MECHANICAL BEHAVIOUR OF GLASS FIBRE REINFORCED POLYESTER COMPOSITE FOR FISHING BOAT MANUFACTURING

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ABSTRACT

In this study, the mechanical properties of E-Glass fibre with unsaturated polyester resin were discovered for use in fishing boat building. The fibre and resin are blended in the ratios of 30% - 70%, 40% - 60%, and 50% - 50% using the volume fraction method. The laminates were created using a hand layup technique and some mechanical devices. Due to the more performance demands placed on engineering materials, extensive research and development of new and improved materials, such as composites, has occurred. Composite materials utilized for structural purposes frequently have low densities when compared to traditional engineering materials, resulting in high stiffness to weight and strength to weight ratios. Many composites also have a high fatigue strength-to-weight ratio and are resistant to fatigue degradation, making them a viable option. Mechanical tests on the prepared specimens included tensile, flexural, hardness, water absorption, and glass content. Finally, the optimal fibre and matrix mix design was examined.

Keywords: *Unsaturated polyester resin; E-glass fibre, MEKP, Cobalt napthanate*

1. INTRODUCTION

Because of their light weight and higher mechanical capabilities, glass fibre reinforced polymer matrix composites have been widely used as a substitute material in vehicle and aerospace applications[1]. E glass woven fabric reinforced polymer matrix composites with volume fractions of 60, 65, and 70 percent were tested. Longer longevity, stronger strength, lighter weight, and cheaper maintenance costs are all advantages of composite materials[2]. Glass fibre and polyester matrix are used to make the majority of marine crafts around the world, however they are harmful to aquatic creatures as well as the

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manufacturers who come into close contact with the boat[3]. Glass fibre is non-biodegradable and poses a significant risk throughout the manufacturing process. A automated boat's hull structure typically comprises 13–25 layers of glass fibre and woven roving for a length of 35 ft–90 ft. Every year, a considerable number of fishnets are broken and thrown away[4,5]. Hand layup method was used to create polyester and epoxy resins reinforced with coconut, E-glass, and jute fibres of 5-6mm length. The fibre and resin were mixed in a ratio of 18:82. After the composites were made, they were put through a series of physical, mechanical, and microstructural tests to assess their qualities[6].The mechanical properties of woven bamboo glass polyester (WBGP) hybrid composite material as a function of bamboo fibre and polyester percentage[7]. Hybrid composite plates with varying bamboo fibre percentages were produced using a hand layup procedure (3 percent, 6 percent, 9 percent, 12 percent, 15 percent by weight)[8]. With top/bottom layers of chopped strand matt E-glass fiber and a core layer of bamboo fibre, GP-700 resin was utilised to make a three-layered reinforced material[8]. The Himalayan nettle (Girardinia diversifolia L.) grows at heights ranging from 1200 to 1900 metres above sea level in the subtropical Himalayan highlands, from Kashmir to Sikkim, and the state of Uttarakhand. These plants often reach a height of 4-6 metres[9]. Ropes, fishing nets, sacking, apparel (scarves, stoles, and cushion covers), woven place mats, and carpets have all been made from the plant's fibres for centuries. This fibre can be utilised as reinforcement in composite goods. In the lab, Himalayan nettle cloth reinforced polyester composite materials were prepared using a hand layup procedure[10]. The influence of fibre loading (5wt.%, 10wt.%, 15wt.%, and 20wt.%) on the physico-mechanical properties of composite materials was investigated using ASTM standards. The composite panel with a 15 wt. percent fibre loading produced the best results of all the composite samples. The maximum tensile strength (30.69 MPa), impact strength (10.66 Joule), and minimal specific wear rate (0.0199 mm3 /Nm) were reported in a composite material with 15% fibre loading.

To find the best mix design for boat construction, we used E-Glass fibre in combination with unsaturated polyester resin in three distinct mix ratios. Mechanical tests on this composite material encompass tensile, flexural, hardness, water absorption, and glass content.

2. MATERIALS AND PREPARATION

Materials

The manufacturing of composite laminates and the experimental methodologies for their mechanical characterization will be discussed in this study. These are the raw materials utilized in this project

- Fiber: Synthetic Glass
- Resin: Unsaturated Polyester
- Catalyst: Methyl ethyl ketone peroxide
- Accelerator : Cobalt

Glass fibre is a common reinforcing material in fibre reinforced polymer composites because it is affordable and less brittle. Chopped strands, mats, and woven fabrics are all examples of glass fibres in various forms. Bidirectional woven glass fibre mats are employed in this project.

Table 2.1 Properties of E-Glass fiber

Sl.no.	Name of the Material	Density of the material (g/cm3)	Tensile strength of the material (MPa)	Elastic modulus (GPa)
1	E-Glass fiber	2.423	3450.6	71.9

The resin in question will be used for molding and is a general-purpose polyester resin. The polyester resin was chosen because it is one of the most commonly used resins in a variety of structural applications, including the production of wind turbine blades. Polyester is one of the most often used resins for small to big wind turbine blades, which are made using the hand lay method and resin transfer moulding, depending on the blade size.

Table 2.2 Properties of polyester resin

Sl.no	Name of the material	Density (g/cm^3)	Tensile strength (N/mm^2)	Flexural strength (N/mm^2)	Viscosity (Cps)
1	Polyester	1.101-1.13	45.11	111	305-401

The composite samples are made using a hand lay-up approach, which is less expensive and easier to cast. The cast iron mould utilized in the standard is 300mm x 120mm x 3mm. The GLASS FIBER WRM 610 is initially put into the mould for three layers, and then the resin polyester, along with the catalyst and hardener, is poured into the mould to complete the material. The mould is then placed in a CTM compression testing machine for 12 hours at a force of 2KN. The specimen was then cut according to ASTM standards using a laser cutting equipment for various testing reasons.

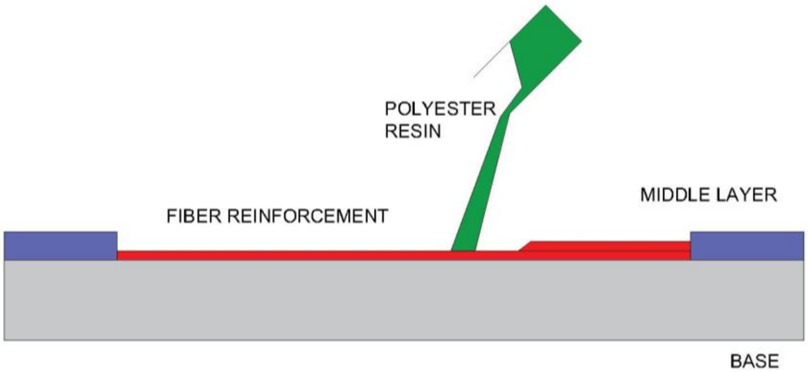

Fig 2.1: Hand lay-up method technique

Table 2.3 Glass Fibre and resin percentages

Sl.no.	Fiber	Resin	Fiber %	Resin %
1.	E-Glass	Polyester	30	70
2.	E-Glass	Polyester	40	60
3.	E-Glass	Polyester	50	50

Fig 2.2 Finished composite laminate

3. RESULTS AND DISCUSSION

Tensile flexural and hardness test

Test specimens are made from the manufactured composites and subjected to ASTM standards for tensile, flexural, hardness, water absorption, and glass content. These experiments' results are listed below.

Table 3.1 Test results of tensile, flexural and harness

Sample no.	Fiber %	Resin %	Tensile strength N/mm^2	Flexural strength N/mm^2	Hardness test
1	40	60	328.46	158.06	45
2	50	50	342.75	163.58	46
3	60	40	350.15	165.31	48
4	70	30	346.12	160.12	46

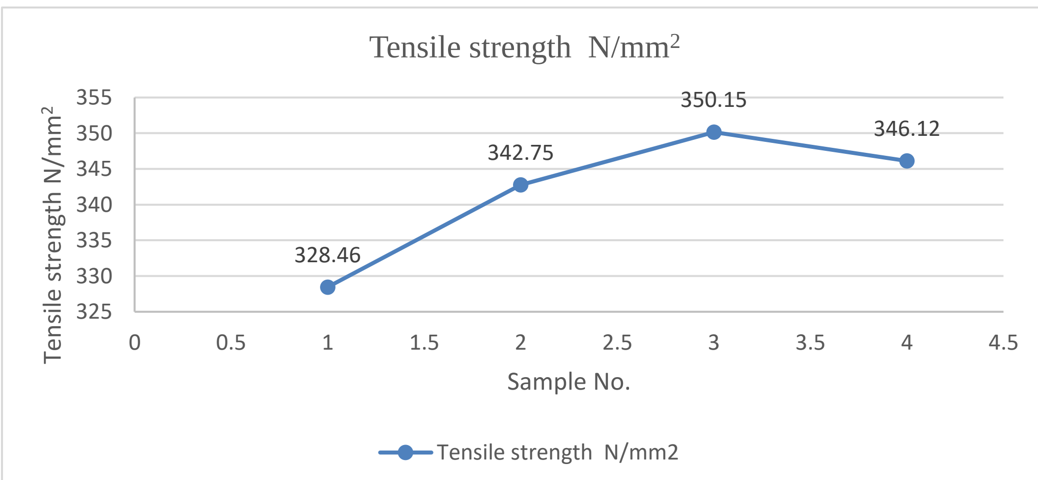

Fig 3.1 Tensile strength of the composite material

Test for water uptake

The water uptake test determines the composite's water intake capabilities, which may then be used to compute moisture absorption. Water absorption is influenced by a variety of parameters, including the kind of plastic, additives, temperature, and exposure period. Before being placed in a desiccator to cool for the water absorption test, the specimens were dried in an oven for a predetermined duration and temperature.

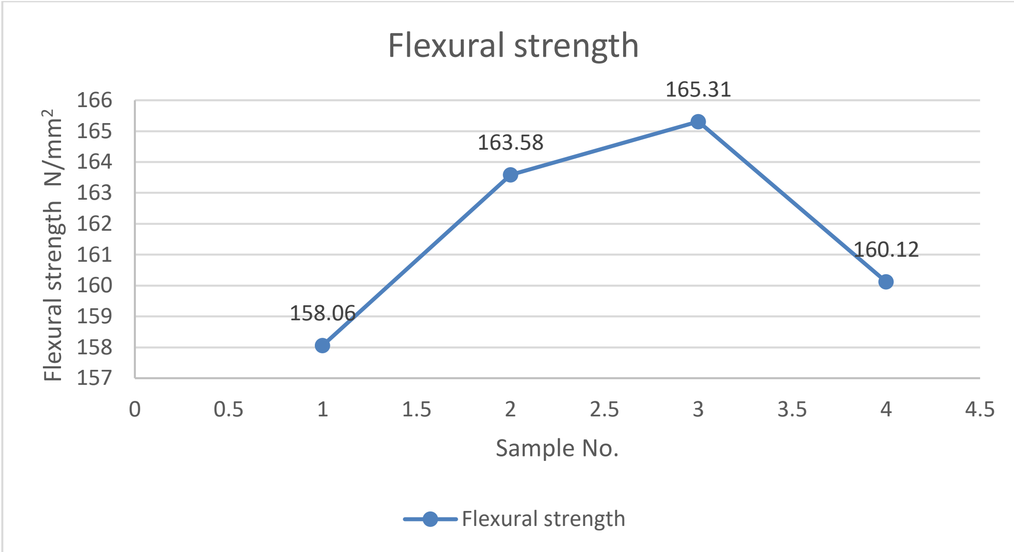

Fig 3.2 Flexural strength of the composite material

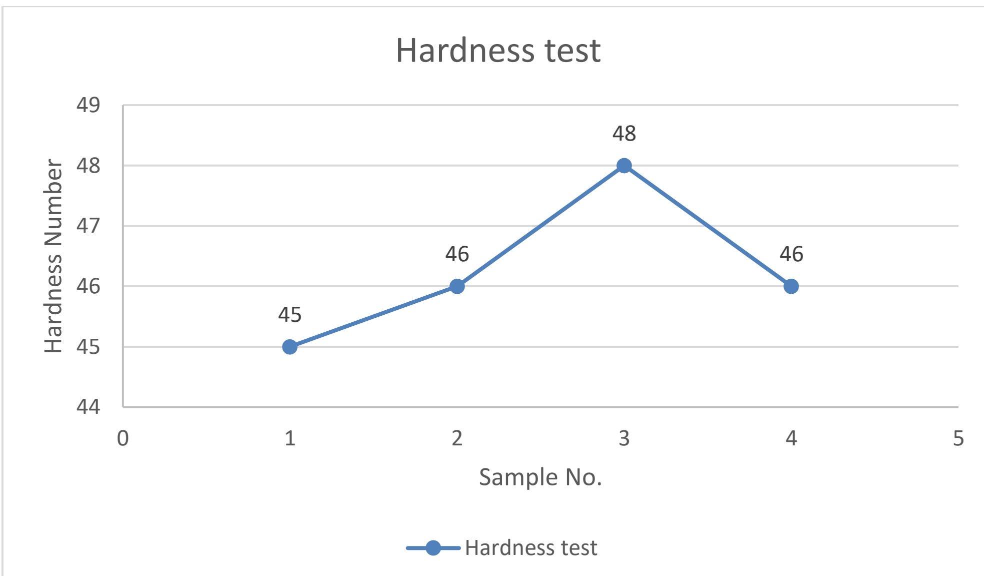

Fig 3.3 Hardness number of the composite material

Before exposing the samples to normal water, a sample size of 50 mm 50 mm was made for each of the nine combinations, and the weight of the samples was determined. The final weight was determined after 24 hours, and the percentage of water absorption was noted in table 5. Water absorption is measured as a percentage increase in weight.

Percentage of Water uptake = [(Wet weight - Dry weight)/ Dry weight] x 100

Table 3.2 Percentage of water absorption for the respective proportion

Sample	Composite proportion	% of absorption
1	Fiber 40% & Resin 60%	0.0156
2	Fiber 50% & Resin 50%	0.0148
3	Fiber 60% & Resin 40%	0.0135
4	Fiber 70% & Resin 30%	0.0142

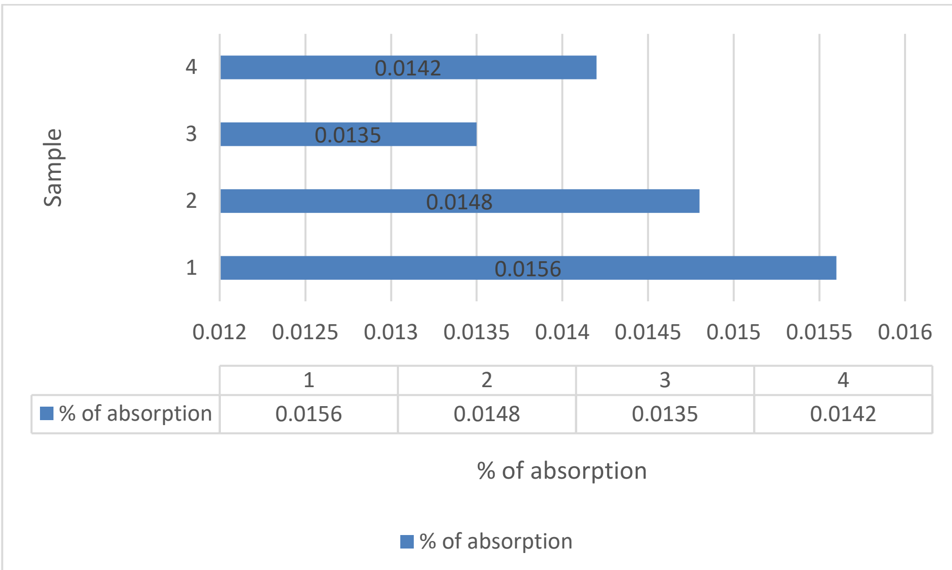

Fig 3.4 Water absorption percentage

Glass Content Test

The sample size was 25 mm by 25 mm. Initially, the weight of the samples was determined. After heating, samples were burned at temperatures ranging from 538°C to 593°C, leaving just the glass fibre as a residue. Because of the high temperature, the resin will burn off. The weight differential of the sample taken was used to compute the glass content, as stated in the table.

Table 3.2 Percentage of glass content for the respective proportion

Sample	Composite proportion	% of glass content
1	Fiber 40% & Resin 60%	39.15
2	Fiber 50% & Resin 50%	48.65
3	Fiber 60% & Resin 40%	59.55
4	Fiber 70% & Resin 30%	69.87

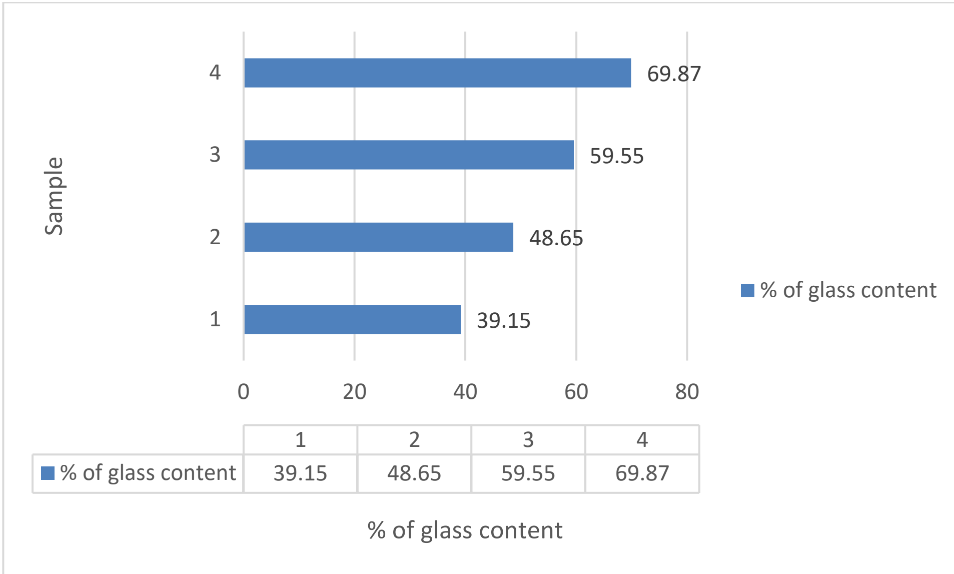

Fig 3.5 Percentage of glass content

4. CONCLUSIONS

The experimental investigations on mechanical behavior of nine different composites lead to the following conclusions.

- The mechanical properties of the samples were determined using ASTM standards.
- The amount of 60 percent fibre and 40 percent resin results in better tensile, flexural, and hardness. As a result, the suitable fibre and resin combination design was concluded.
- The graph depicts the percentage of water absorption and glass content, which was optimum at 60% fibre and 40% resin.
- Based on the above findings, it is considered that the quality of 60 percent fibre and 40 percent resin is superior in the above five tests.

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