Protection and Control of Stator Water Cooling System

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Abstract- **The composite materials are replacing the traditional materials, because of its superior properties such as high tensile strength, low thermal expansion, high strength to weight ratio. The developments of new materials are on the anvil and are growing day by day. In this work the effect of glass fiber hybridization with the randomly oriented natural fibers are considered.The natural fibers are also low cost fibers with low density and high specific properties. The sisal(S), banana (B), E-glass synthetic fibers(G) are chopped and reinforced with polyester matrix is planned to prepare, six layers of the following stacking sequence of S/B/G, S/G/B, G/S/B, G/S/B/G/S/B/G, S/G/B//S/G/B, B/G/S/B/G/S. In this present study of Fiber Reinforced Composite an investigated and compared the mechanical properties like impact, flexural and tensile strength. Finally based on the result fabrication of window door will be fabricated.**

I. INTRODUCTION

During the past 10 years, a lot of fundamental and applied research has been carried out in polymer matrix composites. Due to the molecular size and their reinforcement, polymer composite offers ample possibility to develop new material with usual properties. First, shrinking a thing means that lesser material is required to build it. Material is like an excess baggage. It costs money, adds weight and takes up space. These considerations weigh heavily on all engineering decisions and are of utmost importance for certain applications-for example, satellite and space craft systems, which must be as small as possible. Smaller devices are imperative in the medical field and have enabled unprecedented surgical and imaging techniques. Bulky tools and big cameras simply do not fit inside the delicate path ways of the human body.Smaller systems perform quicker because they have less mass and therefore lesser inertia (the tendency of mass to resist acceleration). This improved speed leads to products that perform tasks faster, just as a fly can flap its wings much faster than the bird. Another example cited is an assembly robot in a factory. It might perform ten welds in a second, while an enzyme in our body performs as many as millions chemical operations in the small amount of time. Thermal distortions and vibrations do not perturb smaller devices as much as the larger ones, because the resonant vibration of a system is inversely proportional to its mass. Generally, the smaller the system, the higher its resonance frequency; and the low-frequency vibrational disturbances that affect large systems are less of an issue. Higher motional exactness and dimensional stability are the other important advantages of smaller devices; highly precise measurements or movements are possible on small scale. Finally smaller things need less energy in order to function. Power consumptions can make or break a new product design, and miniaturization is one way to minimize the fuel factor. Power density is the amount of power that can be generated per unit volume, also favours miniaturization. With the growth in environmental awareness and advancement of civilization, man is looking for new materials, which emerge out from advanced technology to meet livelihood requirements.

2. LITERATURE SURVEY

Mechanical Performance of Natural Fiber – Reinforced Epoxy – Hybrid composites: Girisha.C, Sanjeeva Murthy, Gunti Rangasrinivas, Manu.S / International Journal of Engineering Research and Applications (IJERA) ISSN:2248-9622Vol. 2, Issue 5, September- October 2012, Reported that Epoxy is a thermosetting polymer that cures (polymerizes and cross links) when mixed with a hardener. Epoxy resin of the grade LM-556 with a density of 1.1–1.5 g/cm3 was used. The hardener used was HY-951. The matrix material was prepared with a mixture of epoxy and hardener HY-951 at a ratio of 10:1.

Tensile Strength Test: Tensile tests were conducted using universal testing machine with across head speed of 5mm/min. In each case, five samples were tested and average value tabulated. Tensile test samples were cut as per ASTM D638 test procedure. Tests were carried out at room temperature and each test was performed until tensile failure occurred.

Flexural Strength Test: Flexural analysis was carried out at room temperaturethrough three-point bend testing as specified in ASTM D 790, using universal testing machine. The speed of the crosshead was 5mm/min. 3 composites specimens were tested for each sample and each test was performed until failure occurred. Flexural strength was calculated from the Equation. $\sigma f=(3PL)/(2bd2)$

Damage analysis on composites by impact studies: Izod impact test was performed on arecanut husk fibers and tamarind fruit fibers reinforced hybrid epoxy composite specimens as per ASTM-D256-90. 3 samples were tested at ambient conditions and the average of impact strength was calculated.

and in FRP composites. The microstructure was found to be different in FRP composites compared to that observed in castings. In FRP composites the morphological features are similar in the FRP composites, irrespective of the nature of fibers.

What Are Composites?

A composite is a material made from two or more different materials that, when combined, are stronger than those individual materials by themselves. Simply put, composites are a combination of components. In our industry, composites are materials made by combining two or more natural or artificial elements (with different physical or chemical properties) that are stronger as a team than as individual players. The component materials don't completely blend or lose their individual identities; they combine and contribute their most useful traits to improve the outcome or final product. Composites are typically designed with a particular use in mind, such as added strength, efficiency or durability.

Why composites?

Composites offer several advantages over steel, which has intrinsic design limitations, is heavy and costly to transport and is susceptible to corrosion, which leads to high maintenance costs. Consider these attributes:

Composites are lighter than steel – A cubic foot of cast steel weighs approximately 490 pounds. Depending on the material formulation, composites can be up to 70 percent lighter.

Composites are incredibly strong – They can be custom-tailored to add strength in critical areas, such as spots that may bend or wear out. With steel, if greater strength is needed in any area then more metal must be added, which in turn increases weight.

Composites are corrosion resistant – In outdoor applications, composites stand up to severe weather and wide temperature changes. Steel rusts easily unless it is painted or coated with zinc. And corrosion is expensive, with annual direct costs.

Composites are nonconductive – By their very nature, metals like steel conduct electricity. Composites are superior insulators: They don't respond to an electric field and resist the flow of an electric charge.

Composites allow for parts consolidation – A single piece made of composites can replace an entire assembly of metal parts, streamlining the production process and reducing lifetime maintenance.

What are composites made of?

Composites, also known as Fiber-Reinforced Polymer (FRP) composites, are made from a polymer matrix that is reinforced with an engineered, man-made or natural fiber (like glass, carbon or aramid) or other reinforcing material. The matrix protects the fibers from environmental and external damage and transfers the load between the fibers. The fibers, in turn, provide strength and stiffness to reinforce the matrix—and help it resist cracks and fractures.

Fiber - Provides strength and stiffness (glass, carbon, aramid, basalt, natural fibers)
Matrix - Protects and transfers load between fibers (polyester, epoxy, vinyl ester, others)
Fiber Composite Matrix - Creates a material with attributes superior to either component alone

In many of our industry's products, polyester resin is the matrix and glass fiber is the reinforcement. But many combinations of resins and reinforcements are used in composites—and each material contributes to the unique properties of the finished product: Fiber, powerful but brittle, provides strength and stiffness, while more flexible resin provides shape and protects the fiber. FRP composites may also contain fillers, additives, core materials or surface finishes designed to improve the manufacturing process, appearance and performance of the final product.

3. CLASSIFICATION OF COMPOSITE MATERIALS

The composite materials can be classified into three groups on the basis of matrix material. They are:

a) Metal Matrix Composites (MMC)
b) Ceramic Matrix Composites (CMC)
c) Polymer Matrix Composites (PMC)

Metal Matrix Composites

Metal Matrix Composites have many advantages over monolithic metals like higher specific modulus, higher specific strength, better properties at elevated temperatures, and lower coefficient of thermal expansion. 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.

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.

Polymer Matrix Composites

Most commonly used matrix materials are polymeric. The reasons for this are twofold. 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 equipments required for manufacturing polymer matrix composites are simpler. Composites are used because overall properties of the composites are superior to those of the individual components for example polymer/ceramic.

4. NATURAL FIBER REINFORCED COMPOSITES

The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. Plants, such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana, etc., as well as wood, Tamarind seeds, used from time immemorial as a source of lignocelluloses' fibers, are more and more often applied as the reinforcement of composites.

Their availability, renewability, low density, and price as well as satisfactory mechanical properties make them an attractive ecological alternative to glass, carbon and man-made fibers used for the manufacturing of composites. The natural fiber-containing composites are more environmentally friendly, and are used in transportation (automobiles, railway coaches, aerospace), military applications, building and construction industries (ceiling paneling, partition boards), packaging, consumer products, etc.

CLASSIFICATION OF NATURAL FIBERS

Fibers 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. Fibers are of two types: natural fiber and synthetic Fiber

SOURCES OF NATURAL FIBRES

Natural fibers include those made from plant, animal and mineral sources. Natural fibers can be classified according to their origin.

GLASS FIBRE REINFORCED POLYMER

Fiberglass is a common name of Polymer Matrix Composite materials reinforced by fine glass fibers. The reinforcing dispersed phase may be in form of either continuous or discontinuous glass fibers. Glass Fibers - A fiber spun from an inorganic product of fusion which has cooled to a rigid condition without crystallizing.

Glass is widely used as a material for reinforcing fibers due to the following its properties:

The strands are used for preparation of different glass fiber products (yarns, roving, woven fabrics, mats).

Fiberglass materials usually have laminate structure with different fibers orientations in the reinforcing glass layers.

Various glass fibers orientations result in anisotropy of the material properties in the plane parallel to the laminates.

Concentration of glass fibers in fiberglass is normally about 40% - 70%.

Glass fibers reinforced polymer matrix composites are manufactured by open mold processes, closed mold processes and Pultrusion method.

Fibreglasses (Glass fibers reinforced polymer matrix composites) are characterized by the following properties:

High strength-to-weight ratio;

High modulus of elasticity-to-weight ratio;

Good corrosion resistance;

Good insulating properties;

Low thermal resistance (as compared to metals and ceramics).

Fiberglass materials are used for manufacturing: boat hulls and marine structures, automobile and truck body panels, pressure vessels, aircraft wings and fuselage sections, housings for radar systems, swimming pools, welding helmets, roofs, and pipes.

ADVANTAGES

Glass fibre reinforced polymer has a very high strength to weight ratio

Low weights of 2 to 4 lbs. per square foot means faster installation, less structural framing, and lower shipping costs

Resists salt water, chemicals, and the environment - unaffected by acid rain, salts, and most chemicals

Domes and cupolas are resigned together to form a one-piece, watertight structure

Virtually any shape or form can be molded

Research shows no loss of laminate properties after 30 years

Strength

Composites are one of the strongest materials around. When you consider the density of the material, composites are much stronger than most other building materials. It's no surprise they are the material of choice for everything from airplanes to automobiles.

By combining specific resins and reinforcements – and there are a lot of them – you can customize the formulation to meet specific strength requirements of any application. For example, you can alter the ratio of the resin and reinforcement or orient the fibers in one direction or various directions.

Composites are anisotropic, meaning the material properties change depending on the placement and number of layers of reinforcement materials – the fibers. This provides engineering flexibility so designers can tailor properties of the final product. When it comes to strength, there are four primary kinds that affect structural design: specific, tensile, shear and compressive strength.

Tensile Strength

Tensile strength refers to the amount of stress a material can handle before it breaks, cracks, becomes deformed or otherwise fails. One measure of tensile strength is flexural strength – a material or structure's ability to withstand bending.

Shear Strength

Shear strength describes how well a material can resist strain when layers shift or slide. It's important to know the maximum amount of shear stress (or force per unit area) a material can handle prior to failure. This lets engineers and designers know the amount of weight – or load – a structure can support and what may happen to the structure when forces are applied in different directions.

Shear strength in composites varies based on the formulation and design. Composites can be designed so shear stresses are oriented within a plane, transverse to the plane or throughout the layers (interlaminar). There are several ways to control shear properties, including fiber orientation, the sequencing of layers, the type and volume of fibers used, the type and density of core materials and more.

Compressive Strength

Compressive strength indicates how a material performs when it's compressed or flattened by pressure. Some materials fracture or break when they hit their compressive strength limit, while others deform permanently.

Materials such as concrete and ceramics usually have a higher compressive strength, but lower tensile strength. Conversely, composites typically have higher tensile strengths than compressive strengths. Composites loaded in compression may buckle, kink or crush. That's why it's important to evaluate compressive loading for the specific fiber and resin combination chosen for an application and adjust the formulation accordingly.

Lightweight

Composites materials are both strong and light. That's a winning combination. Lightweight composites can save money and manpower.

Fiber-reinforced composites offer excellent strength-to-weight ratios, exceeding those of other materials. For example, carbon fiber-reinforced composites are 70 percent lighter than steel and 40 percent lighter than aluminum. Producing parts that are light weight is critical to industries such as transportation, infrastructure and aerospace for a variety of reasons. Lightweight composites are easy to handle and install, can reduce costs on projects and help ensure adherence to regulations and standards.

Reduced Costs

Lighter parts and products often save money. And saving on weight and cost is music to the ears of many end users.

Precise Properties

Designers like working with composites because parts can be tailor-made to have strength and stiffness in specific directions and areas. For instance, a composite part can be made to resist bending in one direction. The strategic placement of materials and orientation of fibers allows companies to design parts and products to meet unique property requirements.

Surface Appearance

Composite surfaces can be molded to simulate any finish or texture, from smooth to coarse. Consumers opt for composite countertops because they can be formed into any shape and customized into any color. With composites, designers have endless options to create beautiful products

Durability

Composite structures have an exceedingly long life span. Combine this with their low-maintenance requirements and composites become the material of choice for a host of applications.

Resistant to Fatigue

Composites are strong, allowing them to withstand repeatedly applied loads.

Epoxy Resin

The applications for epoxy-based materials are extensive and include coatings, adhesives and composite materials such as those using carbon fiber and fiberglass reinforcements (although polyester, vinyl ester, and other thermosetting resins are also used for glass-reinforced plastic). A polyepoxide such as epoxy is made up of non-reacted epoxide. The other chemical in the case of epoxy is a hardening or curing agent which works to cure it into a very strong adhesive. Epoxies are created through reacting an epoxy resin and a hardener or simply by reacts the resins themselves. Epoxy resins are thermosetting polymers with unique mechanical and resistance properties. They are the result of a chemical reaction called 'curing', which involves epoxides and other chemicals more commonly known as 'hardeners' or curing agents.

High adhesive strength and high mechanical properties are also enhanced by high electrical insulation and good chemical resistance. Epoxies find uses as adhesives, caulking compounds, casting compounds, sealants, varnishes and paints, as well as laminating resins for a variety of industrial applications.

Epoxy resin is almost totally transparent when cured. In the aerospace industry, epoxy is used as a structural matrix material or as structural glue.

Reinforcement:

Reinforcement usually adds rigidity and greatly impedes crack propagation. Thin fibres can have very high strength, and provided they are mechanically well attached to the matrix they can greatly improve the composite's overall properties.

Fibre-reinforced composite materials can be divided into two main categories normally referred to as short fibre-reinforced materials and continuous fibre-reinforced materials. Continuous reinforced materials will often constitute a layered or laminated structure. The woven and continuous fibre styles are typically available in a variety of forms, being pre-impregnated with the given matrix (resin), dry, uni-directional tapes of various widths, plain weave, hardness satins, braided, and stitched.

Common fibres used for reinforcement include glass fibres, carbon fibres, cellulose (wood/paper fibre and straw) and high strength polymers for example aramid. In this project, we have to using the Banana Fibre as a reinforced material.

Fillers

Fillers not only reduce the cost of composites, but also frequently impart performance improvements that might not otherwise be achieved by the reinforcement and resin ingredients alone. Fillers are often referred to as extenders. In comparison to resins and reinforcements, fillers are the least expensive of the major ingredients. Fillers can improve mechanical properties including fire and smoke performance by reducing organic content in composite laminates. Also, filled resins shrink less than unfilled resins, thereby improving the dimensional control of molded parts. Important properties, including water resistance, weathering, surface smoothness, stiffness, dimensional stability and temperature resistance, can all be improved through the proper use of fillers.

5. PROCESSING

Hand Lay-Up

Hand lay-up is the most common and least expensive open-molding method because it requires the least amount of equipment. Fiber reinforcements are placed by hand in a mold and resin is applied with a brush or roller. This process is used to make both large and small items, including boats, storage tanks, tubs and showers. Hand lay-up is the simplest composites molding method, offering low cost tooling, simple processing, and a wide range of part sizes. Design changes are readily made. There is a minimum investment in equipment. With skilled operators, good production rates and consistent quality are obtainable

Molds:

Simple, single cavity molds of fiberglass composites construction are generally used. Molds can range from small to very large and are low cost in the spectrum of composites molds.

Solvent

Acetone is good solvent that is some paints and varnishes, as well as for most plastics and synthetic fibers. It is ideal fiber glass resin, cleaning fiber glass tools and dissolving two parts epoxies and superglue before hardening. A heavy duty degreaser, it is useful in the preparation of metal prior to painting: it also thins polyester resins, vinyl and adhesives. Acetone can also dissolve much plastic, polystyrene, polycarbonate some type of polypropylene.

Releasing Agent

Mould release must be applied to the plug- this is an improvement step in the process. If the release agents fail to perform the mould will not release from the plug and many hours will be required to fix the damage and develop a smooth surface with the desired geometry. The usual method of applying mould release is 3 layers of carnauba wax. Each layer should be left to dry fully 1-2 hours then buffed to a shine. This is followed by a light coat of PVA film either sprayed or brushed on. Allow to dry overnight before applying the get coat.

6. INSTRUMENTS:

Apart from these materials some of the most essential instruments used in the fabrication of the laminate are discussed in the following sections.

Hydraulic Press

A hydraulic press is a press with its mechanics controlled by fluid pressure. Hydraulic presses have various uses and are available in different Varieties. A hydraulic press has a bed for the die or material to be placed on. Once the stock is properly positioned, the material is pressed between the two places with hydraulic force. The amount of force applied will vary with an application based on the material used.

Once the material is molded, pressed, punched, formed or straightened, it is removed and continues to the next step in its process. A hydraulic press will usually require at least one operator. They also are available in operating capacities that range from manual to fully automated systems.

Rollers

A handmade cylindrical roller made up of iron is used in this process. This roller is similar to that of those used for painting, but made up of iron. The surface of the roller is striped in order to press the mat so that the resin gets impregnated in between each and every fiber.

The main purpose of the roller is to avoid air voids in between each laminate and even distribution of resin over the fiber mat. Other instruments like brushes for the application of resign, stirrer for mixing the resign and hardener, bowl and mallet have been used for the fabrication of the laminate

Fabrication Dyes

A stainless steel mould having dimensions of 300 × 300 × 3 mm3 is used for composite fabrication.

Specimen Preparation Method

The banana fiber is obtained from banana plant, which has been collected from local sources. The extracted banana fiber were subsequently sun dried for eight hours then dried in oven for 24 hours at 105° C to remove free water present in the fiber. The dried fiber were subsequently cut into lengths of 5, 10, 15 mm. The banana fiber based epoxy composite is fabricated using hand lay-up process. The moulds have been prepared with dimensions of 180×180×40 mm3. The banana fiber of different length has been mixed with matrix mixture with their respective values by simple mechanical stirring and mixture is slowly poured in different moulds, keeping the characterization standards and view on testing condition. The releasing agent has been use on mould sheet which give easy to composites removal from the mould after curing the composites. A sliding roller has been used to remove the trapped air from the uncured composite and mould has been closed at temperature 30° C duration 24 hour. The constant load of 50 kg is applied on the mould in which the mixture of the banana, epoxy resin and hardener has been poured. After curing, the specimen has been taken out from the mould. The composite material has been cut in suitable dimensions with help of zig saw for mechanical tests as per the ASTM standards.

TENSILE TEST RESULTS

Sample No	Cross section Area (mm^2)	% of Fibre	% of Resin	Peak load (N)	% of Elongation	UTS (N/mm^2)
000001	75	25	75	1499.527	2.667	19.993
000002	75	30	70	1605.250	2.267	21.405
000003	75	35	65	1689.655	2.333	22.534

FLEXURAL TEST RESULTS

Sample No	Cross section Area (mm^2)	% of Fibre	% of Resin	Peak load (N)	Flexural Strength(Mpa)	Flexural Modulus (GPa)
000001	39	25	75	54.681	44.165	3972.791
000002	39	30	70	60.253	48.666	3155.864
000003	39	35	65	57.850	46.725	4797.910

7. RESULTS AND DISCUSSION

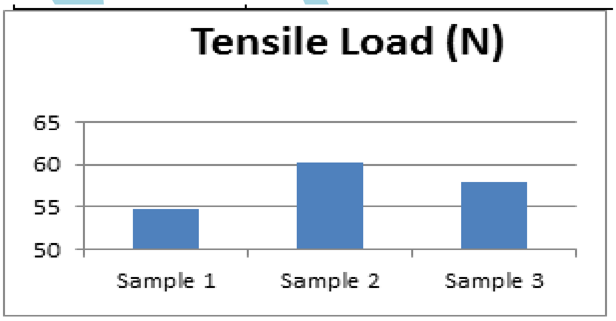
TENSILE PROPERTIES

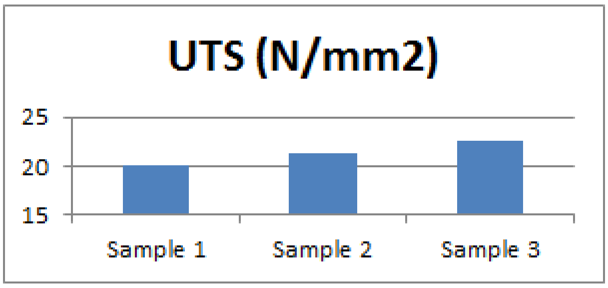
The tensile strength capabilities of the six different kinds of laminates are determined by testing in the UTM. The tensile properties of the laminates are listed in Table 8.1 It has been clear that the tensile strength is increased with the percentage of the glass fibers with the resin. The elongation at break is much higher for the laminates having 75:25 than others. But the ultimate tensile strength is much better in 65:35 than others.

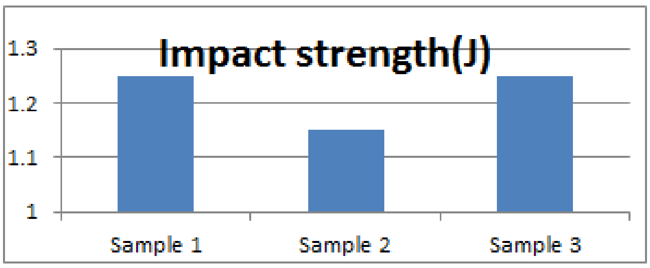
The flexural strength measured with the UTM machine is summarized in Table 8.1. It reveals that the banana and sisal fiber as a composite materials are showing strength between three combinations. During the gradual application of load, it is evenly distributed between the fibers and matrix in the 3 samples and it starts to ruptures when the load exceeds its limit. The crack begins where the adhesion between the fiber and matrix is poor and starts to propagate over the entire length of the cross-section of sample

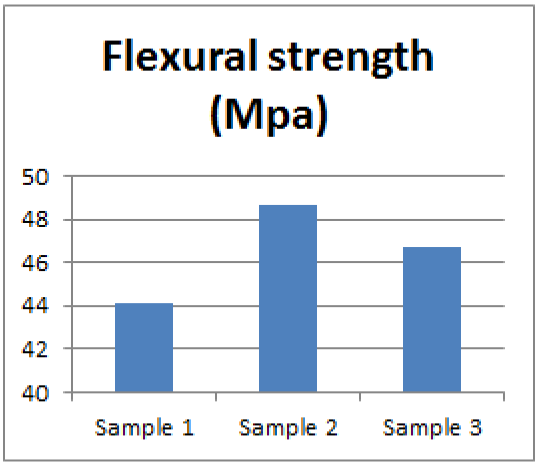
IMPACT TEST RESULTS

Sample Number	Izod Impact Value for 3 mm Thick Specimen in J
000001	1.25
000002	1.15
000003	1.25

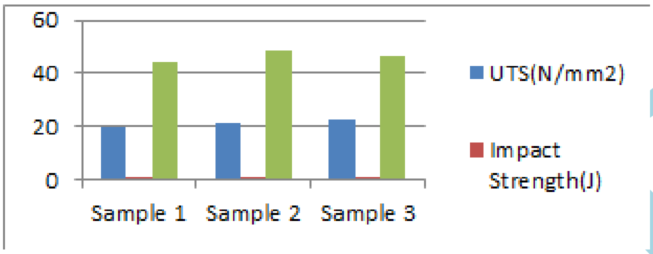








Comparison of Results



From the results obtained, the sample no. 000003 witch 35 % of fibre and 65% of resin has the good ultimate tensile strength and impact strength than the others. Even the flexural is slightly low than others, is suitable for alternating material instead of existing the wood, fibre etc. So we were tried to make a model of Window by this alternative and also user friendly like un-polluted material, and easily available from the nature.

8. CONCLUSION

The mechanical properties of the hybrid combination of glass fibre with banana sisal were studied in this work. From the obtained results, the following conclusions are derived. The maximum tensile strength of 22.534 N/mm2, maximum impact strength 1.25 and maximum Flexural modulus 4797.910 GPa is observed for the laminate having banana–sisal hybrid combination among the three samples which are having three different percentage of fibre and resin combination like 25:75, 30:70 and 35:65. Best impact energy, Ultimate Tensile Strength (UTS) and Flexural Modulus were obtained in the sisal fiber, resin composite of 35% and 65% respectively. From the observations, the composite of 35:65 are showing moderate performance than the other composites. Hence it is suitable for the medium load applications such as welding shield, visor, window door, two wheeler bumper, and automobile body panel. From the result the window door is fabricated by these composite materials

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