EXPLORATION OF TENSILE, FLEXURAL AND HARDNESS TEST PROPERTIES OF PROSOPIS JULIFLORA / GLASS / EPOXY HYBRID COMPOSITE LAMINATES

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Abstract - This work aims on utilising the potential benefits of Prosopis Juliflora which is abundant and is a threat to environment. Many works were done on prosopis Juliflora wood to bring out the thermal properties and this is the first time we tried to bring out the mechanical properties of its bark powder as in the form of composites. This work extracts the mechanical benefits of Prosopis Juliflora powder, glass fibre mat and epoxy resin to be suitable for the structural applications. Specimen with above hybrid composites were made and major tests were done to prove it to be suitable for structural applications. Experimental values were to br in good agreement with the theoretical.

1. Introduction
Recent technological breakthroughs and the desire for new functions generate an enormous demand for novel materials. Scientists and engineers realised early on that mixtures of materials can show superior properties compared with their pure counterparts. One of the most successful examples is the group of composites which are formed by the incorporation of a basic structural material into a second substance, the matrix. Nowadays they are regularly used for lightweight materials with advanced mechanical properties. The development of composite materials based on the reinforcement of two or more fibres in a single matrix which leads to the development of hybrid composites with a great diversity of material properties is still in its infancy. It is generally accepted that the properties of hybrid composite are controlled by factors such as nature of matrix; nature, length and relative composition of the reinforcements; fibre–matrix interface; and hybrid design etc.

2. Material selection and its Characteristics
   A. Prosopis Juliflora powder
“Prosopis juliflora,” (seemai karuvelam), once touted as a saviour of the drought-prone areas in the southern districts of Tamil Nadu, has now become a threat to the environmental system. The evergreen species, native to the South and Central America and the Caribbean, is a fast-growing tree variety and tolerant to arid conditions and saline soil.
Glass fibre (or glass fibre) is a material consisting of numerous extremely fine fibres of glass. Glass fibre has roughly comparable mechanical properties to other fibres such as polymers and carbon fibre. Although not as strong or as rigid as carbon fibre, it is much cheaper and significantly less brittle when used in composites. Glass fibres are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively lightweight fibre-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fibre glass". This material contains little or no air or gas, is denser, and is a much poorer thermal insulator than is glass wool.

Epoxy resins are low molecular weight pre-polymers or higher molecular weight polymers which normally contain at least two epoxide groups. The epoxide group is also sometimes referred to as a glycidyl or oxirane group. A wide range of epoxy resins are produced industrially. The raw materials for epoxy resin production are today largely petroleum derived, although some plant derived sources are now becoming commercially available (e.g. plant derived glycerol used to make epichlorohydrin).

**Prospis juliflora**

- Young's modulus ($E_f$) = $30.00 \times 10^9$ N/m$^2$
- Density ($\rho$) = $0.580 \times 10^3$ Kg/m$^3$
- Poisson's ratio ($\nu$) = 0.21

**Glass fiber**

- Young's modulus ($E_f$) = $72.00 \times 10^9$ N/m$^2$
- Density ($\rho$) = $2.56 \times 10^3$ Kg/m$^3$
- Poisson's ratio ($\nu$) = 0.21

**Epoxy Resin**

- Young's of modulus ($E_m$) = $4.00 \times 10^9$ N/m$^2$
- Density ($\rho$) = $1.20 \times 10^3$ Kg/m$^3$
- Poisson's ratio ($\nu$) = 0.40

**E. Preparation of composites**
Composite samples were made using compression molding machine. A die size of 250x150x3 mm is used to prepare the composite samples. Initially the glass chopped fibre strand is cut as per the die size and the mass of the materials can be found out by using the following formula,

$$\text{Mass of fibre/resin} = \text{Volume of die} \times \text{proportion} \times \text{Density of fibre/resin}$$

The materials is placed in the die as per the volume that can be placed and the die is loaded in the compression molding machine.

**F. Sample proportions**

| Sample 1: | Sample 2: | Sample 3: | Sample 4: |
|-----------|-----------|-----------|-----------|
| Matrix - 60% | Matrix - 70% | Matrix - 70% | Matrix - 60% |
| Glass - 28% | Glass - 24% | Glass - 21% | Glass - 32% |
| Prosopis Juliflora - 12% | Prosopis Juliflora - 6% | Prosopis Juliflora - 9% | Prosopis Juliflora - 8% |

**Fig 2.4 Various composition of Specimen**

### 3. Numerical Analysis

- **Element type**: 4 node shell 181
- **Analysis type**: Linear, Orthotropic
- **Boundary conditions**: All DOFs are constrained at x=0

A tensile load of 1KN is applied at the other end

**Fig 3.1 Deformation using Ansys**

### 4. Experimentation and Results

#### A. Tensile test

**Tensile testing**, also known as **tension testing**, is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until failure. Properties that are directly measured through a tensile test are ultimate tensile strength, breaking strength, maximum elongation and reduction in area. Uniaxial tensile testing is the most commonly used for obtaining the mechanical characteristics of isotropic materials. Some materials use biaxial tensile testing.

**ASTM D638-03**

* 19mm in wide * 165mm in long

**Fig 4.1 ASTM D638-03**
Sample 1: Tensile strength = 81.3MPa
Sample 2: Tensile strength = 110.41MPa
Sample 3: Tensile strength = 77.32MPa
Sample 4: Tensile strength = 101.79MPa

B. Flexural test

The three-point bending flexural test provides values for the modulus of elasticity in bending, flexural stress, flexural strain and the flexural stress–strain response of the material. The main advantage of a three-point flexural test is the ease of the specimen preparation and testing. However, this method has also some disadvantages: the results of the testing method are sensitive to specimen and loading geometry and strain rate.

ASTM D790

Length: 127mm
Breadth: 12.7mm
Machine: 3-point bending machine

Results of Flexural Test
Sample 1: Max bending load = 0.08kN
Sample 2: Max bending load = 0.085kN
Sample 3: Max bending load = 0.105kN
Sample 4: Max bending load = 0.105kN
Comparison of test results

![Fig 4.6 Plots of flexural test]

**C. Hardness Test**

**Hardness** is a measure of the resistance to localised plastic deformation induced by either mechanical indentation or abrasion. Some materials (e.g. metals) are harder than others (e.g. plastics). Macroscopic hardness is generally characterized by strong intermolecular bonds, but the behavior of solid materials under force is complex; therefore, there are different measurements of hardness: scratch

**Results of Hardness Test:**

- **Sample 1:** Hardness = 87.5HD
- **Sample 2:** Hardness = 83HD
- **Sample 3:** Hardness = 86.5HD
- **Sample 4:** Hardness = 85.17HD

![Fig 4.7 Results of Flexural Test]

![Fig 4.8 Machine: Shore D hardness tester]

![Fig 4.9 Results of Hardness Test]

5. **CONCLUSIONS**

Thus, prosopis Juliflora/glass/epoxy resin hybrid composite laminates of four proportions were fabricated and various tests were done on the four samples.

The hybrid fibre reinforced composite samples of different proportions were fabricated using Compression molding machine in the laboratory conditions. Among the four samples prepared, it is found that

- The tensile strength of the sample 2 is higher, when compared with other samples.
- The maximum bending nature of sample 3 and sample 4 is high.
- The hardness nature of sample 1 is good, when compared with the other samples.

6. **REFERENCES**

[1]. Nino Serah Baby, N.Sakthiswaran, G.Shiny Brintha & O.Ganesh Babu, A Review on Hybrid Composites Reinforced With Sisal Fibres, Glass Fibres, Steel Fibres and Prosopis Juliflora Volume 4 Issue V, May 2016 IC Value: 13.98 ISSN: 2321-9653

[2]. Seethalakshmi, A. N., Subramanian, S., and Muthuchelian, Thermal, Structural, Mechanical and Electrical properties of biomaterial Prosopis Juliflora, K. Vol. 5, Issue, 10, pp.3116-3120, October, 2013 ISSN: 0975-833X
[3]. Sam Sundar, V.S. Aishvarya, S. Priyanka, A Bio-composite substitute for Aluminum used in Airplane International conference on explorations and innovations in engineering and technology, ISSN: 2349 -9362

[4]. Keerthi, V Devender, V Mahesh (2014) “Mechanical Characterization of Biodegradable Linen Fiber Composites”, International Journal of Modern Engineering Research (IJMER), Vol. 4, Iss.11, pp. 39-46.

[5]. U S Bongarde, V D Shinde, (2014) “Review on natural fiber reinforcement polymer composites”, International Journal of Engineering Science and Innovative Technology (IJESIT), Volume 3, Issue 2, pp 431-436.

[6]. Avinash S, H G Hanumantharaju, Vignesh M, Akash S, (2014) “Investigation Of Mechanical Properties On Vinylester Based Bio-Composite With Gelatin As Randomly Distributed Filler Material”, International Journal of Research in Engineering and Technology, Volume 03, Issue 11, pp 252-258.

[7]. D. Chandramohan, K Marimuthu (2011), “A Review on Natural Fibers”, IJRRAS, Vol 8, Issue 2, pp 194 -206.

[8]. Arpitha G R, Sanjay M R, L Laxmana Naik, B Yogesh, “Mechanical Properties of Epoxy Based Hybrid Composites Reinforced with Sisal/SIC/Glass Fibers”, International Journal of Engineering Research and General Science, Volume 2, Issue 5, pp 398-405.

[9]. Farshid Basiji, Vahidreza Safdari, Amir Nourbakhsh, Srikanth Pilla (2009) “The effects of fiber length and fiber loading on the mechanical properties of woodplastic (polypropylene) composites”, Research Article, pp 191-196.

[10]. Oladele, I O Omotoyinbo, J A Adewuyi, B O And Kavishe F.P.L. (2013) “The Effects of Production Processes on the Mechanical Properties of Sisal Fibre Reinforced Polypropylene Composites”, Philippine Journal of Science vol 142 (2): 189-198. pp 189-198.