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A REVIEW- Mechanical Properties of Hybrid Composite

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ABSTRACT

Composite materials have occupied major part in current era due to its light weight, good stiffness, high specific strength and flexible nature. Due to large availability of naturally occurring fibers and their capability to hybridize with glass fiber, the applications of these fibers vary according to purpose. Natural fibers will take a major role in the emerging "green" economy based on energy efficiency, the use of renewable materials in polymer products, industrial processes that reduce carbon emissions and recyclable materials that minimize waste. These fibers are completely renewable, environmental friendly, high specific strength, non-abrasive, low cost, and bio-degradability. Due to these characteristics, natural fibers have recently become attractive to researchers and scientists as an alternative method for fibers reinforced composites. This review paper summarized the history of natural fibers and its applications. Also, this paper focused on different properties of natural fibers (such as banana, hemp, jute, bamboo and sisal) and its applications which were used to substitute glass fiber.

Keywords: Nature fibers, Glass fibers, Polymer, Hybrid Composites, tensile test, flexural test, impact test.

I. INTRODUCTION

What is a Hybrid Composite?

A composite material is a mixture of two or more than two materials (bonded or mixed). Typically, a composite material is group of reinforcement (particles, fibers, flakes, or fillers) and a matrix (polymers, ceramics or metals). The reinforcement is held by the matrix to form the preferred shape while the reinforcement imparts the overall mechanical properties of the matrix. When designed accurately, the new united material exhibits enhanced strength than would each entity material. The unified structures of composites are made by physically mixture of two or more materials, different in symphony and characteristics and occasionally in form. It is very clearly stresses that the composites should not be regarded simple as a combination of two materials. Hybrid composites are material systems with multifunctional use that provide uniqueness which is obtainable from any isolated material. Hybrid composite materials are made by combining two or more different types of fibers in a common matrix. Hybridization of two types of short fibers having different lengths and diameters offers some advantages over the use of either of the fibers alone in a single polymer matrix.[16]

Why a Hybrid Composites?

Over the last few years Hybrid composite materials, ceramics and plastics have leading share among emerging materials. The volume and number of applications of hybrid composites have developed steadily and attractive in new markets relentlessly. It is necessary that there be an integrated effort in designing, tooling, quality assurance, material processing, manufacturing, and even program management to make hybrid composites competitive with metals. Whilst the use of hybrid composites will be an obvious choice in many instances, material selection will depend on other factors such as produced number of items or run length, required working life, complexity of product shape, possible investments in assembly costs and on skills and experience of the designer in tapping the best possible potential of composites. Modern hybrid composite materials represent a significant part of market in engineered materials range from everyday products to classy niche applications. While hybrid composites have already established their place as weight-saving materials, the present challenge is to make them cost efficient.[16]

Characteristics of the Hybrid Composites

Hybrid Composites consist of two or more irregular (discontinues) phases rooted in a continuous or regular phase. The irregular phase is usually stronger and harder than the continuous phase also called the "reinforcement" or "reinforcing material", while the continuous phase is termed as the "matrix". Properties of Hybrid composites are strongly reliant on the properties of their element materials, their distribution and the interaction among them. The hybrid composite properties maybe the volume fraction sum of the properties of the constituents or the constituents may interact in a synergistic way resulting in improved or better properties. Apart from the nature of the element materials, the property of the hybrid composite also depends on geometry of the reinforcement (size, shape and size distribution). The shape of the discontinuous phase (which may by spherical, cylindrical, or rectangular cross-sanctioned prisms or platelets), the size and size distribution (which controls the texture of the material) and volume fraction determine the interfacial area, which plays an important role in determining the extent of the interaction between the reinforcement and the matrix. Concentration, typically measured as volume or weight fraction, evaluates the contribution of a single element to the overall properties of the hybrid composite.[16]

Classification of Composites

a) According to the Type of Reinforcing Material Composites can be Classified as:

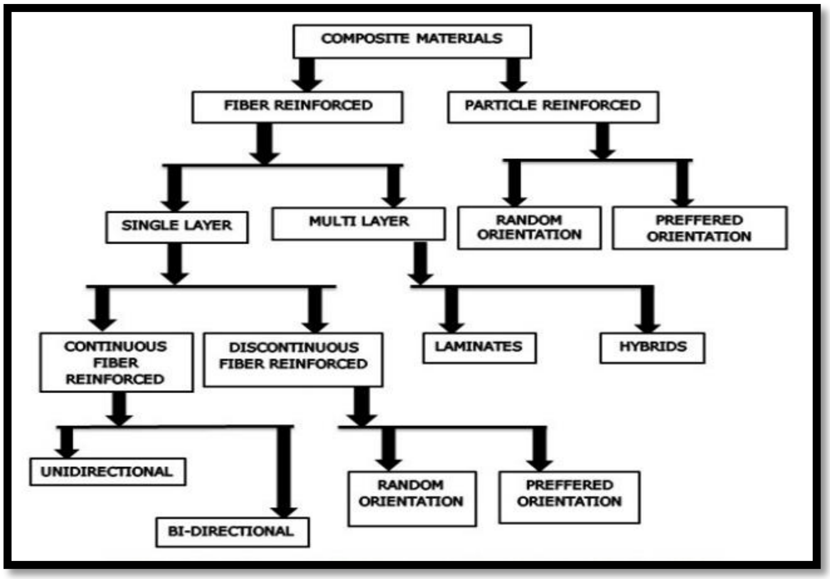

Figure 1 Classification of composites [17]

The geometry of the reinforcement is accountable for the mechanical properties and high-performance of the hybrid composites. A typical classification is presented in figure 1

1) Particulate Composites

In particulate composite the reinforcement is of particle nature (platelets are also included in this class) as the name it-self indicates. It may in various shapes like spherical, cubic, tetragonal, a platelet, or of other regular or irregular shape, but it is approximately equaled. Commonly, particles are not so able to improving fracture resistance apart from they improve the stiffness to a limited amount for the hybrid composite material. In some applications like to modify the thermal and electrical conductivities, increase wear, develop performance at superior temperatures, reduce friction and abrasion resistance, improve Mach inability and reduce shrinkage, increase surface hardness, particle fillers are broadly used to get better properties of matrix materials. [16] These are the economical and generally used. Depending on the size of particles they categorized in two categories:

- Random oriented: Large-particle composites, if well bonded they act by restraining the movement of the matrix.
- Preferred oriented: Dispersion-strengthened composites, similar particle size of 10-100 nm as discussed under precipitation hardening. The matrix with stands the major part of the applied load and the small particles obstruct displacement motion, limiting plastic deformation.[16]

2) Fibrous Composites

A fiber is characterized by its length being much greater compared to its cross-sectional dimensions. The dimensions of the reinforcement decide its potential to contributing to the composite properties. Fibers are very effectual in improving the fracture resistance of the matrix since they have long dimension resist the growth of initial cracks which are normal to the reinforcement that may cause failure, mostly with brittle matrices. Fibers are not directly usable in engineering applications because of their small cross- sectional dimensions. Therefore they are implanted in matrix materials to form fibrous composites.

The matrix binds the fibers together, and also transfer loads to the fibers. Matrix protects them against environmental attack and damage due to handling. In discontinuous fiber reinforced composites, it is more critical to transfer the load than in continuous fiber composites.[16]

b) According to type of matrix material they are classified as:

- Metal Matrix Composites (MMC)
- Ceramic Matrix Composites (CMC)
- Polymer Matrix Composites (PMC)

1) Metal Matrix Composites:

Higher strength, fracture toughness and stiffness are offered by metal matrices. Metal matrix can withstand elevated temperature in corrosive environment than polymer composites. Titanium, aluminum and magnesium are the popular matrix metals currently in vogue, which are particularly useful for aircraft applications. Because of these attributes metal matrix composites are under consideration for wide range of applications viz. combustion chamber nozzle (in rocket, space shuttle), housings, tubing, cables, heat exchangers, structural members etc.[15]

2) Ceramic Matrix Composites:

One of the main objectives in producing ceramic matrix composites is to increase the toughness. Naturally it is hoped and indeed often found that there is a concomitant improvement in strength and stiffness of ceramic matrix composites.[15]

3) Polymer Matrix Composites:

Most commonly used matrix materials are polymeric. In general the mechanical properties of polymers are inadequate for many structural purposes. In particular their strength and stiffness are low compared to metals and ceramics. These difficulties are overcome by reinforcing other materials with polymers. Secondly the processing of polymer matrix composites need not involve high pressure and doesn’t require high temperature. Also equipment required for manufacturing polymer matrix composites are simpler. For this reason polymer matrix composites developed rapidly and soon became popular for structural applications.[15]

Components of Hybrid Composite Materials

In its most basic form a hybrid composite material is one, which is composed of minimum three elements working equally to produce material whose properties are singular to the properties of those elements on their own. In practice, most hybrids composite made up of a bulk material which is the “matrix”, and a reinforcement of some kind, added to increase the stiffness and strength of the matrix.[18]

a) Role of Matrix in Hybrid Composites

Many materials when they are in a fibrous form exhibit very good strength but to achieve these properties the fibers should be bonded by a suitable matrix. The matrix used to prevent abrasion and formation of new surface flaws and acts as a bridge to hold the fibers in place. A good matrix should have ability to deform under applied load, transfer the load onto the fibers and uniformly distributive stress concentration. The Materials used as matrices are normally a lighter metal such as aluminum, magnesium, or titanium and provides a submissive support for the reinforcement. Cobalt and cobalt–nickel alloy matrices are common in high-temperature applications.[18]

b) Role of Reinforcement in Hybrid Composites

The role of the reinforcement in a hybrid composite material is primarily one of increasing the mechanical properties of the neat resin system. The reinforcement material is implanted into a matrix. The reinforcement also contributes to change physical properties such as wear resistance, friction coefficient, or thermal conductivity. The reinforcement can be either continuous or discontinuous and can be worked with regular metalworking techniques, such as forging, extrusion, or rolling. In accumulation, they may be machined using usual techniques. Because the fibers are entrenched into the matrix, the result is an anisotropic structure in which the arrangement of the material affects its strength.[18]

Advantages of Composites Materials

- Compare to metals they exhibit high strength.
- Stiffness of the material is improved.
- They are having low specific gravity.
- At high temperature also maintain the weight.
- Toughness is also improved.
- Production is lower.
- Fabrication is also cheaper.
- Fatigue strength and creep is better than traditional material.
- Oxidation and corrosion resistance. [18]

Disadvantages of Composites Materials

- Compare with the wrought metals, composite are more brittle and they easily damaged.
- During the time of transportation material required chilling.
- Special equipment's are required and hot curing is also required.
- For curing process it required time for cold and hot process.
- After rivets are removed without causing any damage.
- Pressure and tooling are required to repair at the original curing temperature.
- Before starting the repair the composite must be cleaned. [18]

Advantages of Hybrid Materials over Traditional Composites

- Inorganic clusters or Nano particles with particular optical, magnetic or electronic properties can be included in organic polymer matrices.
- Hybrid materials show a more polymer-like handling, also because of their large organic content or because of the configuration of cross linked inorganic networks from small molecules just similar to in polymerization reactions whereas pure solid state inert materials for their processing repeatedly require a high temperature treatment.

- Light diffusion in uniform hybrid material can be neglected and therefore optical precision of the resulting hybrid composite materials can be achieved.[19]

Applications of Hybrid Composites

1) **Automobile Industry**: For inner and outer parts fiber reinforced plastics are used. These are used in industries because of their advantages over the glass fiber reinforced composites such as cheaper, environment friendly, etc. By these fibers cars according to End-of-Life directive can be developed as the resulting products from these composites can be re-used and do not have to be land filled unlike glass fiber. Because of their softness and non-harsh behavior unlike glass fibers they are used in interior automotive uses and are having advantages of not injuring the passengers.
2) **Packaging Industry**: In these industries these are used for light weight pallets. Weight reduction is the chief reason for using composite material in place of wood, which saves fuel during transportation.
3) **Consumer Products**: Natural fiber can be used for any injection moulded product. Reduction of plastic use, flame retardancy and re-use. Examples are household appliances like cell phones, refrigerators and computers. They are less vulnerable to fire due to the fiber structure of composite. Also the high fiber loads results in major material cost reduction.
4) **Building and construction industry**: In these they are used for roofing and instance profiles. Cost reduction, re-use and flame retardancy are the advantages.
5) **Sports**: In sports they are used for the bicycles, golfing, boats, badminton, tennis and hockey.
6) **Transportation and Infrastructure**: In transportation and infrastructure the composite material used for the bridges, ships, boats, dam's railway coaches, floors and truck bodies.
7) **Aerospace**: In aircrafts, satellites, rockets and missiles they are used for the manufacturing of doors, nose, out boards, stabilizer, fuel tank, edges, elevators, inboard flaps, rudders, fin tips, pressure tank, stators, turbo motor and structural parts etc. [18]

II. LITERATURE REVIEW

N. Venakateshwaran, G. K. Sathiya (2012)[1]the tensile strength and modulus of short, randomly oriented hybrid-natural fiber composite was found out experimentally and also predicted using Rule of Hybrid Mixture (RoHM). Hybrid composites were prepared using banana/sisal fibers of 40:0, 30:10, 20:20, 10:30, and 0:40 ratios, while overall fiber volume fraction was fixed as $0.4V_f$.The epoxy LY556 and hardener HY951 to be used. And 300mm×300mm×3mm sheet to be fabricated by hand layup method. After fabrication, the test specimens were subjected to various mechanical tests as per ASTM standards. The standards followed are ASTM-D 638-03 for tensile test with the test speed of 5 mm/ min. In each case, five specimens were tested to obtain the average value. Find the tensile strength and modulus of hybrid composite and compare to RoHM. To concluded the RoHM equation predicted tensile properties of hybrid composites are little higher than experimental values.

Daiane Romanzini, et.al [2]In this work, glass and ramie fibers cut to 45 mm in length were used to produce hybrid polymer composites by resin transfer molding (RTM), aiming to evaluate their physical, mechanical and dynamic mechanical properties as a function of the relative glass–ramie volume fractions and the overall fiber content (10, 21 and 31 vol.%) and the glass/ramie volume fractions (0:100/25:75/50:50/75:25) in the composite. Density and water absorption were evaluated according to ASTM: D792-08 and ASTM: D570-10, respectively. Impact test was performed using an impact machine in accordance with ASTM: D256-10. Un-notched specimens (dimensions: 63.5, 12.7,4 mm) were prepared and an average value from ten samples for each family is reported. Inter laminar shear strength (ILSS) was carried out in a universal testing machine accordance with ASTM: D2344-06. A span-to-depth ratio of 4:1 and a bending rate of 1.0 mm/min were used and 10 specimens were tested in each case. The cross-section surface of the hybrid composites (after cryogenic fracture) was examined using a scanning electron microscope (SEM-JEOL JSM-6060). All specimens were sputtered with a gold layer prior to SEM observations. Dynamic mechanical properties were assessed using a Dynamic Mechanical Analyzer DMA 2980. Analysis of the specimens (dimensions: 60, 10,4mm) were performed in dual cantilever mode (oscillation amplitude: 15 lm) at 1 Hz frequency, from room temperature to 180 ^{o}C. To conclude Hybridization enables the production of lower weight composites with intermediate water absorption values. The mechanical properties (impact and inter laminar shear strength) of the composites improved for higher fiber content.Analyzing the SEM micrographs, at higher fiber content, an increase in fiber–fiber contact was observed, which could decrease the interaction between fibers and the matrix.

V.S. Srinivasan, et.al [3] this paper deals with one of such hybrid composite made of natural fibers namely, banana and flax fibers. The structural build-up is such that one layer of banana fiber is sandwiched between two layers of flax fibers by hand layup method with a volume fraction of 40% using Epoxy resin and HY951 hardener. Glass fiber reinforcement polymer (GFRP) is used for lamination on both sides. The properties of this hybrid composite are determined by testing its tensile, impact, and flexural loads using a Universal testing machine. The three composite sheet are fabricated GBF, GF, GB. The tensile test is done by cutting the composite specimen as per ASTM: D638 standard. The Flexural test is done in a three point flexural setup based on ASTM: D790 standard. The impact test set up consists of a pendulum which is dropped from an angle of 135 degree to impact the specimen and to fracture it. From the tests and comparisons, the ultimate tensile strength of the composite 3 is higher than that of the composite 2 and composite 1. From the tensile testing, the elongation of composite 2 is highest than Composite 1 and composite 3. From the Flexural test it is clear that composite 1 has a higher ultimate stress than composite 3 and 2. Hence, composite 1 has good flexural properties. Composite 1 has excellent ability to absorb impact force greater than composites 2 and 3.

Maries Idicula, et.al [4] in this paper the dynamic and static mechanical properties of randomly oriented intimately mixed short banana/sisal hybrid fiber reinforced polyester composites were determined. Dynamic properties such as the storage modulus (E'), damping behavior (tanδ) and static mechanical properties such as tensile, flexural and impact properties were investigated as a function of total fiber volume fraction and the relative volume fraction of the two fibers. The storage modulus was found to increase with fiber volume fraction and maximum value was obtained at a volume fraction (V_f) of 0.40. The tanδ peak height was minimum and peak width was maximum at 0.40V_f. Tensile modulus and flexural strength were found to be the highest at 0.40 volume fraction, which indicates effective stress transfer between the fiber and matrix. Keeping the total fiber volume fraction, 0.40Vf, hybrid composite shaving different volume ratios of the fibers and un-hybridized composites were prepared and analyzed. Fracto-graphic evaluations carried out under scanning electron microscope (SEM) confirm the quantitative characterization obtained from static and dynamic mechanical analysis.

R.Panneerdhass, et.al [5] in this paper presents the study of the tensile, compressive, flexural, impact energy and water absorption characteristics of the luffa fiber and Ground nut reinforced epoxy polymer hybrid composites. Luffa fiber and Ground nut reinforced epoxy resin matrix composites have been developed by hand lay-up technique with luffa fiber treated conditions and Ground nut with different volume fraction of fibers as in 1:1 ratio (10%, 20%, 30%, 40% and 50%). The water absorption characteristics of luffa fiber and Ground nut reinforced polymer composite were studied by immersion in distilled water at room temperature for 12, 24, 48, 72 hours. The test specimen size (5mm x 5mm) is prepared as per ASTM D-570 for water absorption test. The tensile tests were conducted according to ASTM D 3039 -76 with dimensions of 300mm×25mm×5mm. Flexural strength of the composites was determined from the three point bend technique according to ASTM D790-03 with dimension of 80mm x15mm ×5mm.The morphological characterization of the composite fracture surface was carried out using SEM. Tensile strength, compressive strength, flexural strength and impact energy are increasing, as a function of fiber volume fraction. The optimum mechanical properties were obtained at 40% of fiber volume fraction of treated fiber composites.

TP Sathishkumar, P Navaneethakrishnan.[6]This paper presents the extraction and preparation methodology of the isophtallic polyester composites using the naturally available fibers like snake grass, banana and coir fibers. The tensile and flexural proper ties of the snake grass fiber-reinforced composites are compared with the snake grass/banana and snake grass/coir fiber-reinforced hybrid composites. Tensile properties such as tensile strength, tensile (elastic) modulus, tensile load and elongation at break for the composites are measured based on the ASTM D-638 standards with the standard size of 165mm×13mm×4mm.Three-point bending flexural testing is conducted according to the ASTM D 790 standards, to evaluate the flexural properties like flexural strength, flexural modulus, flexural load and deflection at break of the composites with the standard dimensions of 128mm×12mm×4mm. The micro-structural failures of the tensile and flexural fractured composite specimens are studied and analyzed for the fiber pullouts in the cross section through the scanning electron microscope (SEM).The result shows that the tensile strength for the SG/B is higher than the SG/C fiber-reinforced composites. The maximum tensile modulus is obtained for the SG/B and SG/C fiber-reinforced hybrid composites at 20% V_f. The flexural strength in SG/C is higher than the SG/B fiber-reinforced hybrid composites, but the maximum flexural modulus is obtained for the SG fiber-reinforced composites at 25% V_f, which is closer to the SG/B fiber composites at 20% V_f. The snake grass/banana and snake grass/coir fiber composites have the maximum tensile and flexural properties when compared with the snake grass fiber composites.

Madhukiran.J et.al [7] work has been carried out to investigate the flexural properties of composites made by reinforcing banana and pineapple as the new natural fibers into epoxy resin matrix. Hybrid composites were prepare during banana/pineapple fibers of 0/40, 15/25, 20/20, 25/15, and 40/0 Weight fraction ratios, while overall fiber weight fraction was fixed as 0.4Wf. Three point bend tests were performed in accordance with ASTM D-790 with specimen's dimension 100mm ×25mm ×3mm. Specimen were tested at a cross head speed of 2.5mm/min. Inter-Laminar Shear Test was carried out as per ASTM standard with cross head speed of 2.5mm/min. The banana/pineapple hybrid composite with weight fraction of 25/15 shows maximum flexural strength and maximum flexural modulus. The banana/pineapple hybrid composite with weight fraction of 25/15 shows maximum inter laminar shear strength. The banana/pineapple hybrid composite with weight fraction of 25/15 shows maximum break load. It has been observed that the flexural properties increase with the increase in the weight fraction of fibers to certain extent.

Girisha.C, et.al [8]in this investigation, areca nut fruit husk fibers and tamarind fruit fibers are reinforced with Epoxy matrix and composites have been developed by manual hand layup technique. The fiber percentages (10%, 20%, 30%, 40% and50% by weight) were used for the preparation of hybrid composites. Tensile tests were conducted using universal testing machine with across head speed of 5mm/min. tensile test samples were cut as per ASTM D638 test procedure. Flexural analysis was carried out at room temperature through three-point bend testing as specified in ASTM D 790.The speed of the crosshead was 5 mm/min. impact test was performed on areca nut husk fibers and tamarind fruit fibers reinforced hybrid epoxy composite specimens as per ASTMD256-90. The result shows the strength of the hybrid composites increases with increase in volume fraction of fiber in the hybrid composites. It is found that all the hybrid natural fiber composites show maximum mechanical properties for 40-50% of the fiber reinforcements. Maximum flexural strength was obtained for40% of the treated fiber reinforced. Maximum impact energy absorbed was for the composites reinforced with 50% of treated fiber.

P Sivaraj , G Rajeshkumar [9]this work presents a systematic approach to evaluate and study the effect of process parameters on tensile, flexural and impact strength of coir and bagasse fiber reinforced polyester-based hybrid composites and also predicts the properties of random oriented hybrid composites. The composite panel was fabricated using hand lay-up method to the size of 300mmx200mmx3mm with various weight percentage of natural fibers namely coir (10, 20 and 30wt %) and bagasse (10, 20 and 30 wt %) combined with polyester resin. The tensile strength of the composites was measured with a universal testing machine in accordance with the ASTM D3039 procedure. The speed of the tensile testing machine is about 2mm/min. The flexural strength of the composites was also done by universal testing machine in accordance with the standard of ASTM D790. The speed of the machine is about 2mm/min. The impact test was conducted to find the impact energy in accordance with the standard of ASTM D256.To found out that the 30% of coir fiber and 10% of bagasse fiber with 60% of polyester resin is the best values of tensile strength, flexural strength and impact energy the second-order polynomial curve fitting equations were modelled which predicts the values of tensile, flexural and impact strengths with various other combinations of fibers contents with resin. From the SEM test, it is cleared that there is no pull out holes on the specimens.

Narra Ravi Kumar, Gorle Ravi Prasad. [10] In the present work, banana fiber is incorporated in polypropylene resin matrix hybridized with glass fiber for preparing composite specimens at various fiber weight percentages. The composite samples were prepared by mixing of fibers in proper proportions (0, 5, 7.5, 10, 12.5 and 15%) by weight, glass fiber (2.5% of fiber weight) and polypropylene pellets were properly mixed to get a homogeneous mixture. Dog bone shaped tensile test specimens were made in accordance with ASTM-D 638M to measure the tensile properties and the samples were tested at a crosshead speed of 1 mm/min. Three point bend tests were performed in accordance with ASTM D790M to measure the flexural properties. The samples were 98mm×10mm×4mm thick. Impact test specimens were prepared in accordance with ASTM D256-97, to measure the impact strength. The specimens are prepared to dimensions of 64 x 12 x 9 mm. from the results 7.5% fiber weight fraction composites exhibited maximum tensile strength and maximum flexural strength is observed for 10% fiber weight fraction composites. Maximum Impact strength is observed in 10% fiber weight fraction composites. Tensile and Flexural Modulus values increased with increase in fiber weight fraction and higher values are observed in 15% fiber weight fraction composites.

M. Jawaid, et.al [11]in this research, tensile and flexural performance of tri layer oil palm empty fruit bunches (EFB)/woven jute fiber reinforced epoxy hybrid composites subjected to layering pattern has been experimentally investigated. Sandwich composites were fabricated by hand lay-up technique in a mould and cured with 105 ^{o}C temperatures for 1 h by using hot press. The tensile strength and modulus of the pure epoxy as well as EFB/Jute/EFB and Jute/EFB/Jute fiber reinforced composites was conducted as per the ASTM D-3039 specifications. Flexural analysis was carried out at room temperature through three-point bend testing as specified in ASTM D 790 with speed of the crosshead was 2 mm/min. A scanning electron microscope was used to analyze the morphological images of the hybrid composites. From results that incorporation of woven jute fiber in pure EFB composites enhanced the tensile and flexural properties of hybrid composites. Layering pattern (EFB/Jw/EFB and Jw/EFB/Jw) significantly affects the tensile and flexural properties. Indicated that the hybrid composites with two skin layer on either side is better combination with good tensile and flexural properties.

H.Venkatasubramanian, et al[12]This work deals with fabrication and investigation of mechanical properties of natural fibers such as abaca and banana fiber and compares with the hybrid natural fiber composite. Tensile, flexural and impact strength of the composites are investigated in the process of mechanical characterization. The Reinforcement material used is a by-product of epoxy resin namely Bisphenol-A . Hand lay-up technique is used to manufacture the composite and the fiber content is varied through volume fraction of upto 0.5. Glass fiber on top and bottom layers of the laminate improves its surface finish and adds up strength. The Natural fiber is sandwiched in intermediate layers with the glass fiber. It is found that Abaca-Glass composite is found to have better tensile strength than the other two combinations and Abaca-Glass-Banana Hybrid Composite is found to have better Flexural strength and Impact value.

Hemant Patel, et al[13]In this paper, test are conducted for composite material constitutes banana and less discovered sisal These composites are adhered using epoxy resin consists resin and hardener suitably mixed in appropriate volume. Here for preparing samples Hand layup method is used, specimens are prepared and tests are carried out, which shows tensile and bending strengths. The tensile & compressive tests were applied on specimens of 300×50×10 mm in dimensions but in different proportions of banana and sisal by weight. From the results the combination of sisal and banana where banana is in excess amount than sisal tensile strength value is high but bending values are low. Sisal fiber individually had the highest tensile strength but low bending and impact strength so it should be mix with banana fiber to obtain the desired strength and mechanical properties. Composite made from 50%Sisal and 50% banana had less strength from composite having 80% Sisal and 20% banana fiber ratios.

Ashwani Kumar et, al[14] Banana fiber in combination with glass has proved to be excellent for making cost effective composite materials. The hybridization of FRP at 20% wt fraction of reinforcement results an increasing in the tensile strength of HFREC by an amount of 1.24% than GFREC and by 71.2% than BFREC. The hybridization of FRP at 30% wt fraction of reinforcement results an increasing in the tensile strength of HFREC by an amount of 2.5% than GFREC and by 63.4% than BFREC. The tensile strength has shown the highest value when a 10% of banana fiber and 20% of glass fiber is used and an interleaving arrangement of glass and banana fiber is followed. The hybridization of FRP at 20% wt fraction of reinforcement results an increasing in the flexural strength of HFREC by an amount of 6.9% than GFREC and by 27.3% than BFREC. The hybridization of FRP at 30% wt fraction of results an increasing in the flexural strength of HFREC by an amount of 6% than GFREC and by 23% than BFREC. The impact strength shows the highest value .When banana fibers and glass fibers are reinforced in a ratio of 1:2.The impact strength of HFREC increases by an amount of 5.1% than GFREC and by 91% than BFREC.

R.Sakthivel, et, al[15]In the project natural fiber and glass hybrid composites were fabricated by using epoxy resin combination of hand lay-up method and cold press method. Specimen was cut from the fabricated laminate according to the ASTM standard for different experiments for tensile test, flexural text, and impact test. A significant improvement in tensile strength was indicated by the woven fiber glass hybrid composites. In this hybrid composite laminates banana-glass-banana (BGB) and glass-banana-glass (GBG) exhibit higher mechanical properties due to chemical treatment to natural fibers. So, the hybrid composite material shows the highest mechanical properties. From the results the tensile strength and flexural strength increases with increasing fiber volume fraction. Among all the hybrid fiber composites tested, banana reinforced epoxy hybrid composites registered the highest mechanical properties whereas glass and banana fiber composites showed the highest.

III CONCLUSION

Recently all the research work has been carried out to literature on mechanical behavior of natural & synthetic fiber based polymer composites. Various mechanical properties like tensile strength, flexural strength, impact strength etc. of a hybrid composite depend on various factors like: (a) Type of fiber used, (b) Volume Fractional of Fiber and (c) Fiber Content (d) orientation of fibers. It has more significant effect on mechanical properties. The Result of test shows that hybrid composite has far better properties than single fiber reinforced composite. A lot of research has been done on natural fiber reinforced polymer composites but research on Sisal (Agave sisalana), Banana (Musa sepientum) and Roselle (Hibiscus sabdariffa) polymer composites is very rare. Against this background, the present research work has been undertaken, with an objective to explore the potential of the above said fiber polymer composites and to study the mechanical and material characterization of different composites. In future, the final composite material coated by calcium phosphate and hydroxyapatite (hybrid) composite can be used for both internal and external fixation on the human body for fractured bone.

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