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A STUDY ON THE EFFECT OF FIBER LENGTH ON PHYSICAL AND MECHANICAL BEHAVIOUR OF NATURAL FIBER COMPOSITES

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ABSTRACT

At this time, the natural fibers are easily available resources of reinforcing material for the fabrication of composite. This investigation provides the final data on the effect of fiber length on the physical and mechanical behavior of natural fiber-based composite. A composite sample is prepared by using jute, Munja, Sisal, and coconut fiber as a reinforcing material and phenol-formaldehyde as matrix material. The final results of this study are at 9mm fiber length the moisture in composite, water-soaked by the composite during the water-soaked test found minimum. The extension in width, length, and thickness are found minimum for 6mm fiber length composite. Modulus of elasticity found maximum a 15mm fiber length.

Keywords: Physical properties, Mechanical properties, Fibers

1. INTRODUCTION

This chapter contains all the important information which is directly related to the composite material.

1.1 Overview of Composites

Lately, there is immense development in common fiber-based polymer composites because of its different alluring highlights like biodegradability, no abrasiveness, adaptability, accessibility, minimal effort, lightweight, and so on. Various researchers have performed different investigations to improve the mechanical properties of characteristic fiber-based polymer composites.

1.2 Definition of Composites

Composite shaped from two unique materials one of which is in the molecule or fiber is joined with other material known as a framework. The fiber in the composites goes about as a supposition load-conveying part because of its pinnacle quality modules while lattice in the composites proceeds as a heap move medium between the strands. Because of the extra pliability of the composite material, it gives lattice the most extreme durability.

1.3 Types of Composite Material

Types of composite materials are as follows

a) Types on the basis on the matrix material
   - Metal matrix composite material
   - Ceramic matrix composite material
   - Polymer matrix composite material

b) Types on the basis on reinforced material
   - Fiber-reinforced composite material
   - Particle reinforced composite material

1.4 Properties of Composite Material

Some properties of composite material over the conventional one are as follows:

1. They are light in weight.
2. They are fire-resistant.
3. They have a property to weathering resistance.
4. The thermal conductivity is low.

1.5 Applications of composites

Applications of the composite are as follows

1. In vehicles, it is utilized to make body outline, body parts.
2. In electrical it is utilized to make a printed circuit board.
3. It is utilized to make a channel and water tanks.
4. It is additionally utilized for making furniture.
5. It is additionally utilized for making particleboard.

2. LITERATURE REVIEW

This chapter contains the previous research work conclusions which are as follows:

J.A. Flores et al (1) learn about weight sway on normal reed fibreboard creation utilizing smasher edges. Urea-formaldehyde sap use as cement. The conclusive outcome of this examination is that when weight fluctuating 3N/mm^2 to 25N/mm^2. The outcome permitted us to express that weight and molecule size assumes a significant job to upgrade the mechanical properties of the fibreboards.

Himanshu Bisaria et al (2) examined the impact of length of the fiber on physical and mechanical properties of undirected situated short jute fiber composite by taking 30% fiber proportion with different fiber lengths of 5, 10, 15 and 20mm into an epoxy grid. The translation of this exploration is at 15mm fiber length flexural and ductile properties were discovered most extreme and effect properties were discovered greatest ate 20mm fiber length with 30% wt. portion.

Sunil Singh Rana et al (3) look at the impact of distinction on mechanical properties in the fortified composite. The composite is arranged by hand lay-up strategy by utilizing the different fiber lengths (5, 10, 15, and 20mm) by fixed fiber proportion that is 30wt%. The outcome was decided as far as capacity modulus, misfortune modulus, and damping at various frequencies, for example, 1, 2, and 5 Hz.

Wim Nhuapeng et al (4) explore the mechanical properties of Hybrid composite by taking different fiber volume divisions that are as per the following 25wt%, 30wt%, 40wt%, and 50wt%. The finish of this examination was the example of 30wt% and 25wt% demonstrate better mechanical properties while the 40wt% shows exceptional sound properties.

Tiesong Lin et al (5) study the impact of length of fiber on crack conduct and mechanical properties of geopolymer network composite material by taking different fiber lengths (2, 7, and 12mm). After an examination by a three-point twisting test, optical magnifying lens, and filtering electron microscopy the outcome demonstrates that 7mm fiber length show as most extreme flexural sturdiness just as the most noteworthy work of crack.

Ashish Kumre et al (6) learn about the distinction in mechanical properties of sisal glass fiber strengthened composite by supplanting counterfeit fiber to common fiber by taking fiber at different lengths (5, 10, 15, and

20mm). The outcome was of this examination, the elasticity not expanded however pliable modulus, sway properties were improved.

F. Rezaei et al (7) study the impact of fiber length on thermo-mechanical properties of carbon fiber composites by creating an example by hot squeezing strategy. The result came out by executing warm gravimetric inspect and dynamic mechanical investigation and result show that when fiber length rise then warm security expanded and damping properties improved.

Shahana Parbin et al (8) give an audit of the mechanical properties of normal fiber composite. Normal strands are a lot of concurring with the epoxy grid. They can supplant fake fiber. Hence these composite can supplant the most routinely utilized material.

S. Keck et al (9) explore crack mechanical states of unidirectional arrangement flax fiber-strengthened composites were introduced. Conservative pressure tests were tried under stable stacking conditions. Accordingly, five distinctive fiber headings alluding to the underlying break in simultaneousness with five different fiber proportions were examined. It very well may be found, that the game plan of the fiber concerning the situation of the underlying split plane influences the break way development. Additionally, the quantity of a fiber communicated by the fiber volume division impacts the broken way also.

Hari Om Maurya et al (10) research the mechanical conduct of epoxy composite utilizing short sisal fiber. In this examination, composite were create with different lengths of flames (5, 10, 15, and 20mm) with a 30% fiber volume portion. The results of this investigation were at 15mm fiber length flexural quality upgrades 25% and at 20mm fiber length, sway properties improved.

3. MATERIAL SELECTION

In this research work, two types of material are used for the specimen fabrications. The natural fiber is used as a reinforced material and phenol-formaldehyde use as a matrix material.

- Coconut Fiber
- Jute Fiber
- Sisal Fiber
- Munja Fiber
- Phenol-Formaldehyde resin

3.1 Coconut Fiber

COIR is a flexible normal fiber extricated from monocarp tissue, or husk of the coconut organic product generally fiber is of brilliant shading when cleaned in the wake of expelling from coconut husk, and thus the name "The Golden Fiber".

Properties

The properties of coconut fiber are as follows

1. Moth-confirmation; impervious to growths and decay.
2. Gives phenomenal protection against temperature and sound.
3. Not effectively burnable.
4. Fire-resistant.
5. Unaffected by dampness and clamminess.
6. Intense and tough.

Applications

The applications of coir fiber are as follows

1. Use for is making finer brushes.
2. Use for making composites material.
3. Use for making string.
4. Use for making fishing nets.

3.2 Jute Fiber

Jute is a long, delicate, gleaming Bast fiber that can be spun into coarse, solid strings. It is created fundamentally from plants in the variety Corchorus, which was once characterized by the family Tiliaceae. The essential wellspring of the fiber is the Corchorus clitoris, yet it is viewed as the second rate compared to Corchorus capsulitis.

Applications

Applications of jute fiber are as follows

1. Use for making handbags.
2. Use for horse cover.
3. Use for making mailbags.
4. Use for making composite material.

Properties

The properties of jute fiber are as follows

1. Environmental friendly.
2. It is biodegradable.
3. It is the cheapest fiber.
4. Tensile strength is high.

3.3 Sisal Fiber

Sisal fibers are acquired from Agave Sisalana, a local of Mexico. The solid plant develops well lasting throughout the year in the hot atmosphere and bone-dry areas which are frequently unsatisfactory for different harvests. Sisal can be developed in most soil types except for dirt and has low resilience to exceptionally sodden and saline soil conditions. Farming is generally straightforward as it is strong to sickness and its information necessity is low contrasted with different harvests. Sisal can be reaped from 2 years in the wake of planting and its gainful life can reach as long as 12 years, delivering from 180 to 240 leaves relying upon area, height, level of precipitation, and an assortment of a plant.

3.4 Munja Fiber

Munja (Saccharum Munja) plants, accessible in bounty in India, can be utilized to make rope. A stripper for the partition of the sinewy leaves from the stalks and a mixer to make the leaves appropriate for rope readiness was created. A locally accessible rope making machine was assessed and the financial aspects of rope making evaluated. The innovation created has great potential for a reception at the town level with appealing returns.

3.5 Phenol Formaldehyde resin

Phenol formaldehyde resin (PF) or phenolic adhesive are manufactured polymers got by the response of phenol or subbed phenol with formaldehyde. Utilized as the reason for Bakelite, PFs were the main business engineered gums (plastics). They have been broadly utilized for the creation of formed items including billiard balls, research center ledges, and as coatings and blocks of cement. They were at one time the essential material utilized for the creation of circuit loads up, however, have been to a great extent supplanted with epoxy tars and fiberglass fabric, similarly as with heatproof FR-4 circuit load up materials.

Properties

Properties of PF resin are as follows

1. Low thickness.
2. High strength.
3. Dimensional exactness is acceptable.
4. High downer opposition
5. Water assimilation conduct is low.

4. SAMPLE COMPOSITIONS

In this research, composite specimens are prepared by fixing the fiber ratio of 36% and varying the fiber lengths. The compositions of specimens are as follows.

- **S1** sample contains a 36% fiber ratio with 6mm fiber length.
- **S2** sample contains a 36% fiber ratio with 9mm fiber length.
- **S3** sample contains a 36% fiber ratio with 12mm fiber length.
- **S4** sample contains a 36% fiber ratio with 15mm fiber length.

Total four types of fiber are uses for producing the specimens the amount of each fiber is equal for example in **S1** sample jute fiber is 9%, coconut fiber is 9%, Sisal fiber is 9% and Munja fiber is 9%.

Fig. (Composite sample)

5. TESTING AND TESTING RESULTS

In this study both physical and mechanical behavior are examined which are as follows:

5.1 Physical Properties Tests

For the study the physical properties of composite specimens the tests which are performed are as follows:

5.1.1 Density Test

For testing the density samples dimensions for all samples are width is 75mm, the length is 150mm and the thickness is 6mm.

5.1.2 Water Soak Test

Water soak test examined for 2 and 24 hours and the dimensions of specimens are length and width is 150mm and thickness is 6mm.

5.1.3 Moisture Content Test

In moisture content test the dimensions of the specimens for all samples are thickness is 6mm, the length is 150mm and width is 75mm.

5.1.4 Expansion in dimensions

This test provides the variation in thickness, width, and length at the time of swelling in water test. Samples dimensions are length is 150mm; width is 150mm with 6mm thickness

Table 5.1 Observation table for a physical property tests investigation

Sl. No	Density (gm/cm^3)	Water soak for 2 hours (%)	Water soak for 24 hours (%)	Moisture content test (%)	Thickness expansion (%)	Width expansion (%)	Length expansion (%)
S1	0.670	14.80	35.11	04.20	5.50	0.173	0.193
S2	0.671	14.72	34.05	04.17	5.83	0.240	0.220
S3	0.652	15.03	36.48	05.77	6.50	0.280	0.260
S4	0.654	15.66	37.70	06.20	6.83	0.333	0.273

5.2 Mechanical Properties Tests

For the study of mechanical properties the test which is performed is as follows:

5.2.1 Modulus of Rupture

In modulus of the rupture test of composite, the dimension of the sample is width is 50mm, the thickness is 6mm and the length is 24 times of thickness.

5.2.2 Modulus of Elasticity

For this test, the dimensions of all specimens are the same as is used in modulus of rupture test.

Table 5.2 Observation table for mechanical property tests analysis

Sl. No	Modulus of Rupture (N/mm^2)	Modulus of Elasticity (N/mm^2)
S1	12.26	600.23
S2	12.29	612.21
S3	13.41	618.24
S4	14.23	624.14

6. CONCLUSION

All the tests are examined and after examine, all tests some conclusions come out which are as follows:

1. At 9mm of fiber length, the density is found maximum.
2. The moisture present in composite minimum for 9mm fiber length.
3. For a 2 and 24-hour water soak test, the specimen of 9mm fiber length is soaked minimum water.
4. Expansion in length, width, and thickness found minimum at 6mm fiber length composite.
5. At 15 % fiber length the modulus of elasticity and modulus of rupture is found maximum.

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