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Study Analysis & Application of Bio-Composite Smart Material

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ABSTRACT

Natural fibres have been used to reinforce materials for over 3000 years. More currently they have been employed in combination with plastics. Many types of natural fibres have been investigated for use in plastics including sunnhemp, jute, sisal, munj and banana. The main objective of this experimental study is to fabricate the sunnhemp fibers reinforced hybrid composites and to evaluate the mechanical properties such as flexural strength, tensile strength and impact strength. There are three different types hybrid laminates are fabricated by hand lay-up method by using sunnhemp fibers as reinforcing material with epoxy resin. Application of composite materials to structures has presented the need for the engineering analysis the present work focuses on the fabrication of polymer matrix composites by using natural fibres like sunnhemp, coir, banana, and sisal which are abundant nature in desired shape by the help of various structures of paterns and calculating its material characteristics (Flexural strength ,tensile test, hardness number,% gain of water) by conducting tests like flexural test, hardness test, water absorption test, impact test, density test, and their results are measured on sections of the material and make use of the natural fibre reinforced polymer composite material for automotive seat shell manufacturing. Sunnhemp fibres, available as fibre bundles, are commonly used as fibre reinforcement in composite materials as a substitute for glass fibres.

KEYWORDS: *Flexural test, wettability .Mechanical properties, Sunnhemp fibre composites. Fabrication of Bio-Composite, unidirectional reinforcement.*

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I. INTRODUCTION

Today there is an increase demand for natural fibres for the development of bio composites, which may have application in various fields such as building, and automotive. The performance of current bio composites is inadequate for most structural applications, and increasing the performance of these materials is essential if they are to gain widespread acceptance. Sunnhemp fibre composites in automotive are generally made from scutched flax tows. These Sunnhemp fibres, considered to be cheap technical fibres, are waste product of flax stem obtained after extraction of high quality linen fibres. Nowadays, natural fibers reinforced composites exhibit the superior mechanical properties than synthetic fibre reinforced polymer composites due to its inherent properties. The mechanical properties such as flexural strength, tensile strength, and impact strengths of natural and synthetic fibers reinforced polymer composites with different fiber volume were evaluated by Ramesh *et al*. [1]. The result indicated that, there is the significant improvement in mechanical properties and the process of hybridization reduces the risks related to the environmental concern**.** Sapuan *et al*.[2] fabricated the composites by using banana fiber is a waste product of banana cultivation and which is easily available in tropical countries like malaysia and south india. This fiber has many advantages and holding high mechanical strength when compared to the synthetic fibers. They have prepared three samples with different geometries and evaluated the maximum stress value and young's modulus along two directions and found the maximum deflection under the maximum load conditions. *Ramesh et al.* [3] carried out an experiment to evaluate the tensile and flexural properties of hybrid composites and the results are compared. Form the experiment, they found that the incorporation of natural fibers such as sisal/jute with glass fiber improve the tensile and flexural strength and these composites play a vital role in the field of engineering and technology. They suggested that these hybrid composites can be used for medium strength applications. Venkateshwaran *et al.* [4] studied the mechanical properties such as tensile strength, flexural strength, impact strength and water absorption rate of sisal and banana fibers reinforced epoxy composite materials. They have observed that there is the significant improvement in mechanical strength and reduction in water absorption rate while hybridizing the sisal fibre up to 50% by weight with banana fibre reinforced epoxy composites. Li [12] have evaluated and correlated the compressive strength, flexural strength, toughness, specific gravity and water absorption rate of sunnhemp fibre reinforced composites (HFRC) with different compositions. The water absorbing ratio and the linear specific gravity of the composites are gradually reduced by adding the sunnhemp fibre with concrete matrix. They have observed that the fibre content by weight is the important factor which affects the compressive and flexural strength of HFRC. Kabir *et al.* [16] studied the mechanical property of chemically treated hemp fibre reinforced composites. They found that due to the rapid climate changes in environment, the physical and geometrical characteristics of natural fibre and synthetic fibre components are affected and the fibers are undergoes some irregularities and lose the maximum load carrying capacity of the materials in engineering applications. For better surface finish of the sunnhemp fibre composites the chemical treatment process like alkali, acetyl and silane treatments are carried out. From this study they have found that the tensile strength of untreated fibre composites is much greater than the chemically treated fibre composites. These tensile properties are compared with unidirectional composites with absence of paper between layers of composites. They found that the unidirectional natural fibre composite with one or two layers of thin paper holds the minimum variability in tensile strength and elastic modulus. The tensile strength and delamination properties of laminated composites with paper were improved when compared to without paper unidirectional composites and the modulus are slightly reduced when compared to epoxy composites. Banerjee *et al*. [18] have conducted the micromechanics analysis of hybrid composites by using FEA software (ABAQUS/CAE 6.9-2). The different hybrid laminates are prepared by using short carbon fibers and glass fibers which is reinforced with polypropylene. In this study, the elastic constant and strength properties have evaluated by using analytical formula and the results are compared with FEA results. They have observed that the negligible 2014 R. Bhoopathi *et al. / Procedia Engineering 97 (2014) 2032 – 2041*variability in elastic constants and longitudinal strength properties. They also found that the significant variability in transverse strength properties. Many researchers have reviewed the experimental data about hybrid composites and they observed that rule of hybrid mixtures is the prime factor to predict the mechanical properties of unidirectional interplay hybrid composites. In the present experimental study, the mechanical properties of sunnhemp fibre reinforced composite materials are evaluated. The sunnhemp fibre reinforced composite materials are fabricated by hand lay-up process. The properties such as tensile, flexural and impact strengths are studied and presented in detail.

II. MATERIAL AND METHOD

A 20% Sunnhemp, 64% epoxy (araldite AY-103) and 16% hardner is prepared by using hand lay-up technique. For this purpose, an open mould made of mild steel plate (600 mm long × 300 mm wide × 27 mm thick) has been used. . Firstly, a Mylar sheet is placed on the lower part of mould for a good surface finish and easy withdrawal of bio-composite from the mould in addition to it wax is also used to cover the surface of Mylar sheet for easy withdrawal of bio-composite from Mylar sheet. Sun fibres placed unidirectional on it. Then the matrix (mixture of 20% sun and 64% epoxy and 16%hardner) has been layered on the mould (3 mm) thickness. After removing the entrapped air with the help of metal roller rolled on the layer, thereafter layer of matrix has been poured on the mould. Then upper part of mould is placed on side plates, which placed on both side of lower part of mould. In this way to cast the specimen of size (300 mm × 150 mm × 6 mm) the bio-composite sheet produced single ply having thickness between 3 mm and then left for 48 hours for curing at room temperature (15-27˚C). After 48 hours it is removed from the mould. Then this sheet is used to make tensile test and bending test specimens according to ASTM Standards. Taking out fabricated sheet of Bio-Composite from the mould and fabricated sheet of Bio-Composite. Compression test and impact test specimens are required higher thickness, so closed wooden moulds have been used, in which the mould that has been used to make Flexural test specimens has diffirent length, width and height. The internal surface of mould is covered with Mylar sheet with wax covered over Mylar sheet to protect matrix piece to stick with Mylar sheet. Then the matrix has been layered on lower part of the mould (40 mm) thickness and a layer of sun fibres placed unidirectional on it. After layer of Sunnhemp fibres again matrix layer is applied. Then upper part of mould is placed on lower part of mould and then left for 48 hours for curing at room temperature (15-27˚C). After 48 hours it is removed from the mould. Then Flexural test specimens of required dimensions according to ASTM Standards are cut from the fabricated sheet of bio-composite.

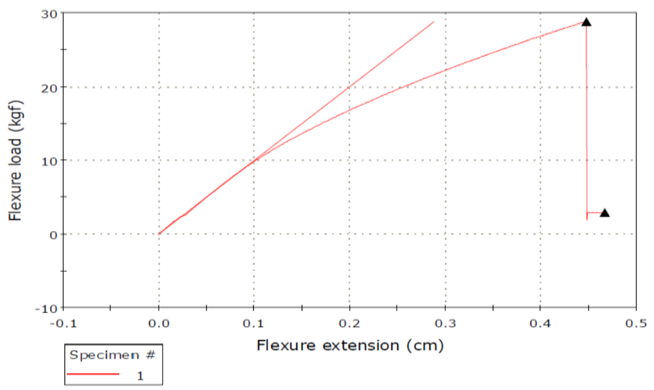
Sunnhemp raw materials Sunnhemp plant

Flexural Testing Machine

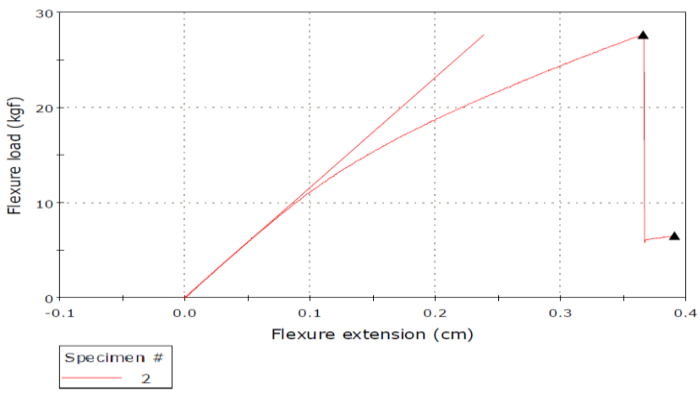
Result and Discussion

The uses of natural and manmade fibers reinforced bio composite materials are growing day by day in every field of engineering due to its characteristics and properties like eco-friendly, recyclable, bio-degradable and user friendly in nature. Many researchers are working in this field to make the sunnhemp composites and to replace metals and alloy materials in the field of engineering and technology without affecting the load carrying capabilities and cost aspects. In the present experimental study, the sunnhemp composite laminates. Then the test specimen is prepared from the composite laminates as per ASTM standards and testing of materials has been carried out under flexural loading conditions by using testing machine. The experimental results on Mechanical properties of the tested composite.

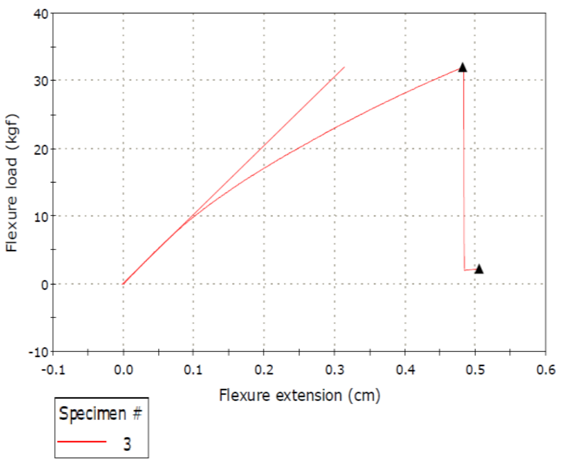
Test Graph 1 to 1

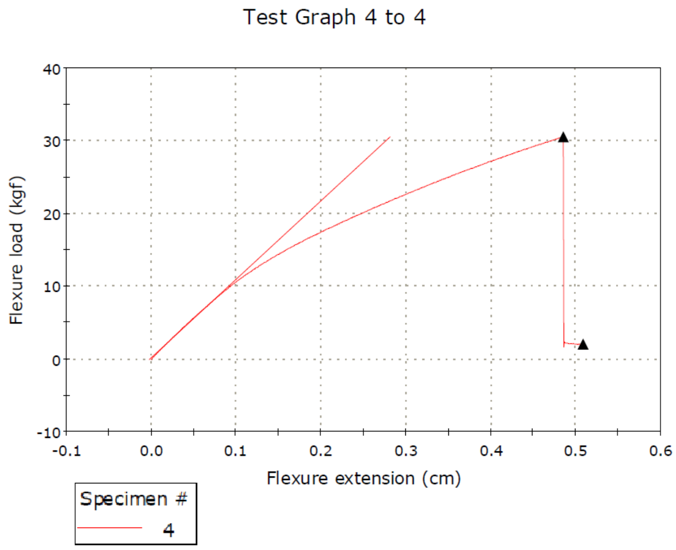


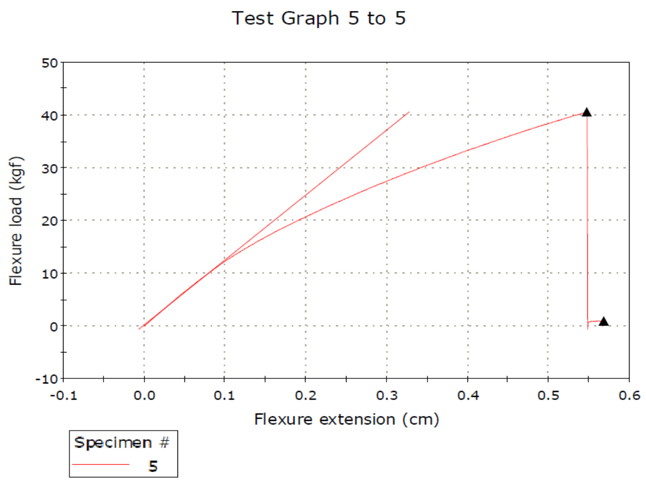
Test Graph 2 to 2



Test Graph 3 to 3







Result of experiments (test)

1. The 1st result –862.90kgf/cm^2 Flexural strength of the specimen tested on dated 06.02.20015 at CIPET LUCKNOW on UTM.
2. The 2nd result -829.26 kgf/cm^2 Flexural strength of the specimen tested on CIPET LUCKNOW on UTM.
3. The 3rd result -961.39 kgf/cm^2 Flexural strength of the specimen tested on CIPET LUCKNOW on UTM.
4. The 4th result – 915.98 kgf/cm^2 Flexural strength of the specimen tested on CIPET LUCKNOW on UTM.
5. The 5th result -1217.73 kgf/cm^2 Flexural strength of the specimen tested on CIPET LUCKNOW on UTM.
   The UTM was fully calibrated on the time of testing.

Width (mm)	Thickness (mm)	Support span (mm)	Speed (mm/min)	Maximum Flexure load (kgf)	Flexure Strength@ Max load (kgf/cm^2)	Flexure Elongation@ Max Load (%)	Flexure load@Break (kgf)	Flexure Strength@Break (kgf/cm^2)	Flexure Elongation @Break (%)	Modulus (kgf/cm^2)
14.00	5.72	91.52	3.49	28.79	862.90	1.83	2.97	88.90	1.91	73,113.94
14.00	5.72	91.52	3.49	27.67	829.26	1.50	6.61	198.01	1.60	84,470.70
14.00	5.72	91.52	3.49	32.08	961.39	1.97	2.35	70.37	2.07	74,371.80
14.00	5.72	91.52	3.49	30.56	915.98	1.99	2.13	63.76	2.08	78,937.35
14.00	5.72	91.52	3.49	40.63	1,217.73	2.24	1.04	31.04	2.32	90,181.59

Overall Conclusion

Hand lay-up technique is successfully employed in manufacturing PPP FRP composites with relative ease and accuracy. The wastage generated during the extraction of the fibre is 20 %. The soaking time for the present chemical composition yields the very good flxural properties .which is evidenced from the experimental results. The mechanical properties of the palmyra palm petiole FRP composites given enough confidence to fabricate light weight and reasonably good strength parts for automobile door panels, house hold applications like doors, window frames etc .

Suggested Applications

The bio-composites fabricated in my thesis work i.e. the jute fibre-rice and natural rubber latex based bio-composites has some applications are given as follows:

- Building material
- Polymer compounds
- Geo textiles
- Pulp and paper
- Cellulose
- Absorbent materials

Suggestions for Future Work

- Also use wheat, rice husk, wheat starch, corn starch, soy protein, etc. in fabrication of bio-composites.
- To observe thermal characteristics of bio-composites.
- Research should be done with for sunnhemp fibre reinforced biodegradable composites so that a fully biodegradable material (green composite) may be fabricated which can be used in packaging and home appliances. It will also be good for eco friendly environment.

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