# EXPERIMENTAL INVESTIGATION OF THERMAL AND MECHANICAL CHARACTERIZATION OF GLASS FIBER REINFORCED EPOXY HYBRID COMPOSITES WITH AND WITHOUT ADDITION OF MILD STEEL SCRAP POWDER

**B.HARI KUMAR[1], T.RAJENDRA PRASAD[2]AND R.VIJAY KRISHNA[3]**

[1]M.Tech student,Email-id: bonduharikumar@gmail.com
[2]Associate Prof,Email-id: trajendramech@gmail.com
[3]Associate Prof,Email-id: vijaykrishna952@gmail.com
NRI Institute Of Technology,Agiripalli,Vijayawada,India.

## Abstract :

***The interest in glass fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. The glass fiber composites are low density, price as well as satisfactory mechanical and thermal properties make them an attractive ecological alternative to carbon and man-made fibers used for the manufacturing of composites. The main objective of this project is to investigate effect of combining glass fibers and addition of mild steel scrap powder (additive) to the matrix material on thermal and mechanical properties of glass fiber reinforced epoxy composites. The composites have been made by two glass fibers and addition of mild steel scrap powder to the epoxy matrix. Mechanical properties such as tensile properties (such as tensile strength, tensile modulus), Flexural properties (such as Flexural Strength, Flexural Modulus), Impact energy when subjected to varying weights of fiber (0.5, 1, 1.5, 2, 2.5 grams) and Thermal conductivity, of maximum loading fibered composites are studied.Tensile strength, Flexural strength, Impact energy of fibered composites increases with increase in weight of fiber in the composite. When compare without and with addition of mild steel scrap powder hybrid glass fibered composite the tensile strength of with addition of mild steel scrap powder fibered composite is low, Flexural strength, Impact energy of with addition of mild steel scrap powder fibered composites are high and Thermal conductivity of fibered composite decreased with increase in weight of fiber in composite. When addition of mild steel scrap powder (10grams) to the epoxy resin material Thermal conductivity is increased***

## Keywords:

**Glass fibers, Hybrid composite, mild steel scrap powder, Mechanical Properties, Thermal conductivity**

## 1.Introduction:

The word “composite” means two or more distinct parts physically bounded together”. Thus, a material having two more distinct constituent materials or phases may be considered a composite material. Fiber-reinforced composite materials consist of fiber of high strength and modulus embedded in or bonded to a matrix with distinct interfaces (boundary) between them. In this form, both fiber and matrix retain their physical and chemical identities, yet they produce a combination of properties that cannot be achieved with either of the constituents acting alone. In general, fiber are the principal load-carrying members, while the surrounding matrix keeps them in the desired location and orientation, acts as a load transfer medium between them, and protects them from environmental damages due to elevated temperatures and humidity etc. The properties that can be improved by forming a composite material include strength, stiffness, corrosion resistance, wear resistance, attractiveness, weight, fatigue life, temperature-dependent behaviour, thermal insulation, thermal conductivity, acoustical insulation and electrical insulation. Naturally, neither all of the properties are improved at the same time nor is there usually any requirement to do so. Composite materials have a long history of usage. Their beginnings are unknown, but all recorded history contains references to some form of composite material. For example, straw was used by the Israelites to strengthen mud bricks. Plywood was used by the ancient Egyptians when they realized that wood could be rearranged to achieve superior strength and resistance to thermal expansion as well as to swelling owing to the presence of moisture.More recently, fiber reinforced resin composites that have high strength-to-weight and stiffness-to- weight ratios have become important in weight-sensitive applications such as aircraft and space vehicles.

Various products around us are made from plastics. One of them is fiber-reinforced plastics (FRP). Advantages of FRP are that specific strength is bigger than that of aluminum plate, and weight of FRP is lighter than that of aluminum plate, etc. Therefore, FRP are used in wide range of fields, for example, automobile field, aerospace field, sport field, and so on. Glass-fiber reinforced plastic (GFRP) in FRP has a lot of excellent functions such as high-strength, lightness, and chemical stability. [1]

The physical, mechanical, and thermal properties of a unidirectional jute fiber reinforced poly vinyl chloride (PVC) film composites at variable weight ratios of these composites namely 100:0, 95:5, 90:10, 85:15 ,80:20 and these composites prepared by compression moulding at 160°c and finally they find the tensile strength of the composites increases with increasing of fiber addition and elongation percentage at break decreases with increasing of fiber addition and thermal degradation of pvc film starts ahead of jute fiber and the degradation of composites was occurred[2]

The effect of pre-deformation per petiole date palm fiber by chosen compression loads on the mechanical properties as well as on the thermal and acoustic insulation properties of prepared composites. He use the petiole date palm fiber as a reinforced material with the length (2-3mm) with different volume fractions (10, 20, 30, 40%) and unsaturated polyester resin as a matrix material for making the composite and he finds the volume of tensile strength and hardness are 133Mpa and 106 respectively for the polymer composite filled with 40% volume fraction of petiole date palm fibers. Which pre –deformed under compression load equal to 6 Mpa and he was concluded pre –deformation to the fibers , improves the thermal and acoustic insulation properties as well as increase in the tensile strength and hardness values with increasing compression loads on the fibers was studied[3].

The palm tree containing borassus inflorescence fiber is available all over the world, especially more in India. The borassus inflorescence fibers are inexpensive, naturally available, renewable, eco-friendly and hence the investigation of its potential properties to the technical world is essential. An attempt is made in this project to evaluate the mechanical properties (tensile strength, tensile module, flexural strength, flexural module, impact energy) and thermal properties (thermal conductivity, specific het capacity, thermal diffusivity)of borassus inflorescence fibers with, without alkali treatment and also addition of chalk powder to introduce them as a natural reinforcement to the composites and finally observe excellent thermal properties and mechanical properties[4].

The thermal conductivity of unsaturated polyester based sisal/ glass hybrid composite has been studied as a function of fiber content. It is observed that the thermal conductivity of sisal/glass fiber hybrid component is higher than sisal fiber reinforced composite, but lower than the glass fiber reinforced composite. The effect of chalk powder on thermal conductivity of sisal/glass fiber hybrid composite has also been studied and it is observed that as the chalk powder quantity by weight of resin increases then the thermal conductivity also increases. The thermal conductivity of a material depends on the nature of the material, the area of cross section normal to the direction of heat flow and the temperature gradient between the hotter part and the colder part of the material [5].

Hence the poor tensile properties of the epoxy coated jute/PA6 composites. This paper investigation intended to improve the thermal stability of natural fibers with the use of surface treatments *i.e.* flexible epoxy so that the natural fiber can be processed with high temperature engineering thermoplastics. It was found that the flexible epoxy coating was able to improve the thermal degradation resistance of jute fibers with the best result given by 5 wt% curative concentration. However, flexural proper-ties improved continuously with increasing curative concentration. The epoxy coated jute fabric composites showed inferior tensile properties as compared to the uncoated jute fabric composite albeit the properties in-creased with increasing curative content. SEM studies revealed strong fiber/matrix interfacial bonding for both coated and uncoated jute fabric composites. The inferior tensile properties of the resin coated jute composites could be attributed to the poor interfacial interaction between the flexible epoxy coating and the PA6 [6].

The variation of mean tensile strength with varying fiber content It was clearly evident that with increasing the fiber content in the polyester matrix, the tensile strength is also increased. This is due to the fact that the polyester resin transmits and distributes the applied stress to the typha angustifolia fibers resulting in higher strength. Therefore, the composite can sustain higher load before failure compared to the unreinforced polyester. [7]

Glass fiber has roughly comparable mechanical properties to other fibers such as polymers and carbon fiber. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Glass fibers are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively lightweight fiber-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fiberglass". This structural material product contains little or no air or gas, is more dense, and is a much poorer thermal insulator than is glass wool. Based on the above literature, an attempt is made in this project to evaluate the mechanical properties (tensile strength, tensile module, flexural strength, flexural module, impact energy) and thermal properties(thermal conductivity, specific heat, thermal diffusivity) of combining glass fibers with and without addition of mild steel scrap powder and to introduce them as a reinforcement to the composites.

## 2. Extractionof GlassFiber:

### 2.1 Melting

There are two main types of glass fiber manufacture and two main types of glass fiber product. First, fiber is made either from a direct melt process or a marble remelt process. Both start with the raw materials in solid form. The materials are mixed together and melted in a furnace. Then, for the marble process, the molten material is sheared and rolled into marbles which are cooled and packaged. The marbles are taken to the fiber manufacturing facility where they are inserted into a can and remelted. The molten glass is extruded to the bushing to be formed into fiber. In the direct melt process, the molten glass in the furnace goes directly to the bushing for formation.

### 2.2 Formation

The bushing plate is the most important part of the machinery for making the fiber. This is a small metal furnace containing nozzles for the fiber to be formed through. It is almost always made of platinum alloyed with rhodium for durability. Platinum is used because the glass melt has a natural affinity for wetting it. When bushings were first used they were 100% platinum, and the glass wetted the bushing so easily that it ran under the plate after exiting the nozzle and accumulated on the underside. Also, due to its cost and the tendency to wear, the platinum was alloyed with rhodium. In the direct melt process, the bushing serves as a collector for the molten glass. It is heated slightly to keep the glass at the correct temperature for fiber formation. In the marble melt process, the bushing acts more like a furnace as it melts more of the material.

Bushings are the major expense in fiber glass production. The nozzle design is also critical. The number of nozzles ranges from 200 to 4000 in multiples of 200. The important part of the nozzle in continuous filament manufacture is the thickness of its walls in the exit region. It was found that inserting a counterbore here reduced wetting. Today, the nozzles are designed to have a minimum thickness at the exit. As glass flows through the nozzle, it forms a drop which is suspended from the end. As it falls, it leaves a thread attached by the meniscus to the nozzle as long as the viscosity is in the correct range for fiber formation. The smaller the annular ring of the nozzle and the thinner the wall at exit, the faster the drop will form and fall away, and the lower its tendency to wet the vertical part of the nozzle.] The surface tension of the glass is what influences the formation of the meniscus.

The attenuation (drawing) speed is important in the nozzle design. Although slowing this speed down can make coarser fiber, it is uneconomic to run at speeds for which the nozzles were not designed.

## 2.3 Continuous filament process

In the continuous filament process, after the fiber is drawn, a size is applied. This size helps protect the fiber as it is wound onto a bobbin. The particular size applied relates to end-use. While some sizes are processing aids, others make the fiber have an affinity for a certain resin, if the fiber is to be used in a composite. Size is usually added at 0.5–2.0% by weight. Winding then takes place at around 1000 m/min.

## 2.4 Staple fiber process

For staple fiber production, there are a number of ways to manufacture the fiber. The glass can be blown or blasted with heat or steam after exiting the formation machine. Usually these fibres are made into some sort of mat. The most common process used is the rotary process. Here, the glass enters a rotating spinner and due to centrifugal forces thrown out horizontally. The air jets push it down vertically, and binder is applied. Then the mat is vacuumed to a screen and the binder is cured in the oven.

**Fig1 Glass fibers**

## 3.Fabrication of composite specimens:

### 3.1 Tensile and flexural testing specimens

The standard test method for Mechanical properties of fiber-resin composites, ASTM-D790M-86 is used to prepare specimens as per the dimensions. The test specimen has a constant cross section with tabs bonded at the ends.

The mould is prepared on smooth ceramic tile with rubber shoe sole to the required dimension. Initially the ceramic tile is cleaned with shellac (NC thinner) a spirituous product to ensure clean surface on the tile. Then mould is prepared keeping the rubber sole on the tile. The gap between the rubber and the tile is filled with mansion hygienic wax. A thin coating of PVA (polyvinyl alcohol) is applied on the contact surface of specimen, using a brush. The resulting mould is cured for 24 hours.

Hand layup method is adopted to fill the prepared mould with general-purpose epoxy resin. ECMALON 4411 is an unsaturated epoxy resin of orthophthalic acid grade with clear colourless or pale yellow colour. Its viscosity is 500-600 CPS (Brookfield Viscometer) and specific gravity is 1.13 grams/c.c. at 250 C. Acid Number (mg KOH/g) is 22 and monomer content is 35%. Cobalt accelerator and MEKP catalyst are added for curing the resin at room conditions. The quantity of each of these materials, added is 1.5% of the volume of resin. The gel time is found to be about 20 min. The accelerator is mixed thoroughly with the resin and the catalyst is added later to avoid explosion. A thin coating of the resin is applied to the mould surface and known weight of the fiber is placed along the longitudinal direction of the specimen so that the fibers are oriented $0^0$ along the axial direction of the specimen. Then the rest of the mould is filled with the resin making sure that there are no air gaps in the mould. Then, a thin Polyethylene paper of 0.2mm thick is placed on the rubber mould. A flat mild steel plate is placed on the mould and a pressure of $0.05MN/m^{-2}$ is applied and left for 24 hours to cure. Later the specimen is removed and filed to obtain the final dimensions. The specimen is cleaned with NC thinner and wiped off to remove dirt particles. The ends of both flat sides of the specimen are roughened enough using a sandpaper, so as to bond the end tabs.

Two such identical specimens are prepared for each fiber content in the specimen. Six different fiber contents (0.5, 1, 1.5, 2.0, 2.5, grams) are incorporated in the specimen and also prepared specimens with addition of mild steel powder (10 grams) to the epoxy resin material same content fiber mentioned previously. Two of plain epoxy specimen's is also prepared in order to compare the results of glass fiber reinforced composite

**Fig 2without addition of mild steel powder tensile specimens**

**Fig 3with addition of mild steel powder tensile specimens**

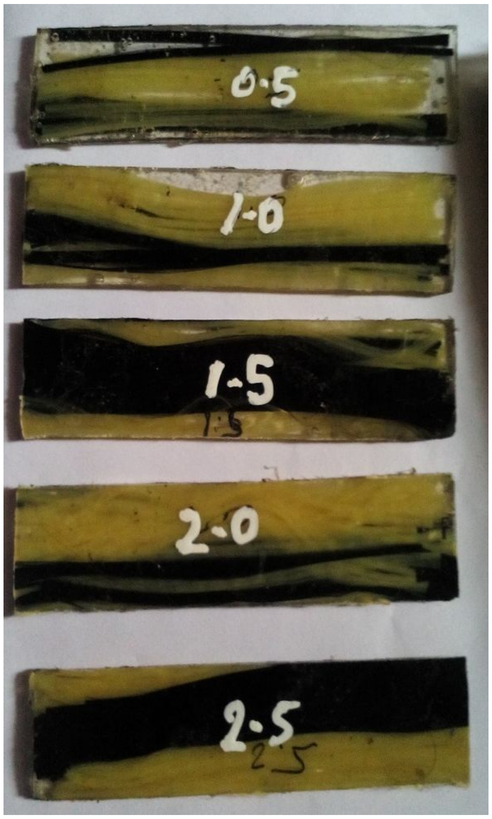

**Fig 4without addition of mild steel powder flexural specimens**

**Fig 5with addition of mild steel powder flexural specimens**

## 3.2 Impact testing specimens

The mould is prepared on smooth ceramic tile with rubber shoe sole to the required dimension. Initially the ceramic tile is cleaned with shellac (NC thinner) a spirituous product to ensure clean surface on the tile. Then mould is prepared keeping the rubber sole on the tile. The gap between the rubber and the tile is filled with mansion hygienic wax. A thin coating of PVA (polyvinyl alcohol) is applied on the contact surface of specimen, using a brush. The resulting mould is cured for 24 hours.

Hand lay-up method is adopted to fill the prepared mould with general-purpose epoxy resin. ECMALON 4411 is an unsaturated epoxy resin of orthophthalic acid grade with clear colourless or pale yellow colour. Its viscosity is 500-600 CPS (Brookfield Viscometer) and specific gravity is 1.13 grams/c.c. at $25^0$ C. Acid Number (mg KOH/g) is 22 and monomer content is 35%. Cobalt accelerator and MEKP catalyst are added for curing the resin at room conditions. The quantity of each of these materials, added is 1.5% of the volume of resin. The gel time is found to be about 20 min. The accelerator is mixed thoroughly with the resin and the catalyst is added later to avoid explosion. A thin coating of the resin is applied to the mould surface and known weight of the fiber is placed along the longitudinal direction of the specimen so that the fibers are oriented $0^0$ along the axial direction of the specimen. Then the rest of the mould is filled with the resin making sure that there are no air gaps in the mould. Then, a thin Polyethylene paper of 0.2mm thick is placed on the rubber mould. A flat mild steel plate is placed on the mould and a pressure of $0.05MN/m^{-2}$ is applied and left for 24 hours to cure. Later the specimen is removed and filed to obtain the final dimensions (63.7mm*12.6*10mm). The specimen is cleaned with NC thinner and wiped off to remove dirt particles. The ends of both flat sides of the specimen are roughened enough using a sandpaper, so as to bond the end tabs.

**Fig 6with addition of mild steel powder impact specimen's**

**Fig 7without addition of mild steel powder impact specimen's**

## 3.3 Thermal conductivitySpecimens

The standard test method for thermal conductivity of fiber-resin composites is ASTM-E 1530 which is used to prepare specimens as per the dimensions. The mould is prepared on smooth ceramic tile with rubber shoe sole to the required dimension. Initially the ceramic tile is cleaned with shellac (NC thinner) a spirituous product to ensure clean surface on the tile. Then mould is prepared keeping the rubber sole on the tile. The gap between the rubber and the tile is filled with mansion hygienic wax. A thin coating of PVA (polyvinyl alcohol) is applied on the contact surface of specimen, using a brush. The resulting mould is cured for 24 hours.

Hand layup method is adopted to fill the prepared mould with general purpose epoxy resin of ECMALON 4413 grade, supplied by ECMAS RESINS PVT. Ltd, Hyderabad, as matrix and various fibers as reinforcement. ECMALON 4413 is an unsaturated epoxy resin of orthophthalic acid grade with clear colorless or pale yellow colour. Its viscosity is 500-600 CPS (Brokfield Viscometer) and specific gravity is 1.13 grams/c.c. at $25^0$ C. Acid Number (mg KOH/g) is 22 and monomer content is 35%. Cobalt accelerator and MEKP catalyst are added for curing the resin at room conditions. The quantity of each of these materials, added is 1.5% of the volume of resin. The gel time is found to be about 25 min. The accelerator is mixed thoroughly with the resin and the catalyst is added later to avoid explosion. A thin coating of the resin is applied to the mould surface and known weight of the fiber is placed along the longitudinal direction of the specimen so that the fibers are oriented $0^0$ along the axial direction of the specimen. Then the rest of the mould is filled with the resin making sure that there are no air gaps in the mould. Then, a thin Polyethylene paper of 0.2mm thick is placed on the rubber mould. A flat mild steel plate is placed on the mould and left for 24 hours to cure. Later the specimen is removed and machined to obtain the final dimensions. The specimen is cleaned with NC thinner and wiped off to remove dirt particles. Two such identical specimens are prepared for each fiber content in the specimen. Five different fiber contents are incorporated in the specimen. With each fiber content, five identical specimens are prepared for each variety of fibers. Two plain epoxy specimens are also prepared in order to compare the results of natural fiber reinforced composites. The percentage volume of fiber present in the specimen is determined for each set. These processes do repeatedly and prepare treated and 10grms addition of mild steel scrap powder to resign. The mixing of mild steel scrap powder with the epoxy resin is done by using sonicator which works on the principle of processor high frequency vibrations are produced by the S.S. velocity horn which is immersed into the liquid to be processed. The vibrations give rise to millions of intense microscopic vacuum bubbles which form and implode at a very high rate (twenty thousand times per second) this phenomenon is known as cavitations. Cavitation's thus give rise to intense local pressure waves and micro-streaming of the liquid round the points of collapse this in turn produces high-shear gradients which are responsible for the above stated application. Prepare circular shape specimen of 10grmsof mild steel scrap powder to the resin and fiber composites. The specimen dimensions are 10mm thick and 50mm dia.

**Fig 8without addition of mild steel powder thermal conductivity specimen's**

**Fig 9with addition of mild steel powder thermal conductivity specimen's**

## 4.Results and Discussions:

### 4.1 Tensile strength

Tensile strength of composite increases with increase in weight of fiber. When compare without and with addition of mild steel scrap powder fibered composites the tensile strength of with addition of mild steel scrap powder fibered composite low with without addition of mild steel scrap powder one due to proper adhesion of fiber and matrix material due to this proper bonding is created between them.

The tensile strength of a without addition of mild steel scrap powder fibered composite is 137.8 N/mm$^2$ (for maximum loading). With addition of mild steel powder fibered composite tensile strength is 101.86 N/mm$^2$ (for maximum loading).

| S.no | Weight of fiber (grams) | Without addition of mild steel scrap powder fibered composite Tensile strength(N/mm$^2$) | With addition of mild steel scrap powder fibered composite Tensile strength(N/mm$^2$) |
|---|---|---|---|
| 1 | 0 | 58.5 | 55.26 |
| 2 | 0.5 | 71.23 | 62.13 |
| 3 | 1 | 100.23 | 79.73 |
| 4 | 1.5 | 116.8 | 88.26 |
| 5 | 2 | 123.46 | 88.53 |
| 6 | 2.5 | 137.8 | 101.86 |

**Table:1 Tensile strength of with and without addition mild steel powder fibered composite by varying fiber**

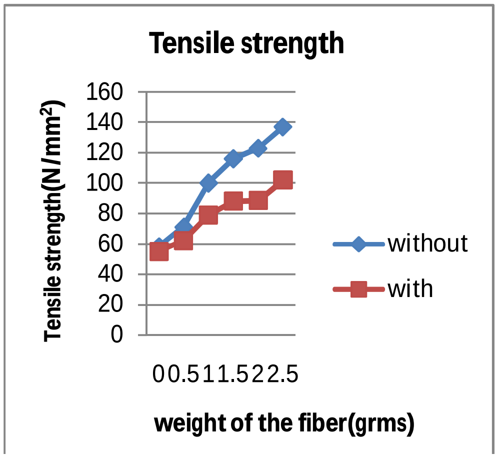

**Fig.10 Tensile strength of with and without addition mild steel powder fibered composite by varying fiber**

### 4.2 Tensile module

Tensile module of composite increases with increase in weight of fiber. When compare without and with addition of mild steel scrap powder fibered composites the tensile module of with addition of mild steel scrap powder fibered composite high with without addition of mild steel scrap powder one due to proper adhesion of fiber and matrix material due to this proper bonding is created between them

The tensile module of a without addition of mild steel scrap powder fibered composite is 1435.41 N/mm$^2$ (for maximum loading). With addition of mild steel powder fibered composite tensile module is 2546.5 N/mm$^2$ (for maximum loading).

| S.no | Weight of fiber (grams) | Without addition of mild steel scrap powder fibered composite Tensile module(N/mm$^2$) | With addition of mild steel scrap powder fibered composite Tensile module(N/mm$^2$) |
|---|---|---|---|
| 1 | 0 | 513 | 951 |
| 2 | 0.5 | 551.7 | 1071.2 |
| 3 | 1 | 1671 | 1307.04 |
| 4 | 1.5 | 1460 | 1192.7 |
| 5 | 2 | 1371.7 | 1580.8 |
| 6 | 2.5 | 1435.41 | 2546.5 |

**Table:2 Tensile module of with and without addition mild steel powder fibered composite by varying fiber**

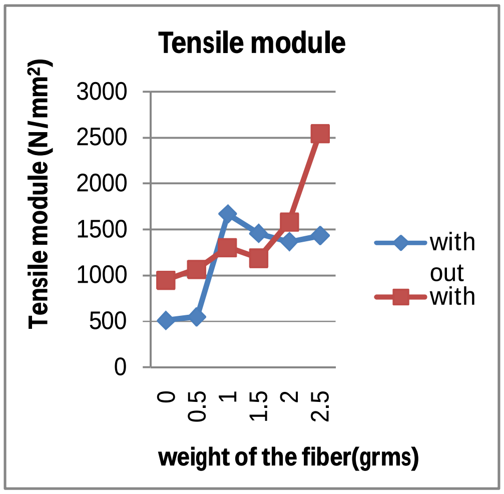

**Fig. 11 Tensile module of with and without addition mild steel powder fibered composite by varying fiber**

### 4.3 Flexural strength:

Flexural strength of composite increases with increase in weight of fiber. When compare without and with addition of mild steel scrap powder fibered composites the flexural strength of with addition of mild steel scrap powder fibered composite high with without addition of mild steel scrap powder one due to proper adhesion of fiber and matrix material due to this proper bonding is created between them.

The flexural strength of a without addition of mild steel scrap powder fibered composite is 424.06 N/mm$^2$ (for maximum loading). With addition of mild steel powder fibered composite flexural strength is 601.14 N/mm$^2$ (for maximum loading).

| S.no | Weight of fiber (grams) | Without addition of mild steel scrap powder fibered composite Flexural strength(N/mm$^2$) | With addition of mild steel scrap powder fibered composite Flexural strength(N/mm$^2$) |
|---|---|---|---|
| 1 | 0 | 146 | 169 |
| 2 | 0.5 | 177.33 | 200.38 |
| 3 | 1 | 284.66 | 382.12 |
| 4 | 1.5 | 308.2 | 456.68 |
| 5 | 2 | 372.8 | 470.66 |
| 6 | 2.5 | 424.06 | 601.14 |

**Table:3 Flexural strength of with and without addition mild steel powder fibered composite by varying fiber**

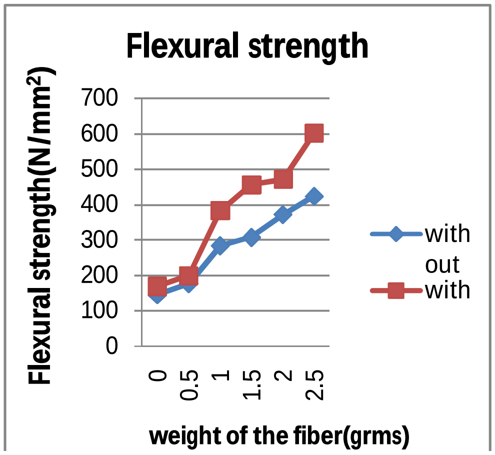

**Fig. 12 Flexural strength of with and without addition mild steel powder fibered composite by varying fiber**

### 4.4 Flexural module:

Flexural module of composite increases with increase in weight of fiber. When compare without and with addition of mild steel scrap powder fibered composites the flexural module of with addition of mild steel scrap powder fibered composite high with without addition of mild steel scrap powder one due to proper adhesion of fiber and matrix material due to this proper bonding is created between them.

The flexural module of a without addition of mild steel scrap powder fibered composite is 1053.07 N/mm$^2$ (for maximum loading). With addition of mild steel powder fibered composite flexural module is 1079.75 N/mm$^2$ (for maximum loading).

| S.no | Weight of fiber (grams) | Without addition of mild steel scrap powder fibered composite Flexural module(N/mm$^2$) | With addition of mild steel scrap powder fibered composite Flexural module(N/mm$^2$) |
|---|---|---|---|
| 1 | 0 | 759 | 787 |
| 2 | 0.5 | 21.88 | 825.69 |
| 3 | 1 | 875.23 | 887.93 |
| 4 | 1.5 | 952.72 | 964.15 |
| 5 | 2 | 1002.26 | 1014.96 |
| 6 | 2.5 | 1053.07 | 1079.75 |

**Table:4 Flexural module of with and without addition mild steel powder fibered composite by varying fiber**

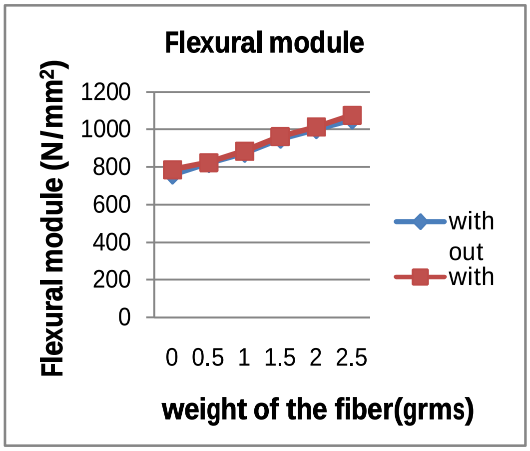

**Fig. 13 Flexural module of with and without addition mild steel powder fibered composite by varying fiber**

### 4.5 Impact energy:

Impact energy of composite increases with increase in weight of fiber. When compare without and with addition of mild steel scrap powder fibered composites the impact energy of with addition of mild steel scrap powder fibered composite high with without addition of mild steel scrap powder one due to proper adhesion of fiber and matrix material due to this proper bonding is created between them.

The impact energy of a without addition of mild steel scrap powder fibered composite is 175 J/m (for maximum loading). With addition of mild steel powder fibered composite impact energy is 262.5 J/m (for maximum loading).

| S.no | Weight of fiber (grams) | Without addition of mild steel scrap powder fibered composite Impact energy(J/m) | With addition of mild steel scrap powder fibered composite Impact energy(J/m ) |
|---|---|---|---|
| 1 | 0 | 60.5 | 75.8 |
| 2 | 0.5 | 92.5 | 97.5 |
| 3 | 1 | 100 | 112.5 |
| 4 | 1.5 | 118.75 | 135.5 |
| 5 | 2 | 131.25 | 172 |
| 6 | 2.5 | 175 | 262.5 |

**Table: 5 Impact energy of with and without addition mild steel powder fibered composite by varying fiber**

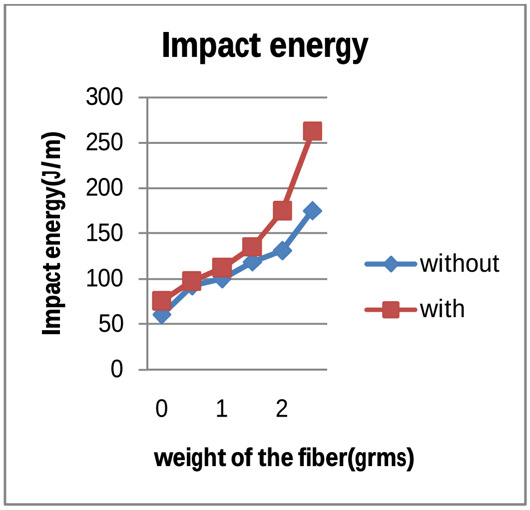

**Fig. 14 Impact energy of with and without addition mild steel powder fibered composite by varying fiber**

### 4.6 Thermal conductivity:

It was observed that for maximum fiber loading the thermal conductivity of composite is less compared to pure whereas for composite of Addition of mild steel scrap powder to resign increases slightly. And compare to with and without addition of mild steel scrap powder Thermal conductivity of with addition of mild steel powder composite is slightly higher than without addition of mild steel scrap powder. Those values at $55^0$C are tabulated below It was observed that for maximum fiber loading the thermal conductivity of composite is less compared to pure

The thermal conductivity of a without addition of mild steel scrap powder fibered composite is 0.225 W/mk (for maximum loading). With addition of mild steel powder fibered composite thermal conductivity is 0.245 W/mk (for maximum loading).

| S.no | Weight of fiber (grams) | Without addition of mild steel scrap powder fibered composite Thermal conductivity(W/mk) | With addition of mild steel scrap powder fibered composite Thermal conductivity(W/mk) |
|---|---|---|---|
| 1 | 0 | 0.235 | 0.238 |
| 2 | 5 | 0.234 | 0.236 |
| 3 | 10 | 0.233 | 0.235 |
| 4 | 15 | 0.229 | 0.240 |
| 5 | 20 | 0.225 | 0.245 |

**Table:6 Thermal conductivity of with and without addition mild steel powder fibered composite by varying fiber**

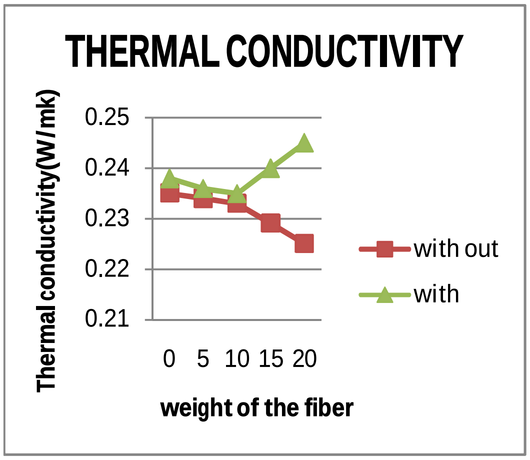

**Fig. 15 Thermal conductivity of with and without addition mild steel powder fibered composite by varying fiber**

## 5.Conclusions:

The thermal and mechanical properties such as thermal conductivity,tensile strength, flexural strength, impact energy of glass fiber reinforced hybrid composites are determined experimentally.

1) By adding mild steel scrap powder we can increase the impact strength and flexural strength but tensile strength remains low.
2) It can be seen that by varying weight of fiber the mechanical properties of the composite also change. by increase in weight of fiber in composite mechanical properties also increased up to maximum loading except tensile strength.
3) It can be seen that there is an appreciable decrease in Tensile properties on with addition of mild steel powder composite when compared to without addition of mild steel powder fibered composites they are
    i) The tensile strength of a without addition of mild steel scrap powder fibered composite is 137.8 N/mm$^2$ (for maximum loading). With addition of mild steel powder fibered composite tensile strength is 101.86 N/mm$^2$ (for maximum loading).
    ii) The tensile module of a without addition of mild steel scrap powder fibered composite is 1435.41 N/mm$^2$ (for maximum loading). With addition of mild steel powder fibered composite tensile module is 2546.5 N/mm$^2$ (for maximum loading).
4) It can also see that there is an appreciable change in the flexural properties of with addition of mild steel powder composite when compared to without addition of mild steel powder fibered composites they are
    i) The flexural strength of a without addition of mild steel scrap powder fibered composite is 424.06 N/mm$^2$ (for maximum loading). With addition of mild steel powder fibered composite

flexural strength is 601.14 N/mm$^2$ (for maximum loading).

   ii) The flexural module of a without addition of mild steel scrap powder fibered composite is 1053.07 N/mm$^2$ (for maximum loading). With addition of mild steel powder fibered composite flexural module is 1079.75 N/mm$^2$ (for maximum loading).

5) The impact energy of a without addition of mild steel scrap powder fibered composite is 175 J/m (for maximum loading). With addition of mild steel powder fibered composite impact energy is 262.5 J/m (for maximum loading).
6) The thermal conductivity of a without addition of mild steel scrap powder fibered composite is 0.225 W/mk (for maximum loading). With addition of mild steel powder fibered composite thermal conductivity is 0.245 W/mk (for maximum loading)

## 6.Scopesfor Future Work:

Hence, the addition of mild steel powder to composite. Hybrid glass fiber composite exhibit favorable mechanical and thermal properties. The present work, therefore, can be extended in the following directions further, by adding some additives such as Nano clay, fly ash, Aluminum powder in the epoxy resin and also we have used two types of glass fibers for reinforcement. Work can be done using multiple fibers (natural and manmade fibers) for reinforcement

## References

1. Mori H., Takagi H., Hino J. and Nakaoka M., Damping Properties of Bamboo Fiber.
2. Md. Alamgir kabir, Humayun kabir, M.Mahbubur Rahman. Study of physical, mechanical, and thermal properties of unidirectional jute fiber reinforced PVC film composites. IJARET Vol 3, page no 267-274,2012.
3. Dr.sihama i.salih. Acoustical and mechanical properties of polymer composites reinforced by pre-deformed palm fiber. Eng. &Tech.journal,vol 31, no 3, 2013.
4. Mahesh, k. Govindarajulu, V. Balakrishna Murthy.Experimental Investigation of Thermal and Mechanical Properties of Palmyra Fiber Reinforced Polyester Composites With and Without Chemical Treatment and Also Addition of Chalk Powder
5. Thermal Properties of Maize Fiber Reinforced Unsaturated Polyester Resin Composites Saravana Bavan D and Mohan Kumar G C. Member, IAENG.
6. The Effect of Curative Concentration on Thermal and Mechanical Properties of Flexible Epoxy Coated Jute Fabric Reinforced Polyamide 6 Composites Smith Thitithanasarn1*, Kazushi Yamada1, Umaru S. Ishiaku, Hiroyuki HamadaDepartment of Advanced Fibro-Science, Kyoto Institute of Technology, Kyoto, Japan; Department of Textile Science and Tech-nology, Faculty of Science, Ahmadu Bello University, Zaria, Nigeria
7. Effect of Alkaline Treatment on Mechanical and Thermal Properties Oftypha Angustifolia Fiber Reinforced Composites M.Dedeepya, T.Dharma Raju & T. Jayananda Kumar.IJMIE vol 1,2012