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COMPARATIVE STUDIES AND MECHANICAL PROPERTIES ON DIFFERENT VOLUME FRACTION OF PINEAPPLE LEAF FIBER AND JUTE FIBER REINFORCED EPOXY RESIN COMPOSITES

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Abstract

Fiber reinforced composites have been around since the dawn of civilization. Natural fibers such as banana fiber, glass fiber, jute fiber, palffiber, sisal fiber, and baggasfiber are utilised as reinforcements for composite materials at random because of their different advantages over conventional fibres such as low cost, low density, and low energy consumption. They are both recyclable and biodegradable. A hybrid fibre composite (palf fibre and jute fibre) was developed in this study. They were made by hand using the lay-up method. The epoxy resin that was employed to make the hybrid composite. PALF is crystallised and has high cellulose content (between 70 and 80 %). To improve its mechanical and thermal characteristics, PALF is composited with jute fibre. The ultimate tensile strength, flexural strength, hardness, and percent of elongation of specimen samples all were tested. The experiment results showed that hybrid fibre reinforced epoxy composites outperform single fiber glass fiber reinforced in terms of characteristics.

Keywords: Palffiber, Jute fiber, Mechanical properties

I.INTRODUCTION

Natural fibers are abundant, biodegradable, and offer no health risk to humans or animals. Furthermore, natural fiber-reinforced fibers are thought to have a promising future as an alternative to petroleum and fossil-based fibers. Natural fibres are taken from various components of plants and then categorised. It's worth noting that natural fibers like jute, coir, banana, and sisal are abundant in developing countries like Vietnam, Thailand, and India.

Natural fibers have become more popular in composite manufacturing than any other type of material. Natural fibers have already replaced synthetic fibers in a variety of applications, including boat hulls, packaging, automotive, civil constructions, chemical equipment and machinery constructions, bathtubs, electrical and electronic equipment, automobile and marine industries, car manufacturing, aircraft manufacturing, military, industrial, and biomedical sectors, archery bows, and so on. Because natural fibers are durable, has good thermal qualities, is low in density, and is inexpensive, recyclable, biodegradable, and environmentally safe. Fibers are progressively being used in research projects. Plant fibers are employed on a variety of plastic substrates. **Arib et al., (2006)** proposed that fiber content should be increased. With a volume percentage of 10.8%, the tensile modulus and strength are 687.02 and 37.28 MPa, respectively. **Rahman et al., (2008)** investigated mechanical parameters and observed that 60 % jute content generated the best tensile strength (70 MPa), bending stress (75 MPa), and bending-E-modulus (2.35 GPa), whereas 38 % jute content produced the highest Young's modulus (1.95 GPa).According to **Vivek Mishra et al., (2012),** these properties improved when the void content was lowered from 12 wt. % to 48 wt. % and the fibre loading was reduced from 0 wt. % to 12 wt.%.Flexural tests were performed by **Santosh Kumar et al., (2012)** on specimens with volume ratios of 10%, 20%, and 30%. The results of the test revealed that when the volume ratio improved from 10% to 30%, the flexural strength increased substantially. At 30%, the maximum value of flexural strength was attained.**J.K. Odusoteet al., (2016),** high concentrations of NaOH improved the crystallinity and size of the PALF crystallite while also increasing the mechanical strength and stiffness of the fibre up to a point after which the fiber strength and stiffness steadily declined. **Glória et al., (2017)** despite

the poor fiber/matrix contact, Sem analysis showed that PALF acts as an effective reinforcement for the brittle polyester matrix. **Patwaryet al., (2017)** observed that jute fibre composites with a fiberlength of 2 mm have higher tensile strength than those with a fiber length of 1 mm or 4 mm. In terms of fiber content, composites with 10% fiber (by weight) have higher tensile strength than composites with 5 and 15% fibre. **Jagadishet al., (2017),**adding short fiber can increase mechanical properties, and in all cases, composites with 10% reinforcement 5-mm thickness outperform the other combinations.The PALF was characterized as a hybrid composite with other natural and synthetic fibersby **Todkar S.S et al. (2019).** Surface treatments to improve the interfacial and interphasial PALF, as well as coupling agents for improving mechanical strength, are discussed. The increase in wt. % of jute fiber, according to **Nath S et al., (2019),** decreases the thermal conductivity of these composites. The thermal conductivity of these composites is reduced when chemosphere filler is added. With the addition of 0 to 10% filler, the decrease in thermal conductivity is nearly 9%.**Kumaran et al. (2019)** found that chemically treated Portunussanguinolentus shell powder-filled jute fabrics-based epoxy composites had improved thermo-mechanical properties.

II. MATERIALS AND METHODS:

The raw materials used to make the hybrid composite material were palffiber, jute fiber, epoxy resin, and hardener, as illustrated in **Fig (1, 2).** Jute fibre was employed as a natural reinforcing composite in this study to prepare palf. As a matrix material, epoxy and harder are mixed in a 10:1 ratio.Palf composites come in four distinct percentages: 20%, 30%, 40%, and 50%. Palf-jute fiber composites, meantime, are manufactured in four different ratios, each including equal proportions of palf and jute fiber. 10% palf-10% jute, 15% palf-15% jute, 20% palf-20% jute, and 25% palf-25% jute are the percentages. **Table. 1** lists the several types of composite fibersthat were used in this investigation, as well as their properties.

Fig 1: Palf fiber

Fig 2: jutefiber

TABLE .1 PHYSICAL PROPERTIES OF FIBER MATERIALS

	Palf fiber	jute fiber
Density (g/cm3)	1.48	1.5
Young modulus (GPa)	34.5-82.5	10-30
Tensile strength(MPa)	298	393-773
Elongation (%)	2-4	1.8

III. PREPARATION OF SPECIMENS:

Figures show how the test specimens are made individually (3-8)

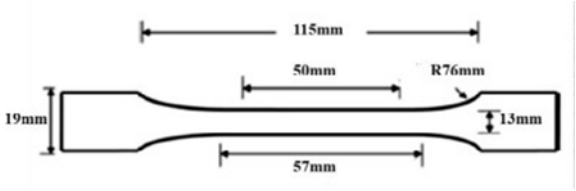

Fig 3: Schematic diagram of tensile test specimen

Fig 4: Dog-bone specimen of the composite

Fig 5: Schematic diagram of Flexural test specimen


Fig 6: specimen of the composite

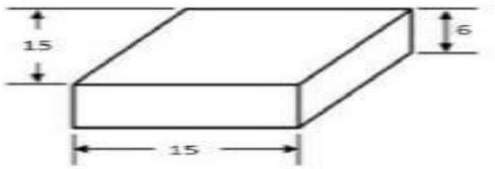

Fig 7: Schematic diagram of Hardness test specimen


Fig 8: specimen of the composite

IV.RESULTS AND DISCUSSIONS:

The hardness, ultimate tensile strength, flexural strength, and percent of elongation of the experimental results are all evaluated here.

Hardness testing: Figures (9,10) show the experimental hardness results of hybrid composites. The experiment is based on Durometer hardness test results (Shore-D). The experiment is being conducted to determine the hardness of a hybrid composite (palf fiberand jute fiber) with a volume fraction of (20% palf, 30% palf, 40% palf, and 50% palf) and epoxy resin. This research discovered that the Hardness Value of 20% palf + 80% epoxy had a higher hardness than the other three fibercompositions, with an 80.67 N/mm2 value.

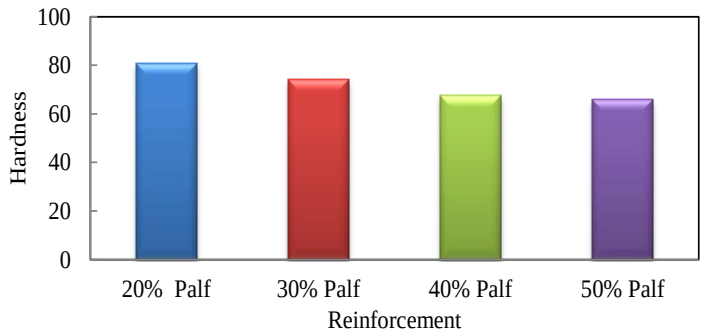

Fig 9: Comparison of hardness of Various % of palf fiber with Epoxy resin reinforcement

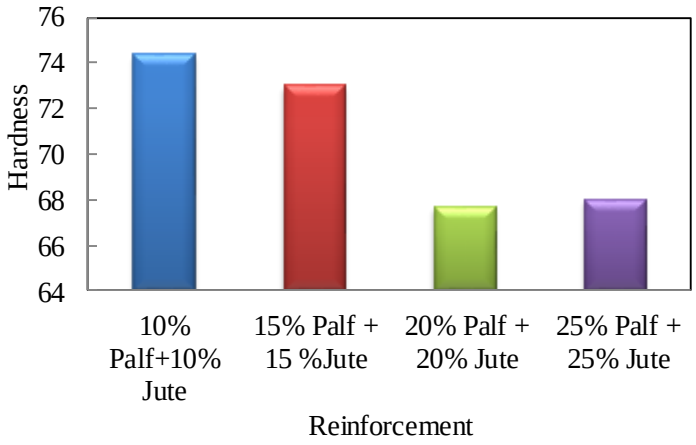

Fig 10: Comparison of hardness of various% of palf and jute fiber with Epoxy resin reinforcement

The palf fibre reinforced epoxy composite has properties suitable, such as lightness, high strength, design flexibility, effective anti-shock performance, fatigue and corrosion resistance, as well as good water protection and concealment, according to the hardness test findings. Furthermore, the cost is lower, making it more cost-effective for engineering applications. In comparison to palffiber, the experiment results indicate that hybrid composite material has the lowest hardness value (Fig. 10). 74.33, 73, 67.67, and 66 N/mm^{2}is the values.

Flexural testing: A three-point bending test is performed on the specimen to measure its flexural strength. A material must have this strength to withstand bending stresses. All specimens for flexural testing are prepared according to ASTM standards. The experimental flexural strength values and comparison are provided in Fig (11, 12). The greatest flexural strength was found in a 20 %palffibercomposite with a value of 26.91N/mm2 at a load of 103N. The palf-jute composite maximum flexural strength is 19.27 N/mm2 with a load of 232N in a 25 % Palf+25 % Jute fibercomposite.

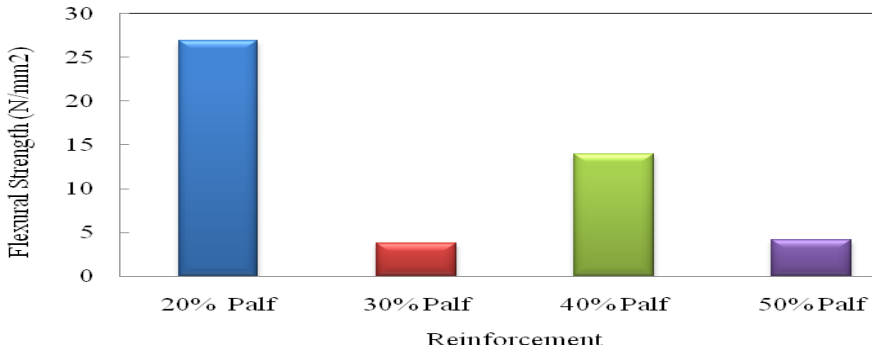

Fig 11: Comparison of Flexural strength of various% of palffiber with Epoxy resin reinforcement

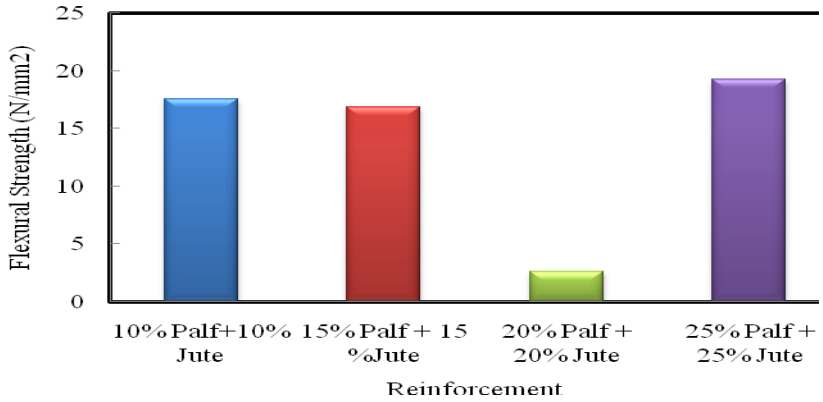

Fig 12: Comparison of Flexural strength ofvarious% of palf and jute fiber with Epoxy resin reinforcement

Ultimate Tensile strength Testing: The tensile strength of a palf and jute fiberhybrid composite is shown in Figures 13 and 14. The composite consisting of 20% Palf and 80% resin has a higher tensile strength of 17.52 N/mm2. The tensile strength of the composite reinforced with palf and jute fiberwas lower. This is because jute fiberswith low tensile strength and elongation may break first, allowing the load to be carried by palm leaf fibres with high strength and elongation without causing matrix failure,

resulting in improved stress transfer from matrix to fibersand improved mechanical properties of hybrid composite. Another reason is that palm leaf fiberhas a high cellulose content, which helps to improve the mechanical qualities of the composite.

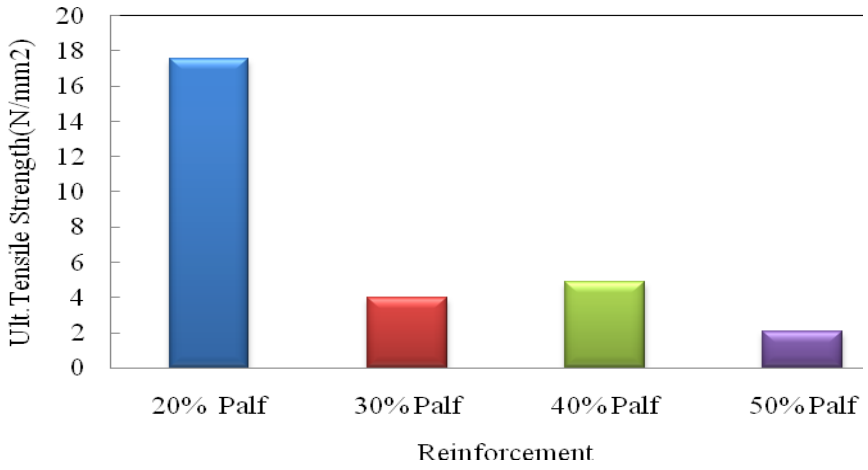

Fig 13: Comparison of Ultimate Tensile strength of various % of palffiber with Epoxy resin reinforcement

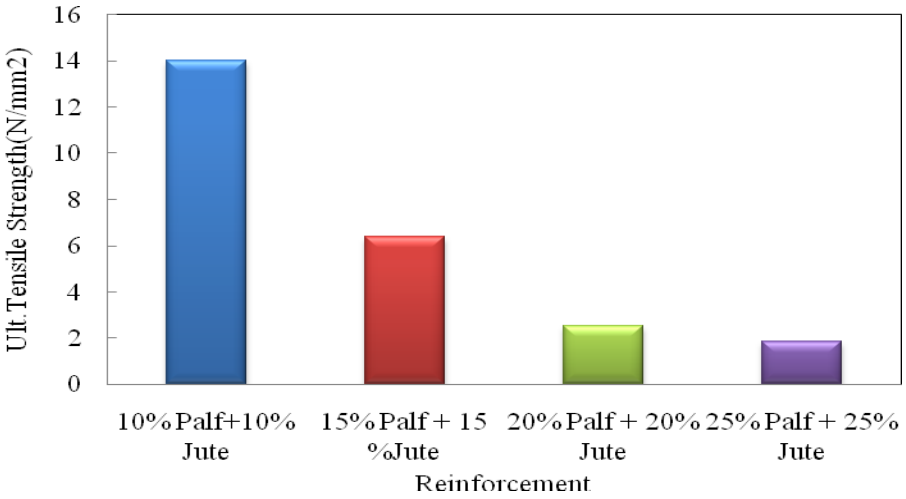

Fig 14: Comparison of Ultimate Tensile strength of various% of palf and jute fiber with Epoxy resin reinforcement

Elongation Testing: Elastic elongation is critical because fiberproducts without elasticity would be difficult to use. They must be able to distort and return to their original shape. Elongation of the fibersshould be at least 1-2 %, preferably slightly higher. As demonstrated in Fig. 15, the specimen with 20% palffiberand 80% epoxy resin in total percentage of composite material has the best elongation when compared to the 10% palf and 10% jute fiber. Elongation is 4.98 % for 20 %palffiber, 4.7 % for 30 %palffiber, 4.24 % for 40 %palffiber, and 3.9 % for 50 %palffiber. Figure 16 indicates that the hybrid fibercomposite has the lowest elongation when compared to the palffiber.

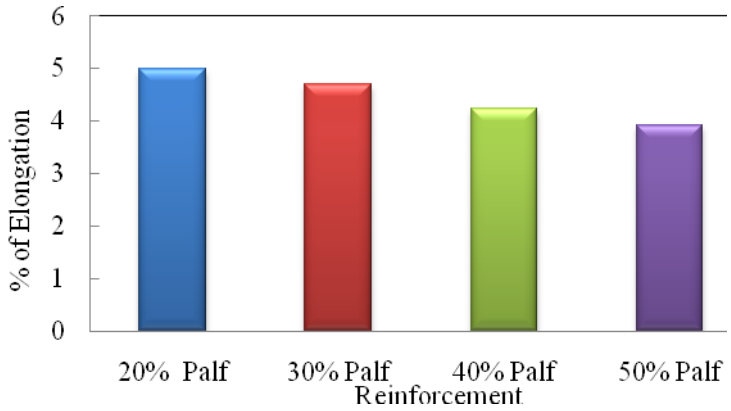

Fig 15: Comparison of Elongation of various percentages of palffiber with Epoxy resin reinforcement

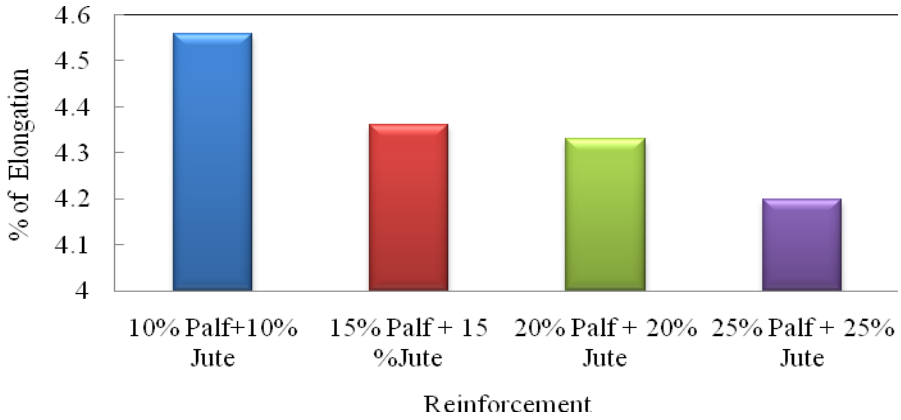

Fig 16 : Comparison of Elongation of Various % of palf and jute fiber with Epoxy resin reinforcement

V.CONCLUSIONS

From the experimental results

- The combination of 20% palffiber+ 80% epoxy resin has a high hardness rating of 80.67 N/mm^2 among various proportions.
- The palffiber (20% palffiber+80% Epoxy resin) shows high ultimate strength, flexural strength and % of elongation values are 17.52 N/mm2, 26.97N/mm2 and 4.98% among the other proportions as compared to jute fiber(10% palffiber+10% jute fiber and Epoxy Resin).
- Pineapple has the highest cellulosic percentage of any natural fiber, at over 80%. PALF has a density similar to other natural fibers, a high Young's modulus, and the best tensile strength of the related natural fibers. These characteristics make it ideal for use as building and construction materials, automobile components, and furniture.

REFERENCES

[1] R.M.N.Arib, S.M.Sapuan, M.M.H.M.Ahmad, M.T.Paridah, H.M.D.Khairul Zaman, "Mechanical properties of pineapple leaf fibre reinforced polypropylene composites", materials and design 2(7),pp. 391–396, 2006.

[2] Rahman, S.M.M.A.Khan, M.A.and Mustafa.A.I.(2008)," Jute reinforced polypropylene composite: effect of surface pretreatment by photocuring with acrylic monomers, journal of reinforced plastics and composites", 28(14).

[3] Vivek Mishra,Sandhyarani Biswas,"physical and mechanical properties of bi-directional jute fiber epoxy composites", Sciencedirect,51(x), pp.561-566, 2012.

[4] Santosh Kumar DS,Praveen.B.A.Kiran,Aithal.S, U.N.Kempaiah," Development of Pineapple Leaf Fiber Reinforced Epoxy Resin Composites", International Research Journal Of Engineering And Technology (IRJET), 02(03),pp.210-215, 2015.

[5] J.K.Odusote1,A.T.Oyewo," Mechanical properties of pineapple leaf fiber reinforced polymer composites for application as a prosthetic socket", Journal Of Engineering And Technology,june 2016.

[6] G.O.Glória,M.C.A.Teles,F.P.D.Lopes,C.M.F.Vieira,F.M. Margem, Mde,A Gomes, " Tensile strength of polyester composites reinforced with PALF", J Mater Res Technol, 6 (2017).

[7] Patwary Plateau, Tazdik. "Evaluation of tensile strength of jute fiber reinforced polypropylene composite", Advances in Materials 6, no. 6 (2017

[8] Jagadish,MaranRajakumaran,Amitava Ray "Investigation of mechanical properties of pineapple leaf based short fiber reinforced polymer composite from selected indian(north eastern part) cultivators"(ASC),2018.

[9] Todkar,S.S Patil.S.A. "Review on mechanical properties evaluation of pineapple leaf fibre (PALF) reinforced polymer composites", Compos. Part B Eng. 2019.

[10] Nath.S, Jena.H,Sahini.D, "Analysis of mechanical properties of jute epoxy composite with cenosphere filler." Silicon 2019.

[11] Kumaran, P, Mohanamurugan, S, Madhu, S, "Investigation on thermo-mechanical characteristics of treated/untreated Portunus sanguinolentus shell powder-based jute fabrics reinforced epoxy composites", J Ind Text 2020.

[12] Jain.J,Sinha.S,Jain.S, "Compendious Characterization of Chemically Treated Natural Fiber from Pineapple Leaves for Reinforcement in Polymer Composites", J. Nat. Fibers 2021, 18, 845–856.

[13] performance Analysis of Jute Fiber As A Micro Reinforcement Badavath Naveen and J Logeshwari (2021).