Mechanical characterization of bamboo and glass fiber hybrid composite material

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Abstract: Natural fibers are appealing due to its inexpensive price, small weight, and high specific modulus, renewable nature, as well as biodegradability. Bamboo fibers is one of the most promising natural fibers (along with jute, sisal, bamboo, coir, banana, and others) owing to its low cost, light weight, quick growing cycle, and wide availability. The goal of this paper is to look into fibers orientation reinforced hybrid polymer nano composites that combine BAMBOO/E-GLASS and epoxy polymer in the ratios of E-glass fibre80 percent +bamboo 20 percent, E-glass Fibre70 percent +bamboo 30 percent, and E-glass Fibre60 percent +bamboo 40 percent of volume. The mechanical characteristics will be calculated by performing tests on the specimen's tension, hardness, and flexural qualities in line with ASTM standards. Finally, the values are verified when the testing results have been obtained.

Keywords: bamboo, E-glass, hybrid ASTM and mechanical properties

1. Introduction

The advancement of composite materials and their applications connected plan and assembling advances to quite possibility of a main advances throughout the entire existence of material. Composites are the material utilized in a variety of sectors, with specialised mechanical and physical features, and are manufactured for a specific use. Composite materials have a number of advantages over conventional materials, including elasticity, impact strength, flexural properties, solidity, and exhaustion qualities. Due to their various potential benefits they are broadly utilized in the avionic business, Machine parts, automobiles, ignition motors, mechanical parts such as drive shafts, tanks, brakes, pressure vessels, and flywheels, warm control, and electronic bundling are examples of business mechanical design applications. rail line mentors , plane structures, and so forth. A composite material is formed when at least two different materials with different properties are combined . Composite material contain a solid burden-carrying material (known as support) embedded with more delicate materials (known as matrix). The framework's primary functions are to transfer stresses between the strands/particles and to protect them from mechanical or potentially

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environmental harm, even though the presence of filaments/particles in a composite improves its mechanical properties such as elasticity, flexural strength, influence strength, firmness, and so on.

Natural Fiber

The normal filaments have the lion‟s portion of the logical consideration. Being broadly and effectively accessible, being especially modest, eco-accommodating, inexhaustible and having a high unambiguous mechanical presentation are probably the main properties of regular strands, which make it a most loved choice for the substitution of Synthetic filaments. The term „natural fibers‟ may allude to an extremely wide class of strands. Every one of the strands are gotten from normal sources. They may either be Animal filaments (creature hair, chicken quill and so forth) or Plant Fibers (Leaf, seed, and so on.)

Table 1.1. Composition of a few Natural Fibers

Natural Fiber	Cellulose (%)	Lignin (%)	Pentosans (%)	Ash (%)
Coir	43	45	-	-
Banana	65	5	-	-
Sisal	47-62	7-9	21-24	0.6-1
Jute	41-48	21-24	18-22	0.8
Bamboo	26-43	21-31	15-26	1.7-5
Kenaf	44-57	15-19	22-23	2-5
Cotton	85-90	0.7-1.6	1-3	0.8-2
wood	40-45	26-34	7-14	<1

2. Literature Survey

Bledzki et al [1]
Has researched the presentation's impact of Flax and jute strands on composite mechanical properties. Expanding of fibre content influences the shear modulus and effect power of the composites. A number of similar tests on everyday strands, For example, bamboo, flax, hemp, and kenaf reveal that the mechanical properties of Fiber supported Composites are dependent on a few fibre constraints, such as fibre period, fibre stacking, fibre perspective proportion, fibre route, and fibre framework grip.

Mishra et al[2]
It changed into determined that the enlargement of reasonably limited quantities of a addition glass fibre to the polyester lattice's pineapple leaf fibre and sisal fiber-supported mechanical properties improved the mechanical properties, resulting in a high-quality move breed effect. The optimal glass fibre loadings for PALF/glass aggregate polyester and sisal/glass half of breed polyester composites are 8.6 and 5.7 wt, respectively. Charge personally. It has additionally been determined that the extent of dampness assimilation of aggregate composites isn't precisely that of monofilament composites.

Jacob et al [3]
Targeting the effects of strand grouping, fibre percentage, and fibre floor adjustment in sisal/oil palm aggregate fibre supported to a elastic composites. Expanding to convergence of a strands introduced about decrease of elasticity and tear energy. Simultaneously, a ramification in the modulus of the composites is observed. The vulcanization limitations , processability characteristics, and strain-pressure properties of those composites have been discussed. The elastic/fiber factor of interaction become labored on through the growth of a resorcinol-hexamethylene tetramine retaining framework. The fibre breakage test revealed that the degree of breaking was minimal.
Singleton et al (2003) [4].
They tentatively determined the pressure strain qualities, yield pressure, elasticity, and pliable (Youngs) modulus, flexibility, and durability as a matter of fibre content. It was discovered that by changing the fibre stacking and controlling the preserving among the layers of the composite, improvements in electricity and solidity combined with high durability can be accomplished. The mechanical residences were thought to be ideal for 15 to 20% flax fibre stacking. Due to fibre clustering, it was also observed that cloth houses exhibit a more distinct degree of range at higher fibre volume divisions.

3. Materials and Methods

METHODOLOGY :

Fig.3.1 Flow chart of process

The unrefined components needed for composite assembly:
1. The epoxy resin
2. Glass Fibre E-glass
3. Bamboo Fibre
4. Strengthener
E-Glass: By combining materials items (sand, kaolin, limestone and colemanite) at 1,6000 degrees Celsius,The fluid glass is formed. The fluid is cooled as it passes through micro fine bushings,

resulting in glass fibre strands ranging in width from 5 to 24 grams to give fibre union and protect the glass from scraped spots, the fibres are brought together

Table 3.1: Material Properties of E-Glass Fibers

S.No	Description of property	Value
1	Density	2.7 g/cm^3
2	Tensile strength	3400MPa
3	Modulus of elasticity	75GPa
4	Strain	4.5

Bamboo

Bamboo material is any fabric, yarn or apparel produced using bamboo filaments. While generally utilized exclusively for primary components, for example, clamors and the ribs of undergarments, lately various innovations have been fostered that permit bamboo fiber to be utilized for a wide scope of material and design applications.

Properties	Bamboo
Tensile Strength (MPa)	330
Modulus (GPa)	9.8
Elongation (%)	20
Density (g/cc)	0.45

Table3.2: Properties of natural Fibers

Epoxy and resin

The manufacture of the polymer framework composite was done at room temperature. The necessary fixings are LY-556 Resin and HY-951 Hardener were blended completely in measuring glass and the combination so made was moved to carbon texture the carbon composite is manufactured utilizing straightforward hand layup strategy to the form and the shape is fixed with the assistance of nuts and screws.

Property	Specification	Unit	Araldite® LY 556
Viscosity at 25° C	ISO 12058	mPa.s	10,000 – 12,000
Density at 25° C	ISO 1675	gm/cc	1.15 – 1.20
Flash point	ISO 2719	°C	> 200

Table 3.2 Material Properties of Resin

Tensile Test

Elastic properties, like Tensile strength, the poisson's proportion of level composite and tensile modulus, are still up in the air due to static Tensile tests.The tensile is a straight-sided example and has a study cross segment and slanted tabs that are adhesively reinforced at their ends. For the end tabs, a consistent and strain-viable material is used to diminish pressure focuses in the held region and thus advance Tensile disappointment over the length of the example. Adjusted [0=90] cross-handle tabs of nonwoven E-carbon - epoxy produced satisfactory results. Any high-stretching (extreme) glue framework can be used to attach the end tabs to the test Specimen.

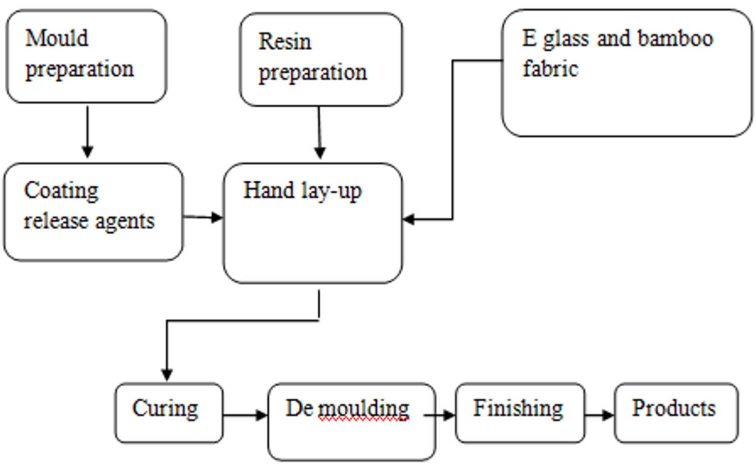
Fig:3.2 Tensile test specimen sketch

Flexural Tests: The purpose of the flexural tests is to determine the mechanical properties of gum and covered fibre composite materials. Further, These tests are used to determine an overlay's interlaminar shear strength, shear modulus, shear strength, malleable and Tensile modules, as well as flexural and shear firmness. These tests are used for both composites and sandwich radiates. These tests are basic one. Further, they need basic instrumentation and hardware required. These tests directed on light emissions cross segment. These bar examples don't need the end.

Fig 3.3 : Bending test specimen sketch

4. Experimental Setup

Fabrication Procedure



Preparation of laminate composite

The E-glass strands, and bamboo filaments with epoxy gum framework were utilized to create half breed composites by means of hand layup method .The weight not set in stone by thinking about the thickness, explicit gravity and mass. The manufacture of the composite was done at room temperature. The determined weight proportion of epoxy tar and hardener are blended involving mechanical stirrer for 10 min. The necessary size of E-glass, and bamboo mats are cut according to the necessary size and each layer is covered by the sap blend till the necessary thickness of overlays got.

Table 4.1: sample preparation in ratios

Samples	E - glass fibre (%wt)	Bamboo (%wt)	Epoxy resin (%wt)	Hardener (%wt)
1	40	8	47	5
2	37	11	47.6	4.4
3	34	14	48	4

Table 4.2: sample weight in grams according to the ratios

Samples	Weight of E-glass fibre in grams	Weight of bamboo in grams
1	8.4	1.68
2	8.4	2.52
3	8.4	3.36

Fabrication Procedure

Fig 4.3: Final specimens

5. Results And Discussions

Tensile Strength Test

Table 5.1: Results of Tensile Strength of bamboo and E glass composite

S.No	Samples	UTS (N/mm^2)	Elongation (%)
1	E-glass fibre80%+bamboo 20%	155.810	4.2
2	E-glass Fibre70%+bamboo 30%	152.034	4.280
3	E-glass Fibre60%+bamboo 40%	150.12	4.34

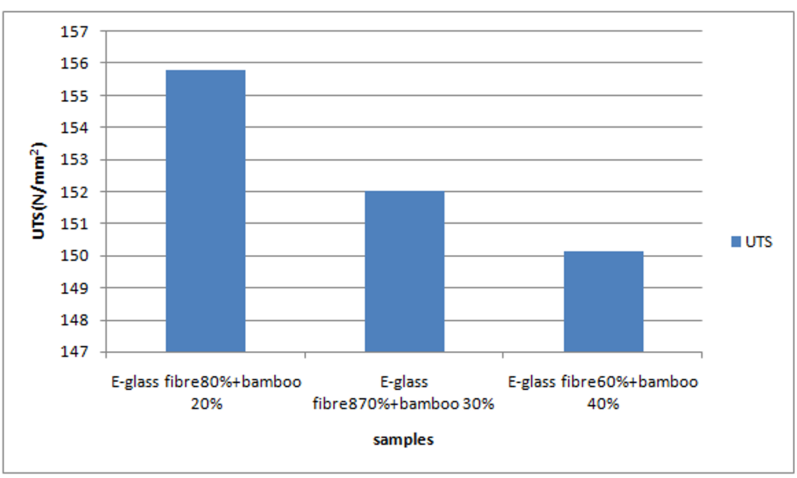


Fig. 5.2 materials composition Versus Tensile strength

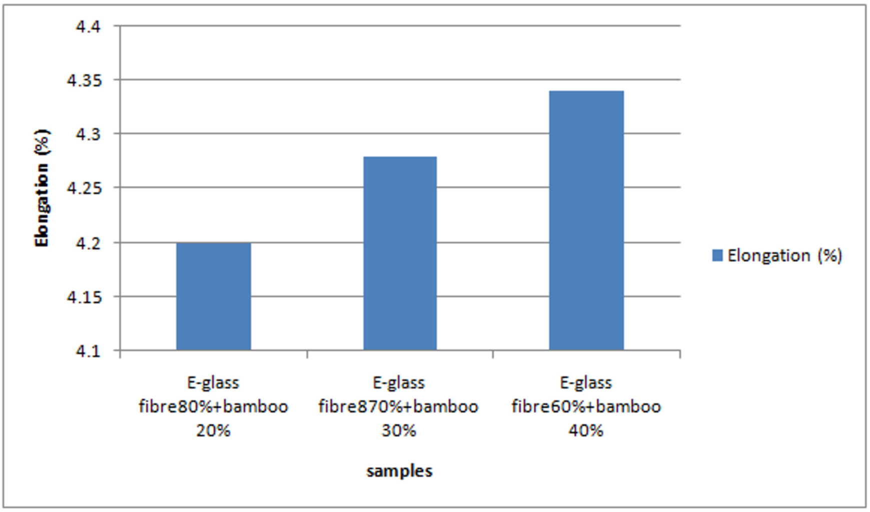


Fig. 5.2 (a) materials composition Versus Elongation

SHORED HARDNESS TEST

Table 5.3: Results of hardness of bamboo and E glass composite

Samples	Hardness
E-glass fibre80%+bamboo 20%	82.67
E-glass Fibre70%+bamboo 30%	81.67
E-glass Fibre60%+bamboo 40%	80.13

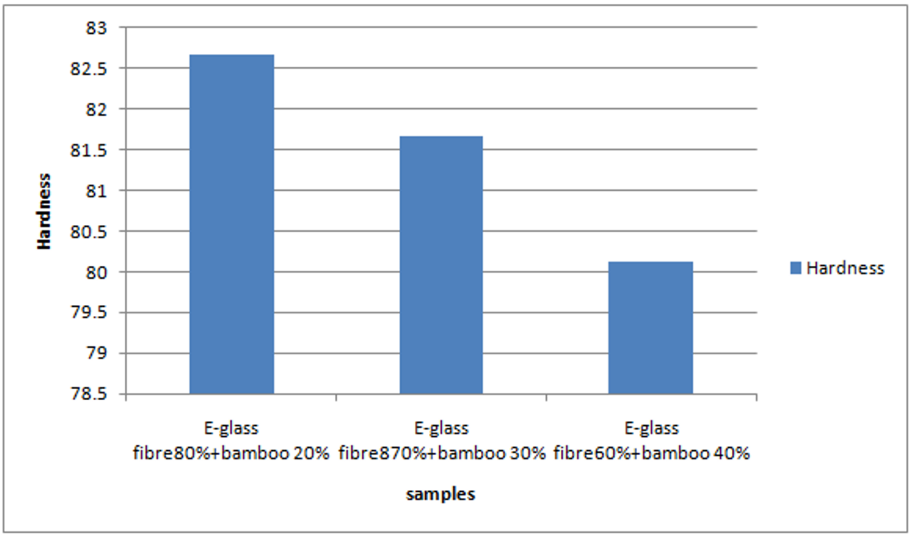


Fig. 5.3. materials composition Versus Hardness

FLEXURAL TEST

Table 5.4: Results of Flexural strength of bamboo and E glass composite

Samples	Flexural strength (N/mm^2)
E-glass fibre80%+bamboo 20%	308.43
E-glass Fibre70%+bamboo 30%	248.76
E-glass Fibre60%+bamboo 40%	152.45

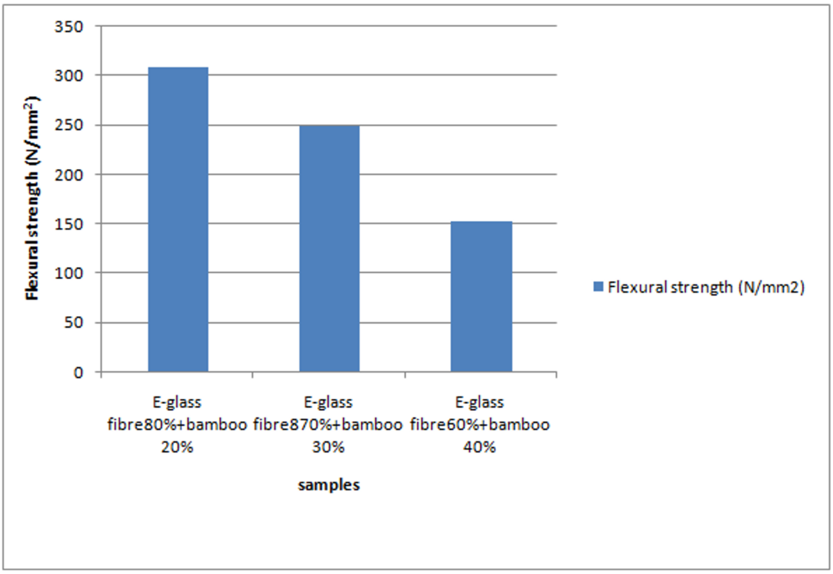


Fig 5.4. materials composition Versus Flexural strength

6. Conclusion

Various composite laminates using epoxy resin are manufactured in the current study. Bamboo and coir are the fibres investigated in this experiment. Different coir ratios (E-glass fibre80 percent +bamboo 20 percent, E-glass Fibre70 percent +bamboo 30 percent, and E-glass Fibre60 percent +bamboo 40 percent) are applied to these. The hand lay approach is used for this experimental production. ASTM D638 is used to determine tensile strength. Analytical research has been completed. The laminates are efficiently manufactured using the hand layup process.
The results of the experiment show that mechanical qualities like as hardness, flexural strength, and tensile strength have improved.

The mechanical characteristics of fibres will change as their content changes. E-glass Fibre80 percent +bamboo 20 percent composites had high tensile strength and hardness maximum composites with E-glass Fibre 80 percent +bamboo 20 percent had high tensile strength and hardness. Tensile strength, hardness, and flexural strength all rise as the proportion of glass fibre increases. As a result, E-glass Fibre 80 percent + bamboo 20 percent may provide greater tensile and flexural strength. The hardness of the basic alloy was enhanced by adding reinforcements. The inclusion of epoxy resin particles enhanced the hardness and improved the wear characteristics of the hardener and epoxy resin.

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