Study on Mechanical Properties of Bio-Composites

Mr. Korisidda[1] Mr. Mahadev Prasad C.[2] Mr. Mahantesh B. C.[3] Mr. Sanketh S. Sheregar[4] Mr. Praveena B. A.[5]
[1,2,3,4]Student [5]Assistant Professor
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]Nitte Meenakshi Institute of Technology, Bangalore, India

Abstract— In recent years natural fibers appear to be the outstanding materials which come as the viable and abundant substitute for the expensive and non-renewable synthetic fiber. The advantage of natural fibers is their continuous supply, easy and safe handling, and biodegradable nature. The objective of the present work is to explore the potential of using PINEAPPLE LEAF FIBER as reinforcement and investigate the effect of fiber length on mechanical properties of PALF reinforced polypropylene Resin composite.

Key words: Natural Fiber, Pineapple Leaf Fiber, Polypropylene Resin, Mechanical Properties

I. INTRODUCTION

PALF is obtained from the leaves of pineapple plant Ananas Comosus, which is a perennial herbaceous plant, widely cultivated in tropical regions of Asia, Central and South America After harvesting, the pineapple plant has to be removed, generating a large volume of wastes. Wastes consist of leaves of 30 to 90 cm length and they usually contain herbicides spreading into the air during incineration processes. Moreover, postharvest utilization of pineapple waste would be an alternative and renewable source of natural fibers for industrial purposes since it can add value to pineapple cultivation and reduce negative environmental impacts in the field [1].

India endowed with an ample availability of natural fiber such as Bamboo, Ramie, Jute, Sisal, Pineapple, Coir, Banana etc. has focused on the improvement of natural fiber composites mainly to explore value-added application avenues. Such natural fiber composites are well matched as wood substitutes in the housing and building sector. The development of natural fiber composites in India is based on two cleft strategy of preventing depletion of forest resources as well as ensuring good economic returns for the cultivation of natural fibers [2].

Wherever Times is specified, Times Roman or Times New Roman may be used. If neither is available on your word processor, please use the font closest in appearance to Times. Avoid using bit-mapped fonts. True Type 1 or Open Type fonts are required. Please embed all fonts, in particular symbol fonts, as well, for math, etc.[3]

Among various natural fibers, PALF has the potential for use as reinforcing filler in green composites with satisfying mechanical properties. PALF exhibits excellent mechanical properties, associated with their high cellulose content; due to its main chemical constituents are cellulose (70-82 %), lignin (5-12 %) and ash (1.1 %) [4].

II. OBJECTIVES

- Fabrication of a new class of short pineapple leaf fiber based polyester resin composites.
- Evaluate the mechanical properties such as tensile strength and flexural strength of fabricated composite.
- To study the influence of fiber length and fiber loading on mechanical properties of composites.

III. MATERIAL PROCESSING

Pineapple leaf fiber (PALF) was obtained from Gogreen products (Gandhi Road Alwarthiru Nagar, Chennai) fig 3.1. The fiber was washed with an alkaline solution and dried in the air after this is chopped to the desired length, (15mm-45mm). This chopped fiber will be used for composite fabrication. General-purpose polypropylene resin will be used for the study. The physical and mechanical properties of the pineapple fiber and polypropylene are given in Table 3.1

Fig. 3.1: Raw PALF

Properties	Fiber	Polypropylene
Density (g/cm3)	1.3	2.159
Tensile Strength (Mpa)	387-1486	20.9
Tensile modulus (Mpa)	29.8-81	----
Cellulose Content (%)	64-67	----
Lignin Content	4%	----
Diameter	0.6-1.1mm	----
Elongation of Break	2-3.5%	2.6

Table 1: Properties of Pineapple Fiber and Polypropylene Resin

IV. PREPARATIONS OF SPECIMENS

Randomly oriented pineapple fiber Polypropylene composites with varying fiber length and fiber volume fraction were prepared by a hand layup method. Composite sheets of size $300mm * 300mm * 5mm$ were prepared using a Hand lay-up Method.

First, the mold will be prepared and then a mold-releasing agent was applied on the surface. When the mat was completely wet by the resin, the mold was closed, pressed, and cured at a room, the temperature for 18-24 hr.

Sheets were prepared with fibers of varying length (15mm, 30mm & 45mm) and of varying fiber loading. The specimens of required dimensions were cut from the sheets, smoothed by sanding, and used for testing.

V. FABRICATION

A. Cleaning

The fiber washed thoroughly in a solution of NaOH and water. NaOH is added to water at the percentage of 2% of the water it means for 500ml NaOH solution to 25liters of water fig 5.1. In this solution, fibers were soaked for 60 minutes, after soaking in solution it was washed in clean water thoroughly 4-5 times and spread over the wire in outdoor for drying in sunlight for 2days.

Fig. 5.1: Fiber Cleaning

After drying in the air it was cleaned by hand to remove any unwanted material from the fiber fig 5.2. After cleaning of fibers weight into 3 parts equal and each part was cut into different sizes of 1.5cm, 3cm, and 4.5cm approx. And put into separate bags.

B. Preparation of Mold

In this composite sheet making, we need some more materials like resin. These things some help directly some other helps indirectly for example acetone thinner used to clean the mold, bowl and other things. Similarly, an accelerator is like are used in the making of the composite sheet inside it. The following figure shows some of their list.

Cleaning of lower die in our case it was granite, it was cleaned with cotton waist after that acetone thinner liquid was used to remove any dust particles from the face of the stone. After cleaning the upper die the lower die was cleaned in the same manner but the plywood plate was used as upper die.

As of the upper and lower die cleaned the frame also cleaned and kept aside. After cleaning all the things the wax film was applied to the lower mold and left for 5minutes to set up. On the wax film, polyvinyl alcohol thin film applied using blade evenly.

For frame also a thin coating of PVA applied and set on the lower die and ensured there was no any air pass gap from the frame and lower die joining line.

It was left to dry for 60minutes to 90minutes. For upper die glue was applied on that a transparent sheet was pressed and ensured there were no wrinkles created. On the sheet, the wax film was made and kept aside.

Fig 5.2 Preparing Mold

The fiber was weight to 3 different measures of 10gram, 12.5gram, and 15gram for 3 different sizes which are 15mm, 30mm, and 45mm it means total 9 compositions. For volume fraction of fiber was 10%, 15%, and 20%, of resin, taken.

For first model 15grams of the fiber of 4.5cm length has been taken and resin of 215grams. A 15grams of fiber were weight and kept aside.

After that a bowl was taken and cleaned using acetone and wiped with the cotton waste, the resin was poured and weight to 215grams fig 5.6. For resin accelerator and hardener mixed at a ratio of 2% of resin weight ratio.

While pouring and mixing of resin and additives special care has to be taken to avoid as much as possible of air bubble formation. In this mixture that weighted fiber mixed slowly and ensured all the fibers were wet by resin.

Fig. 5.3: Mixing Of Resin & Fibers

As additives mixed with the resin, this will induce quicker harden of resin, to avoid this we have to hurry up to work and with care.

C. Setting up Mold

The fiber and resin mixture was taken and it spread all over inside the frame with hand and ensured evenly distributed all over the frame.

To level setting the fibers inside the frame we had used the blades fig 5.10. After setting fiber upper die has been placed on that weight was placed for 18 hours to 24 hours approx.

Fig. 5.4: Evenly Distributing Of Fibers

Fig. 5.5: Weight Loading

D. Removing & cleaning

After the time lapse, the weight was removed from the mold and upper die was removed slowly, it came easily. After removing upper die the four side frame was removed carefully with the cleaning blades.

For removing the composite sheet the blade was pushed underneath of composite sheet and pushed slowly and taken from lower die. The back side of the composite sheet a thin layer was created by the polyvinyl alcohol which has to be removed.

Due to the pouring of an excess of resin, the protruded excess material removed using scissors. After cutting excess material it has to be measured by the Vernier caliper to know the thickness of composite sheet.

Fig. 5.6: Finished Composite Sheet

VI. PREPARATIONS FOR TESTING

A. Tensile Test

Tensile testing of pineapple fibers was carried out in Tensor machine in R & D lab at speed of 0.7mm per min. Specimens was prepared by hand layup process. The specimen was cut as per the ASTM standard of D3039

Fig. 6.1: Tensile Testing Machine / Tensor

The ends of the fibers were fixed on the fixture. The width of the fiber specimens was measured using a Vernier caliper. Tensile testing of the composite specimens was carried out using rectangular specimens of size 200mm ∗ 20mm ∗ 5mm were used for testing.

Fig. 6.2: Tensile Test Specimens

B. Flexural Test

Flexural tests were performed according to ASTM D 790. The test was carried out at Indian Institute of Science-Bengaluru. The specimen was cut into rectangular strips of size 80 mm long, 20 mm wide, and 5 mm thick for these tests. The flexural strength and flexural modulus were calculated using the following relationships.

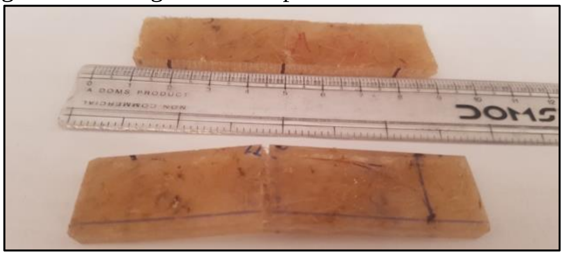

Fig. 6.3: Flexural Test Specimens

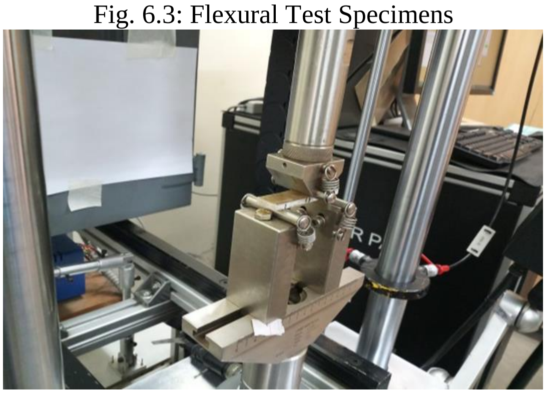

Fig. 6.4: Flexural Test

VII. RESULTS & DISCUSSIONS

A. *Tensile Test Result*

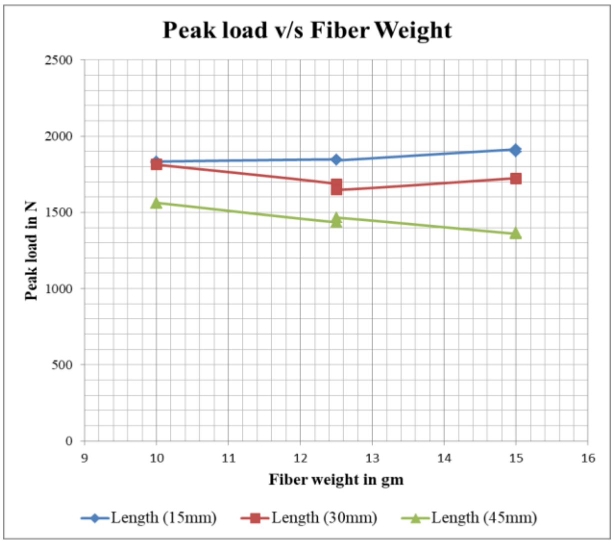

Fig. 7.1: Tensile Load V/S Fiber Weight

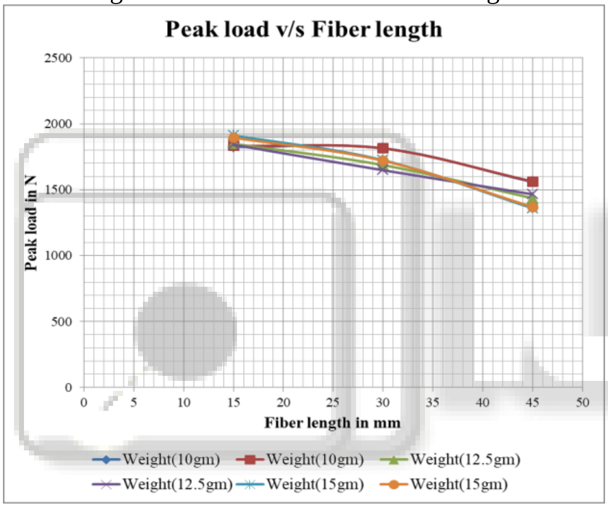

Fig. 7.2: Tensile Load V/S Fibers Length

B. *Flexural Test Result*

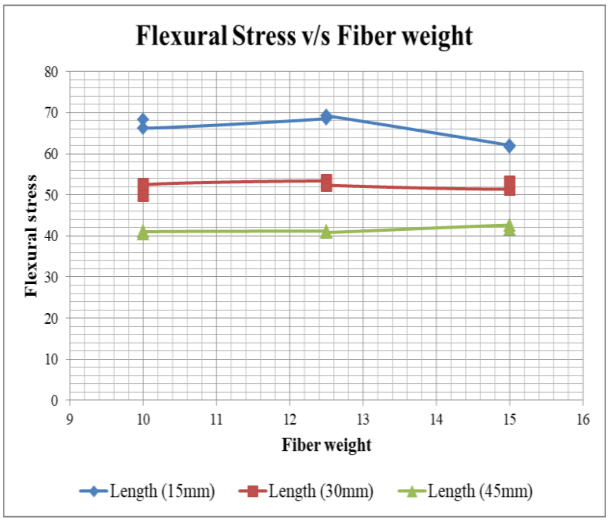

Fig. 7.3: Stress V/S Fiber Weight

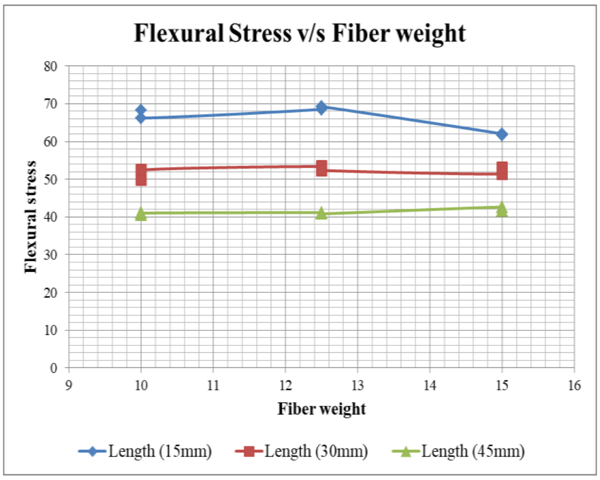

Fig. 7.4: Stress V/S Length of Fibers

VIII. CONCLUSION

The pineapple leaf fiber-polyester composite specimens prepared as per ASTM standards subjected to mechanical characterization results were Discussed.

The 2% NaOH treated pineapple leaf fiber-polypropylene reinforced composites seemed to have a higher tensile strength. The tensile strength of pineapple leaf fiber-polypropylene composites was found to be 28.6Mpa. The flexural strength leaf fiber-polypropylene composite was 60.54N/mm^2.

Though the natural fibers composites have some merits and demerits, the combination of the useful properties of two different materials, quicker processing time, lower manufacturing cost, etc., make them as a versatile material in the field of composite engineering and technology. Hence with this conclusion, it is sure that the technology shows composite is the most wanted material in the recent trend.

REFERENCE

[1] Natalia Jaramillo, David Hoyos, Juan F. Santa. "Composites with Pineapple-Leaf Fibers Manufactured By Layered Compression Molding" Ingenieríay Competitividad, Volumen 18, No. 2, p. 151 - 162 2016.

[2] Jagannatha Sahu "Study of Tensile and Flexural Properties of Luffa Fiber Reinforced Epoxy Composites", NIT Rourkela.

[3] L. Uma Devi, S. S. Bhagawan, Sabu Thomas. "Mechanical Properties of Pineapple Leaf Fiber-Reinforced Polyester Composites" 3 November 1996.

[4] Supranee Kaewpirom and Cherdthawat Worrarat. "Preparation and Properties of Pineapple Leaf Fiber Reinforced Poly (lactic acid) Green Composites", Fibers and Polymers 2014, Vol.15, No.7.

[5] V. Muthukumar, R. Venkatasamy, A. Sureshbabu, D. Arunkumar "A Study on Mechanical Properties of Natural Fiber Reinforced Laminates of Epoxy (Ly 556) Polymer Matrix Composites". International Journal of Production Technology and Management Research July-December 2011 Volume 2 Issue 2.

[6] M. Asim, Khalina Abdan, M. Jawaid, M. Nasir, Zahra Dashtizadeh, M. R. Ishak, and M. Enamul Hoque. "A

Review on Pineapple Leaves Fibre and Its Composites" Fibers and Polymers 2017, Vol.18, No.5, 940-947.
[7] Vikas Sahu, Keshav Singh Bisen, Murali Krishna." Mechanical Properties of Sisal and Pineapple Fiber Hybrid Composites Reinforced With Epoxy Resin, IJMER ISSN: 2249–6645, Vol. 5 Iss.1 Jan. 2015.
[8] Anbia Adam, YusriYusof, and Asia Yahya. "Extraction of Pineapple Leaf Fiber".ARPN Journal of Engineering and Applied Sciences, Vol. 11, No. 1, Jan 2016.
[9] Professor William Joseph Stuart. "Composite Materials Layup Lab Manual".