ISSN: 0974-5823 Vol. 6 No. 3 December, 2021

International Journal of Mechanical Engineering

Comparison of Mechanical Properties of Hemp Fiber and Glass - Hemp Fiber Reinforced Polymer Hybrid composite

Mr. Vishwanatha N R [1], Dr. Mallikarjuna C[2]

[1]Assistant Professor, Department of Mechanical Engineering, Navkis Colege of Engineering, Hassan, Karnataka 573217, India

[2]Associate Professor, Department of Mechanical Engineering, VTU Centre for Post Graduate Studies, Mysuru, Karnataka 570029, India

Abstract

Since fibre reinforced polymer composite have a greater specific strength and modulus, plant-based natural fibres are increasingly replacing synthetic fibres in polymer composite reinforcement. A novel material with a strength-to-weight ratio greater than any currently available material will be developed in this study. The Hybrid composite made of glass and hemp with an epoxy matrix was made by hand in accordance with ASTM standards. Low-cost, high strength, low density, sustainability, low abrasive wear and corrosion resistance are all advantages of hemp plant fiber/epoxy "composite in the current economic environment. The investigation of mechanical strengths, such as tensile strength and impact strengths, is an important goal of this experiment. For automotive applications, it is recommended to use the hybrid hemp/glass fibre reinforced laminates as an alternative to synthetic fiber-incorporated composites because of their high tensile and impact strengths.

Keywords: Hemp/glass fibre "composite's Mechanical properties

1. INTRODUCTION

The tensile strength, flexural strength, as well as impact strength of natural as well as synthetic fiber-reinforced polymer "composites were investigated. [1]. Improved mechanical properties and a reduction in environmental hazards were found as a result of hybridization. [2] The tensile as well as impact properties of "Hybrid "composites were experimentally analysed. Using natural fibres such as hemp/glass with hemp fibre, researchers found that the tensile and impact strength of the "composites were improved in the experiment. These "Hybrid "composites can be utilized for medium-strength applications, according to the claims. [3] For example, the tensile and impact strengths of the materials were studied. It has been discovered that mechanical strength has been greatly enhanced. With synthetic fibre reinforced "composite's, natural materials are biodegradable and environmentally friendly, as well as lighter in weight and more recyclable. [4, 5]. Using these "composite's is on the rise because of their cost, which is a crucial factor in many technical fields.

Lignocelluloses, a natural plant fibre used to make "composite" materials, has attracted attention in the automobile industry because of the growing environmental consciousness and interest. Because of their many advantages, natural plant fibres are more cost-effective and environmentally friendly than synthetic alternatives. They are also stronger, less prone to abrasion, easier to get, recyclable, permeable, thermal and acoustic insulators, biodegradable, and renewable.

[6-10]. Reinforcing "composite" materials with plant fibres such as hemp and flax, as well as sisal and kenaf, is currently garnering a lot of interest. Because hemp plant bast fibres are exceedingly long and strong, hemp fibres are cellulose-enriched fibres. Cargo floor trays, spare tyre covers, and floor mats for the luggage compartment, as well as interior storage bins and underbody panels, all use hemp fibre reinforced "composite" parts that may be made in either a single direction or two directions at random. [11The mechanical characteristics of hemp fibres embedded in polyester, polypropylene, as well as biodegradable matrix "composite's was evaluated. "Composite" materials can be made from hemp plant fibres instead of synthetic fibres. Hemp fibre composite materials have been extensively studied for their bio-based thermoplastic and thermoset resins. Fiber surface treatments have been shown to increase mechanical strength, improve interfacial adhesion between fibres and polymer matrices, and reduce water absorption. [12]. [13] Mechanical and thermal properties of hemp fiber-polylactic acid "composite's containing 30% hemp were studied.

2. Experimental method

2.1. Material

The' hemp/glass fibre' included "composite" plates were made by hand lay-up method for this experimental effort. "M/s. Go green goods Ltd., Chennai, is the source of the raw hemp fibres. Epoxy resin (Grade: 758), hardener (Grade: HY911), accelerators, and waxes are all purchased from M/s. Sakthi glass fibres Ltd. in Tamilnadu, India."

2.1.1 Glass Fiber:

Woven Fiberglass Roving the interweaving of direct roving results in the bidirectional fabric known as mat. Polyester, vinyl ester, epoxy, and phenolic resins, among others, are compatible with woven roving. As an engineering material, fiber-reinforced polyester (FRP) roving has many great properties such as anti-burning and corrosion resistance as well as stable structure, heat-isolation and minimum elongation shrinkage. An electrically-resistant, FRP and engineering plastics product can be made using E-glass roving. These include electrical appliances and electronic systems; transportation; chemical; architectural; thermal insulation; sound absorption, and fire prevention; and environmental protection, among other things.. Low fuzz, high strength in both directions of the warp-and-weft-direction weaves, incombustibility and corrosion resistance, as well as heat resistance. An excellent electrical insulation property is provided by E-Grade Fabric (E-fibreglass Textile Cloth).

Fig. 2.1 E-glass fabric

2.1.2 Hemp Fiber

Flax, Kenaf, Jute, and Ramie are all bast fibre plants, and hemp is no exception. Bast fibre plants are distinguished by the presence of long, slender main fibres on the stalk's outer section. First used in Asia, perhaps. Before the advent of Christ, hemp was one of the bast fibres known in Asia. Clothing, papermaking, building materials, and insulation are all examples of how hemp fibres have been used for millennia. It is not the same as the cannabinoids that are used for intoxication.

Fig. 2.2 Hemp fabric

2.1.3 Epoxy Resin

In the epoxy resin family, epoxy refers to the fundamental components or cured end products. It's a type of epoxy resins, or polyepoxides, that have epoxide groups in their structure. Also known as epoxy, the epoxide functional group is a functional unit in organic compounds. A hardener (HY951) provides the essential interfacial adhesion for the epoxide group, which is known as an oxirane. To achieve the ideal matrix composition, a 10:1 resin to hardener ratio is employed. Waterproofing, strength, and durability can be achieved by using it as a coating or infusion on materials such as timber and carbon. During the curing process, the epoxy becomes resin, and so has a wide range of advantages.

Fig. 2.3 Epoxy resins LY 556, Hardener HY951

2.2. Manufacturing process

2.2.1 Hand Lay-Up Method

Hand lay-up is the simplest and earliest open moulding method for manufacturing "composites. Reinforcing material is painted with a resin matrix using a brush before being moulded into the final shape. In order to get the desired thickness, hand rollers are utilised to roll the wet "composite's". As a result, the reinforcement and matrix have better contact, and the resin is distributed more evenly. Natural curing of the laminates is then allowed to take place. Preparation of the mould, gel coating, laying up, as well as curing are the four essential steps in this procedure. Without the use of external heat throughout curing, The "composite's" of fiber-reinforced resin solidify. To provide a high-quality product surface, a coloured gel coat is initially sprayed to the mould surface. 60 percent of the "composite's were made up of fibres, and 40 percent were made up of the matrix.

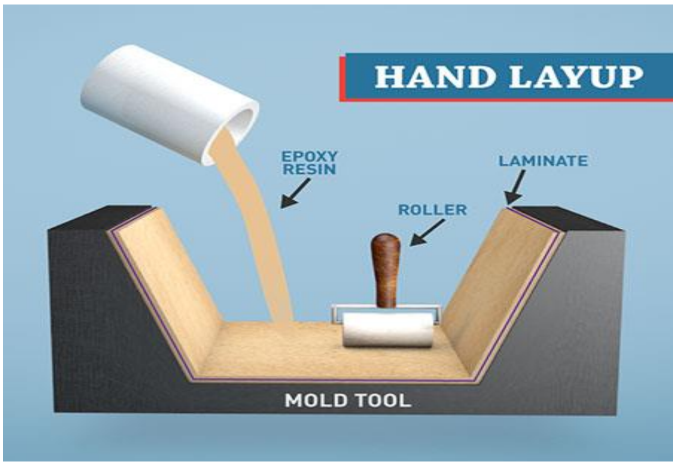

Fig. 2.4 Hand lay-up method

2.2.2 Specimen Preparation

Rub the base plate with abrasive paper to remove corrosion. Once it had dried, the surface was cleaned with a thinner solution and then allowed to air dry. Silicon gel was sprayed on the surface after it had dries out. To lay-up the mould, the surface was kept as it is for few minutes. epoxy resin is combined with the hardener at a 10:1 ratio. Once blended, the curing time (also known as the pot life) was 20 minutes, as noted on the lab charts. The resin must not be allowed to cure inside the curing pot. A stopwatch was used to keep an eye on the mixture in the pot. The base plate is covered with an epoxy resin laminate made from hemp and glass fibres. Hemp and glass fibres were hand-laid to create this laminate, which has a thickness of three layers. The laminate's dimensions are limited to 300 x 300 x 3 mm. Natural and synthetic fibres are employed in different parts of each laminate, with glass fibre in the top, middle, and bottom.

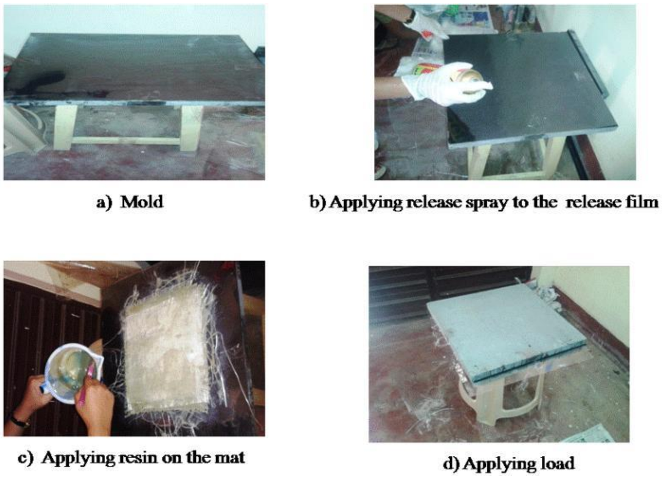

Fig. 2.5 Fabrication Process

2.2.3 Preparation of Hybrid composites

Rub the base plate with abrasive paper to remove corrosion. Once it had dried, the surface was cleaned with a thinner solution and then allowed to air dry. Silicon gel was sprayed on the surface after it had dries out. The epoxy resin is combined with the hardener at a 10:1 ratio. Once blended, the curing time (also known as the pot life) was 20 minutes, as noted on the lab charts. The resin must not be allowed to cure inside the curing pot. A stopwatch was used to keep an eye on the mixture in the pot. The base plate is covered with an epoxy resin laminate made from hemp and glass fibres. Hemp and glass fibres were hand-laid to create this laminate, which has a thickness of three layers. The laminate's dimensions are limited to 300 x 300 x 3 mm. Natural and synthetic fibres are employed in different parts of each laminate, with glass fibre used in the top, middle, and bottom layers. To finish curing the three-set hybrid laminate, a weight press was employed and loaded for 12 hours. Figures 2.1 and 2 depict the hemp raw fibres used in the fabrication of "composite" laminates. Fig. 2.5 shows the final "composite" laminates. The approach is as follows:

Table 2.1: Laminates designation as per stacking sequence

Sl. No	Fabric	No. of layer	Thickness
1	HFRP	3	3.45mm
2	GFRP + HFRP	03 + 02 = 05	3.12mm

Specimen calculation for the preparation of Lamina

Required Laminates	Number of Hemp fibre layers (gsm: 1.15)	Number of glass fibre layers (gsm: 0.26)	Total Thickness
HFRP	3	-	3.45mm
GFRP + HFRP	02	03	3.12 mm

2.3. Test setup

Fig. 2.6 Test set up for Tensile test and Specimens

2.3.1Tensile Test

Tensile strength testing The tensile test specimens and "composite" laminates are prepared in accordance with ASTM D3039 standards and procedures. Three specimens from each laminate are used in the tensile testing for hybrid and non-hybrid laminates. Results have been noticed when the testing machine applied a load to the specimen till it failed. The mean tensile strength and related stresses of the remaining "composite" laminate specimens are determined by comparing them using the same procedures as before.

2.3.2 Impact Test

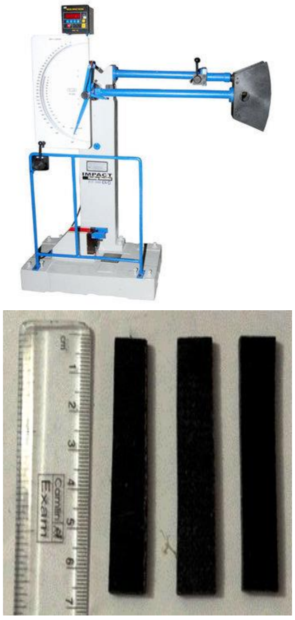

Fig. 2.7 Test set up for Tensile test and Specimens

In each hemp and glass fiber-reinforced "composite" laminate, three test specimens are used to determine how well the material is able to endure an impact load. Hybrid and non-"Hybrid "composite"" laminates are used for test specimens according to ASTM D256. The specimens' margins are nicely polished. The findings can be interpreted in a variety of ways. One method is to calculate the amount of energy that is stored in a sample. This image shows the impact test specimen before and after it was broken apart by a hemp-glass fibre reinforced epoxy "composite".

3. RESULTS AND DISCUSSION

3.1.1 Ultimate Load and Tensile Strength

During stretching or elongation, it is the amount of stress that a material can bear without breaking. One square inch of cross-sectional area can bear a load of one square inch of cross-sectional area in simple tension, which is the material's maximal resistance to fracture

Table 3.1: Experimental Load and Tensile Test Values

Tensile strength of Pure HL + Pure hybrid of GL and HL		
HL	**HL+GL**	
37.17	135.91	
Load v/s displacement of Pure HL + Pure hybrid of GL and HL		
Load	**HL**	**HL+GL**
0	0	0
1.4	0.6	0.6
2.8	1.2	1.2
3.35	3.15	1.8
5.6		2.4
5.98		4.7

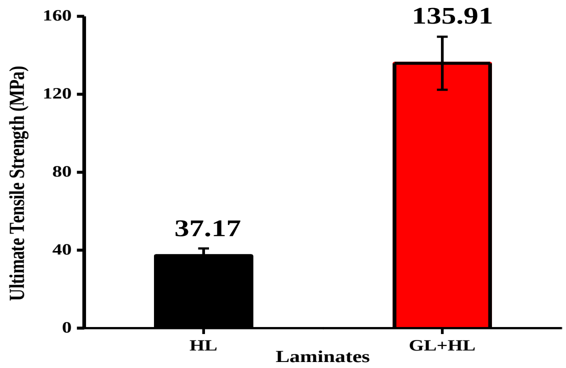

Fig.3.1 Laminates v/s Ultimate Tensile Strength of pure HL and GL+HL

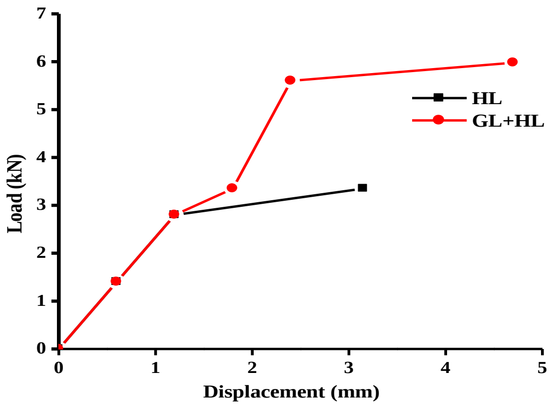

Fig. 3.2 Load v/s Displacements of pure HL and GL+HL

The ultimate tensile strength and load elasticity of pure HL laminates were compared to those of pure HL+GL hybrid laminates in the current study. Pure HL had a tensile strength of 37.17 MPa, while HL+GL had a tensile strength of 135.91 MPa. Table 5.11 and Fig. 28 show that hybrid laminates of HL+GL have the highest ultimate tensile strength compared to pure HL. The pure HL showed a displacement of 3.15 mm for loading 3.35 kN and 2.4 mm for loading 5.6 kN, while the hybrid of HL+GL showed a displacement of 2.4 mm for loading 5.6 kN. Table 3.1 and Figs. 3.1 and 3.2 show that hybrid laminates of HL+GL have the greatest elasticity when compared to pure HL.

3.1.2 Impact Strength

Table 3.2: Experimental Impact Test Values

Impact strength of Pure HL + Pure hybrid of HL+GL	
HL	**HL+GL**
4	4

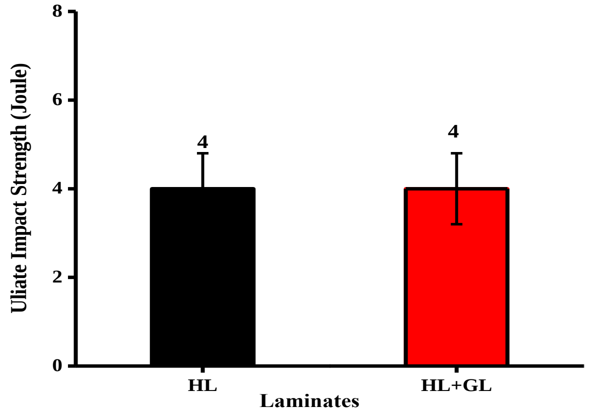

Fig. 3.3 Laminate v/s Impact Strength of pure HL and HL+ GL

This is a preliminary impact test. Testing a material's impact resistance, which engineers use to make predictions about how the material will behave in real life. Flaws and cracks are common causes of failure in many materials when they are subjected to an impact. Both pure HL and HL+GL laminates had an ultimate impact strength of 4 joule, which was lower than the pure GL laminates, as shown in table 3.2 and fig. 3.3, respectively

3.1.3 Scanning electron microscopy (SEM) analysis

Examination of “Hybrid “composite”” sample failure morphology by scanning electron microscopy is performed in the present experiment. Figure 3.4 shows the SEM images of the “Hybrid “composite”” samples that were exposed to tensile loading. The fracture of the fibre and matrix can be seen in the photographs, as the tensile load was applied.

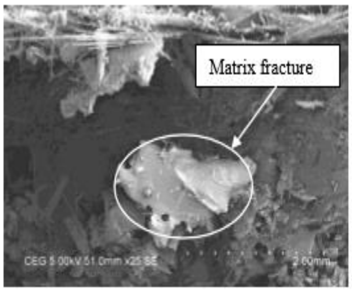

Fig. 3.4 “SEM micrographs of the “Hybrid “composite”” samples subjected to tensile loading”

4. CONCLUSION

“composite’s made of glass fibre, hemp fibre, or both are being tested for tensile and impact strength, respectively. The following findings were reached as a result of research experiments.

- Fiber reinforced “composite’s made of hemp and glass fibres are capable of withstanding a tensile strength of 135.91MPa, whereas hemp-glass fibre “composite’s are capable of withstanding a tensile strength of 37.17MPa.
- There is very little change in the impac t strength of the “Hybrid “composite””s from 4 Joules.
- The morphological investigations of the interfacial properties and internal structures of the shattered surfaces quickly reveal the fibre failure mode, fibre pull out, and fibre dislocation.
- These hemp-glass fibre reinforced epoxy “composite’s could be used as an alternative to synthetic materials, according to the researchers.

5. References

[1]. M. Ramesh, K. Palanikumar, K. Hemachandra Reddy, Mechanical property evaluation of sisal–jute–glass fiber reinforced polyester “composite’s, “composite’s: Part B; 2013; 48:1–9.

[2] M. Ramesh, K. Palanikumar, K. Hemachandra Reddy, Comparative evaluation on properties of hybrid glass fiber- sisal/jute reinforced epoxy “composite’s, Procedia Engineering; 2013;51:745 – 750. [3] N. Venkateshwaran, A. Elayaperumal, A. Alavudeen, M. Thiruchitrambalam, Mechanical and water absorption behaviour of banana/sisal reinforced “Hybrid “composite””s, Materials and Design; 2011; 32:4017–4021.

[4] K.M.M. Rao, K. M. Rao, Extraction and tensile properties of natural fibers: vakka, date and bamboo. “composite” Structures, 2007;77:288– 295.

[5] M. Boopalan, M. Niranjana, M. J. Umapathy, Study on the mechanical properties and thermal properties of jute and banana fiber reinforced epoxy “Hybrid “composite””s, “composite’s: Part B; 2013;51:54–57.

[6] Ramesh M, Palanikumar K and K. H. Reddy 2016 Evaluation of mechanical and interfacial properties of sisal/jute/glass hybrid fiber reinforced polymer “composite’s, Transactions of Indian Institute of Metals 69(10) 1851–9.

[7] Ramesh M, Deepa C, Aswin U S, Eashwar H, Mahadevan B and Murugan D 2016 Effect of alkalization on mechanical and moisture absorption properties of Azadirachta indica (Neem Tree) fibre reinforced green “composite’s, Transactions of Indian Institute of Metals, doi: 10.1007/s12666-016- 0874-z.

[8] Ramesh M 2016 Kenaf (Hibiscus cannabinus L.) fibre based bio-materials: A review on processing and properties Progress in Materials Science 78-79 1–92.

[9] Ramesh M and Nijanthan S 2016 Mechanical property analysis of kenaf–glass fiber reinforced polymer “composite’s using finite element analysis Bulletin of Material Science 39(1) 147–57.

[10] Palanikumar K, Ramesh M and K. H. Reddy 2016 Experimental investigation on the mechanical properties of green hybrid sisal and glass fiber reinforced polymer “composite’s Journal of Natural Fibers 13(3) 321–331.

[11] Liu M, Thygesen A, Summerscales J and Meyer A S 2017 Targeted pre-treatment of hemp bast fibres for optimal performance in bio “composite” materials: A review Industrial Crops & Products 108 660–683.

[12] Shahzad A 2017 Hemp fiber and its “composite’s – A review Journal of “composite” Materials 46(8) 973–986.

[13] Baghaei B, Skrifvars M, Salehi M, Bashir T, Rissanen M and Nousiainen P 2014 Novel aligned hemp fibre reinforcement for structural bio”composite”s: Porosity, water abs