



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 9, September 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijrset@gmail.com

www.ijrset.com



Manufacturing and Characterization of Hemp Reinforced Epoxy Composites

GADIPALLY SAIRAM, DR.J. SURESH KUMAR

M. Tech Student, Department of Mechanical Engineering, JNTUH University College of Engineering Hyderabad,
Kukatpally, Hyderabad, India

Senior Professor, Department of Mechanical Engineering, JNTUH University College of Engineering Hyderabad,
Kukatpally, Hyderabad, India

ABSTRACT: In the recent years Composites are rapidly developing and replacing metals or alloys in numerous Engineering applications as in automobiles, Marine Engineering, Aerospace and cooling tower fan blades etc. Due to their properties like wear resistance, corrosion resistance, high stiffness and strength for reduced weight, superior fatigue characteristics etc and also during last few years, the interest in using natural fibres as reinforcement in polymers has increased dramatically. Natural fibres are not only strong and lightweight but also relatively very cheap and are bio degradable. In this research work, an investigation has been carried out to make use of hemp fibre, a natural fibre abundantly available in India. The present work describes the development and characterization of a new set of composites consisting of hemp fibre as reinforcement and epoxy resin as matrix material. The composite is fabricated using hand lay-up technique and are characterized with respect to their physical and mechanical properties. For this purpose specimens of composite are fabricated as per ASTM standards with varied fibre volumes of 15% 20% 30% and 40%. Experiments are carried out to find parameters like Tensile strength, Flexural strength and Impact strength

I. INTRODUCTION

The development of composite materials and their related design and manufacturing technologies is one of the most important advances in the history of materials. Composites are the material used in various fields having exclusive mechanical and physical properties and are developed for particular application. Composite materials having a range of advantages over other conventional materials such as tensile strength, impact strength, flexural strengths, stiffness and fatigue characteristics. Because of their numerous advantages they are widely used in the aerospace industry, commercial mechanical engineering applications, like machine components, automobiles, combustion engines, mechanical components like drive shafts, tanks, brakes, pressure vessels and flywheels, thermal control and electronic packaging, railway coaches and aircraft structures etc. When two or more materials with different properties are combined together, they form a composite material. Composite material comprise of strong load carrying material (known as reinforcement) imbedded with weaker materials (known as matrix).The primary functions of the matrix are to transfer stresses between the reinforcing fibres and to protect them from mechanical and/or environmental damage whereas the presence of fibres in a composite improves its mechanical properties like tensile strength, flexural strength, impact strength, stiffness etc.

Among all reinforcing fibres natural fibres have gained great significance as reinforcements in polymer matrix composites. Depending upon the source of origin, natural fibres are classified as plant, animal and mineral fibres. Recently, due to the growing global energy crisis and ecological risks, natural fibres reinforced polymer composites have attracted more research interests. The main advantages of natural fibres are their availability, biodegradable, renewable, environmental friendly, low cost, low density, high specific properties, good thermal properties and enhanced the energy recovery, low energy consumption, non-abrasive nature and low cost. A great deal of work has been carried out to measure the potential of natural fibre as reinforcement in polymer such as hemp, jute, coir, bamboo, sisal, banana and wood fibres have been reported. Plant fibres are justifies their use as reinforcement for polymer composites due to their renewability with good mechanical properties. It is also observed that natural fibres are non-uniform with irregular cross sections, which make their structures quite unique and much different from man-made fibres such as glass fibres, carbon fibres etc. As most of the natural fibres posses good properties (tensile and % elongation) than some of the metals and due to their low densities these can be used as reinforcements that are embedded in polymer matrix to produce composites with superior properties. One such combination of reinforcement

and polymer matrix is hemp/epoxy and determination of mechanical properties of the hemp epoxy composite the objective of this study.

II. LITERATURE REVIEW

SULTAN OZT URK [1] Studied the effect of fibre content on the mechanical properties of hemp and basalt fibre reinforced phenol formaldehyde composites. Mechanical properties such as tensile, flexural and impact strengths of hemp/phenol formaldehyde (PF), basalt/PF and hemp/basalt hybrid PF composites have been investigated as a function of fibre loading.

ANNA CAROLINA [2] Compared mechanical properties between bio composites of Epoxy and Polyester matrices reinforced by hemp fibre. A comparison between mechanical properties evaluated by tensile tests revealed that the tendency of epoxy composites with 30 vol% of hemp fibers have higher strength and modulus than the polyester composite with hemp fiber.

Ravi Kumar and Hariharan[3] Experimental Investigation has been carried out on Mechanical Properties of Jute and Hemp fibre based Epoxy Composites. Hemp fibre composites have shown better mechanical properties over jute fibre composites with maximum flexural strength of 53Mpa. And the maximum flexural strength of jute fibre composite is 45Mpa.

V MOHANAVEL AND T SATHISH EPOXY[4] resin, fine hemp fibers, and cotton fibers were combined to create bio-composites. The weight percentages of hemp fibers (0, 10, 20, 30 wt. percent), cotton fibers (35, 25, 15, 5 wt. percent), and epoxy resin have been varied to produce four composite mates Tensile, flexural, and impact tests were performed on the composite specimens in order to determine their mechanical properties

AVINOD AND R VIJAY [5] Research has been carried out on four different sequential laminates of Jute (J) and Hemp (H) fibres reinforced hybrid bio-epoxy composites were developed by using the hand lay-up method. The effect of the layering sequence of laminates was evaluated through mechanical properties such as tensile, flexural, interlaminar shear, and impact tests, and physical properties like water absorption, percentage void, and density. The stacking sequence showed minor changes in the hardness of the composites, while the mechanical performance of the hybrid laminates was comparable to the pure hemp laminate. The hybrid composite hemp/jute/hemp showed the highest tensile strength of 65.44 MPa.

RAKESH KUMAR GOWTAM[6] In this research work, the effects of sodium carbonate and hydrogen peroxide treatment of hemp fiber on the water absorption, mechanical, and tribological properties of hemp fiber reinforced epoxy composites (HFREC) were investigated. The change in surface roughness and fiber size after chemical treatment was confirmed by the scanning electron microscopy (SEM) images. Fourier transform infrared analysis confirmed the removal of hemicellulose and lignin content of the fiber after both the chemical treatment. X-ray diffraction analysis showed an increase in the crystallinity index of the chemically treated fiber.

GEETAKSHI TELI [7] Addressed the need for wear-impenetrable packaging in shipment and related sectors, a treated hemp filler-reinforced epoxy composite manufactured in-house is subjected to tribological testing to assess its utilization under extensional load. The surface modification approaches are utilized on hemp fibres by employing alkali treatment with sodium hydroxide solution. Wear tests are executed on the developed samples in a dry atmosphere employing a pin-on-disc (POD) tribometer for three variable applied forces (5, 10, and 15 N), a sliding velocity of 550 RPM, and three sliding lengths (1000, 2000, and 3000 m) for friction against a stainless-steel disc. The mechanical properties (density, tensile, and flexural) of the composites are also assessed.

K SENTHIL KUMAR[8] The biocomposites were produced by layering sequence of pure sisal fiber mat (SSSS), pure hemp fiber mat (HHHH), and their hybrid mats and then subjected to accelerated weathering conditions. The composite specimens were conditioned under ultraviolet (UV) light and water spray simultaneously for 2222 h, which corresponds to approximately 1 year of the outdoor conditions. Mechanical properties and thermogravimetric analysis (TGA) of the weathered composites were compared to the dry or unweathered composites. Chemical changes to the bio-based epoxy matrix and natural fiber induced by photodegradation were evident as a reduction in intensity and broadening of characteristic peaks from the Fourier Transform Infrared spectroscopy (FTIR) analysis. Tensile strength and flexural strength of the weathered HSSH and HSHS declined by 7%, 13%, 25%, and 26%, respectively

III. METHODOLOGY

3.1 Materials

The Hemp fibre was collected from a local market. The hemp is used for the reinforcement is as shown in the Fig.3.1 Epoxy resin (LY55600) Hardener (HY951) selected as a matrix. Epoxy resins are expensive than polyester, but possess better mechanical properties like dynamic strength and fatigue resistance, so as to impart good inter-laminar strength to the composite.



Fig 3.1

3.2. FABRICATION

3.2.1. Laminate preparation: The specimens are prepared using hand layup method, which are further used to study the mechanical properties of 4 different types of composites with varied fibre volume fractions of 15% 20% 30% and 40% by using hemp fibre as reinforcement and epoxy resin as matrix. This matrix is a mixture of epoxy and substance called hardener, mixed in 10:1 ratio. The hardener is highly viscous liquid material, mixed with resin in suitable proportion which helps in the solidification of the wet, smooth composite. Firstly, during the hand layup process, a heavy metallic mould used to prepare the laminate. The surfaces of the moulds are cleaned and then a release wax is applied on the surface thoroughly to avoid sticking of epoxy and hemp fibre to the surface. The reinforcement i.e., hemp fibre cut as per the required dimensions. To avoid any air bubbles or gaps between the layers, a roller is moved on the surface with mild pressure after each layer till all the layers are stacked up. The mould is secured tightly together with the help of bolts and clamps. The laminate is left at room temperature for curing for about 24 hours; the laminate is removed from the mould and left at room temp for further curing. Similarly other types of laminates are prepared using hand layup technique.

Table3.1 different type of Laminates

LAMINATES	VOLUME IN FRACTION
HL1	15
HL2	20
HL3	30
HL4	40



Fig 3.3 wax coated moulds



Fig 3.4 hand layup method

The specimens are cut from the laminate plate as per the standards to use it in the Tensile test, flexural test and impact test following table shows the different laminates and their fibre fractions.



IV. EXPERIMENTAL INVESTIGATIONS

To characterise the composites mechanical properties, such as tensile strength, impact strength all tests were performed in accordance with ASTM standards

4.1 TENSILE TEST

The specimen's tensile property is discovered through testing using a universal testing device (UTM). As a benchmark, ASTM D638 is used to determine tensile properties. The test specimen is sandwiched between the UTM's grippers, and a cross-head speed of 10 mm per minute is used. The weight was applied gradually until the test sample fractured. The results of this test are used to calculate the tensile strength of the composite samples. Each plate's ultimate tensile strength is calculated



Fig 4.1Tensile test setup



Fig 4.2 tensile test specimens before and after the test

4.2 3POINT BENDING TEST

Flexure Testing can be used to determine a material's properties like flexural modulus or flexural strength. Flexural testing is done on rectangular specimens to determine the flexural strength and flexural modulus. Flexural characteristics of the sample by putting the specimen through a test on a universal testing machine (UTM). ASTM D790 is the minimum requirement set for flexural testing. UTM's cross-head speed is 10mm/min. The test sample was

slowly put under weight until it broke. The tensile strength of the composite samples is determined using the test results. The ultimate tensile strength of each sample is determined



Fig 4.3 flexural setup



Fig 4.4 specimens before and after the test

4.3 IMPACT TEST

The Izod impact test method is used in this study to calculate the composite's impact resistance and impact strength. This method involves calculating the toughness and impact strength of the composite based on the energy absorbed by a material during fracture. The ASTM D256 standard is used to determine the impact strength. Utilizing the energy absorbed by the composite specimen when the pendulum impacts it from a known height, the impact strength and impact resistance are determined. Using the relation, we have determined each sample impact strength.



Fig 4.5 impact test setup



Fig 4.6 specimes before and after the test

V. RESULTS AND DISCUSSION

5.2 Effect of fibre content on tensile strength of the composite

As the fibre loading increases the tensile strength of the composites were increased and the maximum tensile strength is obtained for the composite having 40% hemp fibre content which is of 45.2 MPa and lowest strength is obtained for the composite having 15% hemp fibre content which is of 26.34 Mpa

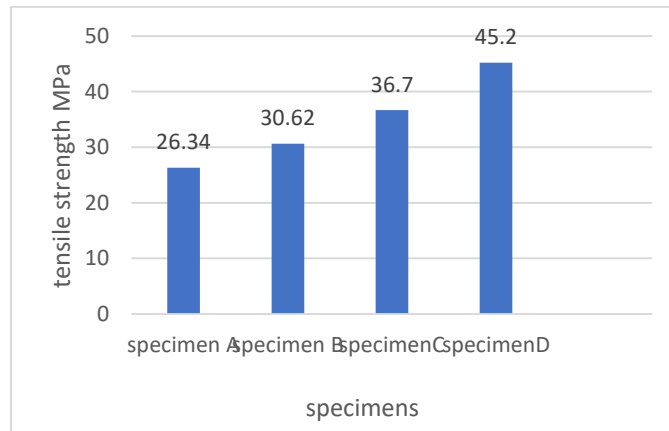


Fig 5.1 tensile strength vs samples

5.3 Effect of fibre content on Flexural strength of the composite

Here also the similar trend has followed, as the fibre loading increases the load carrying capacity of the composite is increased. The maximum

Flexural strength is obtained for the composite having 40% hemp fibre content which is of 56.75 MPa while minimum strength is obtained for the composite having 15% hemp fibre content which is of 24.32MPa

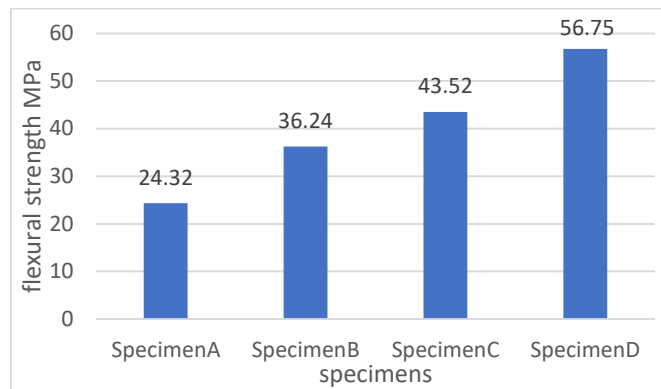


Fig 5.2 Flexural strength vs samples

5.4 Effect of Fibre content on the Impact strength of the composite

Composite having 40% hemp fibre content shown the highest impact strength which is of 10.54 KJ/m² and the lowest strength is obtained for the composite having 15% of fibre content which is 6.32 KJ/m² and it was observed that there was slight decrease of impact strength in the composite which is having 30 % fibre content than the composite having 20% fibre content this is due the unwetting phenomenon.

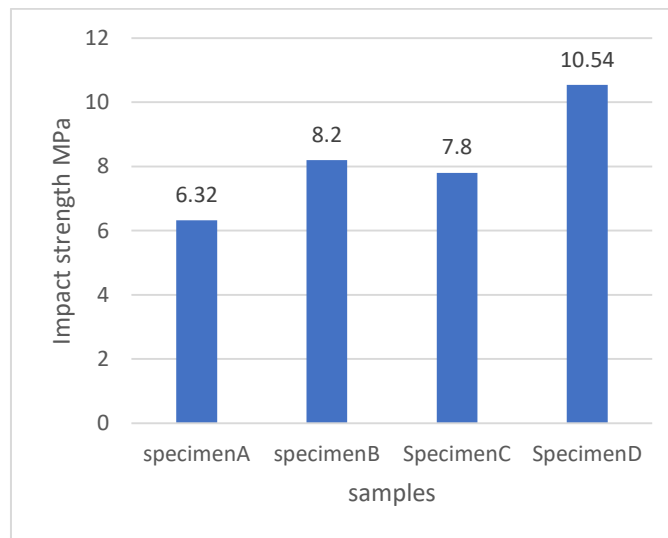


Fig 4.3 impact strength vs samples

Specimen A contains 15% of Fibre content

Specimen B contains 20% of Fibre content

Specimen C contains 30% of Fibre content

Specimen D contains 40% of Fibre content

VI. CONCLUSIONS AND FUTURE SCOPE

6.1 CONCLUSIONS

In this work, Hemp fibre epoxy composites were prepared by varying hemp fibre content through hand layup process, and the mechanical properties were evaluated by the tensile test, Flexural test and Impact test and the result of this work is summarized as follows.

- From the Analysis It is found that the composite having fibre content of 40% has the highest tensile strength which is of 45.20Mpa and the composite having 15% fibre content has lowest strength which is of 26.34Mpa and The specimen D has 71% higher tensile strength compared to specimen A
- From the Analysis It is found that the composite having fibre content of 40% has the highest Flexural strength which is of 56.76Mpa and the composite having 15% fibre content has lowest strength which is of 24.32Mpa and The specimen D has 132% higher Flexural strength compared to specimen A
- From the Analysis It is found that the composite having fibre content of 40% has the highest impact strength which is of 10.54 KJ/m² and the composite having 15% fibre content has lowest Impact strength which is of 6.32kJ/m² and The specimen D has 59.96% higher Impact strength compared to specimen A

6.2 Future scope of the work

- The set of samples prepared in our present work exhibited the better results as expected. By altering the fibres volume fraction, the composite material's load-carrying capacity can be altered.
- This research work can be further extended by performing tensile test, flexural test and impact test by using different fibre volume fractions other than 15% 20% 30% and 40% further investigation of Thermal, Electrical and Moisture absorption of the composites can be carried out

REFERENCES

1. Shahzad A[2020] Hemp fiber and its composites – A review Journal of Composite Materials 46(8) 973–986.
2. Baghaei B, Skrifvars M, Salehi M, Bashir T, Rissanen M and Nousiainen P[2020] Novel aligned hemp fibre reinforcement for structural biocomposites: Porosity, water absorption, mechanical performances and viscoelastic behavior Composites



3. Etaati A, Pather S, Fang Z and Wang H[2019] The study of fibre/matrix bond strength in short hemp polypropylene composites from dynamic mechanical analysis Composites
4. Chaudhary V, Bajpai P K and Maheshwari S [2017] Studies on mechanical and morphological characterization of developed jute/hemp/flax reinforced hybrid composites for structural applications Journal of Natural Fibers
5. Dayo A Q, Gao B C, Wang J, Liu W B, Derradj M, Shah A H and Bakar A A [2017] Natural hemp fiber reinforced polybenzoxazine composites: Curing behavior, mechanical and thermal properties Composites Science and Technology
6. Schluttenhofer C and Yuan L [2017] Challenges towards Revitalizing Hemp: A Multifaceted Crop.
7. V Mohanavel and T Sathish[2017] Experimental investigations on mechanical properties of cotton/hemp fiber reinforced epoxy resin hybrid composites.
8. Ravi Kumar and Hariharan[2016] Experimental Investigation on Mechanical Properties of Jute and Hemp fibre based Epoxy Composites Anna Carolina C. Neves a, Lazaro A. Rohen



Impact Factor: 8.423



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details