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ANALYSIS OF MECHANICAL PROPERTIES OF RANDOMLY ORIENTED TAMARIND FIBRE COMPOSITE MATERIAL

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ABSTRACT

The intension of the project is to develop fully green biodegradable complex laminates using natural fibers from Tamarind, A leguminous tree which belongs to the FABACEAE / FABACEAE INDIGENOUS family. It is aimed to prepare the laminates, using Tamarind (Tamarindus indica) fiber as Strengthener and PVA as the matrix material. Mechanical properties like tensile, flexural strengths are evaluated as per ASTM standards. It is aimed to find the potential of natural fibre complex and promote their production on commercial basis. The whole work aims to develop complex material for improved performance, resulting in the endurance of environment for future generations.

KEYWORDS: *Mechanical Compounds, Tamarind Fibre, Composite Material*

INTRODUCTION

The forests of A.P & T.S are rich resources of Tamarind trees. The stem has potent fibers, hence are habitually used by the farmers in domiciliary and farming practice. Observing these qualities, the Tamarind fibers have been chosen to produce degradable complex material that can be used for various applications such as panels in construction, casings for various household commodities, wrapping applications, gaming goods etc.

Complex Material

A Complex is a structural material, which comprises of twain or ternary constituents. These constituents are aggregated at a noticeable grade and are insoluble in each other. One element is called the Strengthener and the other is called the matrix. For a material to be Complex the conditions to be satisfied are both components should be in fair ratio, complex material qualities are considerably unusual from the qualities of the components.

Matrix

The matrix helps to attach the fibers together and transmit loads to the fibers and protects them from ecological criticism and detriment due to treatment. Matrix shows intense affect on the mechanical props as well as on the selection of fabrication process. Polyester and epoxy resins are familiar polymeric matrix materials used with high performance strengthening fibers. Out of Thermoplastic Resins, Thermoset resins, unsaturated polyester resins, Epoxy resins, Phenolic resins. The unsaturated polyester resin is chosen for this experiment.

Polymer Matrix Complex Materials (PMC)

These complexes consists of a polymer (e.g. epoxy, polyester, urethane) strengthened by lean measure fibers (e.g. graphite, aramid, boron).

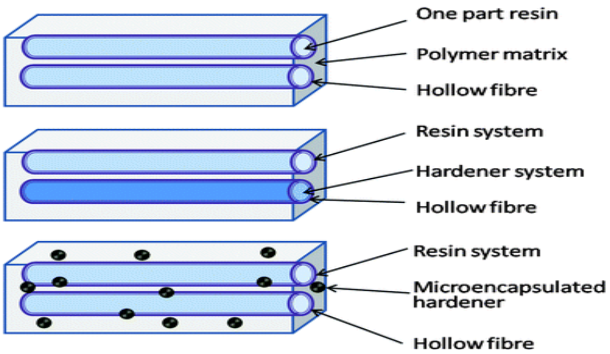

Figure 1: Polymer Matrix Composites.

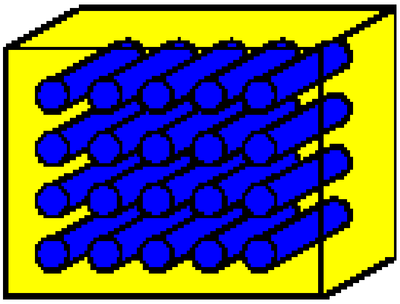

Figure 2: Fiber Reinforced Composites.

Strengtheners / Fibers

A large variety of fibers are available as Strengthener for the composite. The desirable characteristics of most Strengtheners are high strength, high stiffness and relatively low density. A great majority of materials are strong and stiffer in the fibrous form than as the bulk material. Therefore, fibers are very effective and attractive strengthening materials. Different strengtheners are glass fibers, carbon and graphite fibers, aramid fibers and natural fibers like jute, sisal, flax, screw pine, tamarind etc.

Natural Fiber Composites

With the increased knowledge about the nature and its resources, the humans have developed more and more skills in its exploitation. They started manufacturing quick devices, larger gadgets, without concern to the effects on the ecosystem or on the herd. Some worried researchers and designers have concluded that they need to take charge. As a result of their act the future generations has led to the concepts and terms such as green, eco, sustainable and environmentally friendly etc.

Structure and Chemical Composition of Natural Fibers

All plant species are built up of cells. When a cell is very long in relation to its width, it is called a fiber. The components of natural fibers are cellulose, hemicelluloses, lignin, pectin, waxes and water-soluble substances. The cellulose, hemicelluloses and lignin are the basic components of natural fibers, governing the physical properties of the fibers.

Advantages and Applications of Natural Fiber Composites

Advantages

Natural fibres are easily procurable, can be thermally up-cycled, eco-friendly**,** uses low energy**,** health of workers is protected, less grating nature more smooth in treatment.**,** mechanical, thermal and acoustic qualities are rich enough.

Disadvantages

The Quality, cost and procurability of natural fibres alters. The magnitude may vary. Protuberance leads to cleft. Processing temperature is confined. Ignoble Potency. When processed at high temperature, aroma of natural fibers is odd.

- **Applications**
- **Edificial Applications:** Adornable, Casements / Door, Railing and Beautifying
- **Infrastructure:** Boardwalks, Viaduct and Guardrails
- **Transportation:** Interior Panels, Shelves, Ducting, Truck Floor and Head liners
- **Industrial / Consumer:** Pallets, Playground**,** Benches/Tables, Floorings and Trash
- **Marine:** Small fishing boats

Table 1: Details of the Natural Fibre Used in the Work

Fiber Used	Tamarind Fibers
BOTANICAL NAME	Tamarindus Indica
FAMILY NAME	Fabaceae
Resin	poly-ester resin
Accelerator	MEKP(Methyl Ethyl Ketone Peroxide) accelerator
Accelerator	Cobalt Naphthanate
Adhesive material	PVA, WAX

Figure 3: Harvest of Tamarind Fibre

Figure 4: Tamarind Fiber.

Fabrication of Natural Fibre Composite

Procurement of Fibers

Tamarind fibers are procured from surrounding forest area and other places. As Tamarind fibers are natural fibers they has tensile and flexural properties.

Preparation of Laminate

Glass Plate Surface Preparation

Initially, wax is brushed up on the top of glasses and (PVA) is put on with a thicket and let to dehydrate for some time to compose a lean film. These components help in effortless dismissal of the flake from the base glasses. PVA also provides a gleaming appearance to the top of the flakes. Polyester resin is taken along with accelerator-MEKP and accelerator- Cobalt Naphthalate.

The accelerator commences the polymerization method, and the accelerator accelerates this operation. Primarily, the accelerator is added. The components are perfectly agitated and then put on the top of the glass and distributed consistently with the brush.

The fiber mat is placed over the resin mix, and then trolled with the roller to wet the mat uniformly and to remove the air entrapped. Further, quantity of resin is placed over the rolled mat and once again, pressing is done by the breakers for uniform dispersion of the adhesive over the surface of the mat.

It is advantageous to adjoin small amount of catalyst than the specified amount of it, to avoid calcification of the components prior they are applied over the surfaces. Then, the top glass plate that was applied in prior with the wax and PVA is placed on the imposed resin, and a mass of about 300 N is positioned on it for about a day.

Figure: 5: Mould.

Figure 6: Laminate after Solidification.

Figure 7: Final Laminate.

Specimen Preparation and Testing

Preparation of Pattern for Testing

Pattern for tensile and flexure test according ASTM norms are prepared. The magnitude information for tests of pattern are given below.

Tensile Test Specimen

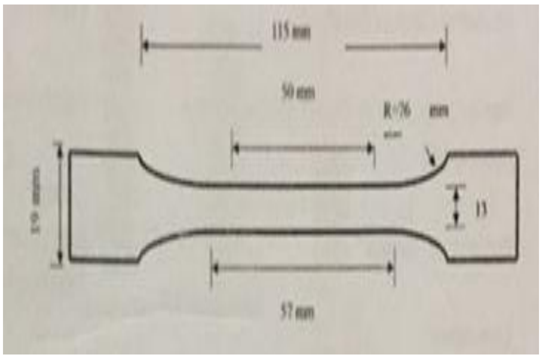

Figure 8: Tensile Specimen.

Flexural Test Specimen

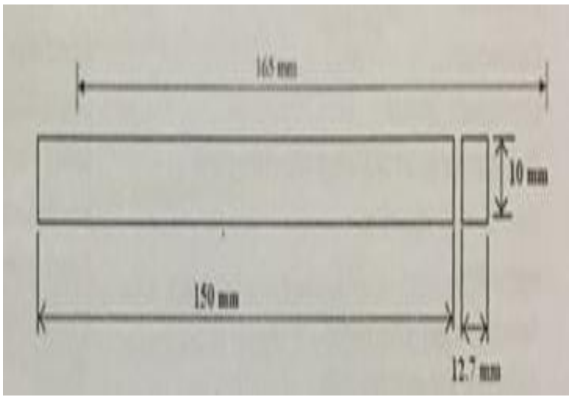

Figure 9: Flexural Test Specimen.

Tensile Test Specimens

Figure 10: Tensile Test Specimen of 10 Mm Length Fiber Before Testing.

Figure 11: Tensile Test Specimen of 10 Mm Length Fiber After Testing.

Testing

Tensile and flexural tests are conducted on the specimens, to find the strength of tamarind fiber composites.

Tensile Test

In a Randomly oriented complex material exposed to multiplying linear tension load, break down starts by fiber failure at its fragile cross sections. Tensile test is conducted on universal testing machine. Load is gradually increased and deflection is observed on extensometer.

Figure 12: Universal testing Machine.

Table 2: Tamarind Randomly Oriented Fibers of 10 mm Length

Specimen	Width (Mm)	Thickness (Mm)	Area (Sq. Mm)	Break Force (N)	Tensile Intensity Near Yield (N / Sq. Mm)	Tensile Intensity Near Fracture (N / Sq. Mm)
1	13.35	3.47	46.3245	375.9	8.11	8.11
2	13.06	3.72	48.5832	419.7	8.64	8.64
3	12.72	3.53	44.9016	353.4	7.87	7.87
4	12.91	3.77	48.6707	599.9	12.34	12.33
5	13.29	3.6	47.8440	483.2	10.10	10.10
					Mean strength at yield =9.412	Mean strength at break=9.41

Table 3: Tamarind Randomly Oriented Fibers of 50 mm Length

Specimen	Width (Mm)	Thickness (Mm)	Area (Sq. Mm)	Break Force (N)	Tensile Intensity Near Yield (N / Sq. Mm)	Tensile Intensity Near Break (N / Sq. Mm)
1	12.93	4.84	62.5812	162.3	2.54	2.59
2	13.75	3.35	46.0625	102.1	2.22	2.22
3	14.04	3.84	53.9136	142.2	2.64	2.64
4	13.85	4.18	57.8930	286.7	4.92	4.95
5	13.85	4.18	57.8930	277.5	4.70	4.79
					Mean strength at yield =3.404	Mean strength at break=3.438

Flexural Test

Flexural intensity is the capability of the substance to bear the bowing strength, enforced vertically to its longwise axis.

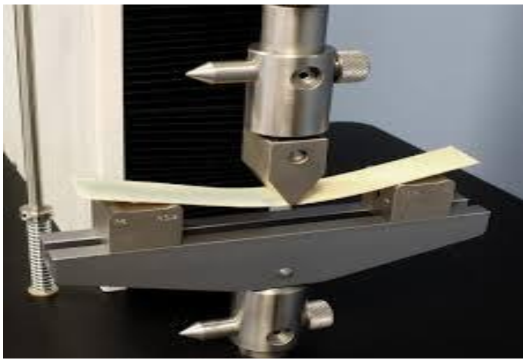

Figure 13: Flexural Testing Machine.

Table 4:Flexural Test Results of Tamarind Fibre of 10 Mm Length

Specimen	Length	Width	Thickness	Area	Flexural Modulus	Flexural Strength At Yield(Σmax)
	(Mm)	(Mm)	(Mm)	(Sq. Cm)	N / Mm^2	N / Mm²
1	70	10.84	4.4	0.4770	369.80	8.73
2	70	10.62	4.76	0.5055	460.28	12.34
3	70	10.29	4.07	0.4188	301.67	7.36
4	70	10.48	3.82	0.4003	476.26	8.37
5	70	10.37	4.65	0.4822	293.65	4.16

Table 5: Flexural Test Results of Tamarind Fibre of 50 Mm Length

Specimen	Length	Width	Thickness	Area	Flexural Modulus	Flexural Strength At Yield(Σ Max)
	(Mm)	(Mm)	(Mm)	(Sq. Cm)	N	N / Mm²
1	70	10.13	5.36	0.5430	492.32	14.93
2	85	10.72	5.46	0.5853	503.36	12.85
3	85	10.04	5.35	0.5371	187.83	3.99
4	85	10.92	5.56	0.6072	548.32	13.43
5	85	10.87	5.25	0.5707	581.56	14.39

CONCLUSIONS

Randomly oriented Tamarind fiber laminates are prepared using polyester resin supplied by a Private company, Hyderabad. Polyester has a great binding capacity. Fiber, matrix volume ratio of 1:10 is applied. 5 Standard test specimens are prepared for tensile and flexural tests of 10mm and 50mm length fibers at 30% fibre weight respectively, as per ASTM standards. Tensile and flexural experiments are conducted.

The specimens exhibited comparable values of tensile strength, with those available in the literature for similar situation. However, it is noticed that the material has exhibited extremely high tensile strength.

The Tensile strength revealed that the tensile impact is more for 10mm fibre length when compared with 50mm fibre length. The Flexural test revealed that, the flexural strength is more for 50mm fibre length when compared to 10mm fibre length. Hence, it is concluded that this type of composite can be used in packaging, door mates, house decors, floor and light weight doors.

Future Work Suggested

In general, tamarind exhibits tensile nature. An attempt can be made to maximize the strength with the help of suitable additives. Characterization of mechanical, thermic and electrical qualities and their enhancement may be taken up.

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