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Analysing Mechanical Properties of Natural Fibres Reinforced With Tea Powder

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Abstract- *Fiber-reinforced polymer composites have played a dominant role for a longtime in a variety of applications for their high specific strength and modulus. The fiber, which serves as a reinforcement in reinforced plastics, may be synthetic or natural. Although glass and other synthetic fiber-reinforced plastics possess high specific strength, their fields of application are very limited because of their inherent higher cost of production. An attempt has been made to utilize the coir, as natural fiber abundantly available in India. Natural fibers are not only strong and lightweight but also relatively very cheap. The present work describes the difference between development and characterization of a new set of natural fiber based polymer composites consisting of Treated and untreated coir's as reinforcement, Tea powder as filler, epoxy as resins. Coir composites were developed and their mechanical properties were evaluated at different volume fractions and tests were carried out and the results were presented. Experimental results showed that the composite material of treated coir, Tea powder is the best of all other combinations.*

1. INTRODUCTION

The composite materials have been used from centuries ago, and it all started with natural fibers. Natural fibers have become important items in the economy and in fact, they have turned out to be a significant source of jobs for developing Countries. Today, these fibers are assessed as environmentally correct materials owing to their biodegradability and renewable characteristics. For example, natural fibers like sisal, jute, coir, oil palm fiber have been proved good reinforcement in thermo set and thermoplastic matrices.

Composites are materials that comprise strong load carrying material (known as reinforcement) imbedded in weaker material (known as matrix).

Reinforcement provides Strength and rigidity, helping to support structural load. The matrix or binder (organic or inorganic) maintains the position and orientation of the reinforcement. Significantly, constituents of the composites retain their individual, physical and chemical properties, yet together they produce a combination of qualities which individual constituents would be incapable of producing alone reduced weight and increased performance properties have paved a path to development of advanced engineering materials. Composite products have good mechanical properties-to-weight ratio and the technologies permit the manufacture of complex and large shapes .Fillers are added to a polymer matrix to reduce cost(since most fillers are much less expensive than the matrix resin), increase modulus, reduce mould shrinkage, and produce smoother surface. The major constituents of particulate (filler added) composites are particles of mica, silica, glass spheres, calcium carbonate, or others The application of natural composites is being targeted in various fields due to the environmental and economic benefits which could be used in automotive industry as interior parts and in constructions sector such as walls and roofs.

Nowadays, many industrial companies are looking for new composites material, which has good and specific properties like mechanical and chemical characteristic. In searching for such new material, a study has been made where coconut fiber (also known as coir fiber) is compounded with composite material. Coir is the natural fiber of the coconut husk. It is a thick and coarse but durable fiber. It is relatively waterproof and has resistant to damage by salt water and microbial degradation.

2. OBJECTIVES

- The objective of this project is to prepare and analyze a hybrid composite material, test its properties and compare the results with the normal sample.
- Preparation of the composite material with tea powder by cold press method.
- Testing of specimens as per ASTM (American Society for Testing and Materials) standards.

3. MATERIALS USED

- Epoxy Resin (L-12)
- Hardener(K-16)
- Fiber Reinforcement Composites
- Tea Powder
- NaOH Solution

3.1 EPOXY RESIN (L-12)

Table No 1: Properties of Epoxy Resin

S. No	Description	Condition	Unit	Typical Values
1	Appearance	-	Visual	Clear viscous liquid
2	Color	-	GS	Max 1
3	Density	25ºC	g/cm³	1.1 – 1.2
4	Viscosity	25ºC	$\frac{N-S}{mm^2}$	9000 -12000

3.2 HARDENER (K-6)

Table 2: Properties of Hardener

Serial No	Description	Condition	Unit	Typical Values
1	Appearance	-	Visual	Pale Yellow Liquid
2	Density	25ºC	g/cm³	0.95 – 1.1
3	Viscosity	25ºC	$\frac{N-S}{mm^2}$	5 – 15

3.3 Coir

- **Untreated coir**

Coir is natural fiber extracted from the husk of coconut and used in products such as floor mats, doormats, brushes, mattresses etc.,

- **Treated coir**

After the collection of fibers, the coir was allowed to undergo with chemical treatment by using the 6-8% of NaOH with the distilled water. This treatment was used to remove the lignin content in the fiber. The lignin content may affect the Young's modulus of fiber. Therefore, the fiber was treated by using the NaOH

3.4 TEA POWDER

- It is available commonly as the waste material, which is unused.
- It is biodegradable in nature.
- It is having the good binding property.
- According to tea board survey 0.0156 million ton of tea waste developed per month

3.5 NaOH SOLUTION

Sodium Hydroxide (NaOH) is an alkaline solution used to enhance the surface morphology of natural fibers. It removes the certain amount of the lignin content from the coir

4. METHODOLOGY

4.1 SELECTION OF MATRIX MATERIAL

Epoxy LY-12 resin belonging to the Epoxide family was taken as the matrix. K-6 is used as the hardener.

4.2 SELECTION OF FIBERS AND FILLER MATERIAL

Natural fibers such as Sisal, Coconut coir, Areca nut, Ridge gourd and Tamarind are available nature. However, we are selected coir as reinforcement material. In addition, we are selected tea powder as the filler material.

- **Coconut Coir Fiber:**

Coconut coir- Coconut fruit peel were gathered and soaked in water. Later clean fibers were drawn manually from them.

4.3 SURFACE TREATMENT OF FIBERS

Freshly drawn fibers generally include many impurities that can adversely affect the fiber matrix bonding consequently the composite material made from such fibers may not possess satisfactory mechanical properties. Therefore, it is desirable to eliminate the impurity content of the fibers and perhaps enhance the surface topography of the fibers to obtain a stronger fiber-matrix bonding. The fibers were treated with 8% NaOH for 72 hrs. Later they were drawn and dried under sunlight for 1-2 hours. The below figure shows the treatment of coir with NaOH.

Fig 1: Treatment of Coir with NaOH

4.4 DESIGN AND FABRICATION OF MOULD BOX.

The below Figure 5.4(a) shows the design of the mould box which is designed by using the solid edge software.

Fabrication of the mould box is made of the cast iron because of the cast iron has the very high strength and cheap compared to other metals. The dimension of the mould box is the 300mm×300mm×5mm the metal thickness used for the mould box is 0.8 mm. The figure 5.4(b) shows the fabrication of mould box

4.5 WET HAND LAY-UP TECHNIQUE

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all a release gel is sprayed on the mould surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mould plate to get good surface finish of the product. Reinforcement in the form of woven mats or chopped strand mats is cut as per the mould size and placed at the surface of mould after Perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener (curing agent) and poured onto the surface of mat already placed in the mould.

Fig 2: preparation of specimen

After the mixing of the materials, the specimen is kept under the compression-moulding machine at 60-bar pressure for 48 hours. Figure 5.5(c) shows the compression of the specimen.

Fig 3: compession of specimen

5. Result

5.1 TENSILE TEST

A. Normal sample

Table 3: Tensile Test of Normal Sample

Load	Load in (N)	Displace ment (mm)	Area in (mm^2)	Stress σ N/mm^2	$e = \frac{\Delta l}{l}$
Peak load	519.8	1.460	116.19	4.474	0.029
Break load	117.7	6.127	116.13	1.0131	0.122

B. Untreated with 10% Tea Powder

Table 4: Tensile Test of untreated Sample

Load	Load in (N)	Displace ment (mm)	Area in (mm^2)	Stress σ N/mm^2	$e = \frac{\Delta l}{l}$
Peak load	941.7	2.452	117.2	8.2029	0.049
Break load	156.9	5.652	117.29	1.338	0.113

C. Treated with 10% of Tea Powder

Table 5: Tensile Test of Treated Sample

Load	Load in (N)	Displace ment (mm)	Area in (mm^2)	Stress σ (N/mm^2)	$e = \frac{\Delta l}{l}$
Peak load	1000.6	3.157	98.329	10.176	0.0631
Break load	431.6	5.168	98.329	4.389	0.1033

5.2 FLEXUR TEST

A. Normal sample

Table 6: Flexural Test of Normal sample

Serial No	Load F in		Deflection Y in mm	Modulus of Elasticity E in N/mm²	Flexural Rigidity EI in N-mm²
	Kg	N			
1.	13.99	137.3	1.943	389	317.9X10³
2.	9.99	98.066	6.1661	87.69	71.62X10³

B. Untreated sample with 10% tea powder

Table 7: Flexural Test of Untreated Sample

SL No	Load F (N)		Deflection Y (mm)	Modulus of Elasticity E (N/mm²)	Flexural Rigidity EI (N-mm²)
	Kg	N			
1.	23.99	235.4	4.506	293.35	235X10³
2.	20.99	205.9	7.985	144.8	116.X10³

C. Treated sample with 10% tea powder

Table 8: Flexural Test of Treated sample

S. No	Load F (N)		Deflection Y (mm)	Modulus of Elasticity (N/mm²)	Flexural Rigidity EI (N-mm²)
	Kg	N			
1.	33.9	333.4	4.336	494	346.15X10³
2.	26.9	264.7	7.527	226.110	158.29X10³

5.3 HARDNESS TEST

Table 9: Hardness Test

Serial No	Sample	Type of Test (Hardness)	Results
1.	Normal Sample	Shore D	62
2.	Untreated Sample with 10% tea powder	Shore D	66
3.	Treated Sample with 10% tea powder	Shore D	72

CONCLUSION

The research was carried out to find the mechanical behaviour of randomly oriented coir fibers mixed with reinforced epoxy composites and tea powder. In general, the composites having mass of 10% tea powder showed notable result when compared to normal fiber sample loading composites due to the effect of material stiffness. Natural frequency of composites was found to be proportional to the tensile strength. The chemically treated fibers have more tensile strength when compared to untreated coconut coir fibers. When the fibers tested in water at different time periods there is a slight change in their tensile properties. The difference is very less due this reason we can use composites in different marine applications.

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