APPLICATION OF HYBRID COCONUT/KENAF FIBRE REINFORCED WITH POLYPROPYLENE COMPOSITED FOR AUTOMOTIVES COMPONENTS

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in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this project report entitled "Application of Hybrid Coconut/Kenaf Fibre Reinforced with Polypropylene Composites For Automotive Components" is the result of my own work except as cited in the references.

Signature :

Name : NURFATIN DALILA BINTI RUZHANI

Date : 11/9/2021

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Structural and Material)

Signature : ……………………………………….

Supervisor's Name : ……………………………………….

Date : ……………………………………….

DEDICATION

To my beloved mother and father

ABSTRACT

Every material has its specific character of mechanical properties. The development of natural fibres is rapidly used in the industry nowadays. Combining the weaker and stronger materials in a hybrid composite material helps the composite becomes harmonize and balance in loading or transfer capacity loads. The modification of the composites will keep coming out when there is the new design of the composites will be used. Usually, the idea comes out to solve the other problem. In future, there will be other fibres that may join the industry whereas the fibre could be used as long as we can avoid the waste. The important test to identify the mechanical properties were tensile strength, the modulus and the hardness or impact strength of the material. Each composite material will undergo testing and keep modified until the composite becomes suitable enough to use in the specific industry. Kenaf fibre was already known as the strong natural fibre in the previous studies. By mixing with coconut fibre and polypropylene, the hybrid composites will produce high strength in mechanical properties. This study has been modified by the past studies which is the weight ratio of the materials will be divided by the composition given and the surface treatment of 6% NaOH will be done on the coconut and kenaf fibres. In this research, the experiment has to change with the comparative study method since the limitation issue for entering the lab. The research was conducted based on a previous study between the years 2000 to 2021. The keyword on searching the paper was according to the title of the project; the application of hybrid kenaf/coconut fibre reinforced with polypropylene (PP) matrix and kenaf fibre reinforced with polypropylene (PP) composites. The review of the study was to compare the data and the factors that affected the result. The discussion is also based on the theory and the result was compared between the paper to discover the variables used may affect the whole experiment. Less the result has given the illustration for this project if it could be done. To observe the mechanical properties, it has satisfied the optimum result regarding the weight ratio of hybrid fibre composites prepared for maximum load and ultimate tensile test.

ABSTRAK

Setiap bahan mempunyai sifat khas sifat mekaniknya. Perkembangan serat semula jadi digunakan dengan pantas dalam industri sekarang. Menggabungkan bahan yang lebih lemah dan kuat dalam bahan komposit hibrid membantu komposit menjadi harmoni dan seimbang dalam memuatkan atau memindahkan muatan kapasiti. Pengubahsuaian komposit akan terus keluar apabila terdapat reka bentuk baru komposit yang akan digunakan. Biasanya, idea keluar untuk menyelesaikan masalah lain. Di masa depan, akan ada serat lain yang dapat bergabung dengan industri sedangkan serat itu dapat digunakan selagi kita dapat menghindari pembaziran. Ujian penting untuk mengenal pasti sifat mekanik ialah kekuatan tegangan, modulus dan kekerasan atau kekuatan hentaman bahan. Setiap bahan komposit akan menjalani ujian dan terus diubah sehingga komposit menjadi cukup sesuai untuk digunakan dalam industri tertentu. Serat Kenaf telah dikenali sebagai serat semula jadi yang kuat dalam kajian sebelumnya. Dengan mencampurkan dengan serat kelapa dan polipropilena, komposit hibrid akan menghasilkan kekuatan tinggi dalam sifat mekanikal. Kajian ini telah diubahsuai oleh kajian lepas yang mana nisbah berat bahan akan dibahagikan dengan komposisi yang diberikan dan rawatan permukaan NaOH 6% akan dilakukan pada serat kelapa dan kenaf. Dalam penyelidikan ini, eksperimen harus berubah dengan kaedah kajian perbandingan kerana masalah batasan memasuki makmal. Penyelidikan ini dilakukan berdasarkan kajian sebelumnya antara tahun 2000 hingga 2021. Kata kunci untuk mencari makalah sesuai dengan tajuk projek; penggunaan kenaf hibrid / serat kelapa diperkuat dengan matriks polipropilena (PP) dan serat kenaf diperkuat dengan komposit polipropilena (PP). Tinjauan kajian adalah untuk membandingkan data dan faktor-faktor yang mempengaruhi hasilnya. Perbincangan juga berdasarkan teori dan hasilnya dibandingkan antara kertas untuk mengetahui pemboleh ubah yang digunakan boleh mempengaruhi keseluruhan eksperimen. Kurang hasilnya telah memberi gambaran untuk projek ini sekiranya ia dapat dilaksanakan. Untuk memerhatikan sifat mekanik, ia telah memperoleh hasil yang optimum mengenai nisbah berat komposit gentian hibrid yang disediakan untuk ujian maksimum dan ujian tegangan akhir.

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Alhamdulillah, first of all, thanks to Allah S.W.T for bless my works and give me a chance to complete all the tasks for my research of final year project with the title, “Application of hybrid kenaf/coconut fibre reinforced with PP for automotive composite component”.

I would like to use this opportunity to show my gratitude to Associate Professor Ts. Dr Mohd Ahadlin bin Mohd Daud for his guidance, advice and encouragement throughout completing this final year project for these two semesters. Also, thanks to other lecturers for their giving ideas and advice for improvement for me to have a better solution in this research.

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PP	Polypropylene
wt%	weight percentage
UPE	Polymer Epoxy

CHAPTER 1

1.1 Background

A polymer is a substance made from a chemical link which is a large molecule were transform by bonding. Hence, the come out of the resins and polyester may help the bonding in the natural fibre stronger and more firm. Based on the knowledge of kenaf fibre, researchers tend to mix it with polymer resin due to the resulting substantial change in mechanical performances. (Radzuan et al., 2019). From that, it is proved that the resin matrix spreads and holds the composite bonding when the load is applied and also protects the fibres from damage from impact and corrosion. Rubber and wood are recognized as natural polymers existed as we have known that the woods are widely used in the aerospace industry. From the shredded pieces of wood and transform them into a layer of sandwich composites can withstand the pressure in the air and at the same time, it has a low specific weight. The alternative of this coalition makes the composites are demanded in all applications as the materials are short time renewable and totally drag the cost to the lower phase.

The revolution in the use of natural fibres really made it interesting for many sectors in industry to apply them to their composite manufacturing. Nowadays, the industry has to find out a way to low-cost production as they can by finding a renewable material and have a firm structure with high mechanical strength. Limited petroleum resources will increase petroleum-based products' prices in the near future. It is estimated that a 25% reduction in car weight would be equivalent to saving 250 million barrels of crude oil. (Davoodi et al., 2010) Fibre indicates its performance when reinforced with epoxy or resin. The epoxy polymer matrix is much suitable for the reinforcement of fibres due to its good adhesiveness and mechanical properties. (Vijayakumar & Nilavarasan, 2015) Using low-density natural fibres could lead to a weight reduction of 10–30%, therefore it is possible that manufacturers will consider expanding the use of natural fibre in their new products. (Davoodi et al., 2010) Properties such as high stiffness, low specific weight and biodegradability found in all-natural fibres make them unique to other materials. Although natural fibres and their composites are environmentally friendly and renewable (unlike traditional sources of energy, i.e., coal, oil and gas), these have several bottlenecks. These have poor wettability, incompatibility with some polymeric matrices and high moisture absorption (Taj et al., 2007). Plus, the shape, size, and strength of the natural plant fibres may vary widely 2 depending on the cultivation environment, the region of origin, and other characteristics (Ochi, 2008).

The coconuts were known as the plantation in the Asian states. Within the nonrenewable of this plant have caught the industry's attention to modify its fibre until getting the same result of toughness with the other composites. . Coconut fibre possesses a high failure strain of 15–40% and contains a thin continuous surface layer of an aliphatic compound, hereinafter referred as a waxy layer. (Brahmakumar et al., 2005) Meanwhile, the kenaf fibre was extracted from a plant named Hibuscus Cannibas to have long fibre which is can give more strength for the performance.

As the main material in this research is a natural fibre, there will be an issue with its chain molecules during the preparation of blends. Several techniques ranging from the grafting of short-chain molecules and polymers onto the fibre surface to using coupling agents and radical-induced adhesion promoters have been reported for improving interfacial bonding. (Brahmakumar et al., 2005) The techniques used were enhanced interfacial bonding with strengthening the covalent bonding between the fibre and the matrix used. Compared to other cellulose-rich fibre such as jute or pineapple, coconut fibre is weak with the presence of the waxy layer. The surface treatment may be used for coconut fibre in removing the unnecessary layer to gain a better interfacial bonding in polar-matrix composites.

1. 2 Problem Statement

Based on the earlier studies obtained, the natural fibres can use to withstand the stress apply to them. Many researchers have studied to fabricate more consumption of the composite in many industries as long as the exact manufacture of the composites is produced according to its shape and size of specimens and the addition of the fibre contains in the composites. Now, the coconut fibre will take the same action as others to apply in the composite and enhance its strength when having force. Earlier, the coconut fibres have been studied with the differ situation whereas the studies used the only and untreated coir fibres in the specimens to be tested. Also, the other paper stated that the coir fibre undergoes the treatment but with different saturation of alkali solution. In this study, the coir fibre and the kenaf fibre will have 6% of alkali solution treatment and mix with polypropylene powder before having any test.

1.3 Objectives

The research is to investigate the application of hybrid coconut/kenaf fibre reinforced with polypropylene for automotive composites components. There are the main objectives:

1. To fabricate the hybrid for the automotive composite components
2. To determine the mechanical properties contains in the hybrid according to the insertion of the weight fraction fibres

1.4 Scope

This research focuses on the mechanical properties of the hybrid kenaf/coconut fibre with PP composites. Then, the paper will go through the research about the properties that natural fibres contained, what are the right quantity in mixing the different types of fibre and the limitation of fibres have in using for production. The test conducted will show the properties such as the hardness, strength, impact on the surface, fracture point and density of the hybrid when carrying loads. Since this pandemic situation, the scope of this project reaches its limits in experimental works due to the limitation of entering workshops and laboratories. However, this study will be continuing in the scope of a comparative study by using related previous studies. The examples of the parameter that could be taken in the comparison are the use of the same fibres, surface treatment or the weight ratio of the materials in each specimen.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Various types of plants were used for production in many sectors such as textile, aerospace, automotive and furniture. The toughness of structure approved that large force may be applied with the standard limits of the material. The demanding criteria of natural fibre such as lightweight, environmentally friendly, economical and high performance moves more researchers, scientists and engineers who are target to develop more hybrid material to enhance the desired mechanical properties for automotive structural components. Thus, there will be more bunches of composite being composed in the future.

The various types of composite depending on their behaviours on the characteristics, relative amounts, distribution, properties of the phase and the design of the materials within property combination. Generally, the composites can be identified with the separation group of metal, polymer and ceramics. Materials that have specific properties are needed in technology applications such as those found in the aerospace and automotive industries. Recently, aircraft engineers are developing research for structural materials that have low densities but are strong, stiff and abrasion. Moreover, with the engagement load applied in the life-cycle system, the materials are desired with the impact-resistant and do not easily corrode. Composite materials provide much lower costs, are less time consuming, and can be managed based on application requirements for their performance (Radzuan et al., 2019).

In the going of enhancing the properties of materials, usually, started to focus on the fibre concentration and the distribution, and all of these have a significant influence on the strength and other properties of fibre-reinforced composites. The arrangement or orientation of the fibre may present in a parallel alignment of the longitudinal axis of the fibre in a single direction or a very random alignment. Not only that, but the mechanical characteristics of a fibre-reinforced composite also depend on the degree to which is an applied load is transmitted by the matrix phase to the fibres. As for the effectiveness of the strengthening and stiffening of the composite material, there is the approximation of the critical fibre length, lc.

2.2 Characteristics of natural fibre

Basically, fibres are based on natural fibre and man-made fibre (synthetic). Synthetic is a chemical fibre form such as polyester, acrylic, lycra and nylon. The development manufacturing of synthetic fibre cause pollution while the production process and waste from operations. The natural fibre is being wanted in industrial uses because they are environmentally friendly and safe for humans (Zaini et al., 2020). Compared to synthetic fibre, the advantages of natural fibres are their relevant strength properties, easy accessibility, lightweight, easy separation, improved energy recovery, high strength, non-corrosive design, low density, low cost, strong thermal properties, biodegradability and renewability (Singha & Thakur, 2008). Moreover, the natural fibre is made out of plant-based, animal-based and mineral. Thus, the fibre becomes the researcher choice for their studies as the biodegradability of the material helps an ecosystem becomes a healthy cycle likes in figure 2.1 (Akil et al., 2011) while at a low cost with high performance.

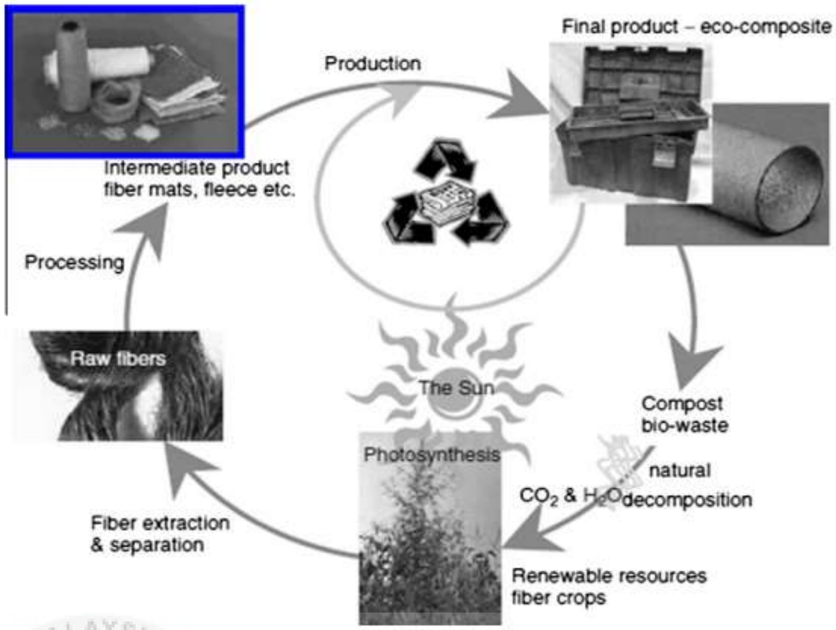

Figure 2.1: The life-cycle of bio-composites

Earlier, natural fibre was already involved in the automotive industry but on a less scale due to its low performance in the mechanism. Natural fibres have uneven quality, hydrophilic character, limitations in processing temperatures and polymer bonding problems (Davoodi et al., 2010). From figure 2.1, there are numerous types of fibres whereas they will extract from the plant-based which are suitable for reinforcement in composite material manufacture. Natural fibres such as coconut, sisal, jute, ramie, banana, hemp, kenaf, flax, bamboo, palm and cotton are usually strengthened in the polymer process to complete certain different qualities in the final products (Saba et al., 2016).

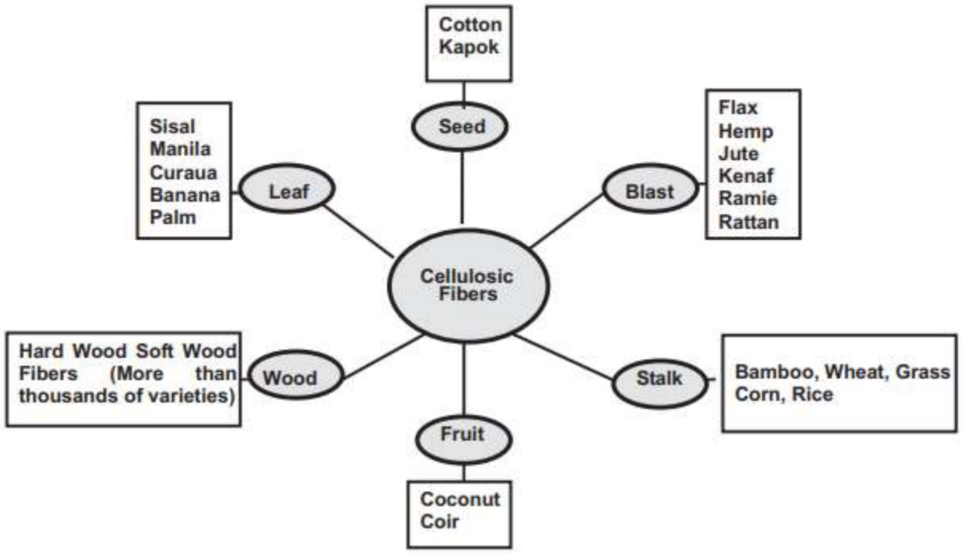

Figure 2.2 : The classification of natural fibre (Pandey et al., 2010)

Natural fibre or other green plants are usually coats with a linear chain called cellulose. This main substance in the primary wall of organic habits helps to remain the plant stiff and strong. A plant's strengths depend on its moisturization because the water acts as a plasticizing agent that alters the key to mechanical properties. In order to get a complete understanding of the process of moisture absorption, all factors that influence the distribution of fibre will eventually affect the ability to absorb moisture, including fibre concentration, size, shape, need to be treated individually (Wang et al., 2006). While the strengths of reinforcement can be strengthened, hydrophilic fibre still has its main limitations. The weak interfacial adhesion between polar-hydrophilic and nonpolar-hydrophobic fibres and difficulties in mixing due to poor wetting with the matrix of the fibres may occur in plant fibre (M. et al., 2005).

Different type of plant contains different size and length of the fibre but still in the same shape, which is the hair-like pattern. Therefore, the behaviour of the particle reinforcement will change due to its appearance. Based on the research, (M. et al., 2005) the mechanical properties of the composites thus generated depend on different variables, such as strength, modulus, aspect ratio and fibre orientation. Table 1, stated various places of fibre’s origin, which is, affected the properties. Depending on the growing climate, region of origin, and other features, the form, scale, and strength of natural plant fibres may vary widely (Ochi, 2008).

Flax	:	Borneo
Hemp	:	Yugoslavia, China
Sun Hemp	:	Nigeria, Guyana, Siera Leone, India
Ramie	:	Hondurus, Mauritius
Jute	:	India, Egypt, Guyana, Jamaica, Ghana, Malawi, Sudan, Tanzania
Kenaf	:	Iraq, Tanzania, Jamaica, South Africa, Cuba, Togo
Roselle	:	Borneo, Guyana, Malaysia, Sri Lanka, Togo, Indonesia, Tanzania
Sisal	:	East Africa, Bahamas, Antiqua, Kenya, Tanzania, India
Abaca	:	Malaysia, Uganda, Philippines, Bolivia
Coir	:	India, Sri Lanka, Philippines, Malaysia

Table 1: The natural fibre origin (Taj et al., 2007)

2.2 Coconut fibre

Coconut is the fruit of the coconut palm (Cocos nucifera). It is have been grown in tropical regions for more than 4,500 years back in India, Sri Lanka, Philippines and Malaysia. Coconuts will germinate and grow into coconut palms and begin fruiting after three years under suitable climate, rainfall and environmental conditions. A mature coconut can grow up to 30m tall and leave fronds 4-6m long. Instead, using the ocean, the coconut palm disperses its seed, it is very buoyant and extremely resistant to water that can float very long distances through the ocean. The coconut normally takes 12 months to get ripe after pollination, which time they start dropping from the trees. In coconut farming, the best planting season is May to June, which is a pre-monsoon period.

Humans for various uses in daily life have used coconut, which is well known for its flavour, culinary uses and potential health benefits. Meanwhile, its hard shell may use as charcoal. The coconut fruits consist of milk in the seed coat and the whitey flesh in the inner seed coat. Hence, the thickness of the layer fruits and the number of milk contents becomes variables for the fruit's weight which is in the range weighted 1.4kg-1.6kg. Research from (Brahmakumar et al., 2005) said that the natural waxy surface layer of the fibre affects fibre or matrix interfacial bonding and composite properties. The waxy layer provided a good fibre-matrix bond. According to that, by removal of the layer gives a drastic decrease of the fibre pullout stress, increase of the critical fibre length and the corresponding decrease in tensile strength (M. et al., 2005). A fibrous material derived from the outer husk of the coconut is coconut fibre or also known as coir.

Figure 2.3: The hair-like of coconut fibre (Vijayakumar & Nilavarasan, 2015).

From figure 2.3, the fibre seems like has a lightweight and low density as same as human’s hair. Despite that, the specific treatment applied, makes the fibres transformed in aligned and continuity in shape. On the surface of the natural fibre, polar hydroxyl groups have trouble forming well-bonded interphase with a relative nonpolar matrix, such as the. The fibre surface's hydrogen bonds help to prevent the filler surface from wetting (Akil et al., 2011). In addition, the hydrophobic composites lead to weakness in interface adhesion between the fibres and matrix material and therefore affects the overall property of the composite material. In fact, surface treatment chemically of the natural fibres can enhance the interfacial bonding and improvement of the adhesiveness between the reinforcement and matrix material. The coconut fibres appear in cylindrical shape where the higher fibre length shows better performance in thermoforming characteristics (M. et al., 2005).

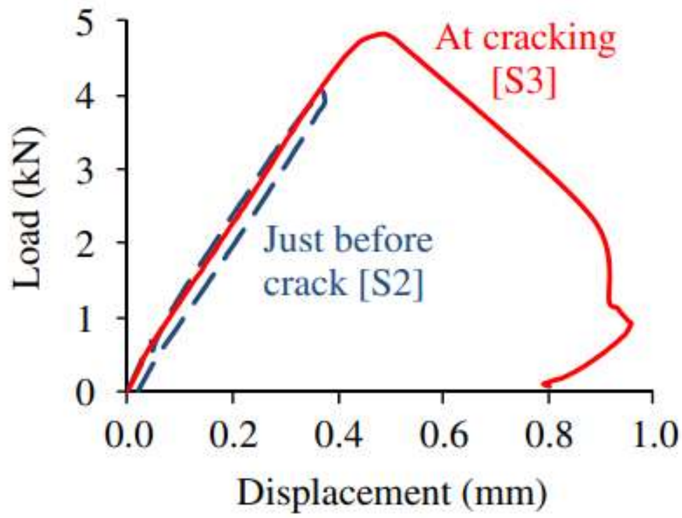

Figure 2.4: The cracking point of coconut fibre depending on its length (Ali et al., 2012)

2.3 Kenaf fibre

Figure 2.5: The structure of the kenaf (M. et al., 2005)

Kenaf fibre is extracted from a plant named Hibuscus Cannibas L, which is native to Southern Asia, and belongs to the family Malavaceae also called Deccan hemp and Java jute. It is a fast-growing plant where it can grow to a height of 4-5m. Kenaf was chosen because it can play an important role as wood, which is harvested 20 or 25 years. Meanwhile, Kenaf plant can be harvested 2-3 times a year during the harvesting season (El-Shekeil et