# Characteristics on Mechanical Possessions of Coconut Fibre Protected with Epoxy and Polyester Mixtures

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***Abstract*:** Fiber-reinforced polymer composites play a predominant role for a longer time in a wide variety of applications for their high specific strength and modulus. The fibre which serves as reinforcement in reinforced polymer is in the form of natural fibres. Natural fibres are not only strong and lightweight but it also relatively very low cost. The present work deals with comparison on the development and characterization of reinforcing the matrix (Epoxy resin & Polyester resin) with natural fibre (Coconut fibre). The natural fibres were exposed to chemical treatment (NaOH) before manufacturing of laminates and the pretreated fibres are tested and the fibres were chopped into 3mm, 5mm, 7mm and 10mm before reinforcement. Samples of Coconut-Epoxy and Coconut Polyester laminate were manufactured using hand layup method were the fibers are dispersed randomly. Specimens were cut from the fabricated and laminate according to the ASTM standard for different experiments. Tensile test, flexural test, and Impact test samples were cut in the desired shape and its results were observed, compared with epoxy and polyester composites to perceive the properties of composites.
***Keywords:*** *Coconut fibres, Epoxy resin, Polyester resin, hand-layup, compression moulding, Mechanical Properties.*

## 1.Introduction

A composite is a material made by combining two or more dissimilar materials in such a way that the resultant material is endowed with properties superior to any of its parental ones. Fibre-reinforced composites, owing to their superior properties, are usually applied in different fields like defense, aerospace, engineering applications, sports goods, etc. Nowadays, natural fibre composites have gained increasing interest due to their eco-friendly properties. A lot of work has been done by researchers based on these natural fibres. Natural fibres such as jute, sisal, silk and coir are inexpensive, abundant and renewable, lightweight, with low density, high toughness, and biodegradable. Natural fibre reinforced polymer composites have raised great attentions and interests among materials scientists and engineers in recent years due to the considerations of developing an environmental friendly material and partly replacing currently used glass or carbon fibres in fibre reinforced composites. They are high specific strength and modulus materials, low prices, recyclable, easy available in some countries, etc. **M. Brahmakumar, et al [1]** used Coconut fibre as reinforcement in low density polyethylene. The effect of natural waxy surface layer of the fibre on fibre/matrix interfacial bonding and composite properties has been studied by single fibre pull-out test and evaluating the tensile properties of oriented discontinuous fibre composites. The waxy layer provided good fibre–matrix bond such that removal of the layer resulted in drastic decrease of the fibre pull-out stress, increase of the critical fibre length and corresponding decrease in tensile strength and modulus of the composites. The waxy layer of polymeric nature also exhibited a stronger effect on interfacial bonding than by grafted layer of a C15 long-chain alkyl molecule onto the wax-free fibre. The morphological features of the fibre along with its surface compatibility with the matrix favours oriented flow of relatively long fibres along with the molten matrix during extrusion.**N.S.M. El-Tayeb [2]** explored the possibility of using this natural fibre to reinforce polyester and thus opens a new way to implement locally available inexpensive fibres and produce a new candidate tribo-material for bearing applications. Sugarcane fibre/polyester (SCRP) and glass fibre/polyester (GRP) composites (with chopped fibres of 1, 5, 10mm length randomly distributed and unidirectional mat fibres) were prepared using compression mould and hand-lay-up techniques. Friction coefficients and wear rates of SCRP and GRP composites were determined under dry sliding contact conditions in parallel and anti-parallel orientations and subjected to different operating parameters such as load, speed and test duration. Results of friction and wear proved that

SCRP composite is a promising composite which can be a competitive to GRP composite. In the case of chopped sugarcane/polyester (C-SCRP) composite, very smooth patches of polymer film (protective layer) due to plastic deformation shielded the surface of C-SCRP composite pin from damage by the metallic asperities and thereby contributed to the higher wear resistance. Furthermore, this layer provided enhancement to the bonding of SCFs fibre with matrix. In contrast C-GRP composite produced broken hard particles of GF at the interface which acted as a third body and restrained the formation of such protective layer. Wear resistance of C-SCRP composite increased significantly with increasing load but decreased drastically for CGRP composite. Finally, microscopic observation evidenced that the SCF has the ability to have a fairly good bonding with the polyester matrix. This in turn made the separation of fibre from the composite more difficult and hence contributed to improvement of wear resistance for C-SCRP composite compared to C-GRP composite. In contrary, the bonding between GFs and the matrix for C-GRP composite was not that strong and the fibres were easily debonding.**K. C. C. C. Beninia et al [3]** investigated the effect of accelerated weathering on the visual appearance and on mechanical properties of high impact polystyrene (hips) as well as hips reinforced with mercerized and bleached sugarcane bagasse fibers composites. After accelerated weathering period of 900 h, under uv-b radiation and moisture regular cycles, changes in mechanical properties are investigated by tensile tests. Materials fracture surfaces are investigated by scanning electron microscopy (sem). The study showed that the exposure time was sufficient to change the visual appearance of hips as the composites. From this study, it was observed that composites reinforced with bleached fibers are less susceptible to accelerated weathering exposure than composites reinforced with mercerized fibers, which is explained by the higher amount of lignin present in mercerized fibers. And decrease in degradation resistance of fiber which is not due to influence of weathering exposure but due to nature of fiber which is confirmed by sem analysis. **Mulinari, d.r. et al [4]** studied the mechanical properties of coconut fibers reinforced polyester composites. In this work, chemical modification of the coconut fibers by alkaline treatment was studied in order to use them as reinforcement in polyester resin. Coconut fibers were modified during 1 hour with sodium hydroxide solution 1% wt/v. The modified fibers were evaluated by scanning electron microscopy, x-ray diffractometry, thermal analysis and fourier transform infrared spectroscopy. The composites were prepared by compression moulding technique using 10% wt of fibers. The mechanical properties were evaluated by tensile and fatigue tests. The surfaces of the fractured specimens were examined in order to assess the fracture mechanisms. Results presented a decrease in fatigue life of composites when applied greater tension, due to bonding interfacial, which was not adequate.Prakash Chandra Gope **et al [5]** Mixed-mode fracture characteristics of epoxy-based biocomposite reinforced with 20 wt% walnut shell particle and 10 wt% coconut fibres are investigated. The biocomposite is fabricated using the squeeze casting method. The positive aspect of hybrid combination of fibre and particle reinforcement is advocated by comparing mode I, mode II and mixed-mode I/II fracture surfaces under a scanning electron microscope.Worraphol Nansu, **et al [6]** A biodegradable composite foam made from cassava starch mixed with coconut residue fiber (CRF) was first successfully prepared using a conventional compression molding technique. Cassava starch is an agricultural economy product of Thailand that is produced in high production each year. CRF is a waste product left over after the removal of coconut milk from coconut fiber.Muthukumar Chandrasekar**et al [7]** In this study, the influence of hybridizing sisal on the wear behavior of coconut sheath (CS) fiber-reinforced polyester composites was investigated. Two different layering arrangements of the hybrid composite with sisal and CS fibers as outer lyer and core arrangement in the polyester matrix were fabricated.K. Prakash Marimuthu **et al [9]** The present work deals with the characterization polymer matrix composites combining glass fiber and fiber got from coconut. The composite was prepared using hand layup process and sufficient precaution has been taken to ensure there is homogeneity. The composite is composed of 60% epoxy resin, 10% glass fiber and 30% coconut fiber. Various mechanical tests like micro hardness test, tensile strength, impact strength test has been carried out to characterise the composite.

A. Balaji, **et al [10]** The primary aim of this study is to develop a bio composite by using biopolymer and natural fibers/particles from renewable resources. With the aid of poly-condensation process, the cardanol thermoset biopolymer resin from cashew nut shell liquid (CNSL) was synthesized. The abundantly available, bagasse fiber (20 mm of length) and coconut shell particle (50 μm) were applied as reinforcement material to produce a new ecological hybrid bio composite.ThamerAlomayri**et al**

TuijinJishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 44 No. 5 (2023)

**[11]** Concretestructures are the most widely used building structures and play an important role in urbanization and modern infrastructures. Cement concrete is the most popular and versatile building material due to several advantages, such as adaptability, high mechanical strength, good insulation and fire resistance, and abundant availability of its constituent materials. Blaming to enormous urbanization and growth in the industrial sector, the demand for concrete has increased to an all-time high. Our green-and-blue world is becoming greyer with each minute. Our built environment is outgrowing the natural one.Salman Ahmad **et al [12]** The experimental research object was low-density polyethene (LDPE) waste plastic as a binding material in the production of LDPE bonded sand paver blocks. The LDPE waste plastic was melted in the open air and mixed with sand to form paver blocks. LDPE to sand ratio, percentage of coconut fibers, and sand particle size was varied. The compressive strength, water absorption and density of paver blocks were measured. It was observed that the incorporation of coconut fiber proportion at 3% improved compressive strength by 18.4% and reduced water absorption by 54.1%. The best experimental results were observed at LDPE to sand ratio of 30:70, whereas the finest sand gives the highest compressive strength. The sustainable paver blocks developed in this research can be used in water-clogged areas

## 2. Experimental Work

### 2.1 Materials

The followingraw materials were used in this experimental work

**For Epoxy Composites**

1. Natural fiber - Coconut inflorescence
2. Epoxy resin - LY 556
3. Hardener - HY 951

**For Polyester Composites**

1. Natural fiber-Coconut inflorescence
2. Resin-Isophthallic unsaturated Polyester resin
3. Accelerator-Methyl Ethyl Ketone Peroxide
4. Catalyst-Cobalt Naphthalene

### 2.2 Processing

#### *2.2.1 Fiber Extraction*

The coconut inflorescence contains fiber which is surrounded by thick flesh material. In order to obtain the fiber the inflorescence is placed in water for about 10 days. Then the coconut inflorescence is hammered such that fiber comes out of the flesh. Then the fiber which is obtained is placed in a room without contact with sunlight such that the fiber gets separated individually. Then the fiber can be prepared for chemical treatment.

#### *2.2.2 Fiber Treatment*

The extracted fibers are to be chemically treated with NaOH for making thesurface of the fiber rougher such that bonding will be better during compositefabrication. In this work the fibers were treated with 2, 5, 7, and 10 % of NaOH. Thechemical treatment erodes the material from the fiber. The chemical treatment also erodesthe cellulose, lignin and wax contents.Specimen are prepared with the mixing ratio of (Epoxy and polyester resin) and coconut inflorescence fibers 70:30.The coconut inflorescence fiber were cleaned dried andexactly chopped with different proportion 3mm,5mm,7mm &10mm.The weight fraction of fibers with particular length should be chosen andmixed in the bowl and spread uniformly on the mold of plat size 270*270*3.2mmand compressed by applying a load of 20 tons by hydraulic compression to get asingle mat. Resin mixed with accelerator and catalyst is poured over the compressedfiber mat and the pressure is applied till the complete closure of mold. The samplesare prepared and cured at room temperature.

**Fig 1:** During pretreatment with 2,5,7,10 %NaOH

**Fig 2:** After Pretreatment process

### 2.3 Fabrication Process

The procedure adopted in the fabrication of both the Epoxy and polyester composites is represented in the systematic diagram as shown in Figure: 3

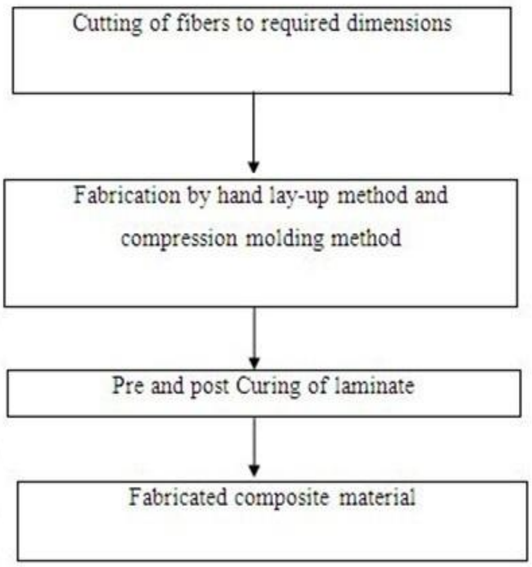
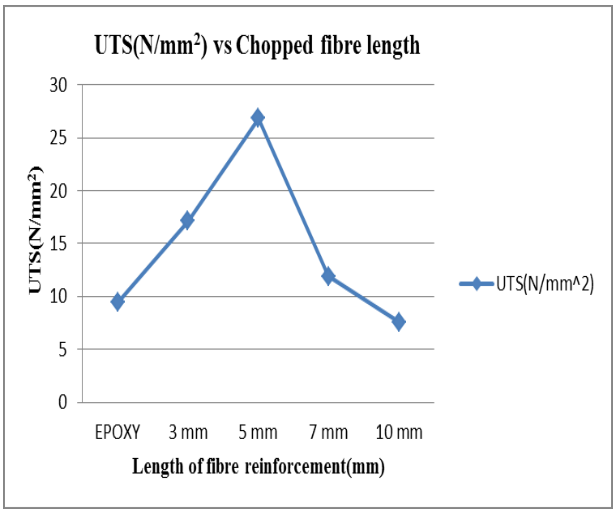



**Fig: 3**Process ofFabrication

## 3. Results And Discussion

### 3.1 Tensile Test

Tensile tests were carried out for both the composites ( Epoxy composites and Polyester composites) using universal testing machine out as per ASTM D638-165mm length, 19mm width, 3.2mm thickness. It is observed that the tensile test shows maximum stress content of 26.83N/mm$^2$ for 5mm fiber reinforced composite which is 3times to that of Polyesterresin.



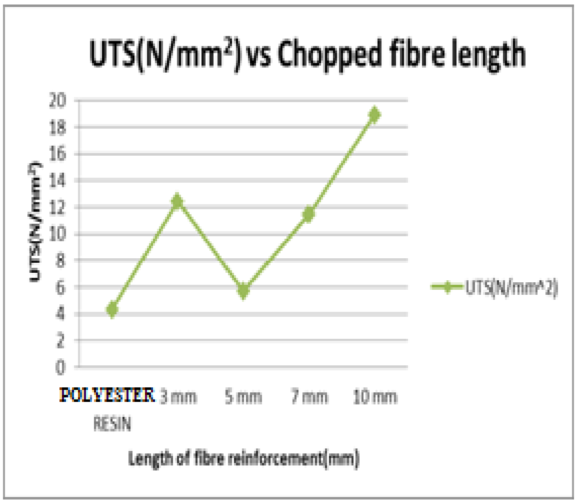
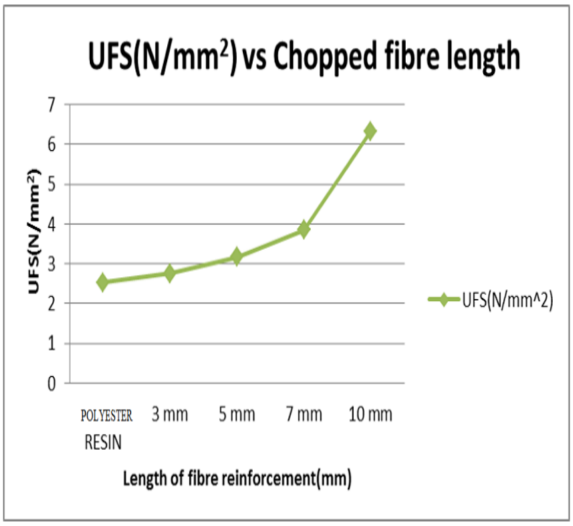




**Fig 4.1:** Tensile Strength of Epoxy Composite laminates

**Fig 4.2:** Tensile Strength of Polyester composite laminates

### 3.2. Flexural Test

Three-pointbending tests were carried out according to ASTM D790-76mm length, 25mm width, 3.2mm thickness. Flexural test were shows the maximum stress content of about 11N/mm$^2$ for 5mm fiber reinforced composite which is approximately 2 times to that of polyester composites.



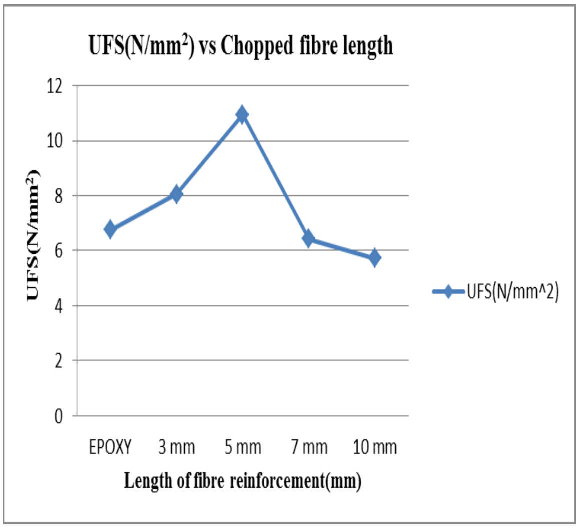




**Fig 5.1:** Flexural Strength of Epoxy Composite laminates

**Fig 5.2:** Flexural Strength of Polyester composite laminates

### 3.3 Impact Test

Impact tests were carried out ASTM D256-65mm length, 12.7mm width,3.2mm thickness on the specimens. It is observed that the 10 mm fiber reinforcement leads to higher impact energy of about 0.95 joules for 10mm fiber reinforced epoxy composite which is 1.8 times to that of polyester composites.

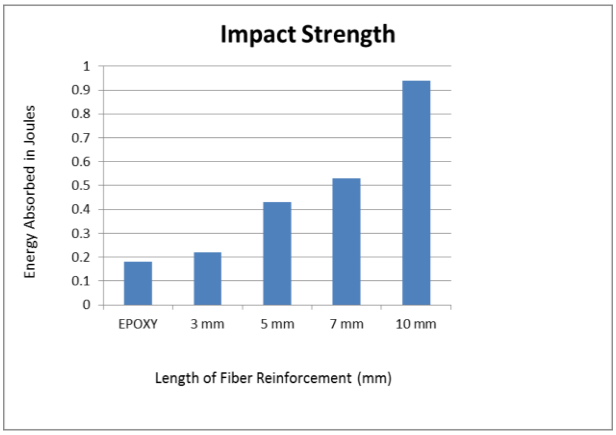



**Fig 6.1:** Impact Strength of Epoxy Composite laminates

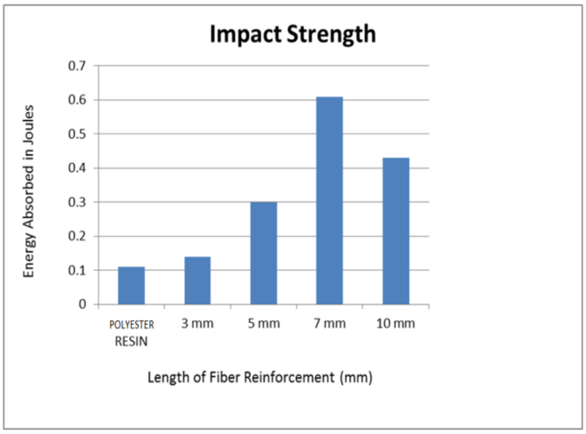



**Fig 6.2:** Impact Strength of Polyester composite laminates

**4. Conclusion**

The performance of Epoxy reinforced with coconut fiber was superior to the polyester reinforced with coconut fiber composites. From tensile test, it exhibits maximum stress content of 26.83N/mm$^2$ for 5mm fiber reinforced composite which is 3 to times to that of Polyester resin and in flexural test, it exhibits maximum stress content of about 11N/mm$^2$ for 5mm fiber reinforced composite which is approximately 2 times to that of polyester composites. From impact test, it exhibits that that the 10 mm fiber reinforcement leads to higher impact energy of about 0.95 joules for 10mm fiber reinforced epoxy composite which is 1.8 times to that of polyester composites. Upon the overall observation, it was observed that the reinforcement of Epoxy with coconut fiber with different fiber size originated a newer material with general superior properties and depending on the loading conditions**.**

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