TGA) to analyze more mechanical properties for Oil Palm Fiber composite. Moreover, Study of the composition of the mixing composite using the other material to get a better result and material performance.

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# APPENDIX 1: GANTT CHART PSM 1

	ST A THE	WEEK															
ACTIVITIES	SIAIUS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Plan																
Supervisor selection and registered title	Actual																
Brief and project explanation by	Plan																
supervisor	Actual																
CHADTER 1: research design and planning	Plan																
CHAPTER 1. research design and plaining	Actual	4.															
Discuss problem statement and objective	Plan																
for chapter 1	Actual		1														
Drafting and writing chapter 1	Plan		5														
	Actual							1	-	1							
CHAPTER 2: final year project literature	Plan		The second														
review	Actual																
Drafting and writing up chapter 2	Plan																
	Actual					- C			·								
CHARTER 2: research methodology	Plan																
CHAPTER 5. Tesearch methodology	Actual																
Drafting and writing up chapter 2	Plan		1	1	_	1		1.0									
Draiting and writing up chapter 5	Actual	2.0			P.A			2	~	لليل	1	Sec.					
Drafting Preliminary Findings	Plan		~		1.0			10	20		/	40-00					
	Actual								**								
Proliminary summarize	Plan	-	1/1	111Z	1.4		A 1	AV	CLA		-	ALC					
	Actual		-ni	NIN	ML		- L	AT.	OL	I IVI		AN	A.,				
Preparation and presentation psm 1	Plan																
reparation and presentation psill I	Actual																
#### APPENDIX 2: GANTT CHART PSM 2

ACTIVITIES	STATUS	WEEK															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Meeting and discussion	Plan																
	Actual																
Conducting the experiment	Plan																
	Actual																
Collect data and make analysis on	Plan																
sample	Actual																
Discuss on result	Plan		-														
	Actual		19														
Start drafting and writing up chapter 4	Plan		2														
	Actual		-								1						
Start drafting and writing up chapter 5	Plan																
	Actual																
Recheck chapter 4 and 5	Plan								· · · ·	1							
	Actual																
Submission of first draft psm 2	Plan																
	Actual			de la calencia de la		/		1.0					1				
Submission of second draft psm 2	Plan	30			RA			23	~	A. S. S.		ero.	4				
	Actual		0					10	2.		1.	1	1				
Submission full report	Plan								**								
	Actual		-17		C & 1		A.L	634	COL	A 11.		A L	1.0				
Finalize the correction of full report	Plan		EN	MIP	A	- M	AL	AT	21	A IN	IEL	An	A				
	Actual																
Preparation and presentation psm 2	Plan																
	Actual												1		1		



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Tuan

## PENGKELASAN TESIS SEBAGAI TERHAD BAGI TESIS PROJEK SARJANA MUDA

Dengan segala hormatnya merujuk kepada perkara di atas.

2. Dengan ini, dimaklumkan permohonan pengkelasan tesis yang dilampirkan sebagai TERHAD untuk tempoh LIMA tahun dari tarikh surat ini. Butiran lanjut laporan PSM tersebut adalah seperti berikut:

Nama pelajar: MUHAMMAD AZRI HANAFI BIN ABU SAMAH (B091810035) Tajuk Tesis: EFFECT OF MACHINING PERFORMANCE ON RECYCLE PALM OIL WASTE BASED MATERIAL

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

3. Hal ini adalah kerana IANYA MERUPAKAN PROJEK YANG DITAJA OLEH SYARIKAT LUAR DAN HASIL KAJIANNYA ADALAH SULIT.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA" "KOMPETENSI TERAS KEGEMILANGAN"

Saya yang menjalankan amanah,

**DR KHAIRUM BIN HAMZAH** Penyelia Utama/ Pensyarah Kanan Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan Universiti Teknikal Malaysia Melaka



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### TAJUK: EFFECT OF MACHINING PERFORMANCE ON RECYCLE PALM OIL WASTE BASED MATERIAL

SESI PENGAJIAN: 2021/22 Semester 1

### Saya MUHAMMAD AZRI HANAFI BIN ABU SAMAH

mengaku membenarkan tesis ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

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- 3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
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**TIDAK TERHAD** 

Alamat Tetap:

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Tarikh: 17 January 2022

Disahkan oleh:

h

Cop Rasmi:

DR. KHAIRUM BIN HAMZAH Pensyarah Kanan Jabatan Teknologi Kejuruteraan Pembuatan Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan Universiti Teknikal Malaysia Melaka

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