Fabrication and Characterization of Bamboo and Pine Apple Fibres Reinforced with Agarbatti Powder Hybrid Epoxy Composites.

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ABSTRACT

A composite material is made from two or more constituent materials; having better properties compared two both two parent materials. The composite is stronger, lighter, and less expensivecompared with the traditional materials. In current years composites have considerable importance as a potential operational material. Fiber reinforced polymer composites are used in almost all type of advanced engineering structure like sheets, blankets, number of otherhousehold textiles and shirts, evening wears etc. Better mechanical properties like tensile strength, flexural strength, impact strength of reinforced epoxy composite, are the main area offocus in the thesis. Composites are bamboo fiber reinforced along with pineapple fiber variations. In this present work research is carried forward to find the best composite based on strength. The aggarbatti powderis hybridized with polyster resin.The hybrid composites are formed by using hand layup techniquein random orientationby considering the proportions.

Bamboo fibre, pine apple fibre, bamboo fibre + pineapple fibre, bamboo fibre + pineapple fibre+10gms of aggarbatti Powder**,** bamboo fibre + pineapple fibre +20gms aggarbatti powderusing hand layup technique using Epoxy and Hardener. The composites for all the tensile, flexural, impact, hardness we prepared using ASTM standards.

KEY WORDS: - Reinforcement, epoxy resin, matrix, bamboo fibre, chemical digestion,pineapple fibre, agarbatti powder.

CHAPTER 1

1.1 NATURAL FIBERS

'Natural fibre' is a term used to refer to the fibres that are obtained from (or are produced by) animals and plants. These fibres have a wide range of applications in the manufacture of composite materials. Paper and felt (a type of textile material) can be prepared by matting different layers of natural fibres into sheets.

Most natural fibres are known to be good absorbers of sweat and other liquids. A wide range of textures can be obtained from different natural fibres (either individually or through a combination of two or more natural fibres). For example, cotton fibres (which are natural fibres that are derived from the cotton plant) are used in the production of cotton fabrics that are characterised by their relatively low weight and their soft texture. Another advantage of cotton fibre is that it can be woven into the clothing of various sizes and colours. Clothing which is made up of natural fibres (like cotton) is usually preferred over clothes that are made up of natural fibres, especially by the people who live in hot and humid regions.

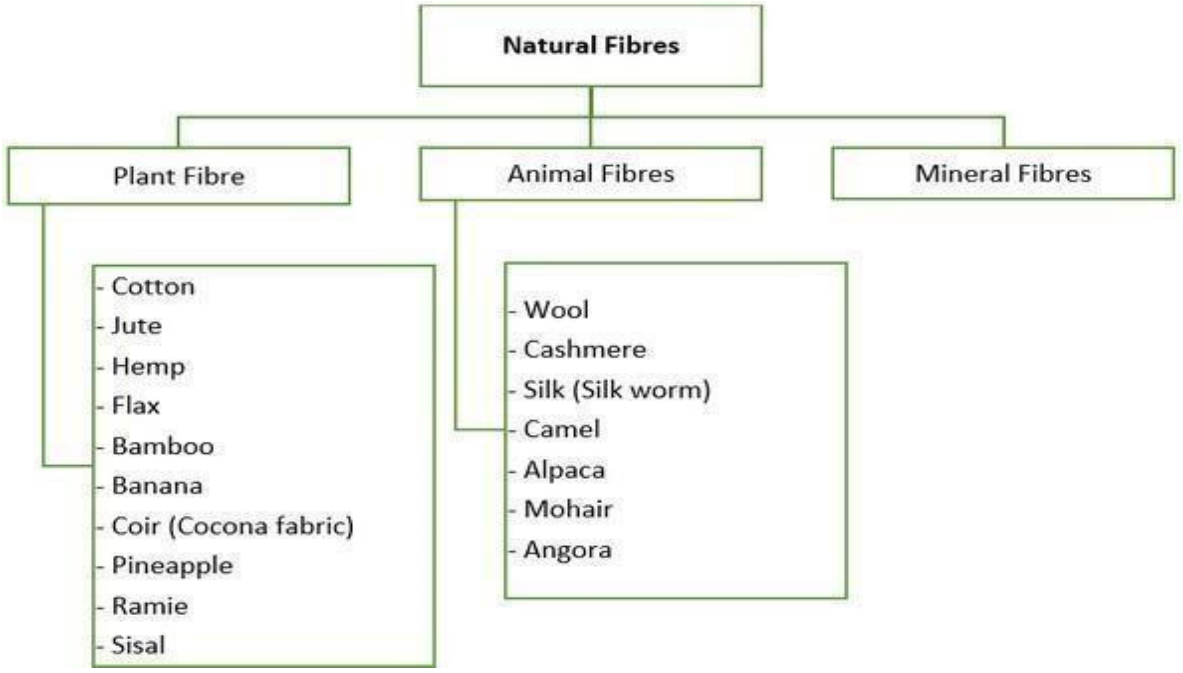

Figure 1.1 Types of natural fibers

Clothes are necessary for all human beings; without clothes, it would be difficult for humans to survive in the modern world. Have you ever wondered how clothes are made and which material is used? The clothes we wear are made up of fibres. Fibres are the thread-like structure which is thin, flexible strands used for various methods like cosmetics production, cloth making, medicines, paper manufacturing etc. Based on the origin of the fibres, they are

classified into two types. The two types of fibres are natural fibres and man-made fibres. Natural fibres are the fibres obtained from animal and plant sources. Man-made fibres are manufactured by industries. Man-made fibres are also known as Synthetic fibres. Natural fibres are defined as thread-like raw materials extracted directly from plants and animal sources that are converted to nonwoven fabrics than woven cloths.

1.1.1 Types of natural fibres

There are two types of natural fibres that are discussed below.

- **Plant Fibre:** Plants fibres are obtained from various parts of plants like leaves, wood, fruits, flowers, stems etc.
- **Animal Fibre:** Animal fibres are extracted from animals like silk, wool, etc.
- **Mineral fibre:** The mineral fibre (or asbestos) refers to a wide range of fibers possessing high elasticity and outstanding resistance against corrosion, humidity, heat, wear, and tear, etc.

1.1.2 Plant fibres

A material which is composed of thin and continuous strands is known as fibre. Plant fibres are elongated most sclerenchyma supportive plant cells with thick cellulose walls with a well- organised structure. Plant fibres are obtained from various parts of plants, such as the seeds (cotton, kapok, milkweed), stems (flax, jute, hemp, ramie, kenaf, nettle, bamboo), and leaves (sisal, manila, abaca), fruit (coir) and other grass fibres. Fibres from these plants can be totally renewable and biodegradable. Fiber is one of the main reasons whole plant foods are good for you. Growing evidence shows that adequate fiber intake may benefit your digestion and reduce your risk of chronic disease. Many of these benefits are mediated by your gut microbiota — the millions of bacteria that live in your digestive system.

Figure 1.2 Cotton fibre

Cotton Fibers are natural hollow Fibers; they are soft, cool, known as breathable fibers and absorbent. Cotton fibers can hold water 24–27 times their own weight. They are strong, dye bsorbent and can stand up against abrasion wear and high temperature. In one word, cotton is comfortable.

Figure 1.3 Jute fibre

Jute fibre is a type of plant fibre which is widely known for its ability to be spun into strong and coarse threads. Individual jute fibres are known to be soft, long, and shiny in nature. The plants belonging to the genus Corchorus are believed to be the primary producers of this fibre. It is important to note that the fibres that are used in the production of gunny cloth, hessian cloth, or burlap cloth are usually jute fibres. Jute fibres is produced from plants in the genus Corchorus, family Malvaceae. Jute is a lignocellulosic fiber that is partially a textile fiber and partially wood. It falls into the bast fiber category (fiber collected from bast or skin of the plant).

Figure 1.4 Hemp fibre

Hemp fibre, as lignocellulosic raw material, shows similarities to other bast fibres due to the comparable chemical composition of this fibre group. Fibres extracted from fibrous plant stalks contain cellulose, hemicellulose, lignin, pectin, waxes, fats, and ash.

Figure 1.5 Flax fibre

Flax fiber is extracted from the bast or skin of the stem of flax plant. Flax fibers are arranged in the form of thin filaments, grouped in longitudinal slender bundles distributed circularly around a central wooden cylinder. These bundles are fully embedded into an intermediary holding tissue binding them outwardly to the protective outer skin and inwardly to the inner supporting wooden cylinder. The holding tissue is made up entirely of dynamic cells, having semi-permeable membranes.

Figure 1.6 Bamboo fibre

Bamboo fibre is a regenerated cellulosic fibre produced from bamboo. Starchy pulp is produced from bamboo stems and leaves through a process of alkaline hydrolysis and multi- phase bleaching. Further chemical processes produce bamboo fibre. Fabrics have been made from bamboo for thousands of years, but it is only in contemporary times that the process of making this hardy and fast-growing wood into fabric has been perfected.

Figure 1.7 Banana fibre

Bananas grow on plants, rather than trees, with the fruit technically being a berry. The leaf sheath around the base of this herbaceous flowering plant is where you find the hidden fibre resource - not in the fruit at all. The banana plant contains good-quality textile-grade fibres popularly known as banana fibre. This fibre is another unexplored natural fibre used for the fashion and technical textile industries for sustainable product development. These fibres are extracted from the pseudostem of the banana plant.

Figure 1.8 Coir fibre

COIR FIBRE is a versatile natural fibre extracted from mesocarp tissue, or husk of the coconut fruit Generally fibre is of golden color when cleaned after removing from coconut husk; and hence the name" The Golden Fibre". Coir is the fibrous husk of the coconut shell. coconut fibre, is a natural fibre extracted from the outer husk of coconut, and used in products such as floor mats, doormats, brushes, and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut.

Figure 1.9 Pineapple fibre

Pineapple fiber, also known as Piña fiber, is a natural fiber extracted from the leaves of the pineapple plant (Ananas comosus). The fibers are obtained from the long, narrow leaves of certain pineapple varieties, particularly those grown in the Philippines. These fibers have been traditionally used for centuries in the Philippines and other tropical regions for making textiles, clothing, and various handicrafts.

Figure 1.10 Sisal fibre

The sisal fibre is traditionally used for rope and twine, and has many other uses, including paper, cloth, footwear, hats, bags, carpets, geotextiles, and dartboards. It is also used as fibre reinforcements for composite fibreglass, rubber, and concrete products. It can also be fermented and distilled to make mezcal.

1.1.3 Animal Fibre

Animal fibres are the natural fibres that can be sourced to animals. These fibres are usually made up of different kinds of proteins. The most popular examples of animal fibres include silk and wool.

Figure 1.11 Wool fibre

Wool fiber is an important natural protein fiber with unique properties like resiliency, reactivity toward different chemicals, moisture content, and elasticity. Depends on fineness and fiber length, it is mainly utilized for apparel fabrics and technical textiles.

Figure 1.12 Silk fibre

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Silk fiber is a protein fiber from silk glands of an insect. Cultivation of silkworm is known as sericulture. A female silk moth produces about 300–400 eggs at once. The female died immediately after producing the eggs while the male moth died a short period after that. The eggs took about 10 days to become larvae.

Figure 1.13 Camel fibre

Camel-hair fibre has greater sensitivity to chemicals than does wool fibre. Its strength is similar to that of wool having a similar diameter but is less than that of mohair. Fabric made of camel hair has excellent insulating properties and is warm and comfortable. Camel wool is a type of fabric derived from the coats of camels. This type of fabric is more commonly known as camel hair, and it is usually derived from a camel subspecies known as the Bactrian camel.

1.2 Properties of natural fibre

Properties of natural fibres include:

- **Biodegradable:** Natural fibres can decompose naturally, reducing the environmental impact of disposing of them.
- **Renewable:** These are produced from plants and animals that can be replenished.
- **Absorbent:** Natural fibers can absorb moisture and release it again, making them comfortable to wear in warm and humid climates.
- **Strong and durable:** They are strong and durable, making them suitable for a variety of applications.
- **Insulative:** Natural fibres can provide insulation, helping to keep the body warm in cold weather.

1.3 Advantages of Natural Fibre

- **Comfortable:** Clothes made by natural fibres are more comfortable than those made of synthetic fibres.
- **Environment:** Producing materials from natural fibres are less harmful to our environment.

- Non allergic to skin.

1.4 Disadvantages of Natural Fibre

- **Expensive:** Materials produced by natural fibres are generally expensive as synthetic fibres can be made easily by manufacturing.
- **Shrink:** Natural fibres might shrink due to aggressive washing.
- Variation in length, fineness, etc. of the natural fibre causes less regular and uniform yarn than that obtained from manmade fibres.
- The availability of natural fibres is affected by natural calamities and vagaries of nature.

1.5 Composite

Materials Composite contains various materials with unmistakable properties to make an unrivaled and special material. Composites are assembled by support or by kinds of network in which fortifications are load conveying component while framework material assist them with keeping in wanted area and become load move medium among support and lattice. Fiber build up composites are acquiring interest in different application, yet their development is restricted because of strength. Hybridisation of fiber is a way to deal with cause composites to harden by joining diverse sort of fiber and these crossover composites offer great mechanical properties contrast with non-half breeds composites. Blending of fiber in unit framework, half and half fiber supported composites offer wide scope of mechanical properties. Cross breed composites enjoy a few three fundamental upper hands over composites which made of utilizing one sort of fiber support. In the first place, they furnish new freedom to planner for certain remarkable properties. Second, powerful expense usage of costly strands can be brought by to some degree trading them to most economical filaments. Third, they give different blend of mechanical properties like malleability, strength and solidness. Likewise, cross breed composites are weight saving, improvement of fractural strength, decrease in score affectability, great effect obstruction, longer exhaustion life contrasted with composite which made of single support.

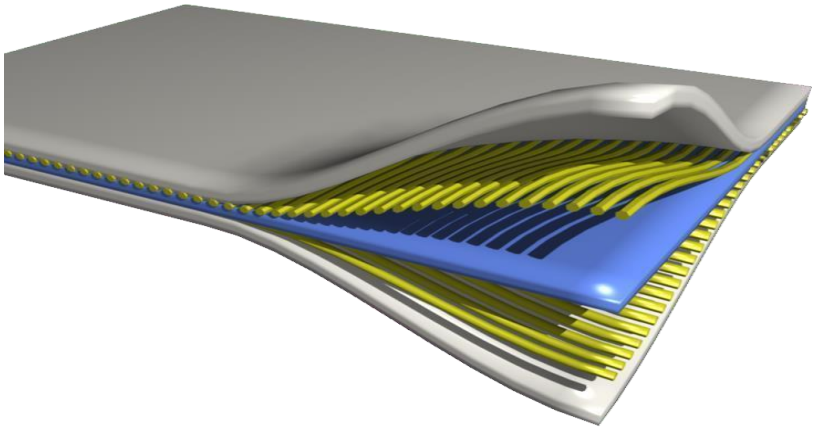

Figure 1.14 Composite material

A "Composite" can be defined as a physical combination of two or more distinct materials. A composite material is made up of two constituent materials with differing mechanical, physical, and chemical properties that are bonded together to generate a material with different characteristics than the individual materials. Reinforcement and matrix are the two components. In a composite material, the reinforcement and matrix are the principal load- bearing parts. This matrix can keep fibbers aligned, keep their shape, and protect them from the elements. The reinforcement can help to increase the material's strength.

- Exhibits a high level of explicit firmness and strength.
- Security in three dimensions.
- Obstruction due to temperature and chemical.
- Preparation is rather straightforward.
- It is light in weight.
- A high weight-to-solidarity ratio.
- Excellent anti-corrosion qualities.

1.5.1 Physical and chemical properties of composites

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1.5.2 Advantages of composites

Composite materials exploit the various qualities and capacities of various materials. On account of mud and straw blocks, for instance, mud is a fantastic restricting material, however it can't tolerate upping to pressure and power well. Straw, then again, is well ready to withstand pressure without disintegrating or breaking, thus it serves to support the limiting activity of the mud. People have been making composite materials to fabricate more grounded and lighter articles for millennia.

The various materials cooperate to create another material, which consolidates the entirety of the properties of the already independent materials. Inside the composite it is as yet conceivable to handily distinguish the various materials. They don't will in general mix or break down into one another.

1.5.3 Applications of composite

Composite materials for development, designing and other comparative applications are shaped by consolidating at least two materials so that the constituents of the composite materials are as yet recognizable, and not completely mixed. One illustration of a composite material is concrete, which uses

concrete as a limiting material in mix with rock as a support. By and large, substantial utilizations rebar as a subsequent support, making it a three-stage composite, on account of the three components included.

The business utilization of composites vows to offer a lot bigger business openings than the aviation area because of the sheer size of transportation industry. Consequently the shift of composite applications from airplane business utilizes has been seen as of late. Progressively empowered by the presentation of more up to date polymer sap framework materials and elite support strands of glass, carbon and aramid, the entrance of these high level materials has seen a consistent development in wording uses and volume. The expanded volume has brought about the normal decrease in costs. Elite FRP would now be able to be found in such different applications as composite armouring intended to oppose hazardous effects, fuel chambers for petroleum gas vehicles, windmill cutting edges, modern drive screws, and even paper making rollers. For specific applications, the utilization of composites instead of metals has indeed brought about reserve funds of both expense and weight. A few models are falls for motors, bended fairing and filets, substitutions for welded metallic parts, chambers, tubes, conduits, cutting edge regulation groups and so on.

Further, the need of composite for lighter development materials and more seismic safe constructions has set high accentuation on the employments of new and progressed materials that diminishes extra weight as well as assimilates shock and vibration through customized

microstructures. Composites are presently widely and proportionately being utilized for recovery/fortifying of previous constructions that must be retrofitted to make them seismic safe. An assessment of the variety of a portion of these fresher applications and the socio- business contemplations that support their presentation gives an informative knowledge into the fate of elite FRP. In contrast to traditional materials (e.g., steel), the properties of the composite material can be planned thinking about the underlying perspectives. The plan of an underlying part utilizing composites includes both material and foundational layout.

Composite properties (for example firmness, warm development and so forth) can be shifted ceaselessly over abroad scope of qualities heavily influenced by the originator. Cautious choice of support type empowers completed item qualities to be custom fitted to practically a particular designing prerequisite for modern employments. While the utilization of composites will be a reasonable decision in many examples, material determination in others will rely upon elements like working lifetime prerequisites, number of things to be delivered (run length), intricacy of item shape, potential reserve funds in get together expenses and on the experience and abilities of the fashioner in tapping the ideal capability of composites. In any case, the best wanted outcomes for composites are seen alongside the conventional material utilized.

- **Transportation Sector Automobiles**

The likely advantages of lighter weight, sturdiness and consumption obstruction settles on cutting edge composites a material of decision in the close to term for auto applications. Significant changes on an expansive range would be needed to make progressed composites alluring for far reaching business use in

vehicles and trucks. The chief restricting element is the significant expense of the crude and manufactured materials when contrasted with existing choices. Anyway there are openings for cutting edge composites in explicit segments in the business auto area. In strength vehicles of a few kinds, created in little numbers progressed composite materials have a chance to exhibit their presentation benefits, aside from the necessities of the serious commercial center.

Bicycles

Figure 1.15 Composites in transport sector example

➢ The composite business overall is putting resources into measure upgrades for the embellishment of polymer composites utilizing types of regular E- glass in mid-level execution saps, both thermoplastic and thermoset. Autos section of composites represents about half of the thermoplastic and 24% of the thermoset composite market on the planet. Glass supported thermoplastic polymer is a promising material for weight decrease due to the generally minimal expense of the fiber, its quick process duration and its capacity to work with parts incorporation. The probable future business openings in car area are referenced beneath

- Pultruded Drive shaft
- RTM Panel
- Fiber Glass/Epoxy Springs for Heavy Trucks and Trailers
- Rocker Arm Covers, Suspension Arms, Wheels and Engine Shrouds
- Filament-Wound Fuel Tanks
- Electrical Vehicle Body Components and Assembly Units
- Valve Guides
- Automotive Racing Brakes and Train Brakes

Composite bike outlines have been a to a great extent American wonder, as a spin-off innovation from the airplane and sailing businesses. Assembling of composites requires more

prominent specialized ability and venture for item advancement. Carbon composite bicycle outline is an unpredictable design with execution attributes that incorporate gentility, unbending nature, sturdiness, shock assimilation and so on As composites manufacture offers variety over the length of the cylinder giving diverse fiber points, various employs, distinctive handle thickness, and various blends of materials. So the properties of the final result produced using composites can be customized to wanted particulars. Half breed fiber (carbon and aramid), carbon/Kevlar epoxy materials are 21 ideal composite materials for bike parts. The composites are discovering application in bike segments, for example,

- Forks
- Handle bars
- Connecting bar closes.

1.5.4 Phases of composite materials

A composite material comprises of two stages: Essential

- Forms the lattice inside which the optional stage is inserted
- Any of three fundamental material sorts: polymers, metals, or ceramics.
- Auxiliary
- Referred to as the imbedded stage or called the supporting specialist.
- Serves to fortify the composite. (Filaments, particles, and so on)
- Can be one of the three fundamental materials or a component like carbon, glass or boron.

1.5.5 Classification of composites

There are two arrangement frameworks of composite materials. One of them depends on the network material (metal, artistic, and polymer) and the second depends on the building up material construction.

Arrangement of composites - I (in view of grid material)

Metal Matrix Composites (MMC)

A metal network composite (MMC) is composite material with somewhere around two constituent parts, one being a metal fundamentally, the other material might be an alternate metal or another material, like a ceramic or natural compound.

Figure 1.16 Metal Matrix Composite

When no less than three materials are available, it is known as a half breed composite. Metal Matrix Composites are made out of a metallic framework (aluminum, magnesium, iron, cobalt, copper) and a scattered fired (oxides, carbides) or metallic (lead, tungsten, molybdenum) stage. **Ceramic Matrix Composites (CMC)**

Fired lattice composites (CMCs) are a subgroup of composite materials just as a subgroup of ceramics. Fired Matrix Composites are made out of an artistic framework and inserted filaments of other fired material (scattered stage). The network and strands can comprise of any ceramic material, whereby carbon and carbon filaments can likewise be viewed as a clay material.

Figure 1.17 Ceramic Matrix Composite

Polymer Matrix Composites (PMC)

A polymer grid composite (PMC) is a composite material made out of an assortment of short or nonstop filaments bound together by a natural polymer network. PMCs are intended to move loads between strands of a lattice. A portion of the benefits with PMCs incorporate their lightweight, high firmness and their high strength along the course of their fortifications. Different benefits are acceptable scraped spot obstruction and great consumption opposition. Polymer Matrix Composites are made out of a framework from thermo set (Unsaturated Polyester (UP), Epoxy (EP) or thermoplastic (Polycarbonate (PC), Polyvinylchloride, Nylon, Polystyrene) and implanted glass, carbon, steel or Kevlar filaments (scattered stage)

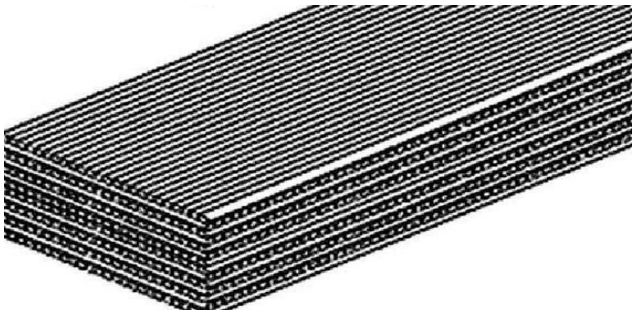


Figure 1.18 Polymer Matrix Composite

Arrangement of composite materials II: (Based on building up material construction)

Stringy composites

Fibrous composites are materials comprising of lightweight, high modulus strands inbedded in an encompassing material called the lattice. These composites have properties that fluctuate with the course of interest.

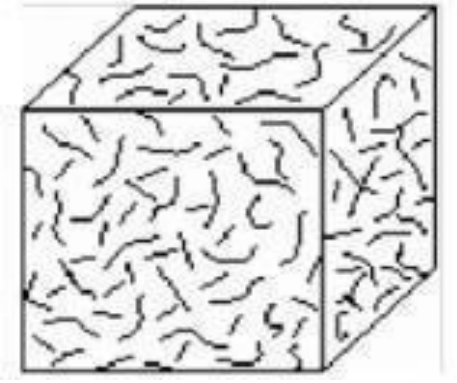


Figure 1.19 Fibrous composite

➢ Short-fiber supported composites. It comprises of a lattice built up by a scattered stage in type of irregular strands (length < 100*diameter).

a. Composites with irregular direction of filaments.

b. Composites with favored direction of filaments.

➢ Long-fiber supported composites. It comprises of a framework supported by a scattered stage in type of nonstop strands.

a. Unidirectional direction of strands.

b. Bidirectional direction of strands (woven).

Glasses and pottery (earthenware production) which are hardened and solid are weak in nature. This weakness in stringy composites prompts a reformist, however not an abrupt, disappointment. Not all composite material properties are only a comparative mix of those segments.

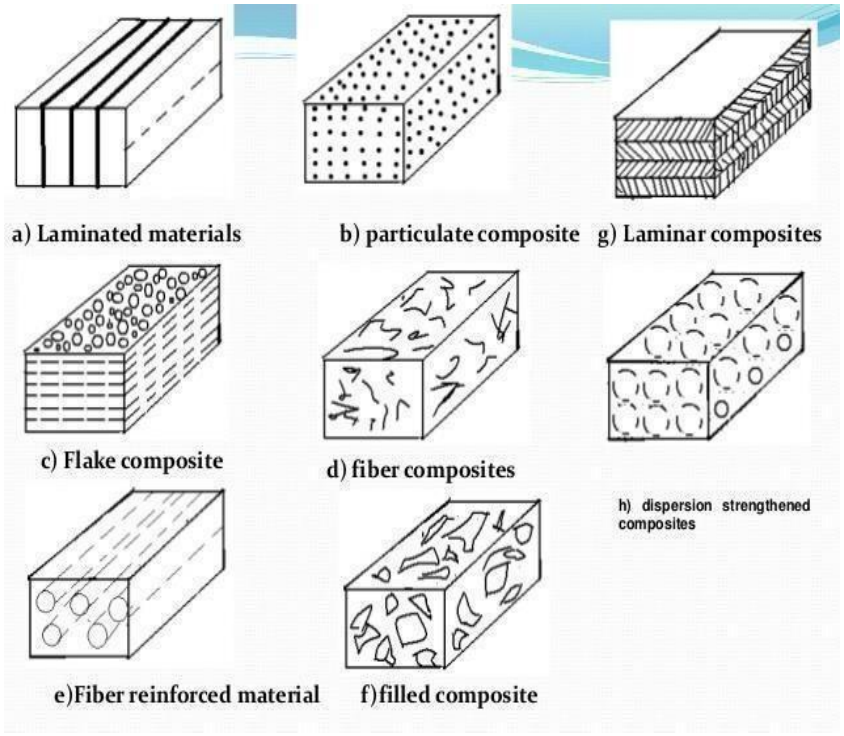


Figure 1.20 Various types of composite structures

In transport and aviation applications materials are made by laying up carbon, glass or manufactured strands in an uncured combination of sap and hardener. This pitch fixes, by framing the state of the form and holding the strands. In present numerous composites depend on polyester pitch, where there is a pattern to utilize the less expensive polyesters. Lay-up is a sluggish and work serious work. It tends to be ready by utilizing thermoplastics containing hacked strands which can be infusion shaped. The haphazardly hacked strands are very little successful as laid-up constant filaments, where there is decline in strength. However, the stream design in infusion forming assists with fixing the strands with great solidness.

The procedure is utilized in sports materials like tennis racquets, and light-weight climbing gear like rucksack outlines. Assembling great fiber composites isn't simple where huge organizations have been bankrupted by their inability to do as such. The three normal significant properties of composites are the place where they are contrasted and high-strength steel and a high-strength aluminum amalgam of the sort utilized for airplane structures.

Laminated composites

At the point when a fiber built up composite comprises of a few layers with various fiber directions, it is called multi-facet (point employ) composite. Blend of discrete materials or same materials prompts covered composites. In this piece of composites, mechanical hooks or discontinuous framework are utilized at time to keep the layers together. Dependent upon the constituent materials of overlays, techniques for fabricate, lead, covered composites are ormally called as clad-metals, bimetal, and prosperity glass, overlaid or overlaid wiry, cross variety composites and sandwiches, plastic based covers.

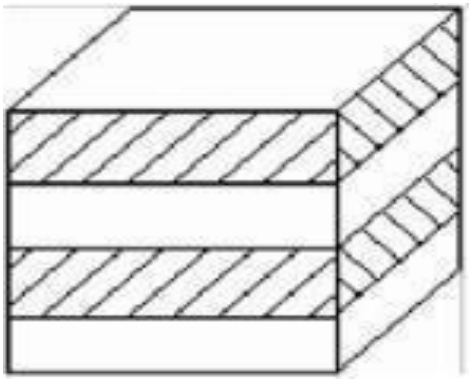


Figure 1.21 Laminated composite

Particulate composites

At the point when a fiber built up composite comprises of a few layers with various fiber directions, it is called multi-facet (point employ) composite. Blend of discrete materials or same materials prompts covered composites. In this piece of composites, mechanical hooks or discontinuous framework are utilized at time to keep the layers together. Dependent upon the constituent materials of overlays, techniques for fabricate, lead, covered composites are normally called as clad-metals, bimetal, and prosperity glass, overlaid or overlaid wiry, cross variety composites and sandwiches, plastic based covers.

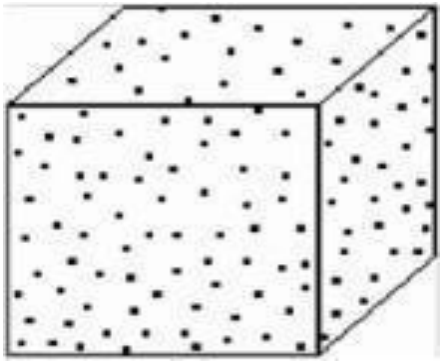


Figure 1.22 Particulate composite

1.5.6 Limitations of Composites

Not all applications are weight-basic. On the off chance that weight-changed properties are not significant, steel and other conventional materials might turn out great at lower cost. Anisotropy and other "extraordinary" highlights are profitable as in they give a lot of plan adaptability, yet the other side of this coin is that they additionally entangle the plan. The notable apparatuses of stress examination utilized in isotropic direct versatile plan should be reached out to incorporate anisotropy, for example, and not all creators are alright with these further developed instruments. Even following quite a while of promoting composites as the "material of things to come " high efficient factor turns into a block in the general agreeableness of the material when contrasted with the customary material like steel.

During the energy-emergency time of the 1970's, car makers were so restless to diminish vehicle weight that they were able to pay a premium for composites for their weight benefits. However, as stress over energy

productivity reduced, the business progressively got back to a severe least expense approach in choosing materials. Henceforth the market for composites in autos got back to a more humble pace of development. Despite the fact that composites have been utilized broadly in requesting underlying applications for 50 years, the drawn out solidness of these materials is substantially less sure than that of steel or other customary primary materials. The very much advanced partition of the tail balance of an American Airlines A300-600 Airbus after departure from JFK air terminal on November 12, 2001 is a valid example. It isn't evident that this mishap was because of disappointment of the tail's graphite-epoxy material, yet NASA is looking extremely hard at this chance. Positively there have been media reports communicating worry about the material, and this point up the vulnerability originators should consider in utilizing composites.

Defenselessness to de-overlay is one of inborn shortcomings of covered composite designs. They are likewise helpless to break inception and proliferation along the laminar interfaces in different disappointment modes. The fiber/framework interface has consistently been considered as a vital part of polymer composites. It is at interface where stress fixation creates in light of contrasts between the support and lattice stage warm development coefficients. The interface may likewise fill in as a locus of compound response across which burden is moved and is of so such significance Another disadvantage of thermoset pitches is their inclination to assimilate critical measure of water when they are presented to aqueous climate. The temperature is probably going to impact dampness get energy in polymer composite pitch a mind boggling way. Because of cooling at super low temperatures, glass filaments show longitudinal compressive pressure. These burdens make warm lingering strain in the grid. Compressive burdens created in the fiber because of cooling are joined into the fiber disappointment strength appropriation.

1.6 Natural Fiber Reinforced Composites (NFRC)

Composites which are manufactured by using natural fibers are called natural fiber reinforced composites. Natural fibers like Jute, hemp, sisal, pineapple, Agave Americana, bamboo, okra,coir abundantly available at low cost which makes the use of natural fibers effectively. These natural fibers are of hair-like materials that are in persistent shape or are in small pieces, or like bits of string. These fibers can be spun into fibers, string, or rope. Natural fibers provide good mechanical properties and are environmentally friendly.

Normal filaments are sustainable, and biodegradable. Low in thickness, inexhaustibility, cost, openness, and compelling mechanical properties make normal strands as elective choice for carbon, glass, and man-made filaments utilized underway of composites. Polymers are classified into two classifications; they are thermoplastics and thermosets. In any case, construction of thermoplastic grid materials comprises of at least one dimensional sub-atomic, so these polymers tend to make milder at an expanded warmth reach and roll back their properties all through cooling. This expands the adaptability of the composite.

Figure 1.23 Jute fiber epoxy composite

The normal fiber composites are really obliging, and are material as a piece of street transportation, military applications, water transportation, building and advancement business adventures like rooftop outlining, section sheets, and purchaser things.

High strength, energy assimilation, and firmness are the critical components for wide utilization of composites in car and motorsport areas. The substance structure of normal strands consequences for the attributes of the composite addressed by the level of cellulose, hemicelluloses, lignin, and waxes. In around the world, the openness of vegetable strands and progressed made filaments stay in significant interest besides rival silk, wool, and strength, concealing, artificial materials for quality opposition, and brightness.

1.6.1 Characteristics of fiber reinforced Composites

Nature is a decent source in the creation of composite material. Wood, bamboo, banana, hemp, sisal, bones, cowhide and so forth are a portion of the regular stringy composites. The trunksof palm trees are genuine models for sandwich constructions of 12 composites. Current composites are engineered and are amassed on the lines of normal composites. As of now, static and dynamic investigation of underlying individuals from composites has a lot of consideration in the development division.

Fiber-supported composite materials have better blend of solidarity and modulus than numerous conventional metallic materials. A fiber-built up composite comprises of low1 explicit gravity, strength-weight proportion and modulus-weight proportions are notably better than those of metallic materials. Exhaustion solidarity to weight proportion's just as weariness harm, resiliencies of numerous composite covers are magnificent. Regular strands are lower in weight when contrasted with metals. So these are utilized in many weight-basic applications like aviation and auto.

Steel and aluminum composites are viewed as isotropic that implies they display almost equivalent properties regardless of the course of estimation. The rigidity and modulus of unidirectional arranged fiber-supported covers are greatest if the properties are estimated longitudinal way of strands, at some other point, properties are lower. Rakish reliance is noticed for different properties like coefficient of warm extension,

warm conductivity and effect strength.

Overall metals show yielding and plastic distortion yet most fiber-supported composites are flexible in their ductile pressure strain qualities. The heterogeneous idea of these materials gives systems of high energy assimilations on a minute scale than the yielding cycle.

Composites construction may displays a superior dimensional dependability in higher temperatures since they have lower coefficient of warm development than metals. Another exceptional quality of fiber-built up composites are their high interior damping limit. These give better vibration energy assimilation inside the materials and results diminished transmission of commotion and vibrations to the adjoining structures.

Numerous normal metals including iron, copper, nickel have directionally subordinate properties because of entomb nuclear bonds. This entomb nuclear bonds are more grounded in certain ways than in others, and displays significant qualities toward the more grounded bond. In heading opposite to solid course, the material is a lot milder and more vulnerable. The electrical conductivity and warmth conduction can likewise be directionally reliant in the metals. Filaments have huge length so they can be handily adjusted one way to give specific support inside the material.

The strength properties of strands are irregular variable that is trying of thousand filaments would bring about thousand distinctive strength esteems. Execution of composite relies on the

- Length
- Orientation
- Shape
- Material

1.6.2 Industrial applications of fiber reinforced composite materials Military and Aerospace Applications

The genuine collaborator applications for fiber built up composites are in the field of military and business flying machine. Since the time that the creation utilization of boron fiber-built up epoxy skins for F-14 even stabilizers in 1969, the utilization of fiber supported polymers has encountered a consistent improvement in the airplane business. The different segments, as under wing fairings, equality, rudder, stabilizer skins, skins on vertical leveling.

Figure 1.24 Light Weight Natural Composite Military Helmet

Box, equality driving edge, wing skins, level or vertical tail boxes, wing and tail control surfaces, and foundation, forward fuselage, altogether stabilizer, folds, ailerons in this way on were acknowledged to different airplane amidst the period 1969 to 1982. The Lear Fan 2100, a business airplane, in which carbon fiber and Kevlar49 fiber-epoxies address over 70% of the plane's fundamental weight. Fiber–built up epoxies are utilized as a piece of rotor cutting edges for some military and business helicopters. Fiber-strengthened composites are picked in rocket structures with a definitive target of weight decrease, which thusly expands the rocket range and furthermore its payload limit.

Among the assorted applications in the designs of room transports are boron fiber-invigorated aluminum tubes for the mid fuselage support structure, aluminum honeycomb in blend in with carbon fiber-built up epoxy face sheets for the pay load gulf entryway, long super high-modulus carbon fiber-built up epoxy tubes for the distant regulator arm, and Kevlar49 fiber-braced epoxy weight vessels. The help structure for mirrors and central focuses in the space telescope is contained carbon fiber-invigorated epoxy bay.

Automotive Industry

Uses of fiber-built up composites in the auto business can be depicted into three social gatherings: body segments, underside parts, and motor pieces. The hood, entryway sheets and so on are a pace of the external body parts, which are contained composite materials.

Figure 1.25 Bio composite cabin in car door

The radiator upholds, screen support shafts, and door jambs are a touch of inside parcels comprised of composite materials. Back leaf springs, underside parts, for example, drive shafts and street wheels, have been feasibly endeavored in the assessment centers and are at present being conveyed for future vehicles and vans. Weariness loads at high temperatures address the best test in the utilization of fiber-fortified composites in the motor areas. An essential step towards higher execution applications was master with the door sheets of the Mercedes-Benz E-Class. The wood fiber materials recently utilized for the entryway sheets was displaced by plant fiber – sustained materials including a flax/sisal fiber mat installed in an epoxy pitch structure. A striking weight decrease of around 20% was refined, and the mechanical properties, essential for traveler assurance in case of an occurrence, were progresses.

Sports and Goods Industry

All through the most two or three years, fiber-built up polymeric composites have encountered a noteworthy use in the wearing stock industry. The delight stock like, Tennis rockets, Racket ball rackets, Gold club shafts, Fishing posts, Bicycle lodgings, Snow and water skis, Ski posts, shaft vault posts, Hockey sticks, Sail boats and kayaks, Oars, paddles, Canoe structures, Surfboards, Arrows, Archery bows, Javelins, Helmets hence on are made of fiber-fortified polymeric composites. The made furthest points are made of carbon fiber or carbon/cross sort of carbon Abelmoschus Esculentus built up plastics. More client stock like seats, figures, tables are made of fiber-supported composites. The bulkheads and packaging, sponsorships, and fittings of air coolers, TV set and estimating instruments are of invigorated composites.

Figure 1.26 Carbon Fiber Reinforced Composite Surfboards

Marine and Chemical Industry

The marine parts like watercraft bodies, decks, bulkheads, edges, screws, and lacking are incorporated Kevlar49 fiber-supported polyester covers. Supported composites have been found by and large well in Chemical industry in light of their ruinous opposition, low upkeep cost, substance obstruction and less expensive than traditional non-harming metals like treated steel. Fuel tanks, stacks, hoods, fans, pipes in this manner on can be securely made with predominant halogenated innovation opposition polyester composites. Modacrylic polyester and poly propylene fiber with better scratched zone and substance protections are utilized as spread mats for corrosive neutralizers. The base expensive trademark fiber jute additionally can be utilized.

Building Industry

Composite materials remembered incredible district for the structure business for making parts like wrinkled sheets, windows, pool, cladding the regions and outside dividers. Overwhelming fiber composites will go far in the device business. Fiber supported plastics have shown persuading in bulkheads, blower lodgings, base dish and isolated area of air cooler, PC, imitating machines and so on.

Figure 1.27 Natural Fiber Reinforced Polymer Composite

1.7 Resins

In polymer science and materials science, sap is a strong or exceptionally thick substance of plant or manufactured beginning that is regularly convertible into polymers. Pitches are normally combinations of natural mixtures. Plants emit saps for their defensive advantages in light of injury. Plant pitches are esteemed for creation of glues and food coating specialists. There are likewise esteemed as crude materials of the engineered of natural mixtures.

Figure 1.28 Plant resins

Numerous materials are created by means of the change of manufactured tars to solids. Significant models are bisphenol A diglycidyl ether, which is a sap changed over to epoxy stick upon the expansion of a hardener. Silicones are regularly ready from silicone gums by means of room temperature vulcanization.

Figure 1.29 Epoxy resin

1.7.1 Basic Classification of Resins: The gums are arranged into two sorts

- Thermosets
- Thermoplastics

Thermo sets (Examples: Epoxies, polyesters, phenolics, polyamide) Thermo sets goes through an irreversible substance change when they are relieved. They synthetically crosslink and fosters an organization construction to sets them fit as a fiddle. In case they are warmed get-togethers have been relieved, they don't soften. They will hold their shape until they start to thermally deteriorate at high temperatures **Thermoplastics** (Examples: Polyethylene, polystyrene, polyether–ether Ketone) Thermo plastics are reversibly dissolve when they are warmed and cement when they are cooled. By warming above lower shaping temperature they can be reshaped.

Thermoplastic can be reprocessed relax on warming, simple to fix and has short fix cycles and amazing dissolvable opposition. Both thermo sets and normal strands are vulnerable to climate including temperature, dampness, light and synthetic specialist and bases, however most polymers are debased by oxidative responses.

1.7.2 Types of Resins

There are three primary kinds of tars which are utilizing now a days with carbon filaments, fiberglass, Aramid. These are Epoxy, vinyl ester, polyester tars. These are having an alternate trademark with individual expenses moreover.

Epoxy Resin: Epoxy has great added substance properties alongside high mechanical strength, low shrinkage, synthetically safe, high dissemination thickness, low gooey and better electric protection limit. Also, it is effectively built up with regular hemp, kenaf and glass strands. The properties of Epoxy Resin are displayed in table 1.1

Table: 1.1 Properties of epoxy resin

Properties	**Epoxy**
Viscosity at 250μ(cP)	12000-13000
Density ρ(g.cm^{-3})	1.16
Heat distortion temperature HDT(°C)	100
Modulus of elasticity E (GPa)	5
Bending strength (MPa)	60
Tensile strength (MPa)	73
Maximum elongation(%)	4

Vinyl esters: Consistency worth of vinyl esters are halfway among polyesters and epoxy gums, prior to adding styrene. Vinyl esters contract less on restoring, which implies that pre-arrival of a cover from a form is less critical. Vinyl esters are more open minded toward extending than polyester. The properties of vinyl

ester sap is displayed in table 1.2

Table :1.2 Properties of vinyl ester resin

Properties	**Vinyl ester**
Viscosity at 250μ(cP)	350
Density ρ(g.cm^{-3})	1.09
Heat distortion temperature HDT(°C)	82
Modulus of elasticity E (GPa)	3.71
Bending strength (MPa)	55
Tensile strength (MPa)	69
Maximum elongation(%)	3

Polyester: Polyester saps are unsaturated engineered saps shaped by the response of dibasic natural acids and polyhydric alcohols. Maleic Anhydride is a regularly utilized crude material with diacid usefulness. Polyester saps are utilized in sheet forming compound, mass embellishment compound and the toner of laser printers. The properties of vinyl ester sap are displayed in table 1.3

Table 1.3 Properties of polyester resin

Properties	**Polyester**
Viscosity at 250μ(cP)	250-350
Density ρ (g.cm^{-3})	1.09
Heat distortion temperature HDT (° C)	54
Modulus of elasticity E (GPa)	3.3
Bending strength (MPa)	45
Tensile strength (MPa)	40
Maximum elongation (%)	1

Natural Powder (Agarbatti)

Figure 1.30 Agarbatti powder

Agarbatti powder, also known as incense powder, is a blend of natural ingredients used to make incense sticks or agarbattis. It typically consists of a base material such as bamboo sticks or charcoal, mixed with aromatic substances like powdered wood, resins, essential oils, herbs, spices, and sometimes floral extracts. The exact composition can vary widely depending on the desired fragrance and cultural or religious traditions. Agarbatti powder is often mixed with water or other binding agents to form a paste, which is then rolled onto bamboo sticks or molds to create incense sticks that release fragrant smoke when burned.

1.8 Hardener

Hardener was utilized as a folio during the manufacture. It has low thickness, fix at room temperature, great mechanical strength, good protection from barometrical and synthetic corruption.

1.8.1 Types of Hardener:

The hardeners are grouped into following kinds

- Aliphatic and Aromatic amines,
- Anhydrides, and Polyamides.

The size of hardener particles is a lot more modest than the pitch atoms. Along these lines the consistency of hardener is low contrasted with the tars.

CHAPTER 2 LITERATURE REVIEW

Rajasekar.KAshok Kumar. KNarayanan.L. All helmets are always ready to protect human hend by many forces, securing it against forces or loads. And their structure also has protective abilitythat would be modified over high-power effects. By their energy power absorption Capacity. Its needed to be watched as that those of a flexural fiber property grows with the rise in the weight porportion for bamboo fibers with assured degree. Harm hazard for the user's human head and also neck. Consistently A large number laborers would get murdered or genuinely harmed in the development Business Concerning illustration an after effect about human wounds. Wearing an fitting wellbeing helmet fundamentally diminishes those hazard that about to damage alternately. Protective headwear Might spare your life. The point of this project will help in expansion of quality of a model of a helmet by making those changes in a material with earlier one. Here regular fiber Also epoxy tar are utilized Likewise crude material should also Manufacture the helmet. In this project, those cap model will be breaking down utilizing Cero mimic 2.0 programming will be tested if. The cap might withstand secondary effect load alternately not also compared the outcomes about both those regular fiber helmet and also Polypropylene helmet.

Sathish Kumar, Jaya kumar, Those point from claiming this paper depicts the helmet manufacturing through Creating protectiveframeworks which need aid viably withstand more impact effect load, light weight, warm insulated surface quality, dimensional precision, and so on. The utilization about characteristic assets for example, aloe vera root Furthermore papaya come fibers, these fibers would more salt water.

Those aloe vera is originate stem cut plant its pushing shiny Also dampness on hair What's more keeping hair passing which repairs dead skin on the scalp, its pushes hair development and diminishes dandruff Additionally. This material Hosting higher load convey limit over that for existing acrylonitrile butadiene styrene (ABS) plastic cap. In this project, the model will be outlined BSEN 397-1995 Toward Cero parametric 2.0 programming and investigated with Ansys 14. 0 with test in those caps might withstand more impact effect load or not.

V. Pradeep A Issue with those past times building helmets might have been that particular architects resded to struggle a considerable measure of time around the lighting framework of the helmets also In addition they required an effort for a considerable measure of time that they needed to do at work. Be That a activity required been taken on Fabricate An helmet which Might make a cure should A large number of the issues faced Toward these particular architects also of course Might make supportive over focusing those lightness in weight age wherever they have any desire and At whatever point they have any desire during the external work in fields. This one task need been tried during the lab level Also required been refined for those Ansys software. This meets expectations on the modifying. In fact the model needed been generated all the which Might uproot every last one of Negative marks of the present days helmet Also every last one of new Characteristics Might a chance to be impregnated will modernize those past helmets.

Sudhir.A, et al [01] defines that hybrid composites were prepared using Bamboo/Pineapple of 0/40, 10/30, 20/20, 30/10, 40/0 weight fractions while overall fiber was fixed as 0.4 wf. Tensile and Flexural properties were carried out using hybrid composite materials. The results indicated that addition of sisal fiber in jute composites up to 50% weight fraction results in increase in mechanical properties. The UTS of pure bamboo and pure pineapple composites are 38.93 MPa and 36.93MPa respectively. And Flexural properties of pure bamboo and pure pineapple are 87.15 MPa and 87.05 MPa. At equal ratios tensile and flexural of hybrid (Bamboo/Pineapple) composite results are 39.93 MPa and 88.33 MPa respectively which shows a clear increment in tensile and flexural properties of pure bamboo and pure pineapple respectively.

QPhanindra Varma.D., et al [02] studied that hybrid composites were prepared using pineapple/bamboo fiber reinforced epoxy hybrid composites of weight fractions of 40/0, 30/10, 20/20, 10/30, 0/40 Tensile, flexural and impact test were carried out to investigate associated properties. They observed that hybrid composite pineapple/bamboo (10/30) weight fraction possess good tensile strength up to 40.21 MPa. The pineapple/bamboo (20/20) weight fraction possess maximum flexural strength of 155.09 MPa. Impact strength for pineapple/bamboo (30/10) was approximately 12.37 J.

CHAPTER 3

FABRICATIONS AND EXPERIMENTAL SETUPS

In our nation India, there are sweeping specific mixed bunches of regenerative plants and trees with some fiber content. In them, some are made from the occasions and some are wild plants, creepers, and trees that make in forests and woods. It is obviously true that any material which is in tacky construction is more grounded than in the mass design. Subsequently, these solid fibers are utilized. Pineapple and Agave Americana are vivaciously open in our country that has been utilized as a piece of their restorative construction. Regardless, same business related to this fiber is all that plentifully obliged when stood apart from different fibers. This assessment fuses to investigate the conceivable utilization of fibers in making of new mixed sack of composites for weight passing on structures. The propose of brand name fibers is to broaden the quality. An immense piece of the standard composites are less expensive than the delivered fiber composites.

These ordinary filaments have a critical part in long time past days. These people, considering these filaments they make them for their private uses like reach homes cruising strength and so forth the assessment has shown that, these assembled fiber progressions are offered by an induced turn of events, on the other hand, these examines are to redesign the application, quality and viability of standard strands. These standard fiber composites have different tendencies of being solid, unassuming, and light, more eco amicable and safe. Notwithstanding, by utilizing of these brand name strands there two or three solicitation raised up that how such kind of materials are to be made progress toward toughness and quality. More works should be needed before these standard fiber composites are utilized as a piece of requesting conditions. From these brand name fiber supported plastics, Daimler Benz have utilized passage sheets for their Mercedes G class vehicles other than they have approaches to develop the material containing ordinary fiber braced plastics for different parts. Once after evolved, the progression would be a unique making of an expansive number.

3.1 Material

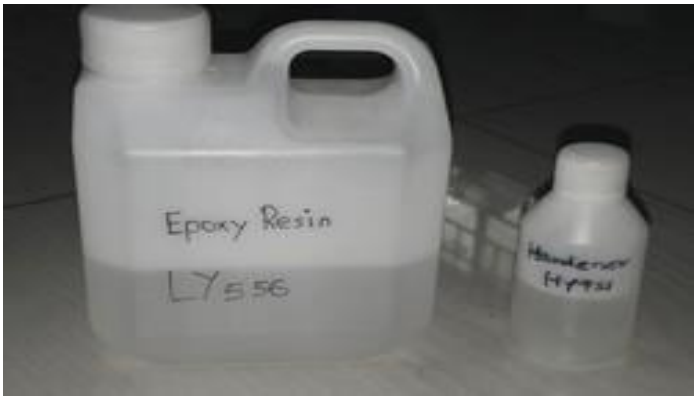
On among various kinds of gums and hardener. Epoxy LY556 and hardener HY951 are picked. The materials taken to manufacture the examples are Bamboo fibre, Pine Apple fibre and natural powder of agarbatti. These are taken in the various proportions and various blends. The five distinct composites are researched the effect strength, rigidity, flexural srength (tensile, impact).

3.1.1 Epoxy

In present work epoxy LY556 is utilized as framework material displayed in figure.3.1 to manufacture half and half fiber epoxy composites. Epoxy LY556 is picked in light of the fact that it is a one such lattice which is broadly utilized on the grounds that it show low shrinkage, higher mechanical properties, simple creation, great synthetic and dampness opposition, great wet capacity. Epoxy tars are the most generally utilized thermoset plastic in polymer framework composites. Epoxy tars are a group of thermoset plastic materials which don't radiate response items when they fix thus have low fix shrinkage. They likewise have great grip to different materials, great synthetic and natural obstruction and great protecting properties.

Figure 3.1 Epoxy Resin LY556

3.1.2 Hardener



Hardener utilized for present examination for starting gel development is hardener HY951 which is displayed in figure.3.2. The mix of epoxy LY556 and hardener which fixes at room temperature, astounding glue strength, great mechanical and electrical properties. The proportion of the epoxy and hardener are taken 10:1 that is 10 grams of epoxy and 1 gram of hardener.

3.1.3 Bamboo fiber

The general process for chemically manufacturing bamboo fiber using hydrolysis alkalization with multi-phase bleaching technology – which is the dominate technology for producing regenerated bamboo fiber – goes like this:

Bamboo leaves and the soft, inner pith from the hard bamboo trunk are extracted and crushed. The crushed bamboo cellulose is soaked in a solution of 15% to 20% sodium hydroxide at a temperature between 20^0C to 25^oC for one to three hours to form alkali cellulose. The bamboo alkali cellulose is then pressed to remove any excess sodium hydroxide solution. The alkali cellulose is crashed by a grinder and left to dry for 24 hours. Roughly a third as much carbon disulfide is added to the bamboo alkali cellulose to sulfurize the compound causing it to jell. Any remaining carbon disulfide is removed by evaporation due to decompression and cellulose sodium xanthogenate is the result. A diluted solution of sodium hydroxide is added to the cellulose sodium xanthogenate dissolving it to create a viscose solution consisting of about 5% sodium hydroxide and 7% to 15% bamboo fiber cellulose.The viscose bamboo cellulose is forced through spinneret

nozzles into a large container of a diluted sulfuric acid solution which hardens the viscose bamboo cellulose sodium xanthogenate and reconverts it to cellulose bamboo fiber threads which are spun into bamboo fiber yarns to be woven into reconstructed and regenerated bamboo fabric. Newer manufacturing facilities have begun using other technologies to chemically manufacture bamboo fiber that are more benign and eco-friendlier. The chemical manufacturing process used to produce lyocell from wood cellulose can be modified to use bamboo cellulose. The uses N-methylmorpholine-N-oxide which is non-toxic to humans and the chemical manufacturing processes are closed-loop so 99.5% of the chemicals used during the processing are captured and recycled to be used again. Nanotechnology is being also used for bamboo fibers.

Figure 3.2 Process of making Bamboo fiber

Mechanical properties of bamboo fiber

Bamboo fibber possesses several mechanical properties that make it a valuable material in various applications:

1. **Tensile Strength:** Bamboo fibers exhibit good tensile strength, which means they can withstand pulling forces without breaking easily. The tensile strength of bamboo fiber can range from 200-400 MPa.

2. **Flexural Strength:** Bamboo fibers have good flexural strength, making them suitable for applications where bending or flexing is involved, such as in composite materials. Flexural strength typically ranges from 250-400 MPa.

3. **Elastic Modulus:** This property refers to a material's ability to deform under stress and return to its original shape once the stress is removed. Bamboo fibers have a relatively high elastic modulus, ranging from 20-30 GPa, which is comparable to some hardwoods.

4. **Compression Strength:** Bamboo fibers also exhibit good compression strength, which is the ability to withstand forces pushing on the material. Compression strength can vary depending on the type of bamboo and its processing but generally falls within the range of 50-150 MPa.

5. **Density:** Bamboo fibers are lightweight, with a density ranging from 0.4 to 0.8 g/cm³, which makes them suitable for applications where weight is a concern.

6. **Impact Resistance:** Bamboo fibers have good impact resistance, making them suitable for applications where the material may be subjected to sudden or repeated impacts.

7. **Abrasion Resistance:** Bamboo fibers show moderate to good resistance to abrasion, which is important for materials that will be subjected to wear over time.

8. **Moisture Absorption:** Bamboo fibers have a relatively low moisture absorption rate compared to other natural fibers, which helps in maintaining their mechanical properties in humid conditions.

Bamboo fiber is indeed versatile, finding application in textiles, paper, composites, and construction materials. However, its mechanical properties can vary significantly based on factors such as bamboo species, processing method, and fiber treatment.

3.1.4 Pineapple fiber

Mature pineapples are harvested when they are ready. The most common variety used for fiber extraction is the Red Spanish pineapple. After harvesting, the leaves are stripped from the pineapple fruit. This is typically done manually, using a special knife or stripping tool to carefully remove the leaves without damaging them. The stripped leaves are then subjected to a process called retting, which involves soaking them in water to break down the pectin that binds the fibers together. This can be done in freshwater or saltwater, and the length of time required for retting can vary depending on factors such as the temperature and pH of the water. After retting, the outer layer of the leaf, known as the epidermis, is scraped away to reveal the fibers underneath. This can be done using a mechanical scraper or by hand. The fibers are then dried either by hanging them in the sun or by using mechanical dryers. Drying helps to remove any remaining moisture and prepare the fibers for further processing. Once dried, the fibers are sorted and graded based on their length, color, and quality. Longer fibers are typically considered more valuable and are used for higher-end products. Finally, the fibers are spun into yarn and woven into fabric or other products. This can be done using traditional hand looms or modern machinery, depending on the scale of production and the desired end product.

Figure 3.3 Hardener HY 951

Mechanical properties of pineapple fiber

Pineapple fiber, also known as Piña fiber, possesses several mechanical properties that make it an interesting material for various applications:

1. **Tensile Strength**: Piña fibers exhibit good tensile strength, with values ranging from 250 to 400 MPa. This means they can withstand pulling forces without breaking easily.

2. **Flexural Strength:** Flexural strength of pineapple fibers is generally good, with values typically falling within the range of 200 to 350 MPa. This property is important for applications where bending or flexing is involved.

3. **Elastic Modulus:** The elastic modulus of pineapple fibers is moderate, typically ranging from 10 to 20 GPa. This property refers to the material's ability to deform under stress and return to its original shape.

4. **Compression Strength:** Pineapple fibers exhibit fair to good compression strength, typically ranging from 50 to 150 MPa. This property is important for materials that will be subjected to forces pushing on them.

5. **Density:** The density of pineapple fibers is relatively low, typically ranging from 1.2 to 1.5 g/cm³. This makes them lightweight, which is beneficial for various applications.

6. **Impact Resistance:** Piña fibers generally have good impact resistance, making them suitable for applications where the material may be subjected to sudden or repeated impacts.

7. **Abrasion Resistance:** Pineapple fibers have moderate to good abrasion resistance, which is important for materials that will be subjected to wear over time.

8. **Moisture Absorption:** The moisture absorption of pineapple fibers is relatively low compared to some other natural fibers, which helps in maintaining their mechanical properties in humid conditions.

These mechanical properties make pineapple fibers suitable for use in textiles, handicrafts, and other applications where strength, flexibility, and lightweight are desired. However, like with other natural fibers, the mechanical properties of pineapple fibers can vary depending on factors such as the variety of pineapple, the processing method, and the treatment applied to the fibers.

3.2 Steps involved in the fabrication of specimen

The bamboo fibre built up Epoxy composite example was manufactured by hand layup procedure. In this cycle 5 sheets of bamboo (50 gms) length of (200/200mm) and pine apple fibre are also same number of sheets and equal length as taken. In this fibre we can take the hardener (HY951) of 10 grams is blended in with 100 grams of epoxy(LY556) which is utilized

as lattice in the composite. The thickness of the example is 4mm for impact and tensile test. Thickness of the example that acquired by 2 sheets of bamboo fiber is around 1.5mm. For acquire 4mm thickness 5 sheets of bamboo are utilized.

Figure 3.4 Bamboo fibre reinforced with epoxy composite

The Pineapple Fibre built up Epoxy composite example was manufactured by hand layup procedure. In this cycle 5 sheets of bamboo (50 gms) length of (200/200mm) sheets and equal length as taken. In this fibre we can take the hardener (HY951) of 10 grams is blended in with 100 grams of epoxy (LY556) which is utilized as lattice in the composite. The thickness of the example is 4mm for impact and tensile test. Thickness of the example that acquired by 2 sheets of Pineapple fiber is around1.5mm. For acquire 4mm thickness 5 sheets of bamboo are utilized.

Figure 3.5 Pineapple fibre reinforced Epoxy composite.

The hybrid bamboo/pineapple supported Epoxy composite example glass fibre (200/200) and 4mm sheets. It was created by utilizing hand layup procedure.In this interaction 3 sheets of bamboo fibre and 2 sheets of pineapple fibre to got the 4mm thickness. What's more, 10 grams of hardener (HY951) is blended in with 100 grams of epoxy (LY556) which is utilized as grid in the composite.

Figure 3.6 Hybridization of bamboo with pineapple fibre reinforced with Epoxy composite

The hybrid bamboo/pineapple/agarbatti powder: supported Epoxy composite example glass fibre (200/200) and 4mm sheets. It was created by utilizing hand layup procedure. In this interaction 3 sheets of bamboo fibre and 2 sheets of pineapple fibre to got the 4mm thickness. What's more, 10 grams of hardener (HY951) is blended in with 100 grams of epoxy (LY556) in with 10 grams of agarbatti powder which is utilized as grid in the composite  .

Figure 3.7 Hybridization of bamboo and pineapple fibre with 10gm of agrbatti powder reinforced with Epoxy composite

The hybrid bamboo/pineapple/agarbatti powder supported Epoxy composite example glass fibre (200/200) and 4mm sheets. It was created by utilizing hand layup procedure.In this interaction 3 sheets of bamboo fibre and 2 sheets of pineapple fibre to got the 4mm thickness. What's more, 10 grams of hardener (HY951) is blended in with 100 grams of epoxy (LY556) in with 20 grams of agarbatti powder which is utilized as grid in the composite.

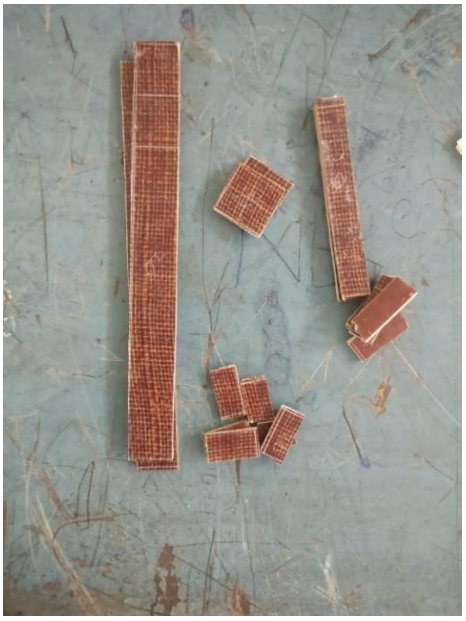


Figure 3.8 Hybridization of bamboo and pineapple fibre with 20gm of agrbatti powder reinforced with Epoxy composite

3.3 TENSILE TESTING OF COMPOSITES

A 2-ton limits electronic tensometer which is displayed in figure 3.13, METM 2000 ER-1 model (Plate II-18), provided by M/S microtech Pune, is utilized to decide the versatility of composites. Its ability can be changed by trouble cells of 20 kg, 200 kg and 2 ton. A weight cell of 2 ton is utilized for testing composite examples. Self-changed energetic handle toss is utilized to hold composite examples. An electronic micrometer is utilized to quantify the necessary thickness and width of composite examples. The check length, width and thickness are estimated with 0.001 mm negligible count mechanized micrometer. This electronic tensometer is fixed with weight and expansion pointers, which has an insignificant count of 0.01 kg and 0.01mm independently. An electronic tensometer is fitted with a modified self changed smart handle throw and other flexible self changed quick hold throw to hold 165 mm long, 12.5 mm wide and 4 mm thick examples. Examples are set in the holds of a tensometer at a particular grasp partition and exposed to stack until disappointment. The power applied is shifted on to measure the load and development of example. The adaptable toss is additionally moved with the end goal that the store pointer simply starts giving proof stacking on the example.

At that moment the extension meter is adjusted to examine zero, when the store on the model is zero. The

speed decline pulleys are picked to such an extent that the cross head speed of 0.2 mm/min is associated on versatile hold. By then the electronic motor fitted to tensometer is started. Beginning from nothing, at each 0.5 mm extension the pile pointer are noted until the example breaks. Toward the finish of test the last burden and expansion is furthermore noted from the electronic pointer show. For each example the sort of disappointment and different discernments identifying with disappointment are recorded. Two indistinct example tests are inspected. The tractable pressure is dictated by the accompanying connection.

$$\text{Tensile stress } \sigma_t = \frac{\textit{tensile load}}{\textit{area of cross-section}} \quad (1)$$

$$= \frac{P}{A} \text{ N/mm}^2$$

3.4 Flexural testing of composites

Three point bowing test are done according to ASTM-D790M-86 test methodology 1, framework A to separate flexural properties, the examples are 100 mm long, 25 mm wide and 4 mm thick . Two vague examples are oppressed for flexural testing. In three-point bowing test, the outside rollers are 70 mm isolated and examples are oppressed at a strain pace of 0.2 mm/min. Flexural stress are dictated by the accompanying relations.

3.5 Impact testing of composites

Effect test is otherwise called charpy v score, Impact analyzer was influencing analyzer provided by M/S International equipments, Mumbai, was utilized to test the effect properties of fiber Reinforced composite example. The Impact analyzer has four working capacities of impact quality for example 0-2.71 J.0-5.42 J,0-10.84 J and 0-21.68 J, with a base assurance on each size of 0.02J, 0.05 J, 0.1 J and 0.2 J separately. Four scales and contrasting hammers (R1,R2,R3,R4) are introduced in gear. Standard test method, ASTM D256-97, for impact properties of fiber composites has been utilized to analyze the unidirectional composite examples. The examples to be inspected are of measurements 63.5mm long, 12.36mm wide and 6mm in thick. A Vpoint is put in sway analyzer record having an included mark of 450 at the point of convergence of the example, and at 90¬¬0 to the example turn. The significance of the example to be inspected under the indent is 2 mm. The assessment gathers with ASTM standard checks. In light of the volume bit of the example, one of the four sledges (R1, R2, R3, and R4) should be picked to break the example. The sledge is fixed to the pendulum as displayed in figure 13.4 in a particular way that it will arrive at the example on a line 22mm incredibly surface. The example is fixed to the blacksmith's iron and sledge is utilized to break the example. The pendulum sledge is delivered from locking position which is at a state of 1500 and hits the example with a striking rate of 2.46m/sec. The example is stripped and energy is exhibited in joules by the pointer on the specific scale.

Figure 3.10 Impact machine for impact testing Impact strength was calculated by the following relation

$$\sigma = \frac{P}{A}$$

P= Energy observed in J A= Area in mm(3)

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Mechanical characteristics of composites

The properties of the Bamboo and Pineapple filaments built up epoxy mixture composites with of fiber under this examination are introduced in underneath Table 4.1. Subtleties of preparing of these composites and the tests led on them have been portrayed in the past section. The mechanical properties of Natural fiber supported composites are largely relies upon the substance, underlying arrangement, fiber type and soil conditions and furthermore on climatic conditions at the hour of creation of the examples.

The consequences of different portrayal tests are accounted for here. This incorporates assessment of elasticity, flexural strength, sway strength. Has been examined and talked about. In view of the classified outcomes, different charts are plotted and introduced in figures for composites.

Table: 4.1 Specimen testing results

S.NO	**Composite**	**Tensile test**		**Flexural test**		**Impact test** Strength in J
		Load in N	Elongatio n in mm	Load in N	Maximum Deflection in mm	
1	B	4000	8.5	2125	18.5	83

2	PA	5250	12.5	1625	11	83
3	B+PA	4500	7.5	1875	14	85
4	B+PA+A10	3250	10.5	1500	11	83
5	B+PA+A20	5750	11	1750	13.5	86

4.2 Tensile strength

Creation and testing effectively finished in this venture the tractable properties of plain-woven basalt, plain woven E-Glass fiber and basalt/E-glass, basalt/E-glass with Graphite power

variety 5%,10%,15%, manufactured by utilizing hand lay-up strategy. The rigidity was determined by the connection.

Tensile stress σ_t = $\frac{\textit{tensile load}}{\textit{area of cross-section}} = \frac{P}{A}$ **N/mm²** (4)

Bamboo : $\sigma_t = \frac{4000}{174\times4} = 5.7$ N/mm²

Pineapple : $\sigma_t = \frac{5250}{174\times4} = 7.54$ N/mm²

Bamboo + Pineapple : $\sigma_t = \frac{4500}{174\times4} = 6.46$ N/mm²

Bamboo + Pineapple + A10 : $\sigma_t = \frac{3250}{174\times4} = 4.66$ N/mm²

Bamboo + Pineapple + A20 : $\sigma_t = \frac{5750}{174\times4} = 8.26$ N/mm²

% elongation = $\frac{\textit{change in length}}{\textit{original length}} \times 100$ (5)

Bamboo :

$$\% \text{ of elongation} = \frac{8.5}{174} \times 100 = 4.8\%$$

Pineapple : % of elongation = $\frac{12.5}{174} \times 100 = 7.1\%$

Bamboo + Pineapple : % of elongation = $\frac{7.5}{174} \times 100 = 4.3\%$

Bamboo + Pineapple + A10 : % of elongation = $\frac{10.5}{174} \times 100 = 6.03\%$

Bamboo + Pineapple + A20 : % of elongation = $\frac{11}{174} \times 100 = 6.32\%$

Table:4.2 Tensile test results for 5 composites

S.NO	Composite	Load in N	Elongation in mm	Tensile strength N/mm²	Percentage of elongation in %
1	B	4000	8.5	5.7	4.8
2	PA	5750	12.5	7.54	7.1
3	B+PA	4500	7.5	6.46	4.3
4	B+PA+A10	3250	10.5	4.66	6.03
5	B+PA+A20	5250	11	8.26	6.32

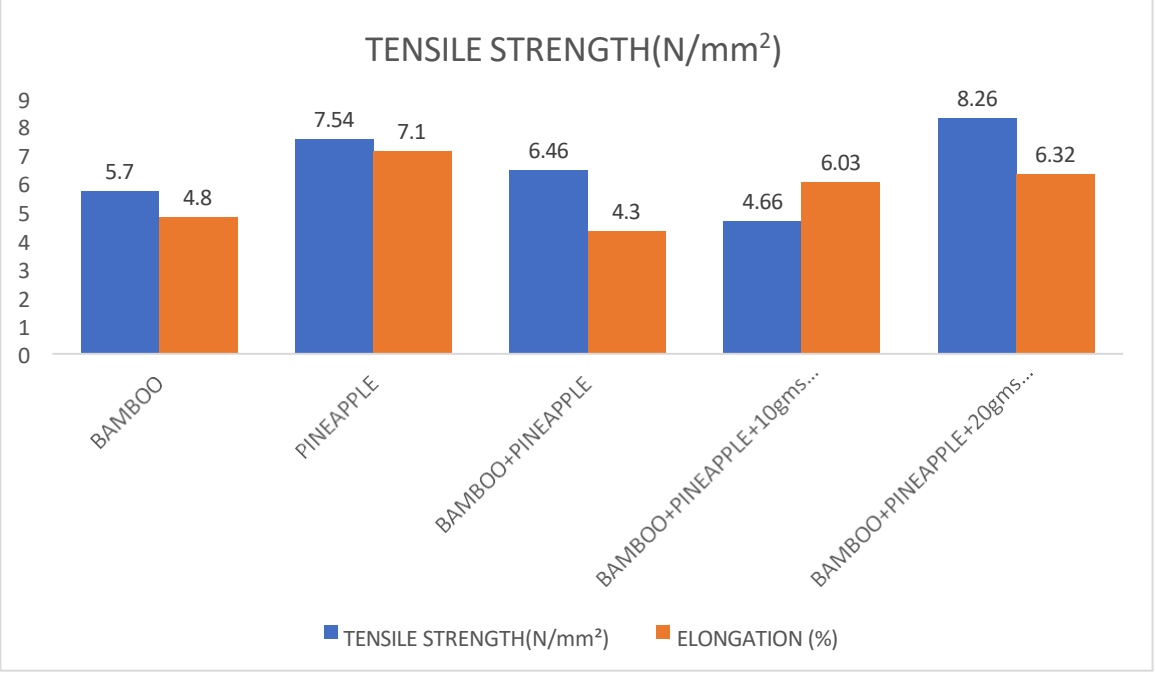


Figure 4.1 Tensile Test Result Graph

4.3 FLEXURAL STRENGTH

Creation and testing effectively finished in this task the flexural strength of plain woven bamboo, plain woven pineapple fibre, bamboo/pineapple fibre, bamboo/pineapple/natural powder10gms, bamboo/pineapple/natural powder 20gms. are manufactured by utilizing hand lay-up strategy. The flexural strength was determined basedheaccompanying connection.

Flexural stress S = $\frac{3PL}{2bt^2}$ (6)

Bamboo : $S = \frac{3\times1750\times70}{2\times25\times4\times4} = 459.75\ N/mm^2$

Pineapple : $S = \frac{3\times1625\times70}{2\times25\times4\times4} = 426.56\ N/mm^2$

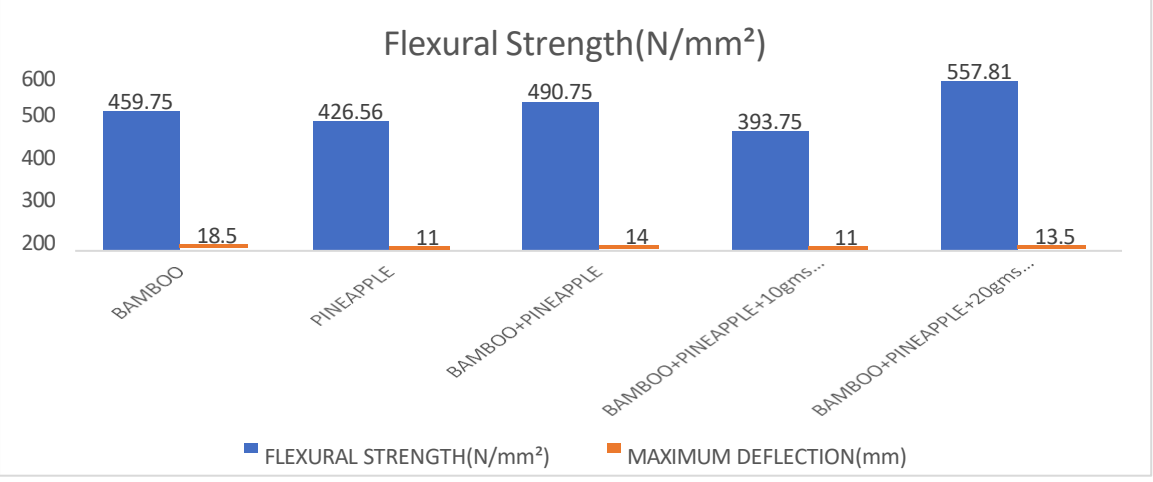
Bamboo + Pineapple : $S = \frac{3\times1875\times70}{2\times25\times4\times4} = 490.87\ N/mm^2$

Bamboo + Pineapple + A10 : $S = \frac{3\times1500\times70}{2\times25\times4\times4} = 393.75\ N/mm^2$

Bamboo + Pineapple + A20 : $S = \frac{3\times2125\times70}{2\times25\times4\times4} = 557.81\ N/mm^2$

Table: 4.3 Flexural testing results for 5 composites

S.NO	Composite	Load in N	Maximum Deflection in mm	Flexural strength in N/mm^2
1	B	1750	18.5	459.75
2	PA	1625	11	426.56
3	B+PA	1875	14	490.75
4	B+PA+A10	1500	11	393.75
5	B+PA+A20	2125	13.5	557.81



In light of the flexural strength at last presumed that Bamboo + Pineapple + Natural powder mixture epoxy composite have high f lexural strength contrasted with staying composite as displayed in figure 4.2

Figure 4.2 Flexural Test Result Graph

4.4 IMPACT STRENGTH

Manufacture and testing effectively finished in this venture I likewise centered around sway strength of plain woven bamboo, plain woven Pineapple fiber and bamboo/Pineapple, bamboo/Pineapple with Aggarbatti powder variety ,10%,20%, created by utilizing hand lay-up

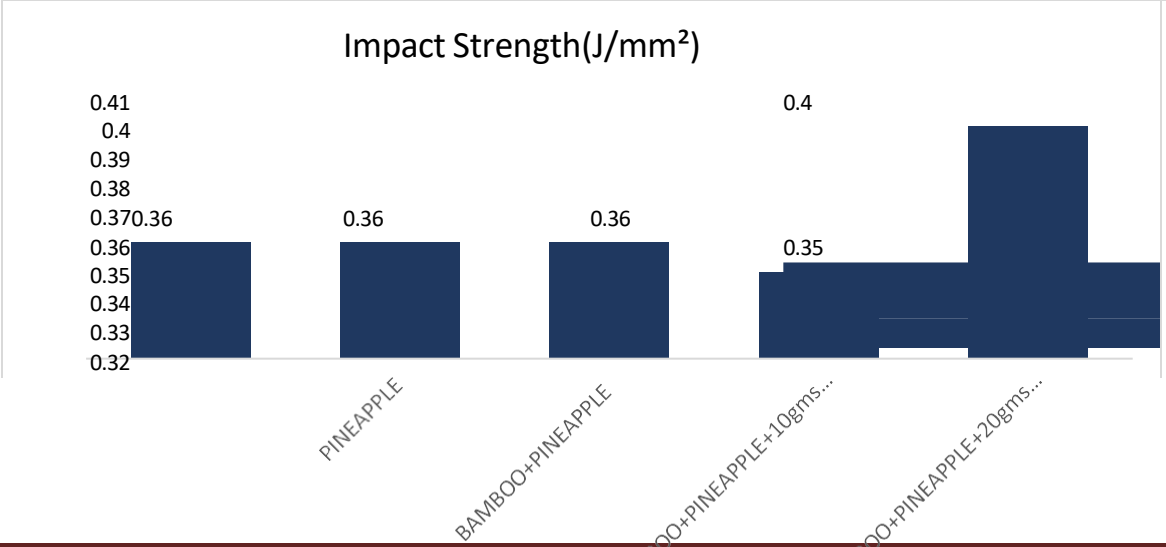
technique And at last closed the Bamboo + Pineapple half breed material have high effect strength contrasted with residual arrangements as displayed figure 4.4

$$\textbf{IMPACT STRENGTH} = \frac{\textit{IMPACT LOAD}}{\textit{AREA OF CROSS SECTION}} \textbf{J/mm}^2 \quad (7)$$

Bamboo	:	80/220 = 0.36
Pineapple	:	84/228 = 0.36
Bamboo+ Pineapple	:	86/228 = 0.36
Bamboo+Pineapple+A(10)	:	86/232 = 0.37
Bamboo+Pineapple+A(20)	:	82/232 = 0.4

Table: 4.4 after testing of impact test on all materials

S.NO	COMPOSITE	IMPACT TEST (J/mm²)
1.	B	0.36
2.	PA	0.36
3.	B+PA	0.36
4.	B+PA+A10	0.37
5.	B+PA+A20	0.4



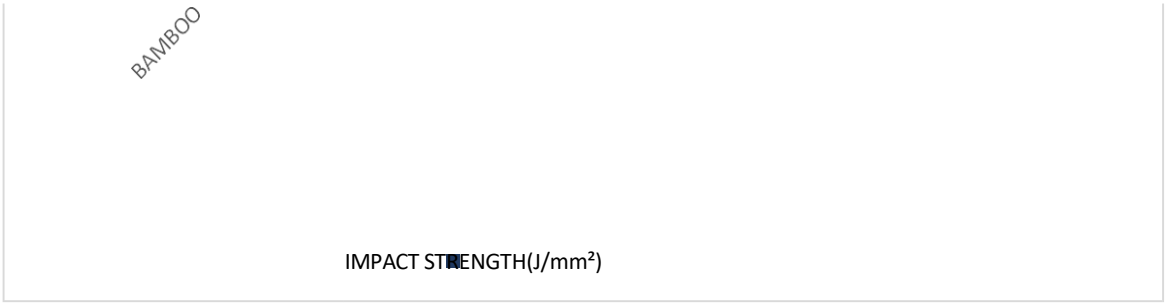


Figure 4.3 Impact Test Result Graph

4.5 HARDNESS NUMBER :

Brinell hardness values of these natural composites. Experiment give the bamboo / pineapple fibres/ natural powder maximum with 10% and 20% of hybrid bamboo fibre, pineapple fibre. Bamboo/pineapple fibre with agarbatti powder of 10% and bamboo/pineapple fibre with aggarbatti powder of 20% mixing composite.

Table 4.5 after testing of hardness test on all materials

S.no	COMPOSITE	HARDNESS
1.	B	38.32
2.	PA	34.33
3.	B+PA	38
4.	B+PA+A10	94.66
5.	B+PA+A20	49.66

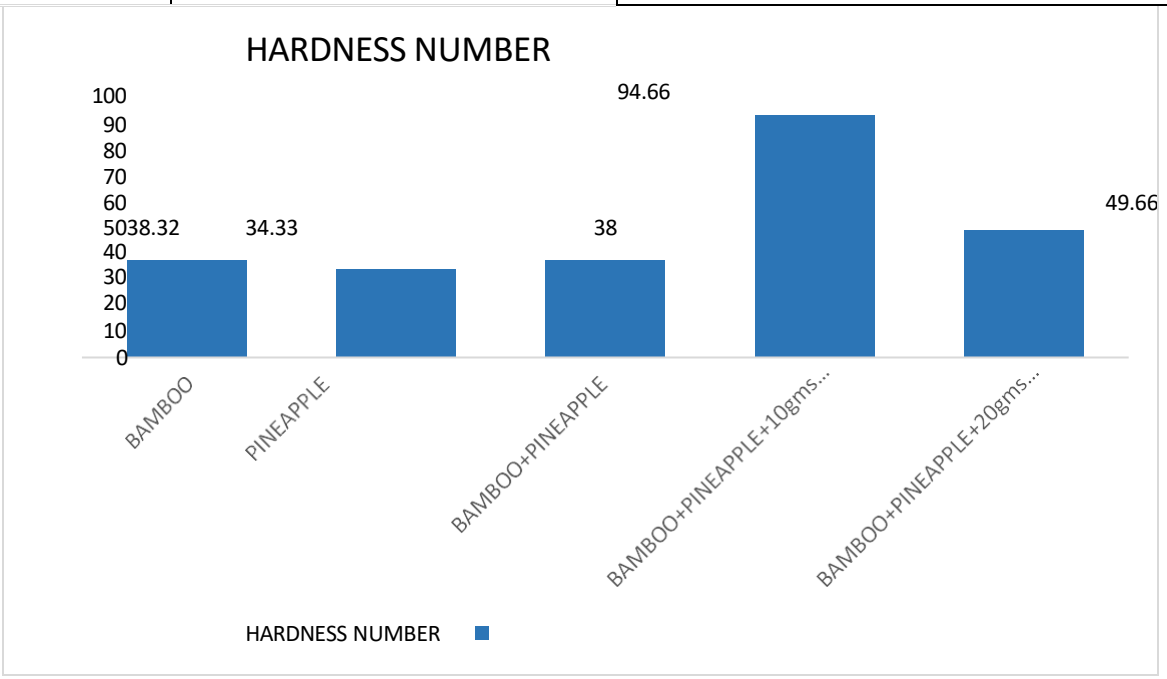


Figure 4.4 Hardness Test Result Graph

Table 5 after testing of hardness test on all materials

Brinell hardness vs. experiment number graph of the composite. Figure 4.4 reveals the graph indicating

Brinell hardness values corresponding to the experiment number. The graph shows, experiment with Bamboo/pineapple fibers and agarbatti powder gives the higher value of Brinell hardness.

CHAPTER 5 CONCLUSION & FUTURE SCOPE

5.1 CONCLUSION

The current work has been finished with a target to investigate the utilization of plain woven bamboo, plain woven Pineapple fiber and bamboo/Pineapple, bamboo/Pineapple with Agarbatti Powder power variety,10%, 20%, are produced utilizing hand lay-up strategy. Epoxy is utilized as network in the supported composite. What's more, researched the mechanical properties like pliable, flexure, effect of composites.

This work is engaged to track down the best composite amomg the five blends. After every one of the tests has performed on the speciemens the bamboo/Pineapple shows a best outcome in the elasticity and just as effect strength. What's more, the effect strength and elasticity of bamboo/pineapple with agarbatti powder 10g composite is close to bamboo/Pineapple composite

The flexural strength is high in the Bamboo+ Pineapple of cross breed material have high flexural strength contrasted with staying composite. Furthermore, this fibers having a second most noteworthy flexural strength contrasted with staying composite.

This handlayup technique is done carefully because of this material , the agarbatti powder gives a strength to the composite and that mixture is calculated before it mix up. The mat of bamboo and pineapple fiber is cut in specified dimensions of 200 x 200. Epoxy resin was mix in the ration of 1:10 by using hardener, after bamboo ,pineapple ,bamboo+pineapple fiber mix composite. Now we can add the powder to the mix fiber to get a high strength to the composite material.

5.2 Future scope

The expansion of this postulation work should be possible by thinking about the accompanying focuses:

- The fiber can likewise take as powder to create the example which may expands the strength.
- Different type reins can be utilized to track down the mechanical properties like strength, wear obstruction
- By thinking about various cycle boundary and various composites which works on the properties of composites.

CHAPTER 6 REFERENCE

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