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Fabrication of Composites Using Natural and Synthetic Fibers and Copper Powder and Their Mechanical Testing

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ABSTRACT: Present work progress a methodology to fabricate a composites material using natural and synthetic fiber material such as Flax Fiber and chopped e-glass materials and copper powder to analyze its mechanical properties such as Tensile test, compression test and Flexural test,impact test by using experimental method Maximum Tensile strength obtained at only chopped e glass 164.49 specimen. Maximum compressive strength obtained at chopped e glass 15gm copper powder 189.25 specimen. Maximum flexurial strenth obtained for e glass 15gm copper powder 495.99 specimen. And maximum impact strenth obtained for e glass 15gm copper powder 3.6 specimen

Keywords—Hybrid composite, jute, Chopped e-glass, Epoxy Resin (LY556) And Hardner (HY951),

I. INTRODUCTION

1.1 Historical Development

The sustainable world's economic growth and people's life improvement greatly depend on the use of alternative product in various fields. In an advanced society like ours we all depend on composite materials in some aspect of our lives. Composite materials are heterogeneous mixtures of two or more homogeneous phases, which have been bonded together. In composites, properties or set of properties can be attained which could not have been obtained separately. Many in nature occurring materials can be regarded as composite e.g. bones, woods and others. Man-made composites are used since thousands of years, e.g. straw and natural fibers in bricks, laminated woods, etc. In the last century, the use of composites has been extended after appearance of pneumatic tyers for vehicles and reinforced concrete.

The next step was the development of glass fiber reinforced plastics during the Second World War. In the 1970s and 1980s, new types of composites have been developed to meet the strict requirements of aircraft and space industries. Composite materials are formed by combining two or more materials that have quite different properties. The different materials work together to give the composite unique properties, but within the composite.

You can easily tell the different materials apart they do not dissolve or blend into each other. Composite exists in nature. A piece of wood is a composite, with long fibers of cellulose (a very complex form of starch) held together by a much weaker substance called lignin. Cellulose is also found in cotton and linen but it is the binding power of lignin that makes a piece of timber much stronger than a bundle of cotton fiber.

The properties that can be improved by a composite material include Strength, Stiffness, Corrosion resistance, less weight and Attractiveness. This paper discuss about the fabrication of Composite material by using the Wood powder, Groundnut Husk and Cashew nut Husk and analysis of its properties. The paper starts with the Literature survey, Experimental details then presents the Result and conclusion and ends with future scope of the research.

1.2 HYBRID COMPOSITES

A combination of two or more types of fibers in a single polymeric matrix (also known as the hybrid composite) can produce greater stiffness and strength in comparison with the individual corresponding reinforced polymer composites. Different fibers have different properties and characteristics. Thus, if these different properties are known, different fibers can be employed in a way that they can superpose their properties towards reaching an optimum behavior when subjected to a certain mechanical loading as a whole. Commonly, some types of fibers in hybrid composites have low modulus and/or lower cost, such as glass and Kevlar fibers, whilst the other types have high modulus and/or high cost such as boron and carbon fibers. Low modulus and inexpensive fibers make hybrid composites more tolerant to damage and reduce the overall cost, while the more expensive fibers with high modulus improve load bearing capabilities and composite stiffness. Hence, hybridization of composites can provide high stiffness and strength, improve the impact and fatigue resistance, provide high fracture toughness and simultaneously cut the total weight and cost

Hybridization is one of the effective methods of achieving desired properties of laminated composites. Hybrid composites are produced by incorporating two or more types of fibers in a laminated composite in order to achieve enhanced properties in comparison with the corresponding single type fiber-reinforced composites. Hybridizing the composite laminates provide the opportunity of benefiting from the advantages of various fibers and suppressing their weaknesses. Hybridization has been used in order to improve the fracture toughness, fatigue resistance and reduce the total cost or weight of composite laminates

1.3 Classification of Composite materials

Composite materials are classified in to types. One of them is basedon the matrix material (metal, ceramic, and polymer) and the second is based on the reinforcing material structure.

1.4 Based On Matrix Material

a)Metal Matrix Composites (MMC)

Metal matrix composites (MMCs), as the name implies, have a metal matrix. Examples of matrices in such composites include aluminum, magnesium, andtitanium. Typical fibers include carbon and silicon carbide. Metals are mainly reinforced to increase or decrease their properties to suit the needs of design.

b)Polymer Matrix Composites (PMC)

The most common advanced composites are polymer matrix composites (PMCs) consisting of a polymer (e.g., epoxy, polyester, urethane) reinforced by thin diameter fibers (e.g., graphite, aramids, boron). For example, graphite/ epoxy composites are approximately five times stronger than steel on a weightfor-weight basis.

c)Ceramic Matrix Composites (CMC)

They consist of ceramic fibers embedded in a ceramic matrix. The matrix and fibres can consist of any ceramic material, where by carbon and carbon fiber can also be considered a ceramic material.

d)Carbon–Carbon Composites

Carbon–carbon composites use carbon fibers in a carbon matrix. These composites are used in very high-temperature environments of up to 6000°F (3315°C), and are 20 times stronger and 30% lighter than graphite fibers.Carbon is brittle and flaw sensitive like ceramics. Reinforcement of a carbon matrix allows the composite to fail gradually and also gives advantages such as ability to withstand high temperatures, low density, good tensile and compressive strengths, high fatigue resistance, high thermal conductivity, and high coefficient of friction.

1.5 Based On Reinforcing Material

1.Particulate composites

They consist of particles immersed in matrices such as alloys and ceramics. They are usually isotropic because the particles are added randomly. Particulate composites have advantages such as improved strength, increased operating temperature, oxidation resistance, etc. Typical examples include use of aluminum particles in rubber; silicon carbide particles in aluminum.

2.Fiber composites

They consist of matrices reinforced by short (discontinuous) or long (continuous) fibers. Fibers are generally anisotropic† and examples include carbon and aramids. Examples of matrices are resins such as epoxy, metals such as aluminum, and ceramics such as calcium–alumino silicate.

3.Flake composites

They consist of flat reinforcements of matrices. Typical flake materials are glass, mica, aluminum, and silver. Flake composites provide advantages such as high out-of- plane flexural modulus, higher strength, and low cost. However, flakes cannot be oriented easily and only a limited number of materials are available for use.

1.6 Properties of Composites

Based on the material composition properties are depended some of the composite material properties are:

- Resistance To Chemicals.
- Electrical Insulating Properties.
- Thermal Insulating Properties.
- High Strength-To-Weight Ratio.
- High Fatigue Resistance.

1.7 Introduction To Laminates

A lamina (also called a ply or layer) is a single flat layer of unidirectional fibers or woven fibers arranged in a matrix.

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a)Laminate
A laminate is a stack of plies of composites. Each layer can be laid at various orientations and can be made up of different material systems.

b)Hybrid Laminate
Hybrid composites contain more than one fiber or one matrix system in a laminate.
The main four types of hybrid laminates follow.

C)Interply Hybrid
These laminates contain plies made of two or more different composite systems. Examples include car bumpers made of glass/ epoxy layers to provide torsional rigidity and graphite/epoxy to give stiffness. The combinations also lower the cost of the bumper

d)Intraply Hybrid
These composites consist of two or more different fibers used in the same ply. Examples include golf clubs that use graphite and aramid fibers. Graphite fibers provide the torsional rigidity and the aramid fibers provide tensile strength and toughness.

e)Interply–Intraply Hybrid
These composites consists of plies that have two or more different fibers in the same ply and distinct composite systems in more than one ply.

d)Resin Hybrid Laminates
These composites combine two or more resins instead of combining two or more fibers in a laminate. Generally, one resin is flexible and the other one is rigid.

1.8 Introduction To Polymers
A polymer is a giant molecules are made up by the linkage of simpler molecules (monomers) by a polymerization reaction into essentially endless chain structures. Polymers occur naturally, but the majority which are used commercially are manufactured from simple monomers.

1.9 Classification of Polymers
Polymers are classified into many types based on availability, bonding and some other factors.

Based on Bonding
Based on molecular bonding the polymers are divided into the following types:

a) Co-polymers
Consist of chains with two or more linkages usually implying two or more different types of monomer units. These may be represented as: - [A-B-A-B-A-B] –

b)Homopolymers
These polymers made by joining together monomers of the same chemical composition or structure.This usually implies that the polymer is made from all identical monomer molecules. These may be represented as - [A-A-A-A-A-A]-

c)Heteropolymers
Heteropolymers consist of macromolecules comprising more than one type of elementary unit. Any sample of a synthetic heteropolymer represents a mixture of an enormous (practically infinite) number of different individual chemical compounds.

d)Condensation Polymers
Condensation polymers are formed by polycondensation, when the polymer is formed by condensation reactions between species of all.

1.11Synthetic Fibers
The most common advanced composites are polymer matrix composites. These composites consist of a polymer thermoplastic or thermosetting reinforced by fiber (natural carbon or boron). These materials can be fashioned into a variety of shapes and sizes. They provide great strength and stiffness along with resistance to corrosion. The reason for these being most common is their low cost, high strength and simple manufacturing principles.

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Fig 1.2 Jute

Fig 1.3 Hemp

1.12 Chopped Strand Mat

Chopped strand mat or CSM is a type of fortification utilized in fiberglass. It comprises of glass filaments laid arbitrarily over one another and held together by a fastener. It is regularly prepared utilizing the hand lay-up method, where sheets of material are set on a shape and brushed with resin. CSM is comprised of 25-50 MM long fiberglass strands that are haphazardly situated and regularly held along with a styrene- dissolvable folio that demonstrations like paste associating the filaments. The fastener is intended to break down upon contact with styrene in polyester pitch. When broken down, the texture mellow, permitting it to wrap around bended shapes. It is an arbitrary fiber mat that gives equivalent quality every which way and is utilized in an assortment of hand expose up and form applications.

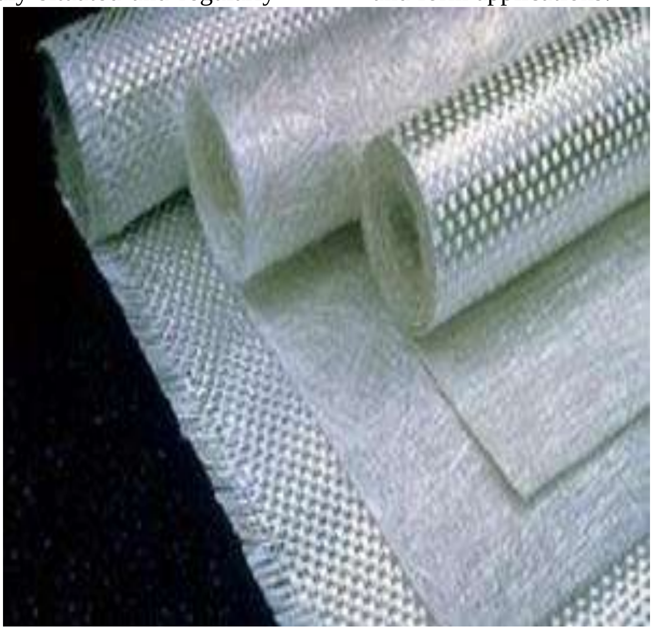

Fig 1.4 Chopped E-Glass Mat

1.13 Applications of Chopped strand mat:

Telecommunication

- CSM is used as basic laminate reinforcement and for gel coat backup to decrease weave print.
- Used in telecommunications industry for shrouding antennas
- Used in storage tanks.

Artificial systems

- Antenna covers and structures
- Large commercial wind turbine blades
- Oil and gas artificial systems.

Buildings

- House building
- Sculpture making

1,14 Advantages of Chopped strand tangle:

- It is entirely agreeable to work with , since it very well may be extended and can take a wide range of complex shapes in view of the impregnation with the tar
- High inter laminar shear quality
- Corrosion opposition
- Leakage opposition

1.15 Disadvantages of Chopped strand tangle:

- It is ordinarily handled utilizing hand lay – up method where sheets of material are set on a form and brushed with sap so safeguards must be taken by wearing a gloves
- It gets placed into suspension and is fixed in the relieved epoxy.
- More hard to deal with.

1.17 Copper Powder

Copper is a sort of non-ferrous metallic which has for some time been firmly related to humans there ample property in nature, yet copper likewise has notable houses. The electrons can flow overtly via the metal. They are known as conduction electrons for the reason that they assist copper to be a respectable conduit of heat and strength. Unadulterated copper powder is utilized within the electrical and the hardware ventures due to its first-rate electrical and heat conductivities Alloyed with tin, zinc, nickel and extraordinary additives, copper in powder shape finely partitioned copper steel residue or
powder has likewise been displayed to be non-flammable in research middle checking out.

Fig :1.5 Copper powder

1.21 Polyester Resin

Polyester sap is the fundamental kind utilized in the boatbuilding business around the world."Unsaturated" polyester gum is a more right term for the fluid state where it is provided. At the point when restored to the strong state during the overlaying cycle it becomes "soaked". Ethylene is another case of an immersed polyester sap and is plainly a plastic and non-natural material. Pitch is gotten from coal and oil.

Anyway it can fix inside two hours of setting to invigorate more noteworthy than solid they are broadly utilized for the quick fix of little zones of harmed solid floors. Most polyester pitches are clear thick fluids comprising of a polyester arrangement in a monomer, which is commonly styrene. The purpose behind this is that the expansion of styrene in sums up to half decreases the consistency of the sap and encourages its dealing with. Another essential capacity of styrene is to permit the pitch to crosslink the chains of the polyester

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Fig:1.7 Polyester Resin

2 Literature Review

2.1 Review of papers

A composite is a material made by combining two or more dissimilar materials in such a way that the resultant material is endowed with properties superior to any of its parental ones. Fiber-reinforced composites, owing to their superior properties, are usually nowadays, natural work has been done by researchers based on these natural fibers such as banana ,pineapple,flax are inexpensive,abundant,and lightweight with low density,high toughness and renewable. Natural fiber reinforced polymer composites have raised great attentions and interests among materials scientists and engineers in recent years due to the consideration of developing an environmental friendlymaterial.

Venkateswararao et al.[1] Studied the mechanical properties such as tensile strength, flexural strength, impact strength and water absorption rate of sisal and banana fibers reinforced epoxy composite materials. They have observed that there is the significant improvement in mechanical strength and reduction in water absorption rate while hybridizing sisal fiber up to 50% by weight with the banana fiber reinforced epoxy composites. The banana and GFRP composites have good tensile property with minimum deflection when compared to the flax and GFRP COMPOSITES. Also the banana and flax fiber reinforced composites holds more flexural and impact strength when compared to the flax and glass fiber reinforced polymer composites.

Li et al.[2]Have evaluated correlated the compressive strength, flexural strength, toughness, specific gravity and water absorption rate of the hemp fiber reinforced composite (HFRC) with different compositions. The water absorbing ratio and the linear specific gravity of the composites are gradually reduced by adding the hemp fiber with concrete matrix. They have absorbed that the fiber content by weight is the important factor which effect the compressive and flexural strength of HFRC. Hemp fiber has superior reinforcement property while increasing tensile property and strong toughness in an alkali environment. JawadKadhimUleiwiet al.[3] Investigated the effect of fiber volume fraction on the flexural properties of the laminated composite constructed of different layers, one of them having reinforced glass fiber and the other layer reinforced with Kevlar fiber has been investigated experimentally and the results illustrate that tension stress decreases with the increase in fiber volume fraction of glass fiber of the lower layer while it increases with the increase of Kevlar volume fraction of the upper layer.

Wen-Pin Lin et al.[4] . Analyzed the Failure of Fiber-Reinforced Compositelaminates under biaxial tensile loading Laminates under Biaxial Tensile Loading. With the onset of failure for individual laminates under Biaxial Tensile Loading. With the onset of failure for individual lamina is determined by a mixed failure criterion composed of the maximum stress criteria. It was observed that after the initial damage takes place, the response of the lamina was described and observed to be brittle or degrading modes with the of the entire laminate.

Slimane Metiche and Radhouane Masmoudi et al.[5] Studied the flexural behaviour of light weight fiber reinforced polymer (FRP) poles. Experimental results show that theuse of low linear density glass-Fibers could provide an increase of the ultimate loadcarrying capacity up to 38 % for some fiber reinforced polymer poles. It is alsoobserved that , the positioning of the hole in the compression side compared to thetension side leads to an increase of the ultimate load carrying capacity up to 22 % forthe 5.4m (18 feet) fiber reinforced polymer poles and it was learnt that there was nosignificant effect (3,5%) for the 12m (40 feet) fiber reinforced polymer poles. This ismainly due to the stacking sequence and the stress states generated around the hole.

H.A.Rijsdijk et al. [6] Investigated the influence of maleic-anhydride-modifiedpolypropylene (m-PP) on monotonic mechanical properties of continuous-glass fiberreinforcedpolypropylene (PP) composites. This study showed an increase incomposite strength as a result of the addition of maleic-anhydride- modified PP to continuous glassfiber-reinforced PP composites. An optimum in both longitudinal and transverse flexural strength was reached for composites based on a PP matrixwith 10wt% m-PP. In recent years, the interest of scientists and engineers has turned over on utilizing plant fibers as effectively and economically as possible to produce good quality fiber-reinforced polymer composites for structural, building, and other needs. It is because of the high availability and has led to the development of alternative materials instead of conventional or man-made ones. Many types of natural fibers have been investigated for their use in polymer such as wood fiber (Maldas et al 1995), sisal (Joseph et al 1999), kenaf (Rowell et al 1999), pineapple (Mishra et al 2001), jute (Mohanty et al 2006), banana (Pothan et al 2003) and straw (Kamel 2004).

Jane Maria Faulstich de Paiva [7]: This paper shows a study involving mechanical (flexural, shear, tensile and compressive tests) and morphological characterizations of four different laminates based on 2 epoxy resin systems (8552TM and F584TM). The results show that the F584-epoxy matrix laminates present better mechanical properties in the tensile and compressive tests than 8552 composites. Further it is observed that PW laminates for both matrices show better flexural and inter laminar shear properties.

Banerji and Nirmal [8]: In a hybrid composite, the two reinforcing Fibres differ intheir mechanical properties and the interface they make with the matrix it was observed that there was an increase in flexural strength of unidirectional carbon Fibre/35 Poly(methyl methacrylate), composite laminates having polyethylene Fibres plies at the lower face.

2.2 The Knowledge gap in earlier investigations

The extensive literature survey presented above reveals the following knowledge gap in the research reported so far:

- Fabrication of jute and e chopped glass
- Optimization methods related to the hybrid composites.

3.1 Methodology

This chapter presents the materials and methods used for the fabrication of hybrid materials. It presents the strength and there mechanical properties of the composite materials. The methodology based on Hand lay -up technique.

3.2 Materials throughout thesis

Jute,e-chopped glass, for mixing proportions copper powder, alluminium powder, graphite powder.

3.4 Hybrid composite material

A hybrid composite is a blend of manufactured and common filaments or in excess of two unique materials in the fiber fortification of a composite. Normally one of these mixes is inorganic and the other one natural in nature. Subsequently, they contrast from conventional composites where the constituents are at the plainly visible (micrometer to millimeter) level. They have been pulling in much consideration for the formation of elite materials. Improvement of materials with coordinated meso structures is a captivating exploration subject in the field of materials science.

They are blends of at least two materials, or of materials and space, amassed so as to have credits not offered by any one material alone. Particulate and fiber composites are instances of one sort of mixture, yet there are numerous others: sandwich structures, cross section structures, divided structures, and that's only the tip of the iceberg. The quantity of potential blends of network, support, filler, and arrangement is gigantic.

Mixture composite materials are progressively used in many designing applications since they offer various improved properties and different focal points over customary composite materials. the mechanical conduct of crossover composites depends not just on the personality of a grid and fortifications yet additionally on properties of the interface between these segments and the lattice, which must be mulled over in the mathematical demonstrating of the mechanical properties. The exhibition of crossover composites is a weighted amount of the individual constituents where there is a more positive characters between the characteristic favorable circumstances and weaknesses. The advantages of one sort of fiber could supplement properties that are inadequate in different kinds of constituents in the cross breed composites.

Accordingly,an equilibrium in cost and execution could be accomplished through appropriate material plan. The properties of a half and half composite can be impacted by the direction of the strands, fiber substance and length,

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layering examples of the two filaments, their intermixing limits, fiber-to-network interface. Because of the various breadths of the filaments in the cross breed composites, more compelling pressure move could occur on account of the expansion in the fiber-lattice interfacial zone.

The positive mixture impact could be seen in such materials as the heap could in any case be connected to the encompassing high lengthening strands upon the crack of the filaments having low extension, in this way bringing about upgraded mechanical properties of the composites. it very well may be utilized for essential structures in business, modern, aviation, marine, and recreational structures. The main favorable position is weight decrease, where it could produce investment funds in the scope of 20%–half. Moreover, the mechanical properties can be customized by "lay-up" plan, with tightening thicknesses of fortifying texture and evolving direction.

Due to previously mentioned focal points of half breed composite materials basalt and chopped strand mat materials are utilized for hand lay-up strategy.

3.5 The steps involved are:

1. Specimen Fabrication by using Hand Lay-Up method.
2. Tensile Test,Compressive Test,Flexural Test,Impact Test

3.6 Raw Materials:

Raw materials which are used in this experimental work are:

(i) Jute fiber mat/chopped e-glass mat.
(ii) Epoxy resin.
(iii) Hardener.
(iv) Accelerator

Fig 3.1 Flax Jute Mat

Fig 3.2 Chopped E-Glass Mat

Fig 3.3 Epoxy Resin (LY556) and Hardner (HY951)

3.7 Jute Fiber

Jute is a long, soft, shiny vegetable fiber that can be spun into coarse, strong threads. It is produced primarily from plants in the genus Corchorus, which was once classified with the family Tiliaceae, and more recently with Malvaceae. The primary source of the fiber is Corchorus olitorius, but it is considered inferior to Corchorus capsularis. Jute is the name of the plant or fiber used to make burlap, hessian or gunny cloth. Jute was used for making textiles in the Indus valley civilization since the 3rd millennium BC. For centuries, jute has been an integral part of the culture of East Bengal and some parts of West Bengal, precisely in the southwest of Bangladesh

Fig 3.4 Jute Field

The jute fiber comes from the stem and ribbon (outer skin) of the jute plant.Moreover, jute can be grown in 4–6 months with a huge amount of cellulose being produced from the jute hurd (inner woody core or parenchyma of the jute stem) that can meet most of the wood needs of the world. Jute is the major crop among others that is able to protect deforestation by industrialization.The fibers are first extracted by retting. The retting process consists of bundling jute stems together and immersing them in slow running water. There are two types of retting: stem and ribbon. After the retting process, stripping begins; women and children usually do this job. In the stripping process, non-fibrous matter is scraped off, then the workers dig in and grab the fibers from within the jute stem. Jute matting is used to prevent flood erosion while natural vegetation becomes established. For this purpose, a natural and biodegradable fiber is essential

Jute is the second most important vegetable fiber after cotton due to its versatility. Jute is used chiefly to make cloth for wrapping bales of raw cotton, and to make sacks and coarse cloth.The fibers are also woven into curtains, chair coverings, carpets, area rugs, hessian cloth, and backing for linoleum.Jute has many advantages as a home textile, either replacing cotton or blending with it. It is a strong, durable, color and light-fast fiber. Its UV protection, sound and heat insulation, low thermal conduction and anti-static properties make it a wise choice in home décor. Also, fabrics made of jute fibers are carbon-dioxide neutral and naturally decomposable. Some of the other properties of jute are :

3.7.1 Advantages of Jute Fiber :

- Good insulating and antistatic properties, as well as having low thermal conductivity and a moderate moisture regain.
- Acoustic insulating properties and manufacture with no skin irritations

 By treating jute with caustic soda, crimp, softness, pliability, and appearance is improved, aiding in its ability to be spun with wool.

 Liquid ammonia has a similar effect on jute, as well as the added characteristic of improving flame resistance when treated with flameproofing agents.

3.7.2 Disadvantages of jute fiber :

  Poor drapability and crease resistance, brittleness, fiber shedding, and yellowing in sunlight.

 Preparation of fabrics with castor oil lubricants result in less yellowing and less fabric weight loss, as well as increased dyeing brilliance.

  Jute has a decreased strength when wet, and also becomes subject to microbial attack in humid climates.

  Jute can be processed with an enzyme to reduce some of its brittleness and stiffness.

3.7.3 Chopped E-Glass Fiber

Glass fibre composites are being used in manufacture of numerous parts/products such as automobile parts, construction equipment parts, sports goods like surfboard, tennis rackets, fishing rods, golf clubs, archery bows and many other household applications due to reasonably high specific strength, tensile strength and hardness. Also, glass fibres are less expensive; possess good resistance to chemical attacks and insulating properties. Utilization of glass fibre with appropriate orientation and proportion can yield composites with strength which are equivalent to steel, superior to aluminum in stiffness and one fourth of the steel in terms of specific gravity.

Thermosetting polymers are an excellent substitute for most of the conventional materials. Epoxy resins are one of the extensively used thermosetting resins. It is mostly used in the form of coatings and structural adhesives for many engineering applications in addition to its usage as matrices for fibre reinforced composites due to its superior thermal and mechanical properties, excellent corrosion and chemical resistance.

3.7.4 Polymer Epoxy Resin:

Epoxy LY 556 resin, chemically belonging to the „epoxies‟ family is used as the matrix. Its common name is Biphenyl Diglycidyl Ether. The low temperature curing epoxy resin (Araldite LY 556) and corresponding hardener (HY951) are mixed in a ratio of 10:1 by weight as recommended. This has a viscosity of 10 -20 poise at 250C. Hardeners include anhydrides (acids), amines, polyamides, dicyandiamide etc. Epoxy resin (Araldite LY 556) made by CIBA GUGYE Limited, having the following outstanding properties has been used.

- Excellent adhesion to different materials.
- Great strength, toughness resistance.
- Excellent resistance to chemical attack and to moisture.
- Excellent mechanical and electrical properties.
- Odorless, tasteless and completely nontoxic.

3.7.5 The major drawbacks of epoxies are:

- Highprice.
- High toxicity and complex processing requirements.
- Which often include elevated temperature and consolidation pressure, thus translating into costly manufacturing operations.
- Epoxies are low viscosity.
- Low shrinkage and the fact that they adhere well to the reinforcement fibers make them a unique matrix.

Fabrication Of Composite:

The composite is prepared by using hand lay-up technique as shown in the below table.

composites	composition
jute	Jute+Epoxy resin
Chopped E glass	Chopped E glass+Epoxy resin
Jute+Chopped E Glass	Jute+Chopped E Glass+Epoxy Resin
Jute	Jute+Epoxy Resin +5% Copper Powder
Jute	Jute+Epoxy Resin +10% Copper Powder
Jute	Jute+Epoxy Resin +15% Copper Powder
Chopped E Glass	Chopped E Glass+Epoxy Resin +5% Copper Powder
Chopped E Glass	Chopped E Glass+Epoxy Resin +10% Copper Powder
Chopped E Glass	Chopped E Glass+Epoxy Resin +15% Copper Powder
Jute+Chopped E Glass	Jute+Chopped E Glass+Epoxy Resin +5% Copper Powder
Jute+Chopped E Glass Powder	Jute+Chopped E Glass+Epoxy Resin +10% Copper
Jute+Chopped E Glass Powder	Jute+Chopped E Glass+Epoxy Resin +15% Copper

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3.8 Hand Lay-upTechnique:

The appropriate numbers of fiber plies were taken: four for each. Then the fibers were weighed and accordingly the resin and hardeners were weighed. Epoxy and hardener were mixed by using glass rod in a bowl. Care was taken to avoid formation of bubbles. Because the air bubbles were trapped in matrix may result failure in the material.

The subsequent fabrication process consisted of first putting a releasing film on the mould surface. Next a polymer coating was applied on the sheets. Then fiber ply of one kind was put and proper rolling was done. Then resin was again applied, next to it fiber ply of another kind was put and rolled. Rolling was done using cylindrical mild steel rod.

This procedure was repeated until four alternating fibers have been laid. On the top of the last ply a polymer coating is done which serves to ensure a good surface finish. Finally a releasing sheet was put on the top; a light rolling was carried out. Then it was left for 24 hrs to allow sufficient time for curing and subsequent hardening.

Fig 3.5 Hand Lay-up techniques

3.8.1 Fabricating process of the test specimens

- First of all, a release gel is sprayed on the mold surface to avoid the sticking of polymer to the surface and to remove dust particles wherever found.
- Thin plastic sheets are used at the top and bottom of the mold plate to get good surface finish of the product.
- Reinforcement in the form of woven mats are cut as per the mold size and placed at the surface of mold.
- Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener (curing agent) and poured onto the surface of mat already placed in the mold.
- The Epoxy Resin and hardener are taken in the ratio of 10:1
- The polymer is uniformly spread with the help of brush.
- The jute and e chopped glass mat has taken and copper powder
- Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present.
- The process is repeated for each layer of polymer and mat, till the required layers are stacked.
- After placing the plastic sheet, release gel is sprayed on the inner surface of the top mold

plate which is then kept on the stacked layers and the pressure is applied.

- After curing either at room temperature or at some specific temperature, mold is opened and the developed composite part is taken out and further processed.
- The time of curing depends on type of polymer used for composite processing.
- For epoxy based system, normal curing time at room temperature is 24-48 hours.

3.8.2 Testing Specimens

After the Fabrication the examples was cut into required piece and the follow test were directed

1. Tensile test
2. Compressive test
3. Flexural test
4. impact test

3.6 Tensile test specimen

3.7 Compressive Test Specimen

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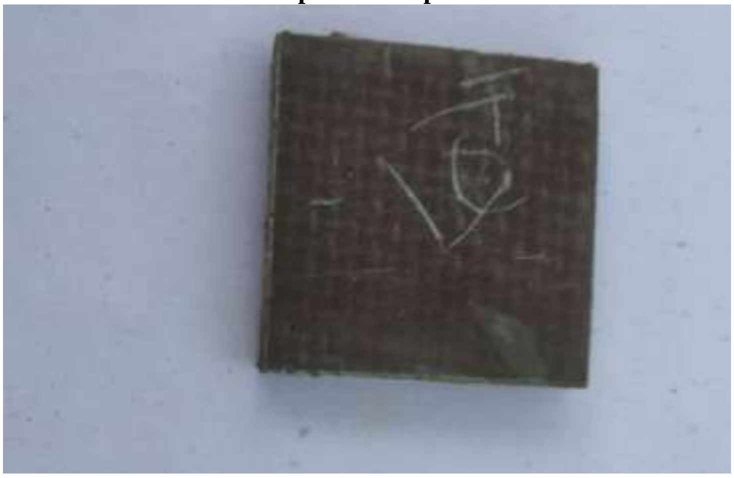
3.8 Impact Test Specimen



3.9 Flexural Test

3.9 Tensile Strength Test(D3039)

The manufactured mixture example were sliced to the ideal components of 200 mm length and width is 25 mm as per ASTM E8/E8M-15A as appeared in the Fig. 3.8.1.the elasticity has been tried on the Universal testing machine (UTM).Fig. 3.8.1.the tensile strength has been tested on the Universal testing machine (UTM).

It is imperative to recognize the tensile energy of a particular metallic or any fabric to make sure it's far the right preference for an software. This ensures an incident-free provider lifestyles. The effects of selecting substances with lower tensile strength than what the application needs can be disastrous.

Tensile test confirms the ability to resist deformation under tensile load. This test consists in straining a test piece by tensile stress, generally to fracture, in order to determine one or more of the mechanical properties. The cross-section of the test pieces may be circular, square, and rectangular or any other form in special cases. But for polymer matrix composite test pieces of rectangular section are used. Plain ends are used for holding the specimen during testing. The test piece is fitted to the testing machine in such a manner that the pull is applied axially.

The following procedure may be adopted in the tensile test: Prepare a test piece as per the standards. Measure the dimensions of the test piece by means of a micrometer and vernier caliper at least at three places and determine the mean value. Also mark the gauge length. Insert suitable jaws in the grips and select a suitable load scale on the testing machine. Insert the test piece in the grips by adjusting the cross heads of the machine. Fix the extensometer on the test piece and set its scale dials to zero positions. Also set the vertical column of the machine to zero position to take readings in the plastic range. Start the machine and take the reading of the dials on the extensometer for a particular value of load. Continue applying the load till the specimen break and then stop the machine. Plot load versus extension diagram. Determine the various mechanical tensile properties.

The ability to resist breaking under tensile stress is one of the most important and widely measured properties of materials used in structural applications. The force per unit area (MPa or psi) required to break a material in such a manner is the ultimate tensile strength or tensile strength at break. Tensile properties indicate how the material will react to forces being applied in tension. A tensile test is a fundamental mechanical test where a carefully prepared specimen is loaded in a very controlled manner while measuring the applied load and the elongation of the specimen over some distance. Tensile tests are used to determine the modulus of elasticity, elastic limit, elongation, proportional limit, and reduction in area, tensile strength, yield point, yield strength and other tensile properties.

Formula for finding tensile strength is

$\sigma = \frac{\text{force}}{\text{area}} = \frac{P}{A}$ (N/mm^2) or MPa

Tensile modulus is the measure of stiffness of a solid material. Formula for finding tensile modulus is

$E = \frac{\text{stress}}{\text{strain}} = \frac{\sigma}{\varepsilon}$ (KN/mm^2) or GPa

3.10 Tensile Test Machine

E-series electromechanical tensile testing machines are used for the performance of tensile tests. The results are displayed in the form of a force travel diagram or a stress strain curve. From there, material characteristic values such as tensile strength or yield pointsare determined.

Electromechanical tensile testing machines are equipped with a ball-screw drive and are available in 330, 400, 600, 1000, 1200, 1600, 2000 and 2500 kN versions (33 - 250 tons). While tensile tests are the most common, compression tests or flexure tests can also be performed.

3.9.1 Compressive testing(D256)

Compressive properties describe the behavior of a material when it is subjected to a compressive load. Loading is at a relatively low and uniform rate. Compressive strength and modulus are the two most common values

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produced. The specimen is placed between compressive plates parallel to the surface. The specimen is then compressed at a uniform rate. The maximum load is recorded along with stress-strain data. An extensometer attached to the front of the fixture is used to determine modulus.

- Compressive strength and modulus are two useful calculations.
- Compressive strength
- maximum compressive load

3.9.2 Flexural Strength (ASTM D7264)

Flexural strength determines the ability of the composite under vertical loading. A bending test is performed on actual beam cross section by using the three points loading systems as Fig.3.12. The bending fixture is supported on the platform. The loading is held in the middle of the specimen when specimen under test is supported with knife edge points. At a particular load the deflection at the centre of the beam is determined.

Flexural strength of a material is defined as its ability to resist deformation under load. For materials that deform significantly but do not break, the load at yield, typically measured at 5% deformation/strain of the outer surface, is reported as the flexural strength or flexural yield strength. Flexural strength, also known as modulus of rupture, bends strength, or fracture strength a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The flexural strength represents the highest stress experienced within the material at its moment of rupture. It is measured in terms of stress, here given the symbol.

Formula for finding flexural strength is

$\sigma = \frac{3\,FL}{2bd^2}$ (N/mm^2) or MPa

Where F is axial load
b is width
d is depth or thickness
L is length of the support span

Flexural modulus is known as the ratio of stress to strain in flexural deformation. Formula for flexural modulus is

$E = \frac{FL^3}{4wdh^3}$ (KN/mm^2) or GPa

Where F is force
L is length of the support span
w is width
d is deflection
h is height or thickness

3.9.3 Impact Test (ASTM D 256)

uitable for Charpy & Izod Impact tests on various materials. Works on Pendulum principle.Rigid designs of machine frame & other parts assure minimum energy absorption during fracture which results in improved test accuracies.The highly stressed & wearing parts like support blocks & strikers are of special alloy steels duly heat treated.

Direct indication of Impact energy absorbed by specimen on large dial for Models :AIT-300-N, AIT-300-EN & on digital panel display for Model : AIT-300-D.

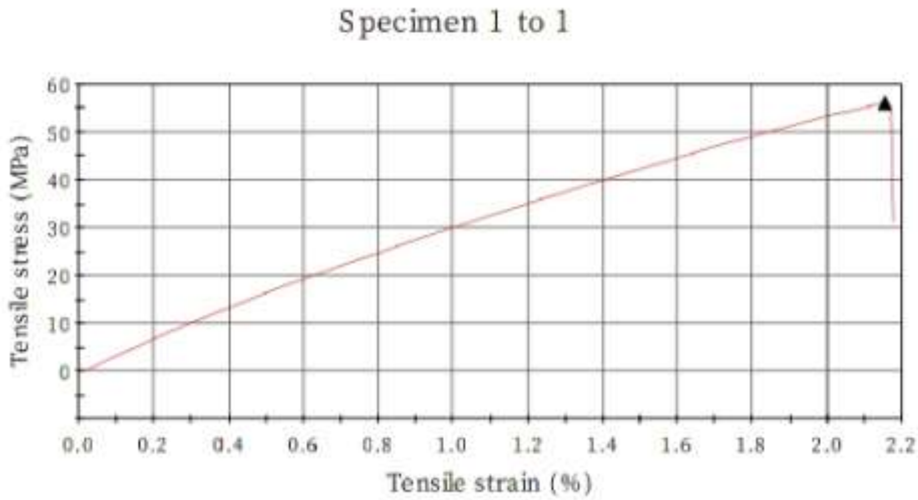
Safety guard for the operator is provided.Initial potential energy for Charpy is 300 Joules & for Izod is 170 Joules with a L.C. of 2 Joules (for Analogue models) & resolution of 0.5 Joules (for Digital Model). Pendulum drop angle for Charpy is 140° & for Izod is 90°.

3.11Impact test machine

ASTM Impact Testing machine is also supplied, which conforms to E-23 ASTM standard.
Gauges, Tongs, Sub-zero bath, Templates, U & V Notch milling cutters are available (Optional).

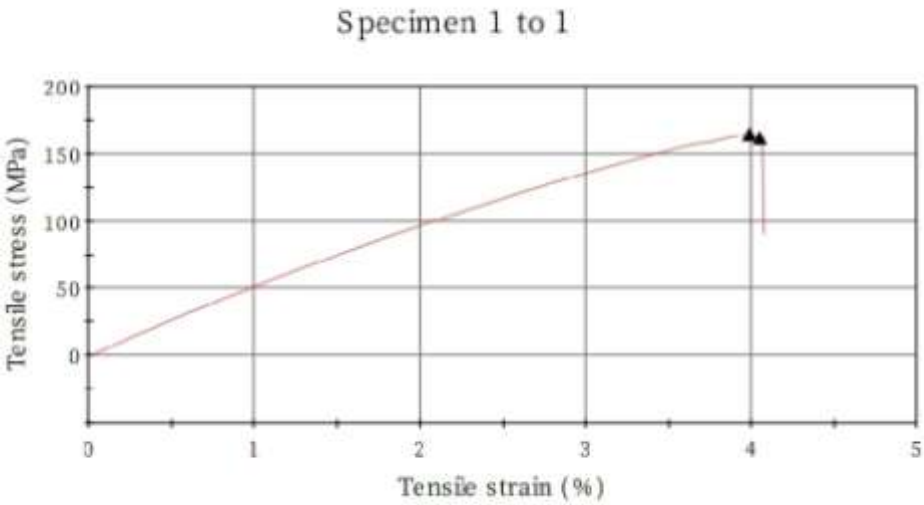
4.Result
This chapter presents the mechanical properties like tensile strength, compressive strength,flexural and impact strength of hybrid composite and their corresponding graphs.

4.1 Tensile Test
The first specimen taken jute flax fiber .The flax fiber tensile stree 56.14 mpa and load 1684.15



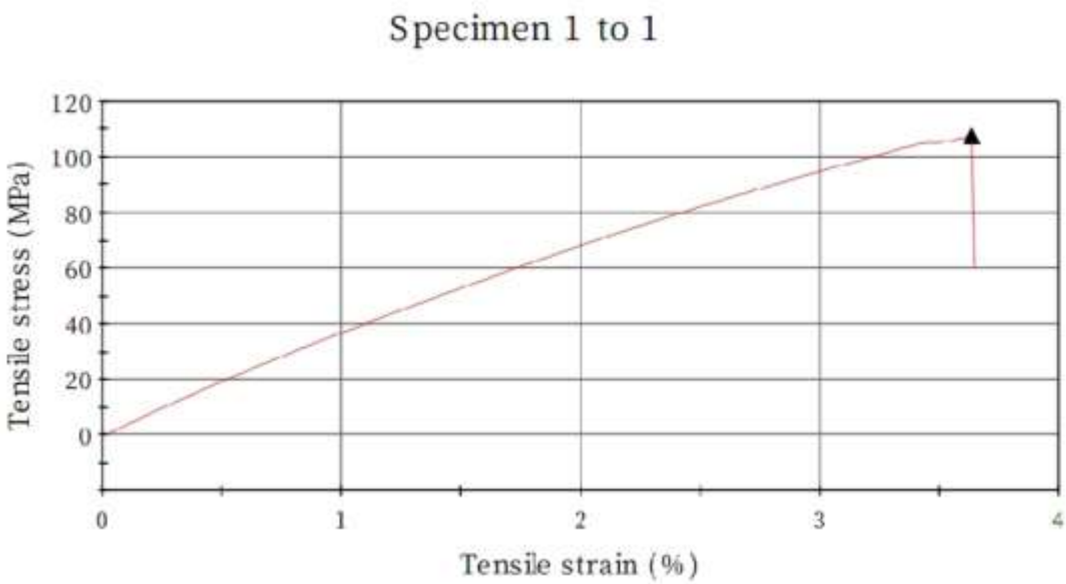
4.1 Graph falx fiber testing graph

The second specimen chopped e glass fiber.the tensile stress chopped e glass 164.49 and load 4934.15



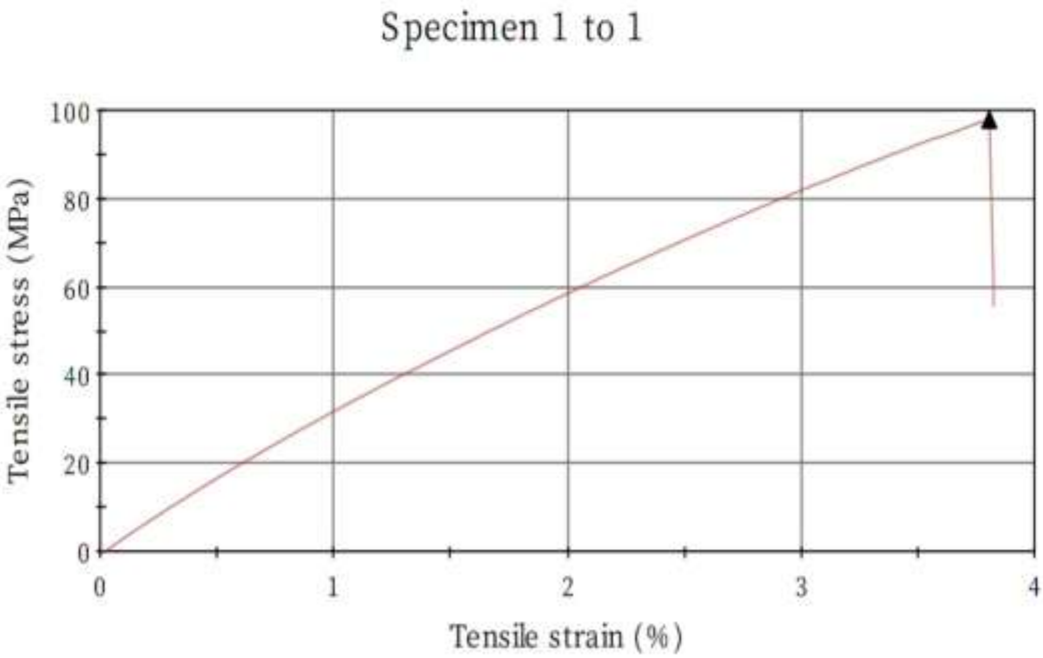
4.2 Graph E chopped glass fiber testing graph

The third specimen taken jute flax fiber+ E chopped glass .The flax fiber and E chopped glass tensile stree 107.76 mpa and load 3232.77



4.3 Graph flax fiber+E chopped glass fiber testing graph

The fourth specimen taken hybrid jute flax fiber+ E chopped glass and 15gm copper powder.The flax fiber and E chopped glass tensile stree 97.99 mpa and load 2939.58



4.4 Graph hybrid flax fiber+E chopped glass fiber testing graph

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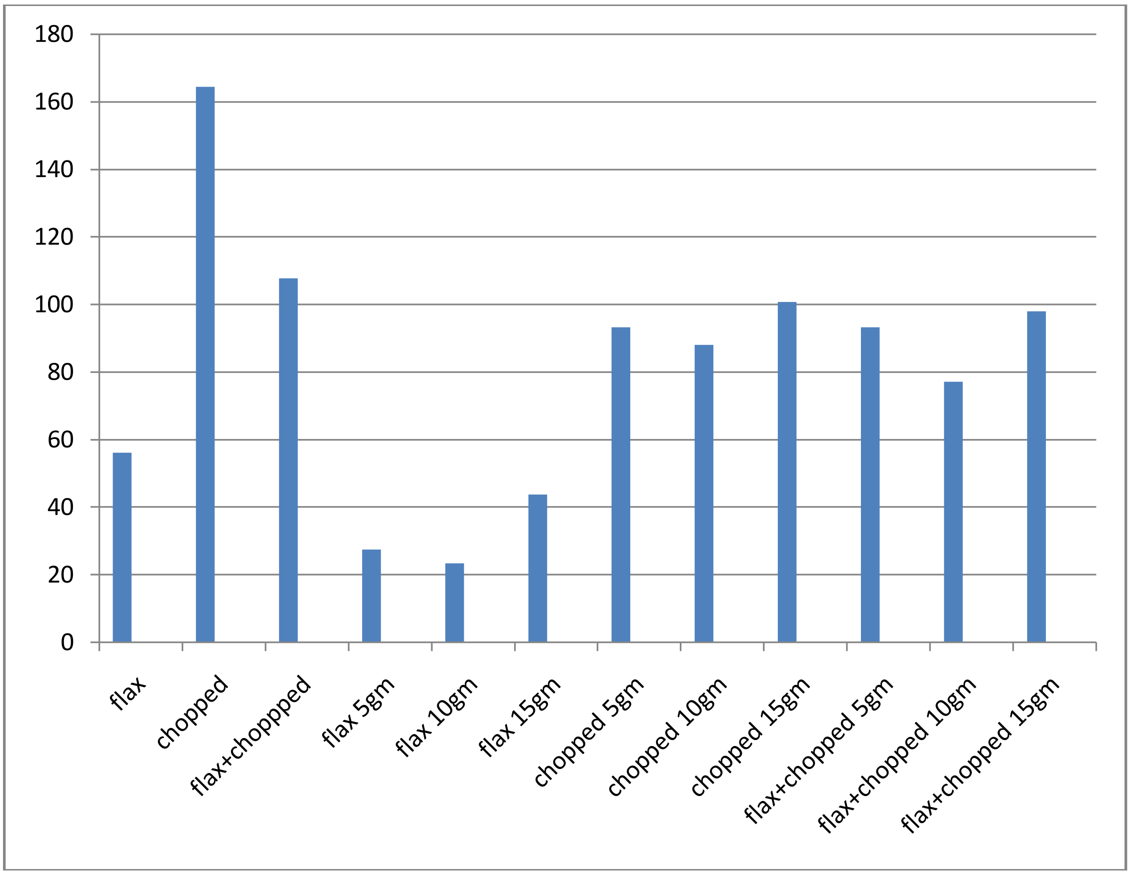
Specimen	Maximum Load(N)	Maximum Tensile Stress(MPa)
Flax fiber	1684.15	56.14
Chopped e glass	4934.75	164.49
Flax+chopped e glass	3232.77	107.76
Flax fiber 5gm copper powder	1647.26	27.45
Flax fiber 10gm copper powder	1406.62	23.44
Flax fiber 15gm copper powder	1314.06	43.80
Chopped e glass 5gm copper powder	5596.83	93.28
Chopped e glass 10gm copper powder	5287.46	88.13
Chopped e glass 15gm copper powder	6052.70	100.88
Flax+chopped e glass 5gm copper powder	2801.07	93.37
Flax+chopped e glass 10gm copper powder	2315.65	77.19
Flax+chopped e glass 15 gm copper powder	2939.58	97.99

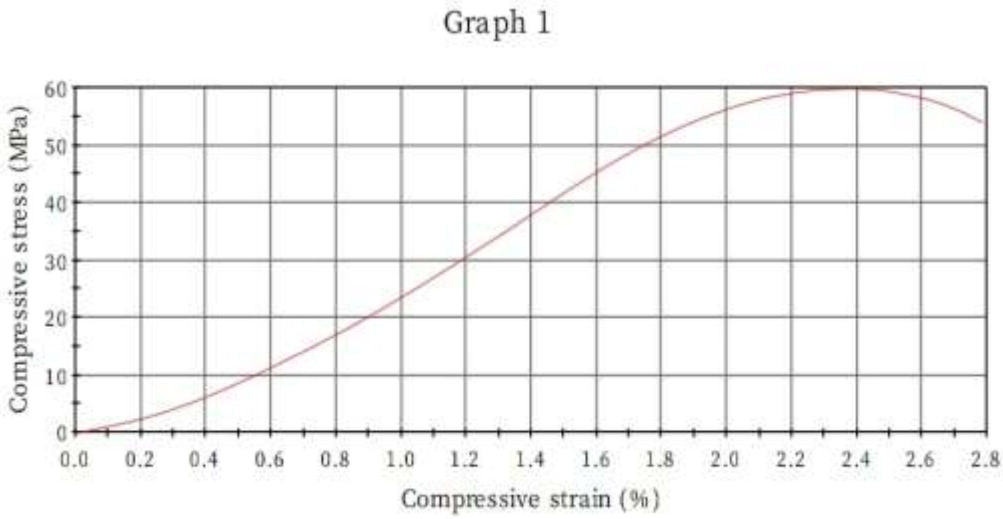
Table 4.1 Tensile Test Result



4.5 Graph Tensile Test Result

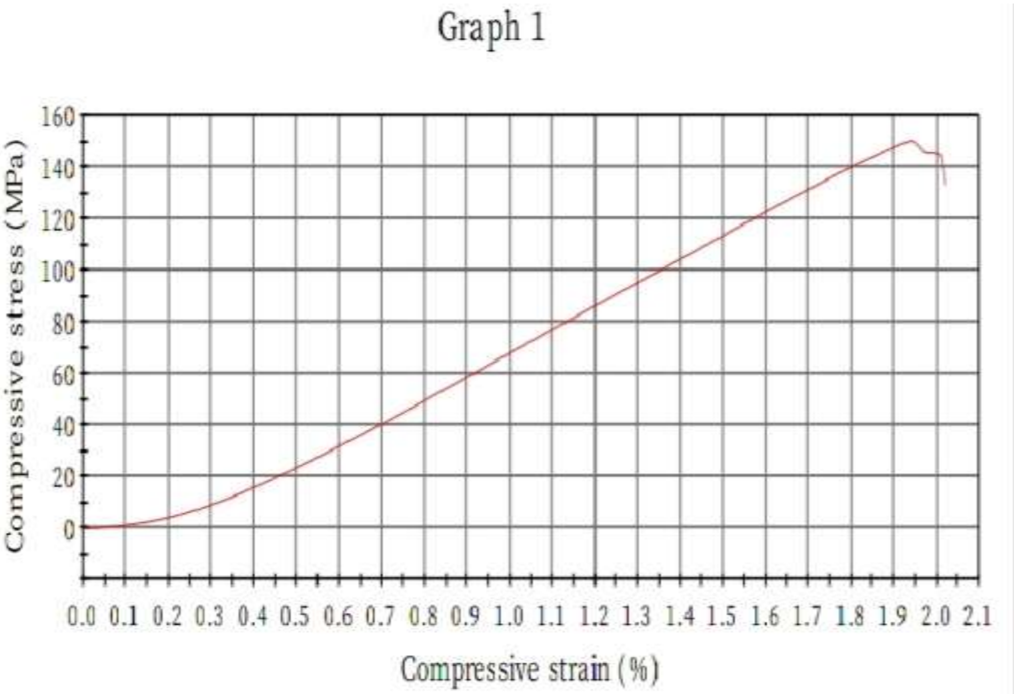
4.2 Compressive Test

The first specimen taken jute flax fiber .The flax fiber Compressive Test 59.76 mpa and load 5.38KN



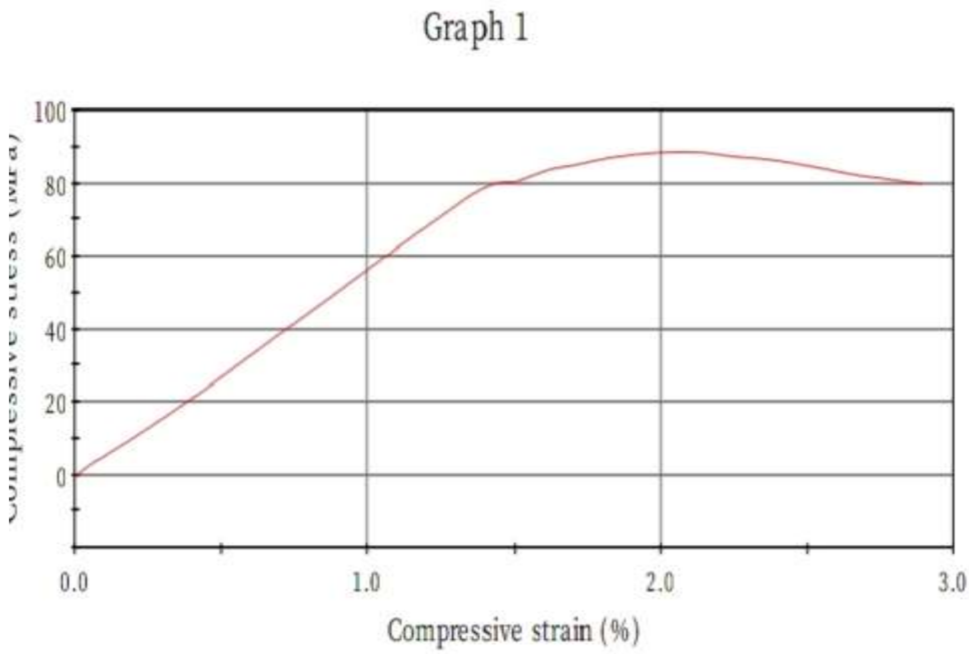
4.6 Graph flax fiber compressive testing graph

The second specimen taken E chopped glass fiber .The chopped E glass fiber Compressive Test 149.90 mpa and load 13.49KN



4.7 Graph chopped e glass fiber compressive testing graph

The Third specimen taken flax fiber+E chopped glass fiber .The flax+chopped E glass fiber Compressive Test 88.40 mpa and load 7.96 KN



4.8 Graph flax fiber+chopped e glass compressive testing graph

The fourth specimen taken hybrid 15gm copper powder flax fiber+E chopped glass fiber .The flax+chopped E glass fiber Compressive Test 97.87 mpa and load 8.81 KN

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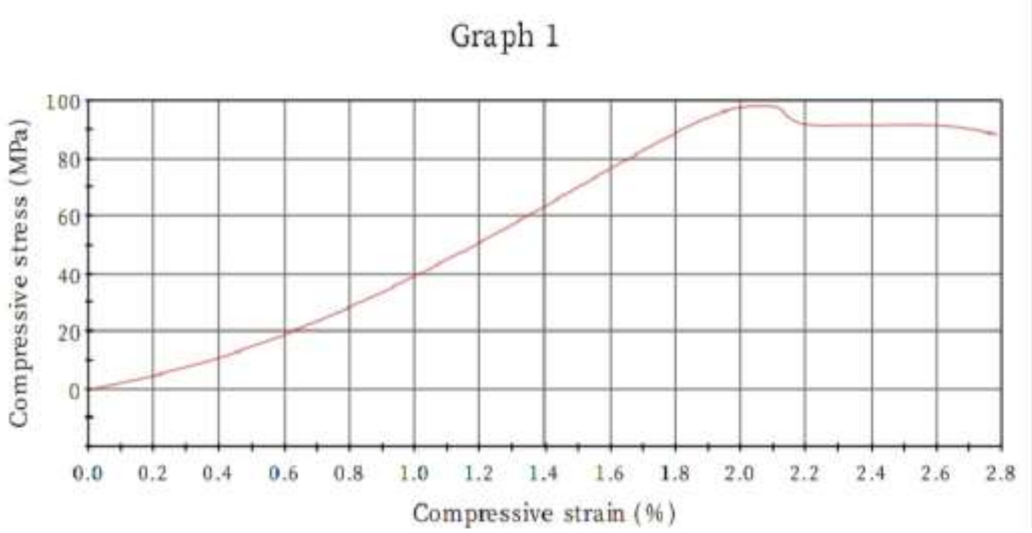
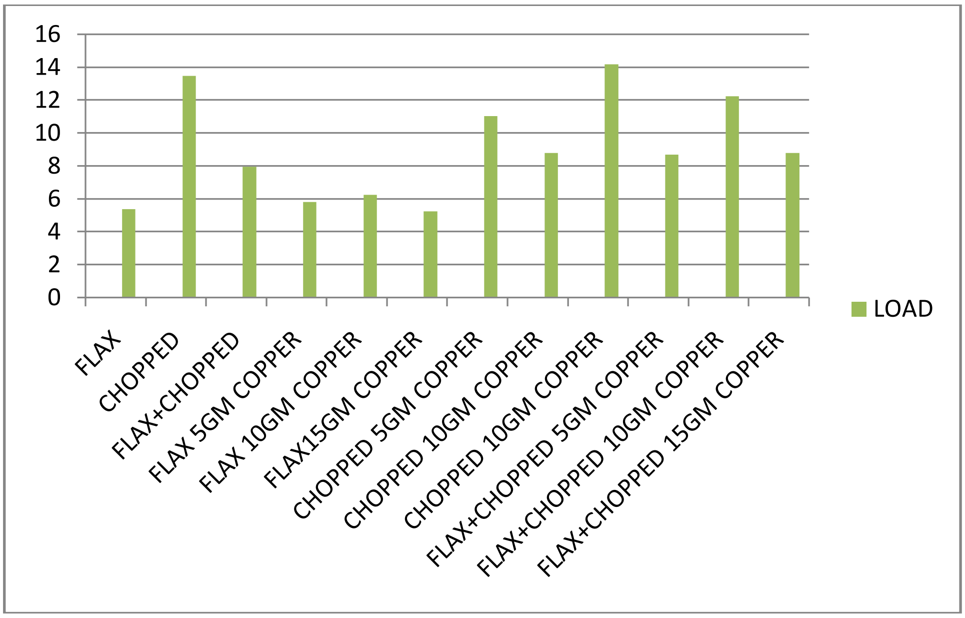


4.9 Graph flax hybrid fiber+chopped e glass compressive testing

specimen	**Critical load(KN)**	**Compressive stress (m.p.a)**
Flax fiber	5.38	59.76
Chopped e glass	13.49	149.90
Flax+chopped e glass	7.96	88.40
Flax fiber 5gm copper powder	5.83	77.76
Flax fiber 10gm copper powder	6.26	83.41
Flax fiber 15gm copper powder	5.27	41.73
Chopped e glass 5gm copper powder	11.04	147.18
Chopped e glass 10gm copper powder	8.82	117.62
Chopped e glass 15gm copper powder	14.19	189.25
Flax+chopped e glass 5gm copper powder	8.70	96.69
Flax+chopped e glass 10gm copper powder	12.26	136.26
Flax+chopped e glass 15 gm copper powder	8.81	97.87

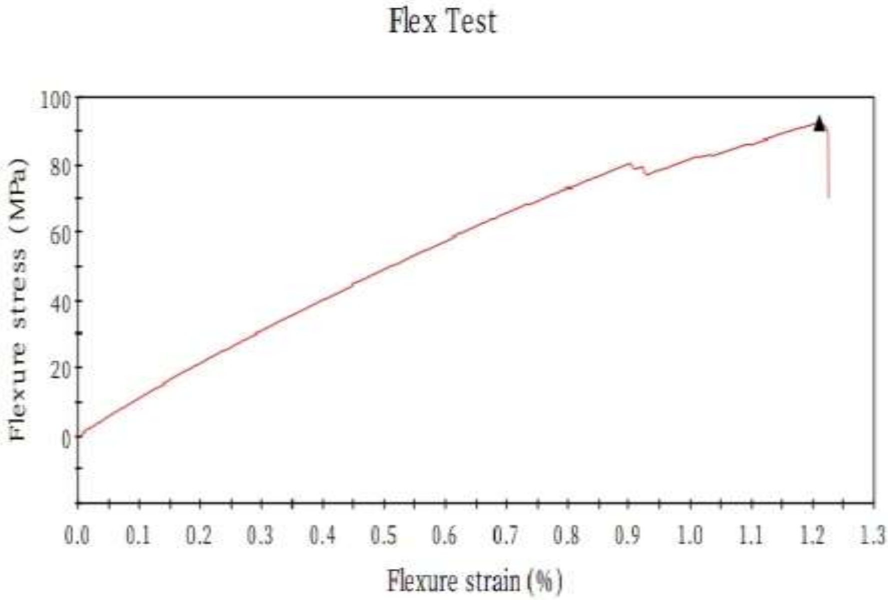
4.2 Table Compressive Test Result



Graph 4.10 Load Comparison graph

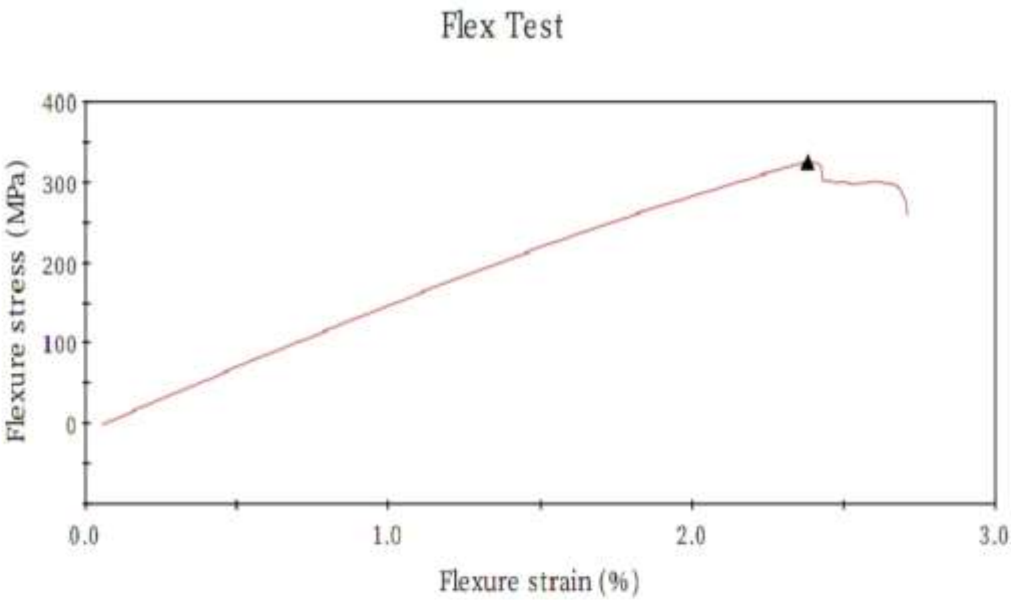
4.3 Flexural Test

The first specimen taken jute flax fiber .The flax fiber Flexural Test 92.30 mpa and load 0.17KN



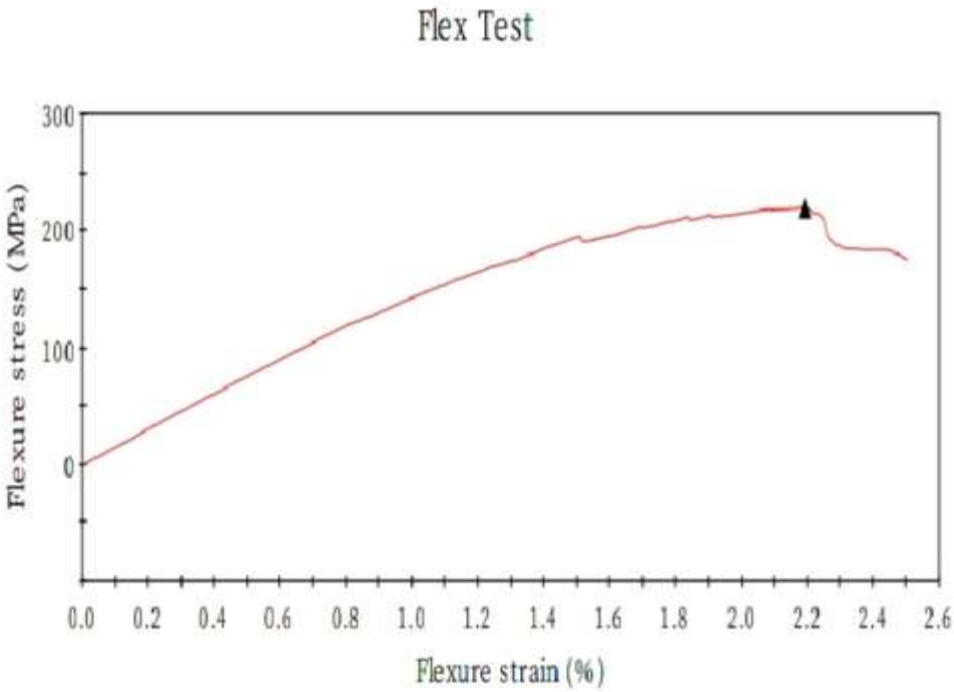
4.11 Graph flax fiber Flexural testing graph

The second specimen taken E chopped glass fiber .The chopped E glass fiber Flexural Test 324.56 mpa and load 0.58 KN



4.12 Graph Chopped fiber Flexural testing graph

The Third specimen taken flax fiber+E chopped glass fiber .The flax+chopped E glass fiber Flexural Test 219.39 mpa and load 0.39 KN



4.13 Graph Flax+Chopped fiber Flexural testing graph

The fourth specimen taken hybrid 15gm copper powder flax fiber+E chopped glass fiber The flax+chopped E glass fiber Flexural Test 161.74 mpa and load 0.39 KN

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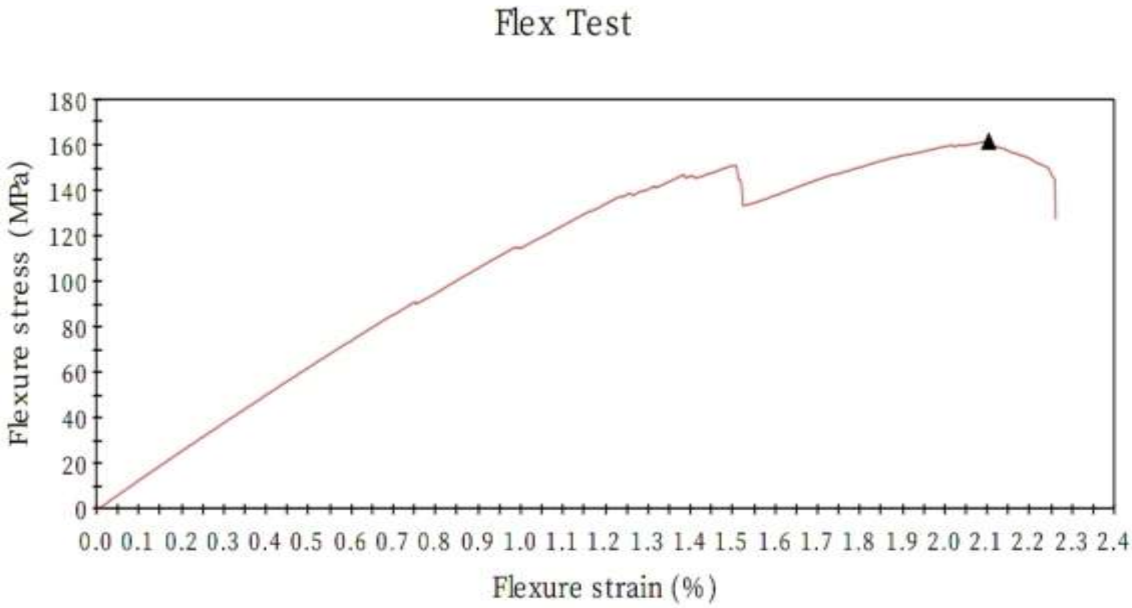
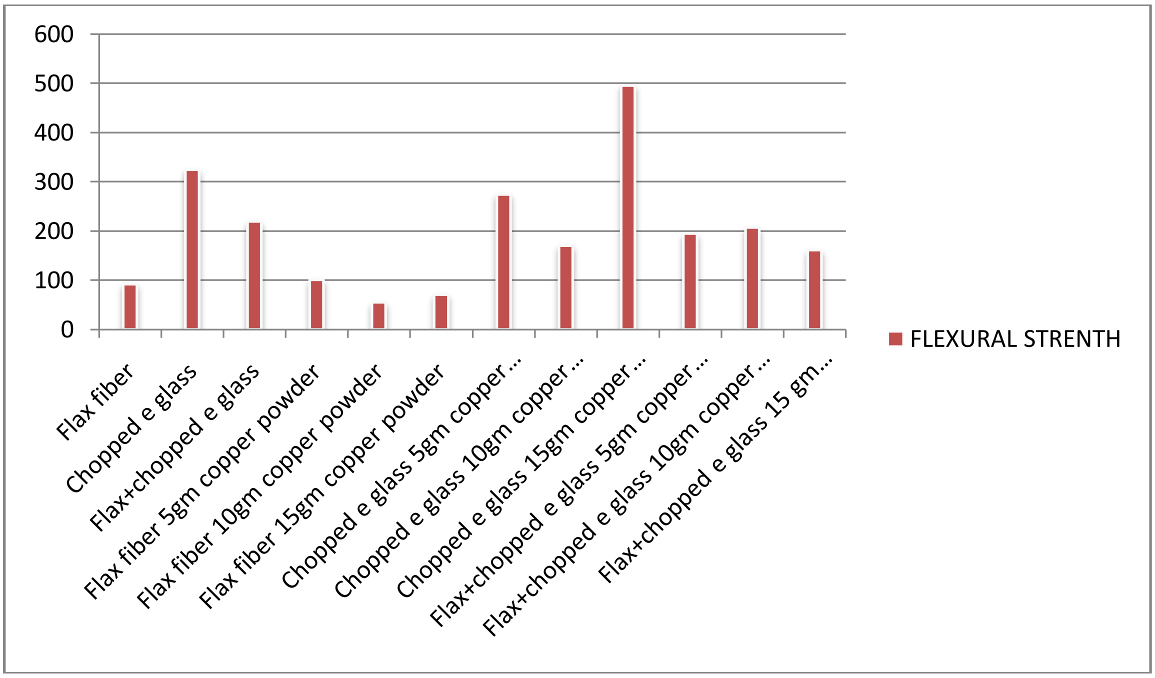


4.14 Graph Hybrid Flax+Chopped fiber Flexural testing graph

Specimen	**Critical load(KN)**	**FLEXURAL Strenth (M.P.A)**
Flax fiber	0.17	92.30
Chopped e glass	0.58	324.56
Flax+chopped e glass	0.39	219.39
Flax fiber 5gm copper powder	0.24	101.26
Flax fiber 10gm copper powder	0.17	55.18
Flax fiber 15gm copper powder	0.21	71.30

Chopped e glass 5gm copper powder	0.82	274.87
Chopped e glass 10gm copper powder	0.51	170.31
Chopped e glass 15gm copper powder	0.89	495.99
Flax+chopped e glass 5gm copper powder	0.47	194.42
Flax+chopped e glass 10gm copper powder	0.50	206.75
Flax+chopped e glass 15 gm copper powder	0.39	161.74

4.3 Table Flexural Test



4.15 Graph flexural strenth

4.4 Impact Test

S.No	Specimen	Impact Test
1	Flax fiber	0.2
2	Chopped e glass	0.5
3	Flax+chopped e glass	2
4	Flax fiber 5gm copper powder	0.4
5	Flax fiber 10gm copper powder	0.6
6	Flax fiber 15gm copper powder	0.4
7	Chopped e glass 5gm copper powder	2.2
8	Chopped e glass 10gm copper powder	3
9	Chopped e glass 15gm copper powder	3.6
10	Flax+chopped e glass 5gm copper powder	1.6
11	Flax+chopped e glass 10gm copper powder	1.8
12	Flax+chopped e glass 15 gm copper powder	1.4

In this test maximum impact test obtained by chopped E glass 15gm copper powder 3,6

II. CONCLUSIONS & FUTURE SCOPE OF WORK

Conclusions

The study on the mechanical properties of hybrid polymer composites leads to the following conclusions:

Fabrication of hybrid polymer composites has been done successfully.

Mechanical properties of Flax fiber,E chopped glass and combination of these fibers are observed.

- Maximum Tensile strength obtained at E chopped glass specimen
- Maximum compressive strength obtained at E chpped glass 15gm copper powder specimen
- Maximum flexurial strenth obtained for E chpped glass 15gm copper powder
- And maximum impact strenth obtained E chpped glass 15gm copper powder

Future Scope

- The present study on hybrid polymer fabrication of composites leaves a wide scope for future to find many other aspects of these composites. Few recommendations for the future investigation are:
- The present study has been carried out using simple hand lay-up technique. However, the work can be extended further by considering other methods of composite fabrication and the

effect of manufacturing techniques on the performance of composites can similarly be analyzed.

- The paper study explains about the mechanical properties. So there is a lot of scope to find other properties of hybrid polymer composite like physical, water absorption properties etc.

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