Study of mechanical properties of banana-jute fibre epoxy composite with carbon fibre

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***Abstract*— Fibre composites are nowadays being used in various engineering applications to increase the strength and optimize the weight and the cost of the product .The use of composite material field is increasing gradually in Engineering .Because of the expanding natural concerns bio composites produced out of the natural fibre and resin is one of the late advancement in business and constituent the present extent of natural work. In our project an investigation will be carried out to make better utilization of banana fibre for making value added products. A Specimen is fabricated by hybridisation of Natural fibres (Banana Fibre and Jute Fibre) and epoxy resin. Another Specimen is fabricated by hybridisation of Fibre (Banana Fibre, Jute Fibre, and Carbon Fibre) and epoxy Resin. Experiments are carried out as per American Standard of Testing and Materials (ASTM) standards to find the mechanical Properties of both specimens. The accessibility of characteristic fibre and simplicity of assembling have enticed scientists worldwide to attempt by regional standards accessible inexpensive fibre and to learning their achievability of fortification determination and to what degree they fulfil the obliged particular of great strengthened polymer composite aimed at structural requisition. The effect of fibre loading and length on mechanical properties like tensile strength and flexural strength of composites is studied.**

Keywords—composite,banana fibre,jute fibre, carbon fibre, tensile, flexural

I. INTRODUCTION

The most widely used meaning is the following one, which has been stated by Jartiz ‘’Composites are multifunctional material systems that provide characteristics not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials different in composition and characteristics and sometimes in form". Kelly very clearly stresses that the composites should not be regarded simple as combination of two materials. In the broader significance, the combination has its own distinctive properties. In terms of strength to resistance to heat or some other desirable quality. It is better than either of the components alone or radically different from either of them. Beghezan defines as "The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings", in order to obtain improved materials. Van Suchetclan explains composite materials as heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale. They can be also consider as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property.

A. Need

There is unabated thirst for new materials with improved desired properties. All the desired properties are difficult to find in single material. For example, a material which needs high fatigue life may not be cost effective. The list of desired properties, depending upon the requirement of the application is given below.

- Strength
- Stiffness
- Toughness
- High corrosion resistance
- High wear resistance
- High chemical resistance
- High environmental degradation resistance
- Reduced weight
- High fatigue life
- Thermal insulation or conductivity
- Acoustic insulation
- Radar transparency
- Energy dissipation
- Reduced cost

The list of desired properties is in-exhaustive. It should be noted that the most important characteristics of composite materials is that their properties are tailorable, that is, one can design the required properties.

B. Overview of fibre and Composites

The attraction in utilizing natural fibre, for example, distinctive wood fibre and plant fibre as support in plastics has expanded drastically throughout last few years. Concerning the ecological viewpoints if natural fibres might be utilized rather than glass fibres as fortification in some structural provisions it might be extremely intriguing. Natural fibres have numerous points of interest contrasted with glass fibre, for instance they have low thickness, and they are biodegradable and recyclable. Also they are renewable crude materials and have generally great strength and stiffness.

C. Classification of Natural Fibres

Fibres are a class of hair-like material that are continuous filaments or are in discrete elongated pieces, similar to pieces of thread. They can be spun into filaments, thread, or rope. They can be used as a component of composites materials. They can also be matted into sheets to make products such as paper or felt Fibres are of two types: natural fibre and man-made or synthetic fibre.

D. Plant Fibres

Plant fibres usually consist of cellulose: examples cotton, jute bamboo, flax, ramie, hemp, coir and sisal. Cellulose fibres are used in various applications. The category of these fibres is as following: Seed fibres are those which obtain from the wood e.g. Kapok and cotton. These fibres having superior tensile properties than the other fibres. Because of these reason these fibres are used in many applications such as packaging, paper and fabric. Fruit are the fibres generally are obtain from the fruit of the plant, e.g. Banana fibre and coconut fibre. Similarly, stalk fibre are the fires which are obtain from the stalks (rice straw, bamboo, wheat and barley). Leaf fibres are the fibres those are obtain from the leaves (agave and sisal). Skin fibres are those fibres which are obtain from the bast or skin surrounding the stems of the plant.

E. Mineral Fibres

Mineral fibres are those which are pet from minerals. These are naturally happening fibre or somewhat changed fibre. it has different classifications they are taking after Asbestos is the main characteristically happening mineral fibre, The Variations in mineral fibre are the serpentine. Amphiboles and anthophyllite. The Ceramic filaments are glass fibre, aluminium oxide and boron carbide Metal filaments incorporate aluminums strands.

F. Animal Fibres

Animal fibre by and large comprises of proteins cases, silk alpaca, mohair downy, Aalmal hair are the strands got from creatures e.g. Sheep's downy, goat hair, hose hair, alpaca hair, and so forth Silk fibre is the filaments gathered from dry saliva of bugs or creepy crawlies throughout the time of planning of cocoons. Avian strands are the fibre from fowls. Composites of natural fibre used for drives of structural, but typically with synthetic thermoset matrix which of course bound the environmental benefits. Now a days natural file composites application are usually found in building and automotive industry the place where dimensional constancy under moist and high thermal conditions and load bearing capacity are of importance. Natural fibres like cotton, sisal, jute, abaca, pineapple and coir have been studied like reinforcement and filler in composites. Among various natural fibres, banana fibre is considered asprential reinforced in polymer composites due to its many advantages such as easy availability, low cost, comparable strength properties etc. Generally, natural fibres are consists of cellulose, lignin, pectin etc. The detail composition of few commonly used natural fibres is shown in

The composite materials could be termed as those materials which are synthesized by two or more materials having diverse properties. By and large, composites materials have strong load carrying reinforcing material imbedded in weaker lattice materials. The primary constitute of composites have nonstop stage which is the significant a piece of the composite is called matrix. Matrix are by large more ductile and less hard and these are generally either inorganic or natural. Optional constituent of composites have ductile called reinforcement and they implanted in the matrix. The constitutes of composite material have their property however when they are consolidated together, they give a blend of properties that singular can't have the capacity to give.

G. Advantages of Natural Fibre Composites

The main advantages of natural liber composite are:

- Low specific weight, resulting in a higher specific strength and stiffness than glass fibre.
- It is a renewable source, the production requires little energy and CO2 is used while oxygen is given back to the environment.
- Producible with low investment at low cost, which makes the material an interesting product for low wage countries.
- Reduced wear of tooling, healthier working condition, and no skin irritation.
- Thermal recycling is possible while glass causes problem in combustion

Furnaces.

- Good thermal and acoustic insulating properties.

H. Composite types

Generally, composite materials are arranged on the basis of matrix materials as:

1. Ceramic Matrix Composites
2. Polymer Matrix Composites
3. Metal Matrix Composites

1. Ceramic matrix composite:

The composite which is consisting of a ceramic combined with a ceramic dispersed phase. Because of availability of new technologies, the demand for high performance products and processing methods, have together improve the Growth of advanced ceramic products but brittleness of ceramics still retain major disadvantage.

2. Polymer matrix composite:

Polymer matrix composites are recognized to be more conspicuous class of composites when contrasted with artistic or metal lattice composites once in business requisitions. It includes a matrix from thermoplastic (polystyrene, nylon) or thermosetting (epoxy unsaturated polyester) or and inserted steel, glass carbon, or Kevlar strands.

3. Metal matrix composite:

Composites consisting of metal matrix such as Mg, Al, Fe is called metal matrix composites. The interest in metal matrix composites is due to many reasons such as their engineering properties. They are of exhibit good stiffness, light weight, and low specific weight as compared to other metal alloys and metals. Although it has many advantages, low cost remains a major point of interest for many applications. Among these all types of composites. Polymer matrix composite is most commonly used composites, because of its advantages such as high strength, low cost, simple manufacturing principle. The requirement of polymer material in this modern dynamic world is increasing day by day because it has wide range of advantages over traditional material in terms of high strength to weight ratio, cost, high toughness, high tensile strength and high creep resistance at increases in temperatures. Polymer matrix composites have three types of polymer which have been used as matrix. These are thermoplastics, thermosetting and elastomer polymer. Thermoplastic polymer is that polymer which are over and pain diminished and formed by heating A few illustrations of the plastics are PVC, LDPE and HDPE Thermoplastic materials are shaped when they are in softened or melted Thermoplastics have properties for example, light weight low thickness, which relying on science they could be similar to elastic and strong as aluminium,.

The other sort of constants of composites is reinforcement. Reinforcements are generally used to upgrade general mechanical properties of matrix and offer quality to composites. The reinforcement in composites is either fibrous or non-fibrous. Again fibrous composites are either natural fibre reinforced or synthetic fibre reinforced composites. There are many factors affecting the properties of fibre reinforced polymer composites such as fibre parameters, matrix fibre-matrix interfacial bonding etc. A great deal of work has been done on the different kinds of natural fibre based polymer composites. The objective of the present work is to study the potential utilization of fibre reinforced composites is a reinforcing material in epoxy composites and to investigate the mechanical behaviour. Fibre are a class of hair-like materials that are continuous filaments" or are in discrete elongated pieces, similar to pieces of thread. They can be used as component of composite materials. Natural fibres are made from plant, animal and mineral sources. The primary advantages of natural fibres are low density, low cost, biodegradability, acceptable specific properties, less wear during processing and low energy consumption during extracting as well as manufacturing composites and wide varieties of natural fibres are locally available. Natural fibres are easy to handle when compare to the synthetic fibre.

II. LITERATURE SURVEY

A report from the National Institute of Research on Jute and Allied Fibre Technology (NIRJAFT), Calcutta reveals that, usually for moulded jute composites with polyester resin, the resin intake can be maximum up to 40%. Both hot press moulding and hand lay-up technique can be used for its fabrication. The effect of chemical treatment of natural fibres with sodium alginate and sodium Hydroxide has also been reported for coir, banana and sisal fibres. This modification results in an increase in adhesive bonding and thus improves ultimate tensile strength up to 30%.Mitraet al. have reported that treatment of jute with poly condensates such as phenol-Formaldehyde, melamine formaldehyde and cashew nut shell with liquid formaldehyde improves the wet ability of jute fibres and reduces water regain properties. Gassanet al. have improved the tensile, flexural strength and stiffness of jute-epoxy composites by treating the fibres with silane. The delignification by bleaching produces better interfacial bond between the jute fibre and the polyester matrix, and hence results in better mechanical properties of the composites. The absorption of steam by banana fibre/novalac resin composites has been found to reduce after esterification of the –OH groups with the maleic anhydride. The tensile strength of maleic anhydride treated fibre composites is higher than that of the untreated fibre composites. Wambuaetal bridged the gap and investigated the response of flax, hemp, and jute fabric reinforced polypropylene composites to ballistic impact by fragment simulating projectiles. The effect of alkali (5% NaOH for 2hrs) and silane (1% oligomericsiloxane with 96% alcohol solution for 1 hr) treatment on the flexural properties of jute epoxy and jute polyester composites. For jute epoxy composites alkali over silane treatment resulted in about 12% and 7% higher strength and modulus properties compared to the alkali treatment alone. Similar treatment led to around 20% and 8% improvement for jute polyester composites. Dipa et al. have reported 4h alkali treated jute- vinyl ester composites accounted 20% and 19% increase in flexural strength and inter laminar shear strength properties. Treated jute fibres with NaOH solution of concentration 1 and 8%for 48 h and observed130% improvement in the tensile strength of the fibres in both the cases.

Similarly, jute fibres were treated with 2%NaOH solution for 1 h and 13% improvement in the tenacity of the fibres was reported. Lina Herrera- Estrade, Selvumpillay and udayvaidy approved that 6% NaoH treated banana fibre/ epoxy composites environmental resistance is higher than banana fibre/polyester composites without any treatment. This is due to improvement in fibre/ matrix interaction with the fibre chemical pre-treatment in epoxy composites and to deterioration of the inter phase in polyester composites. the tensile testing of untreated jute fabric-reinforced polyester composites was studied and the average values of UTS, initial tangent modulus for these composites are 60MPa, 7GPa. Researchers investigating thermal properties of jute/bagasse hybrid composites observed that thermal stability of hybrid composites increased by increasing residual char left at 600oC.Kamaker et al. reported that using 3wt% MAHgPP (type G-3002, with an average molecular weight of 40,000 and containing 6 wt% of maleic anhydride, as coupling agent in Jute/PP composite increases composite mechanical properties. The tensile strength is doubled from 29.82 MPa to 59.13 MPa and the bending strength increases from 49.97 MPa to 87.66 MPa in composite with 50 wt% fibre content.Gassan et al. showed that the tensile, flexural and dynamic strength increase up to 50% but impact energy decreases due to the lower energy absorption in the interface of jute/PP composite when jute fibres are treated by 0.1wt% MAHgPP solution in toluene for 5min at 100°C. Ray et al. used a solution of NaOH 5% to treat the jute fibre for 0, 2, 4, 6 and 8 hours at 30°C. For the vinyester resin composites reinforced by 35 wt% jute fibre treated for 4 h, an improvement of 20% for the flexural strength, of 23% for the flexural modulus and of 19% for the laminar shear strength was observed. The acetylation of jute fibre was investigated by Rana et al. and showed animprovement in thermal resistance compared to untreated fibre.Treatment of the jute fibre with PF and CNSL-PF carried out by Mitra et al. showed a reduction of the thermal stability of the treated fibre.Kita et al. reported that the degradation of lignin in cellulose fibre sets in at around 200°C, and other polysaccharides, mainly cellulose, are oxidized and degraded at higher temperature .The influence of the injection molded processing on the final fibre length of the polypropylene composites based on abaca, jute and flax fibres investigated by Biagotti et al.showed the minor effect with the higher fibre content and a more significant size reduction of the flax fibre due to its more rigid behavior.The swelling of the jute fibre in the polypropylene composite was found by Karmaker et al. to have positive effects on the mechanical properties .The influence of fibre surface treatment by MAHgPP on the dynamic mechanical properties of jute reinforced polypropylene was investigated by Gassan and Bledzki. It was shown that maleic anhydride polypropylene copolymer increases the level of adhesion between polypropylene and jute fibre. Roe reported that the reinforcement of polyesters with jute fibres.

Due to presence of hydroxy and other polar groups in various constituents of jute fibre, the moisture uptake is high (approx. 12.5% at 65% relative humidity & 20o C) by dry fibre. Polymeric coating of jute fibre with phenolformaldehyde or resorcinol formaldehyde resins by different approaches is highly effective in enhancing the reinforcing character of jute fibre, giving as high as 2040% improvements in flexural strength and 40-60% improvements in flexural modulus. These modifications improve the fibre-matrix resin wet ability and lead to improved bonding. Banana fibre Musa paradiisiacaL. varSapientumor MusaulugurensisWarb is the most cultivated banana plant.The word banana comes from Arabic and it means „finger". Satyanarayana et al.reported that the reinforcement of polyesters with banana-cotton fibres. Sreekumar et al., 2008 investigated that Banana FRP composites having fibre length of 30 mm and a fibre content of 40vol% showed the maximum tensile strength. The highest tensile strength values has obtained for an intimate mixture of banana and glass fibres has been obtained for composite samples prepared from interleaving layers of banana fibre and glass fibre. Composites with good strength could be successfully developed using banana fibre as the reinforcing agent in phenolic resins. Where the interfacial shear strength was higher in banana fibre embedded in phenolic resins than for glass fibre indicating a strong adhesion between the lingo cellulosic banana fibre and phenolic resins .El-Abden S. Z et al Asbestos free friction composites reinforced by natural fibres was developed. Asbestos was replaced by natural fibres such as flax linen, kenaf, casuarina, date palm luffa, willow, banana core, bamboo, coconut coir, camphor and human hair. The proposed composites contained iron, sand and phenolic resin. Bilba et al. examined four fibres from banana-trees (leaf, trunk) and coconut-tree (husk, fabric) before their incorporation in cementitious matrices, in order to prepare insulating material for construction. Thermal degradation of these fibres was studied between 200 and 700 °C under nitrogen gas flow. The researchers have reported the mechanical aspects of banana and sisal hybrid fibre reinforced polyester composites. Agarwal et al.analyzed the variation of thermal conductivity and thermal diffusivity of banana fibre reinforced polyester composites caused by the addition of glass fibre. They observed that the thermal conductivity of composites increased as compared to the matrix. However, the thermal conductivity of the composites with increased percentage of glass fibre decreases when compared to composite of pure banana fibre. The composites made up of glass fibre reinforced with nanochitosan has more crystallinity in terms of better strength compared to banana composites reinforced nanochitosan.

A. *Objectives of the current research work*

The main objectives of current research work which are outlined as follows:

1. Fabrication of fibre reinforced Composites with natural fibres and also with carbon fibre

2. Evaluate the mechanical properties such as tensile strength and Flexural Strength

3. To find better application for the composites

III. EXPERIMENTAL STUDY

A. *Materials*

The materials used are:

1. Carbon Fibre
2. Banana fibre
3. Jute Fibre
4. Epoxy
5. Resin and Hardener

1. Carbon Fibre

Carbon fibres are fibres about 5–10 micrometres in diameter and composed mostly of carbon atoms. Carbon fibres have several advantages including high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion. These properties have made carbon fibre very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports. However, they are relatively expensive when compared with similar fibres, such as glass fibres or plastic fibres.to produce a carbon fibre, the carbon atoms are bonded together in crystals that are more or less aligned parallel to the long axis of the fibre as the crystal alignment gives the fibre high strength-to-volume ratio (making it strong for its size). Several thousand carbon fibres are bundled together to form a tow, which may be used by itself or woven into a fabric. Carbon fibres are usually combined with other materials to form a composite. When impregnated with a plastic resin and baked it forms carbon-fibre-reinforced polymer(often referred to as carbon fibre) which has a very high strength-to-weight ratio, and is extremely rigid although somewhat brittle. Carbon fibres are also composited with other materials, such as graphite, to form reinforced carbon-carbon composites, which have a very high heat tolerance.

Fig. 1. Carbon Fibre

2. Banana Fibre

Banana fibre is extracted from the pseudo stem Sheath of the plant. The Extraction can be done mainly in three ways: Manual, Chemical and Mechanical of these, mechanical Extraction is the best way to obtain fibre of both good quality and quantity in an eco-friendly way. After extraction, the fibre is shade dried for a day and packed in HDPE bags. Then extraction, then it is stared away from moisture and light to keep it in good condition until it is used. The banana fibre is used for the following purposes: For manufacturing mattresses, pillows and cushions in the furniture industry, in handicraft extensively for making bags, purse, mobile phone cover, door mats, curtains and yoga mats etc., in the manufacture of textiles.

Fig. 2. Banana Fibre

3. Jute Fibre

Jute is a long, soft, shiny vegetable fibre that can be spun into coarse, strong threads. It is produced primarily from plants in the genus Corchorus, which was once classified with the family Tiliaceae, and more recently with Malvaceae. The primary source of the fibre is Corchorus olitorius, but it is considered inferior to Corchorus capsularis. "Jute" is the name of the plant or fibre used to make burlap, hessian or gunny cloth.

Jute is one of the most affordable natural fibres, and second only to cotton in the amount produced and variety of uses. Jute fibres are composed primarily of the plant materials cellulose and lignin. It falls into the bast fibre category (fibre collected from bast, the phloem of the plant, sometimes called the "skin") along with kenaf, industrial hemp, flax (linen), ramie, etc. The industrial term for jute fibre is raw jute. The fibres are off-white to brown, and 1–4 metres (3–13 feet) long. Jute is also called the golden fibre for its color and high cash value.

Fig. 3. Jute Fibre

TABLE I. MECHANICAL PROPERTIES OF JUTE AND BANANA FIBRE

Fiber Type	**Tensile Strength (Mpa)**	**Specific Tensile Strength (Mpa)**	**Young's Modulus (Gpa)**	**Specific Young's Modulus (Gpa)**	**Failure Strain (%)**
Jute	200-450	140-320	20-55	14-39	2-3
Banana	529-914	392-677	27-32	20-24	1-3

TABLE II. CHEMICAL COMPOSITION OF JUTE AND BANANA FIBRE

Fiber Type	**Cellulose**	**Hemi cellulose**	**Lignin**	**Pectin**
Jute	51-84	12-20	5-13	0.2
Banana	60-65	6-19	5-10	3-5

4. Resin and Hardener

The Epoxy Resin used in this study are Araldite LY556 and Araldite HY951 (Hardener). The Importance of these Epoxy Resins are:

- Industrial composites
- Good mechanical strength
- Good resistance to atmospheric and chemical degradation
- Excellent electrical properties.

Fig. 4. Resin and Hardener

IV. PREPARATION OF SPECIMENS

In this Experiment two Specimens are made with Natural fibres like Banana Fibre and Jute Fibre. In the Second Specimen Carbon fibre is added. The hardener like epoxy (Araldite LY556) and Araldite HY951 is used to manufacture the composite combination. The Composite plates were prepared by Hand layup method.

A. Hand lay-up method

Hand lay-up is the simplest and oldest open molding method of the composite fabrication processes. It is a low volume, labor intensive method suited especially for large components, such as boat hulls. Glass or other reinforcing mat or woven fabric or roving is positioned manually in the open mold, and resin is poured, brushed, or sprayed over and into the glass plies. Entrapped air is removed manually with squeegees or rollers to complete the laminates structure. Room temperature curing polyesters and epoxies are the most commonly used matrix resins. Curing is initiated by a catalyst in the resin system, which hardens the fibre reinforced resin composite without external heat. For a high quality part surface, a pigmented gel coat is first applied to the mold surface.

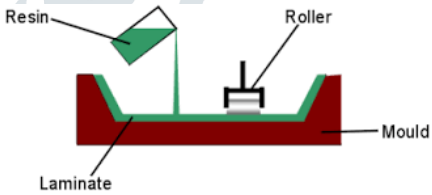

Fig. 5. Hand Lay-up method

B. Specimen A

Specimen A consist only of natural fibres (banana and jute).The Composite is prepared by Hand lay-up method. Jute Fibre is set as base material. Banana Fibre and Jute Fibre are kept over other consisting of 7 layers. At the end of the process thickness is 6.7 mm.

JUTE FIBRE
BANANA FIBRE
JUTE FIBRE
BANANA FIBRE
JUTE FIBRE
BANANA FIBRE
JUTE FIBRE

Fig. 6. Composition of Specimen A

Fig. 7. Specimen A

C. Specimen B

Specimen B consist only of natural fibres (banana and jute) and Carbon Fibre .The Composite is prepared by Hand lay-up method. Carbon Fibre is set as base material. Banana Fibre and Jute Fibre are kept over other sandwiched with carbon fibre consisting of 7 layers. At the end of the process thickness is 6.5 mm.

CARBON FIBRE
BANANA FIBRE
JUTE FIBRE
CARBON FIBRE
BANANA FIBRE
JUTE FIBRE
CARBON FIBRE

Fig. 8. Composition of Specimen

Fig. 9. Specimen B

V. TESTING

A. Tensile test

Tensile test is also known as universal engineering test to achieve material properties such as ultimate strength, elongation. Yield Strength. These important properties obtained from this testing are useful for the selection of stable materials for any applications.

The test is carried out by applying axial load or longitudinal load at a specific extension rate to standard tensile specimen with known dimensions like gauge length, cross sectional area and thickness. The applied load and extension are recorded during the test for stress and strain calculation. A range of Universal standards such as American Society of Testing and Materials (ASTM), JIS Standards, DIN standard and British Standard. Each Standard may contain variety of test standards suitable for different materials. The universal standards we used for this experiment is ASTM. The material specimen is prepared as per the ASTM D638 Standard.

1. Tensile test of specimen A

The universal standards we used for this experiment is ASTM. The material specimen is prepared as per the ASTM D638 Standard. Two samples are taken for testing. A universal testing machine with maximum load rating of 400 KN is used for testing. The material is held by the grips and load is applied till failure occurs. Ultimate tensile test is noted. A stress versus strain graph is generated. Dimensions of the Samples are as follows:

TABLE III. DIMENSIONS OF TENSILE SAMPLES OF SPECIMEN A

Dimension	Sample A1	Sample A2
Gauge Length	1MM	1MM
Width	13.25 MM	13.2 MM
Thickness	6.88mm	6.87mm

Fig. 10. Tensile Samples of Specimen A before testing

Fig. 11. Tensile Samples of Specimen A after testing

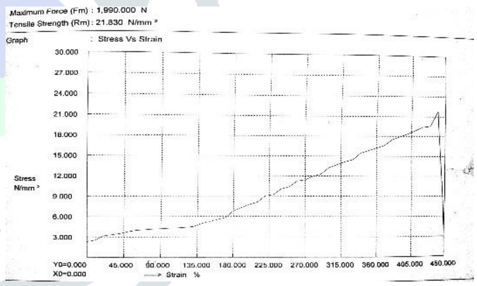

Fig. 12. Stress vs Strain graph for tensile test of Sample A1

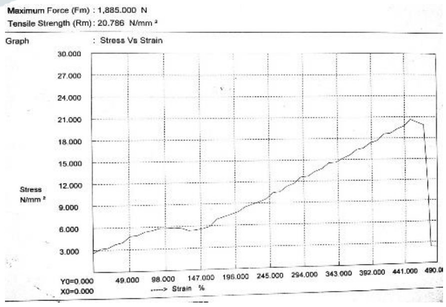

Fig. 13. Stress vs Strain graph for tensile test of Sample A2

The Results obtained from the experiment are given in the below table

TABLE IV. TENSILE TEST RESULT OF SPECIMEN A

Tensile Test	Sample A1	Sample A2	Average Tensile Strength
Maximum Force (Fm)	1990 N	1885 N	
Tensile Strength (Rm)	21.830 MPa	20.786 MPa	21.308 MPa

2. Tensile test of specimen B

The universal standards we used for this experiment is ASTM. The material specimen is prepared as per the ASTM D638 Standard. Two samples are taken for testing. A universal testing machine with maximum load rating of 400 KN is used for testing. The material is held by the grips and load is applied till failure occurs. Ultimate tensile test is noted. A stress versus strain graph is generated. Dimensions of the Samples are as follows:

TABLE V. DIMENSIONS OF TENSILE SAMPLES OF SPECIMEN B

Dimension	**Sample B1**	**Sample B2**
Gauge Length	1MM	1MM
Width	12.39 MM	12.39 MM
Thickness	7.03 mm	7.03mm

Fig. 14. Tensile Samples of Specimen B before testing

Fig. 15. Tensile Samples of Specimen B after testing

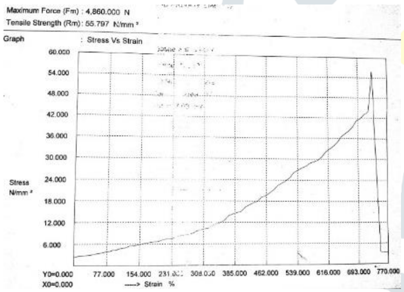

Fig. 16. Stress vs Strain graph for tensile test of Sample B1

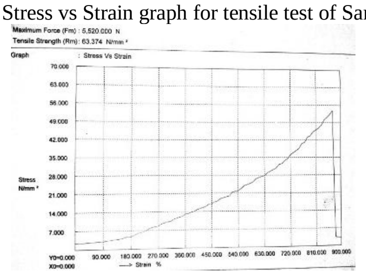

Fig. 17. Stress vs Strain graph for tensile test of Sample B2

The Results obtained from the experiment are given in the below table

TABLE VI. TENSILE TEST RESULT OF SPECIMEN B

Tensile Test	**Sample B1**	**Sample B2**	**Average Tensile Strength**
Maximum Force (Fm)	4860 N	5520 N	
Tensile Strength (Rm)	55.797 MPa	63.374 MPa	59.586 MPa

B. Flexural Load Test

The flexural test measures the force required to bend a beam under three point loading conditions. The data is often used to select materials for parts that will support loads without flexing. Flexural modulus is used as an indication is stiffness when flexed. Most commonly the specimen lies on a support span and the load is applied to the centre by the loading nose producing three points bending at a specified rate. The parameters for this test are the support span, the speed of the loading, and the maximum deflection for the test. These parameters are based on the test specimen thickness and are defined differently by ASTM and ISO. In this project the material specimen is prepared as per the ASTM D790 Standard for ASTM D790, the test is stopped when the specimen reaches 5% deflection or the specimen breaks before 5%. The Specimen prepared is shown in figure.

Fig. 18. Test set up for three point bending tests

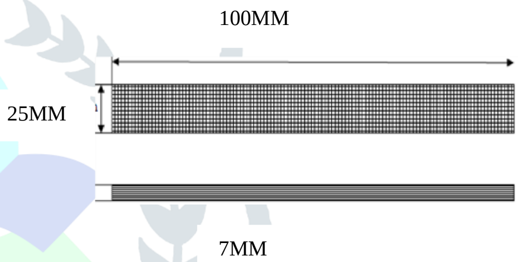

Fig 19. Flexural test specimen

Fig. 20. Flexural test Specimen of Banana-Jute Composite (Specimen A)

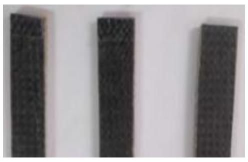

Fig. 21. Flexural test Specimen of Carbon Banana-Jute composite (Specimen B)

Fig. 22. Flexural test Specimen of Banana-Jute composite after testing

Fig. 23. Flexural test Specimen of Carbon Banana-Jute composite after testing

TABLE VII. FLEXURAL TEST RESULT

S.No	Banana+Jute (Specimen A)	Carbon + Banana + Jute(Specimen B)
	Flexural strength (MPa)	Flexural strength (MPa)
Specimen 1	44.30	84.27
Specimen 2	78.18	88.99
Specimen 3	73.57	88.25
Average	65.35	87.17

VI. CONCLUSION

- The present review explores the potentiality of jute & banana fibre composites with Carbon fibre, emphasizes both mechanical and physical properties.
- The ultimate tensile strength of the composite Banana-Jute is 21.308 MPa and the flexural strength is 65.35 MPa . The ultimate tensile strength of the composite Carbon Banana Jute is 59.586 MPa and the flexural strength is 87.17 MPa.
- It also emphasis variation in properties of natural fibre composites when non-natural fibre such as carbon fibre is added in equal ratio.
- The test shows the hybrid composites are much superior in properties than the homogenous composite.
- The utilization and application of the cheaper goods in high performance appliance is possible with the help of this composite technology.
- Combining the useful properties of two different materials, cheaper manufacturing cost, versatility etc., makes them useful in various fields of engineering, high performance applications such as leisure and sporting goods, shipping industries, Aerospace etc. Hence, with this back ground, it is concluded that, the composites stand the most wanted technology in the fast growing current trend.

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