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Fabrication & Characterization of Bio Composite Materials Based On Sunnhemp Fibre

Shailesh Kumar singh[1], Prabhat Kumar Sinha[2], Earnest Vinay Prakash[3]
Department of Mechanical Engineering, Shepherd School of Engineering and Technology,
Sam Higginbottom Institute of Agriculture Technology and Sciences,
Deemed University Allahabad (U.P.) INDIA.

ABSTRACT: *The present day technology demands eco-friendly developments. In this era the composite material are playing a vital roal in different field of Engineering .The composite materials are using as a principle materials. Nowaday the composite materials are utilizing as a important component of engineering field .Where as the importance of the applications of composites is well known, but thrust on the use of natural fibres in it for reinforcement has been given priority for some times. But changing from synthetic fibres to natural fibres provides only half green-composites. A partial green composite will be achieved if the matrix component is also eco-friendly. Keeping this in view, a detailed literature surveyed has been carried out through various issues of the Journals related to this field. The material systems used are sunnhemp fibres. Some epoxy and hardener has been also added for stability and drying of the bio-composites. Various graphs and bar-charts are super-imposed on each other for comparison among themselves and Graphs is plotted on MAT LAB and ORIGIN 6.0 software. To determining tensile strengths, Various properties for different bio-composites have been compared among themselves. Comparison of the behaviour of bio-composites of this work has been also compare with other works. The bio-composites developed in this work are likely to get applications in fall ceilings, partitions, bio-degradable packagings, automotive interiors, sports things (e.g. rackets, nets, etc.), toys etc.*
Keywords: *Bio-composite, Natural fibre bio-composite, Sunnhemp fibre, Characterization, fabrication of bio-composite, unidirectional reinforcement, green composite, mechanical properties of fibre.*

I. Introduction

Sunnhemp *(Crotalaria juncea)* is an important fiber plant in Asia. It has been cultivated since ancient times and there are no known wild ancestors. It is the earliest fiber to be mentioned in Sanskrit writings (Hill 1952). It is a shrubby annual legume from 6-12 ft tall with bright yellow flowers. It is grown primarily in southern India. Sunnhemp is an attractive natural fibre for use as reinforcement in composite because of its low cost, renewable nature and much lower energy requirement for processing. It is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. Its botanical name is Corchorus, which has been classified in the family Tiliaceae, or more recently in Malvaceae. It is mostly produced in India, Bangladesh and China. Fibres come from the stem and ribbon (outer skin) of the sunnhemp plant. which has prepared for harvesting are their fibres bundle of fibres and sunnhemp yarns. Poor resistance against moisture, brittles under influence of light, absorbs paint easily. Sunnhemp consists of very short elementary fibres (length 0.7-6 mm) which are stuck together by lignin to form long brittle fibres. U. S. Ishiaku et al. have studied fabrication and characterization of the mechanical and morphological properties of short fiber reinforced sun/poly butylene succinate (PBS) biodegradable composites in 2005. The effect of a dual gated mold in the fabrication of welded specimens was a key focus of the investigation. It was observed that incorporation of sunnhemp fiber (10 wt %) conferred drastic changes on the stress–strain properties of the matrix as the elongation at break (EB), dropped from 160% in the matrix to sun 10% in the composite. The tensile strength of the composite was lower than that of the matrix. However, it is noteworthy that the tensile modulus of the composite increased. Bending test also revealed that both bending strength and modulus increased with the incorporation of sunnhemp. Morphological studies of the tensile fracture surface using SEM revealed two types of failure mode. Ductile failure was indicated by plastic deformation at the initiation of fracture followed by brittle failure E. A. Bondareva *et. al*. have studied a quantitative relationship between the strengths of a latex compound and the binder, allowing prediction of the properties of the material, has been revealed and also examined how the strength of a composite depends on that of the binder, latex polymer in 2009.Zhi-Fen Wang *et. al*. have studied the starch was modified by esterification, and the starch/natural rubber composite was prepared by blending the modified starch with natural rubber latex. The morphology, thermal stability and mechanical properties of the composite were investigated in 2009. The results show that the crystal structure of starch in the composite disappears after modification with esterification, and the starch particles with an average size around 200 nm homogenously disperse throughout the natural rubber (NR) matrix. The thermal stability of composite is improved significantly after the modification with starch. The mechanical properties of composite are enhanced with the increase of starch loading. The composite possesses the best properties at the starch xanthate content of 20 parts per hundred rubbers (phr). The enhanced thermal stability and mechanical properties of modified starch/NR composite are mainly due to the improved phase interface interactions between rubber and starch. Dipa Ray et al**.** have studied a 5% alkali (Na OH) solution treatment for 0, 2, 4, 6 and 8 h at 30°C of jute fibres in 2012. An improvement in the crystallinity in the jute fibres increased its modulus by 12%, 68% and 79% after 4, 6 and 8 h of treatment respectively. The tenacity of the fibres improved by 46% after 6 and 8 h treatment and the % breaking strain was reduced by 23% after 8 h treatment. For the 35% composites with 4 h treated fibres, the flexural strength improved from 199.1 MPa to 238.9 MPa by 20%, modulus improved from 11.89 GPa to 14.69 GPa by 23% and laminar shear strength increased from 0.238 MPa to 0.2834 MPa by 19%. Quazi T. H. Shubhra et al. have fabricated and studied plant based natural jute fiber reinforced polypropylene (PP) matrix composites (20 wt% fiber) by compression moulding in 2010. Bending strength (BS), bending modulus (BM), tensile strength (TS), Young's modulus (YM), and impact strength (IS) of the composites were found 44.2 MPa, 2200 MPa, 41.3 MPa, 750 MPa and 12 kJ/m^2, respectively. Animal based natural B. mori silk fiber reinforced polypropylene (PP) matrix composites (20 wt% fiber) were fabricated in the same way and the mechanical properties were compared over the silk based composites. TS, YM, BS, BM, IS of silk fiber reinforced polypropylene composites were found 55.6 MPa, 760 MPa, 57.1 MPa, 3320 MPa and 17 kJ/m^2 respectively. B. Singh et al. have studied the durability of jute fibre-reinforced phenolic composites in 2000. The physical and mechanical properties of jute composites have been studied under humidity, hydrothermal and weathering conditions. The aging-induced deteriorative effect of these conditions on the dimensional stability, surface topography and mechanical properties of the composites was observed. The severity of aging was more detrimental in an accelerated water test as compared to the other exposure conditions. Smita Mohanty et al. have studied dynamic mechanical and thermal properties of MAPE treated jute/HDPE composites in 2006. They summarize an experimental study on the mechanical and viscoelastic behavior of jute fibre reinforced high density polyethylene (HDPE) composites. Variations in mechanical strength, storage modulus, loss modulus and damping parameter with the addition of fibres and coupling agents were investigated. It was observed that the tensile, flexural and impact strengths increased with the increase in fibre loading up to 30%, above which there was a significant deterioration in the mechanical strength.. Dynamic mechanical analysis data showed an increase in the storage modulus of the treated composites. The thermal behavior of the composites was evaluated from TGA/DTG thermo-grams. It can be concluded that jute fibres could effectively reinforce HDPE matrix when used in an optimal concentration of fibres and coupling agents.

II. Materials 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. Sunnhemp 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 the bio-composite sheet produced single ply having thickness between 5.50 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 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 tensile test specimens has diffirent length, height and width. 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 sunnhemp 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 tensile test specimens of required dimensions according to ASTM Standards are cut from the fabricated sheet of bio-composite.

Physical, chemical and mechanical properties of epoxy resin (Araldite AY - 103) and hardener (Aradur HY - 951)

Properties	Epoxy (Araldite AY - 103)	Hardener (Aradur HY - 951)
Colour	Clear Amber	Colorless
Odour	Mild	Ammonia
Physical State	Liquid	Liquid
Solubility in Water	Insoluble	Insoluble
Specific Gravity	1.14 (water = 1)	0.98 (water = 1)
Boiling Point	> 300°F (> 149 °C)	>200 °C
pH value	Not Determined	Approx. 13
Flash Point	> 250°F (> 121 °C)	110°C
Percent Volatile	Negligible	Negligible
Shear Strength	8.9 ± 0.6 MPa	-
Young's Modulus	13.2 ± 0.6 GPa	-
Deformation at Break	0.23 ±0.03 %	-
Tensile Strength	31.74 MPa	-
Source: *Huntsman Advanced Materials Americas Inc. (EL), P.O Box 4980, Woodlands.*		

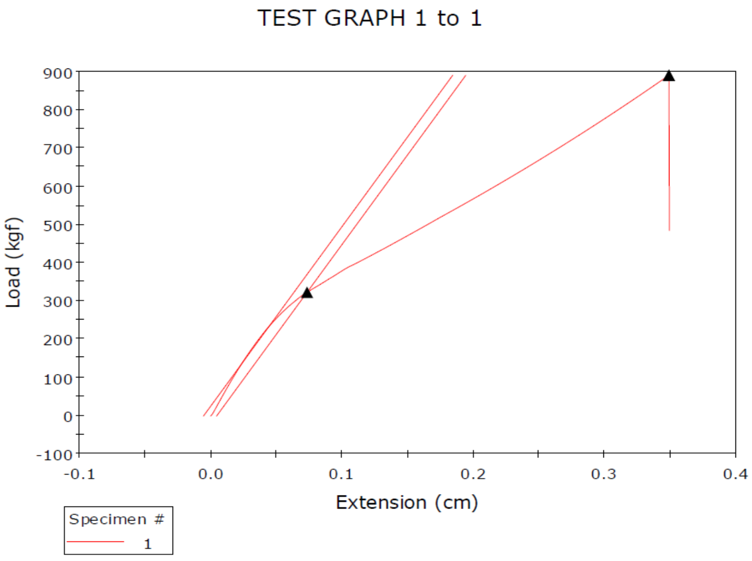
Processed fibre composite material

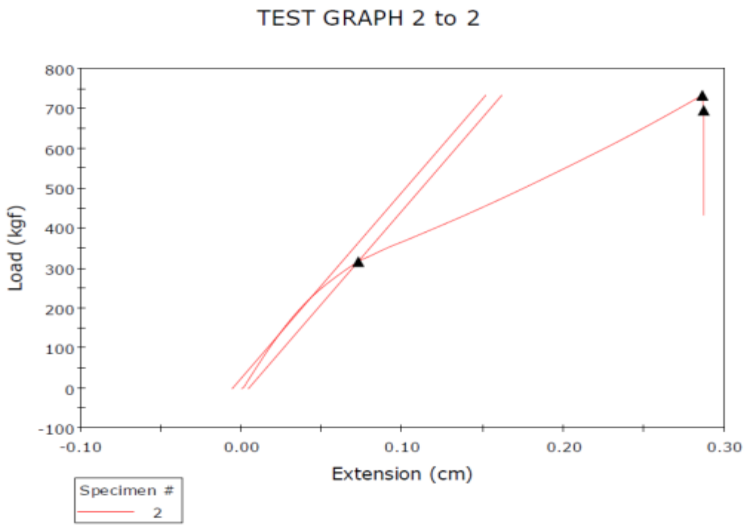
Sunnhemp raw material Sunnhemp plant

Universal testing machine

III. Results And Discussion

The application of natural and manmade fibers reinforced bio composite materials are growing day by day in every field of engineering due to its characteristics 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 are prepared from the composite laminates as per ASTM standards and testing of materials has been carried out under tensile, flexural and impact loading conditions by using universal testing Specimen fracture Specimen fracture Notch machine and impact testing machine.The experimental results on mechanical properties of the tested composite.


TEST GRAPH 1 to 1
Load (kgf)
Extension (cm)
Specimen #
1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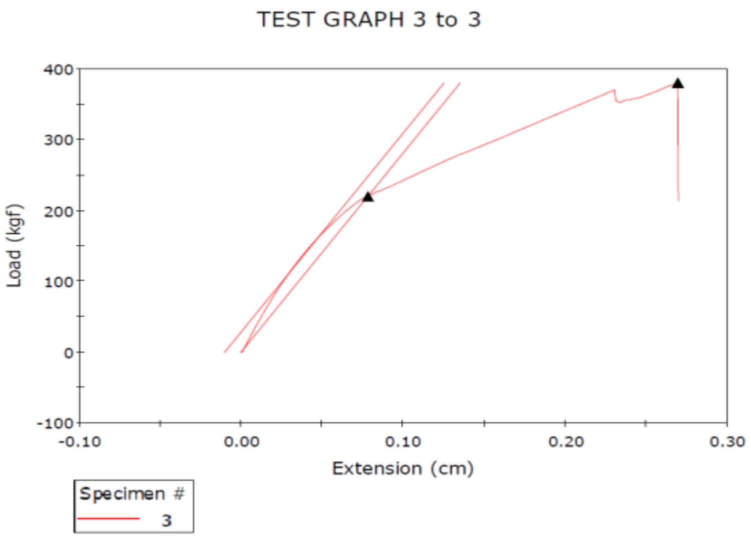
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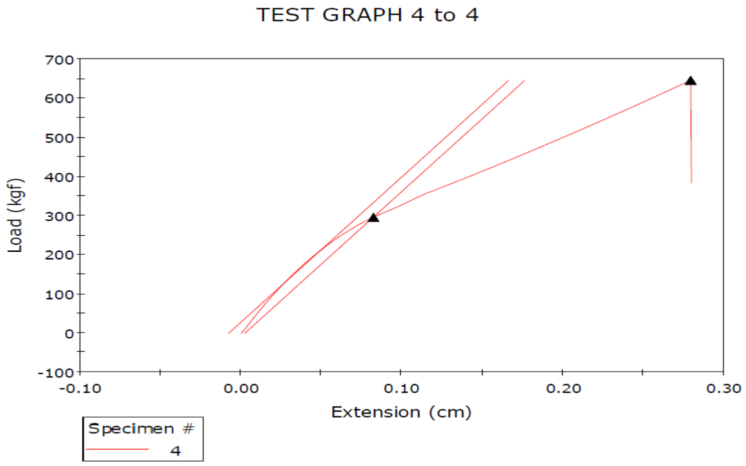
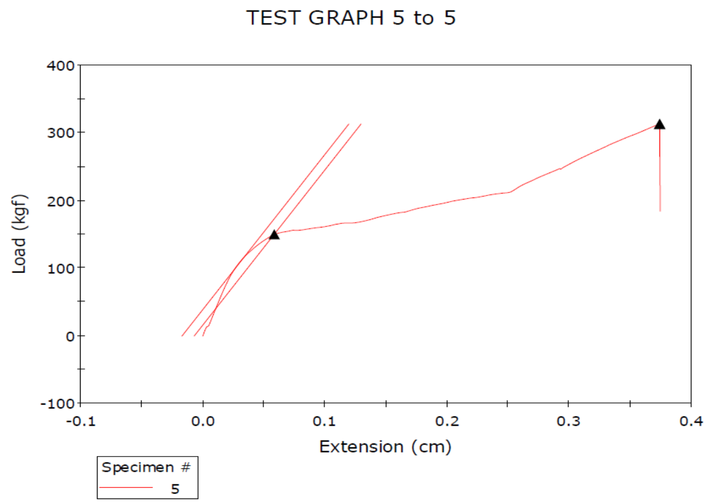
3





Result of experiments (test)

1. The 1st result - 957.56 kgf/cm^2 Tensile strength of the specimen tested on dated 06.02.20015 at CIPET LUCKNOW on UTM.

2. The 2nd result - 803.39 kgf/cm^2 Tensile strength of the specimen tested on CIPET LUCKNOW on UTM.

3. The 3rd result -440.42 kgf/cm^2 Tensile strength of the specimen tested on CIPET LUCKNOW on UTM.

4. The 4th result - 756.98 kgf/cm^2 Tensile strength of the specimen tested on CIPET LUCKNOW on UTM.

5. The 5th result -347.12 kgf/cm^2 Tensile strength of the specimen tested on CIPET LUCKNOW on UTM.

The UTM was fully calibrated on the time of testing.

	Width (mm)	Thicknes s (mm)	Area (cm^2)	Speed (mm/min)	Maximum Load (kgf)	Tensile stress at Maximum Load (kgf/cm^2)	Elongation @Max Load (%)	Load at Yield (kgf)	Elongation@ Yield (%)	Tensile Strength@Yiel d (kgf/cm^2)
1	16.90	5.50	0.93	5.00	890.1	957.56	6.97	323.19	1.47	347.70
2	16.60	5.50	0.91	5.00	733.5	803.39	5.72	318.06	1.45	348.37
3	15.70	5.50	0.86	5.00	380.3	440.42	5.38	220.58	1.56	255.45
4	15.50	5.50	0.85	5.00	645.3	756.91	5.58	296.28	1.64	347.54
5	16.40	5.50	0.90	5.00	313.1	347.12	7.47	150.26	1.17	166.59

IV. Overall Conclusions

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 tensile 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.

V. Suggested Applications

The bio-composites fabricated in my thesis work i.e. the sunnhemp fibre based bio-composites has some applications are given as follows:

- Fall Ceilings
- Partitions
- Bio-degradable Packagings
- Automotive Interiors
- Sports Things (e.g. rackets, nets, etc.)
- Toys etc.

VI. Research Can Be Carried Out Further

- Also find the characteristics of bio-composites should be studied at different temperatures.
- 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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