Design and Analysis of Helmet Using Palmyra Fiber

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Abstract - *Natural fiber reinforced composites is an emerging area in polymer science. These natural fibers are low cost fibers with low density and high specific properties. These are biodegradable and non-abrasive. The natural fiber composites offer specific properties comparable to those of conventional fiber composites. However, in development of these composites, the incompatibility of the fibers and poor resistance to moisture often reduce the potential of natural fibers and these draw backs become critical issue. This review presents the reported work on natural fiber reinforced composites with special reference to the type of fibers, matrix polymers, treatment of fibers and fiber-matrix interface.*

1. INTRODUCTION

A composite material is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure.
The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials. More recently, researchers have also begun to actively include sensing, actuation, computation and communication into composites, which are known as Robotic Materials.
Typical engineered composite materials include:

- mortars, concrete
- Reinforced plastics, such as fibre-reinforced polymer
- Metal composites
- Ceramic composites (composite ceramic and metal matrices)Composite materials are generally used for buildings, bridges, and structures such as boat hulls, swimming pool panels, racing car bodies, shower stalls, bathtubs, storage tanks, imitation granite and cultured marble sinks and countertops. The most advanced examples perform routinely on spacecraft and aircraft in demanding environments.

1.1 Materials

Concrete is the most common artificial composite material of all and typically consists of loose stones held with a matrix of cement. Concrete is an inexpensive material, and will not compress or shatter even under quite a large compressive force. However, concrete cannot survive tensile loading(i.e., if stretched it will quickly break apart). Therefore, to give concrete the ability to resist being stretched, steel bars, which can resist high stretching forces, are often added to concrete to form reinforced concrete.

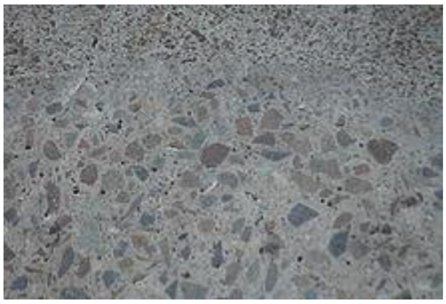

Fig.1.1 Concrete is a mixture of cement and aggregate, giving a robust, strong material that is very widely used.

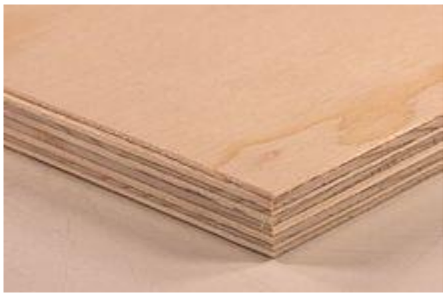

Fig.1.2 Plywood is used widely in construction

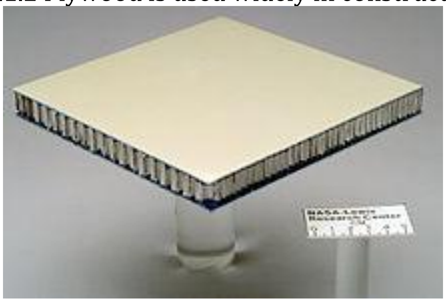

Fig.1.3 Composite sandwich structure panel used for testing at NASA

Fibre-reinforced polymers include carbon-fibre-reinforced polymer and glass-reinforced plastic. If classified by matrix then there are thermoplastic composites, short fibre thermoplastics, long fibre thermoplastics or long fibre-reinforced thermoplastics. There are numerous thermoset composites, including paper composite panels. Many advanced thermoset polymer matrix systems usually incorporate aramid fibre and carbon fibre in an epoxy resin matrix.

Shape memory polymer composites are high-performance composites, formulated using fibre or fabric reinforcement and shape memory polymer resin as the matrix. Since a shape memory polymer resin is used as the matrix, these composites have the ability to be easily manipulated into various configurations when they are heated above their activation temperatures and will exhibit high strength and stiffness at lower temperatures. They can also be reheated and reshaped repeatedly without losing their material properties. These composites are ideal for applications such as lightweight, rigid, deployable structures; rapid manufacturing; and dynamic reinforcement.

High strain composites are another type of high-performance composites that are designed to perform in a high deformation setting and are often used in deployable systems where structural flexing is advantageous. Although high strain composites exhibit many similarities to shape memory polymers, their performance is generally dependent on the fibre layout as opposed to the resin content of the matrix.

Composites can also use metal fibres reinforcing other metals, as in metal matrix composites or ceramic matrix composites, which includes bone, cermet and concrete. Ceramic matrix composites are built primarily for fracture toughness, not for strength. Another class of composite materials involve woven fabric composite consisting of longitudinal and transverse laced yarns. Woven fabric composites are flexible as they are in form of fabric.

Organic matrix/ceramic aggregate composites include asphalt concrete, polymer concrete, mastic asphalt, mastic roller hybrid, dental composite, syntactic foam and mother of pearl mother of pearl. Chobham armour is a special type of composite armour used in military applications.

Additionally, thermoplastic composite materials can be formulated with specific metal powders resulting in materials with a density range from 2 g/cm^3 to 11 g/cm^3 (same density as lead). The most common name for this type of material is high gravity compound, although "lead replacement" is also used. These materials can be used in place of traditional materials such as aluminium, stainless steel, brass, bronze, copper, lead, and even tungsten in weighting, balancing (for example, modifying the centre of gravity of a tennis racquet), vibration damping, and radiation shielding applications. High density composites are an economically viable option when certain materials are deemed hazardous and are banned or when secondary operations costs are a factor.

A sandwich-structured composite is a special class of composite material that is fabricated by attaching two thin but stiff skins to a lightweight but thick core. The core material is normally low strength material, but its higher thickness provides the sandwich composite with high bending stiffness with overall low density.

Wood is a naturally occurring composite comprising cellulose fibres in a lignin and hemicellulose matrix. Ensgineered wood includes a wide variety of different products such as wood fibre board, plywood, oriented strand board, wood plastic composite, Plastic-impregnated or laminated paper or textiles, Arborite, Formica (plastic) and Micarta. Other engineered laminate composites, such as Mallite, use a central core of end grain balsa wood, bonded to surface skins of light alloy or GRP. These generate low-weight, high rigidity materials.

Particulate composites have particle as filler material dispersed in matrix, which may be nonmetal, such as glass, epoxy. Automobile tire is an example of particulate composite. Advanced diamond-like carbon coated polymer composites have been reported[6] where the coating increases the surface hydrophobicity, hardness and wear resistance.

1.2 PRODUCTS

Fibre-reinforced composite materials have gained popularity in high-performance products that need to be lightweight, yet strong enough to take harsh loading conditions such as aerospace components, boat and scull hulls, bicycle frames and racing car bodies. Other uses include fishing rods, storage tanks, swimming pool panels, and baseball bats. The new Boeing 787 structure including the wings and fuselage is composed largely of composites. Composite materials are also becoming more common in the realm of orthopedic surgery. And it is the most common hockey stick material.

Carbon composite is a key material in today's launch vehicles and heat shields for the re-entry phase of spacecraft. It is widely used in solar panel substrates, antenna reflectors and yokes of spacecraft. It is also used in payload adapters, inter-stage structures and heat shields of launch vehicles. Furthermore, disk brake systems of airplanes and racing cars are using carbon/carbon material, and the composite material with carbon fibres and silicon carbide matrix has been introduced in luxury vehicles and sports cars. In a fibre-reinforced composite pool panel was introduced for in-ground swimming pools, residential as well as commercial, as a non-corrosive alternative to galvanized steel.

In 2007, an all-composite military Humvee was introduced by TPI Composites Inc and Armor Holdings Inc, the first all-composite military vehicle. By using composites the vehicle is lighter, allowing higher payloads. In 2008, carbon fibre and DuPont Kevlar (five times stronger than steel) were combined with enhanced thermoset resins to make military transit cases by ECS Composites creating 30-percent lighter cases with high strength.

Pipes and fittings for various purpose like transportation of potable water, fire-fighting, irrigation, seawater, desalinated water, chemical and industrial waste, and sewage are now manufactured in glass reinforced plastics.

1.3. OVERVIEW

Composites are made up of individual materials referred to as constituent materials. There are two main categories of constituent materials: matrix and reinforcement. At least one portion of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combination.Do not use abbreviations in the title or heads unless they are unavoidable.

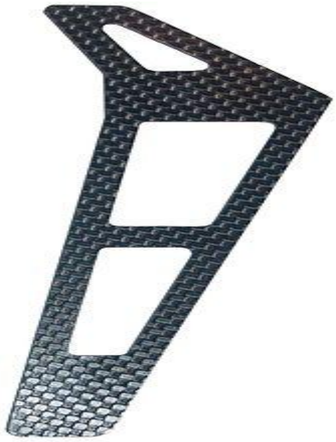

Fig. 1.3 Carbon fibre composite part.

Engineered composite materials must be formed to shape. The matrix material can be introduced to the reinforcement before or after the reinforcement material is placed into the mould cavity or onto the mould surface. The matrix material experiences a melding event, after which the part shape is essentially set. Depending upon the nature of the matrix material, this melding event can occur in various ways such as chemical polymerization for a thermoset polymer matrix, or solidification from the melted state for a thermoplastic polymer matrix composite.

A variety of moulding methods can be used according to the end-item design requirements. The principal factors impacting the methodology are the natures of the chosen matrix and reinforcement materials. Another important factor is the gross quantity of material to be produced. Large quantities can be used to justify high capital expenditures for rapid and automated manufacturing technology. Small production quantities are accommodated with lower capital expenditures but higher labour and tooling costs at a correspondingly slower rate.

Many commercially produced composites use a polymer matrix material often called a resin solution. There are many different polymers available depending upon the starting raw ingredients. There are several broad categories, each with numerous variations. The most common are known as polyester, vinyl ester, epoxy, phenolic, polyimide, polyamide, polypropylene, PEEK, and others. The reinforcement materials are often fibres but also commonly ground minerals. The various methods described below have been developed to reduce the resin content of the final product, or the fibre content is increased. As a rule of thumb, lay up results in a product containing 60% resin and 40% fibre, whereas vacuum infusion gives a final product with 40% resin and 60% fibre content. The strength of the product is greatly dependent on this ratio. Martin Hubbe and Lucian A Lucia consider wood to be a natural composite of cellulose fibres in a matrix of lignin.

1.4 CONSTITUENTS

Polymers are common matrices. Road surfaces are often made from asphalt concrete which uses bitumen as a matrix. Mud has seen extensive use. Typically, most common polymer-based composite materials, including fibreglass, carbon fibre, and Kevlar, include at least two parts, the substrate and the resin.

Polyester resin tends to have yellowish tint, and is suitable for most backyard projects. Its weaknesses are that it is UV sensitive and can tend to degrade over time, and thus generally is also coated to help preserve it. It is often used in the making of surfboards and for marine applications. Its hardener is a peroxide, often MEKP (methyl ethyl ketone peroxide). When the peroxide is mixed with the resin, it decomposes to generate free radicals, which initiate the curing reaction. Hardeners in these systems are commonly called catalysts, but since they do not re-appear unchanged at the end of the reaction, they do not fit the strictest chemical definition of a catalyst.

Vinylester resin tends to have a purplish to bluish to greenish tint. This resin has lower viscosity than polyester resin, and is more transparent. This resin is often billed as being fuel resistant, but will melt in contact with gasoline. This resin tends to be more resistant over time to degradation than polyester resin, and is more flexible. It uses the same hardeners as polyester resin and the cost is approximately the same. Epoxy resin is almost totally transparent when cured. In the aerospace industry, epoxy is used as a structural matrix material or as a structural glue.

Shape memory polymer resins have varying visual characteristics depending on their formulation. These resins may be epoxy-based, which can be used for auto body and outdoor equipment repairs; cyanate-ester-based, which are used in space applications; and acrylate-based, which can be used in very cold temperature applications, such as for sensors that indicate whether perishable goods have warmed above a certain maximum temperature. These resins are unique in that their shape can be repeatedly changed by heating above their glass transition temperature. When heated, they become flexible and elastic, allowing for easy configuration. Once they are cooled, they will maintain their new shape. The resins will return to their original shapes when they are reheated above their Tg. The advantage of shape memory polymer resins is that they can be shaped and reshaped repeatedly without losing their material properties. These resins can be used in fabricating shape memory composites. Traditional materials such as glues, muds have traditionally been used as matrices for papier-mâché and adobe.

1.5 INORGANIC

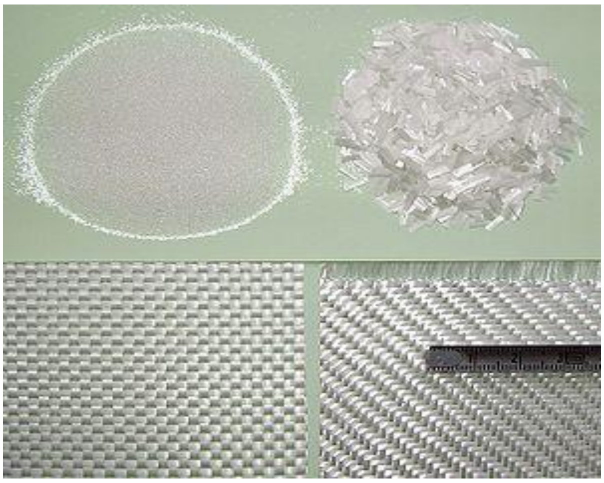

Fig. 1.5 Reinforcements Fibre

Cement, metals, ceramics, and sometimes glasses are employed. Unusual matrices such as ice a Differences in the way the fibres are laid out give different strengths and ease of manufacture. Reinforcement usually adds rigidity and greatly impedes crack propagation. Thin fibres can have very high strength, and provided they are mechanically well attached to the matrix they can greatly improve the composite's overall properties.

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

The short and long fibres are typically employed in compression moulding and sheet moulding operations. These come in the form of flakes, chips, and random mate. Common fibres used for reinforcement include glass fibres, carbon fibres, cellulose and high strength polymers for example aramid. Silicon carbide fibres are used for some high temperature applications. Concrete uses aggregate, and reinforced concrete additionally uses steel bars to tension the concrete. Steel mesh or wires are also used in some glass and plastic products.

Many composite layup designs also include a co-curing or post-curing of the prepreg with various other media, such as honeycomb or foam. This is commonly called a sandwich structure. This is a more common layup for the manufacture of radomes, doors, cowlings, or non-structural parts.

Open- and closed-cell-structured foams like polyvinylchloride, polyurethane, polyethylene or polystyrene foams, balsa wood, syntactic foams, and honeycombs are commonly used core materials. Open- and closed-cell metal foam can also be used as core materials. Recently, 3D graphene structures have also been employed as core structures. A recent review by Khurram and Xu et al., have provided the summary of the state-of-the-art techniques for fabrication of the 3D structure of graphene, and the examples of the use of these foam like structures as a core for their respective polymer composites.[9]

1.6 FABRICATION METHODS

Fabrication of composite materials is accomplished by a wide variety of techniques, including:

- Advanced fibre placement (Automated fibre placement)
- Tailored fibre placement
- fibreglass spray lay-up process
- Filament winding
- Lanxide process
- Tufting
- Z-pinning

Composite fabrication usually involves wetting, mixing or saturating the reinforcement with the matrix, and then causing the matrix to bind together (with heat or a chemical reaction) into a rigid structure. The operation is usually[citation needed] done in an open or closed forming mold, but the order and ways of introducing the ingredients varies considerably.

1.7 MOLD OVERVIEW

Within a mold, the reinforcing and matrix materials are combined, compacted, and cured to undergo a melding event. After the melding event, the part shape is essentially set, although it can deform under certain process conditions. For a thermoset polymer matrix material, the melding event is a curing reaction that is initiated by the application of additional heat or chemical reactivity such as an organic peroxide. For a thermoplastic polymeric matrix material, the melding event is a solidification from the melted state. For a metal matrix material such as titanium foil, the melding event is a fusing at high pressure and a temperature near the melting point.

For many moulding methods, it is convenient to refer to one mould piece as a "lower" mould and another mould piece as an "upper" mould. Lower and upper refer to the different faces of the moulded panel, not the mould's configuration in space. In this convention, there is always a lower mould, and sometimes an upper mould. Part construction begins by applying materials to the lower mould. Lower mould and upper mould are more generalized descriptors than more common and specific terms such as male side, female side, a-side, b-side, tool side, bowl, hat, mandrel, etc. Continuous manufacturing uses a different nomenclature.

The moulded product is often referred to as a panel. For certain geometries and material combinations, it can be referred to as a casting. For certain continuous processes, it can be referred to as a profile.

1.8 VACCUM BAG MOULDING

Vacuum bag moulding uses a flexible film to enclose the part and seal it from outside air. Vacuum bag material is available in a tube shape or a sheet of material. A vacuum is then drawn on the vacuum bag and atmospheric pressure compresses the part during the cure. When a tube shaped bag is used, the entire part can be enclosed within the bag. When using sheet bagging materials, the edges of the vacuum bag are sealed against the edges of the mould surface to enclose the part against an air-tight mould. When bagged in this way, the lower mold is a rigid structure and the upper surface of the part is formed by the flexible membrane vacuum bag. The flexible membrane can be a reusable silicone material or an extruded polymer film. After sealing the part inside the vacuum bag, a vacuum is drawn on the part during cure. This process can be performed at either ambient or elevated temperature with ambient atmospheric pressure acting upon the vacuum bag. A vacuum pump is typically used to draw a vacuum. An economical method of drawing a vacuum is with a venturi vacuum and air compressor.
A vacuum bag is a bag made of strong rubber-coated fabric or a polymer film used to compress the part during cure or hardening. In some applications the bag encloses the entire material, or in other applications a mold is used to form one face of the laminate with the bag being a single layer to seal to the outer edge of the mold face. When using a tube shaped bag, the ends of the bag are sealed and the air is drawn out of the bag through a nipple using a vacuum pump. As a result, uniform pressure approaching one atmosphere is applied to the surfaces of the object inside the bag, holding parts together while the adhesive cures. The entire bag may be placed in a temperature-controlled oven, oil bath or water bath and gently heated to accelerate curing.
Vacuum bagging is widely used in the composites industry as well. Carbon fibre fabric and fibreglass, along with resins and epoxies are common materials laminated together with a vacuum bag operation..
Typically, polyurethane or vinyl materials are used to make the bag. A tube shaped bag is open at both ends. The piece, or pieces to be glued are placed into the bag and the ends sealed. One method of sealing the open ends of the bag is by placing a clamp on each end of the bag. A plastic rod is laid across the end of the bag, the bag is then folded over the rod. A plastic sleeve with an opening in it, is then snapped over the rod. This procedure forms a seal at both ends of the bag, when the vacuum is ready to be drawn.
A platen is sometimes used inside the bag for the piece being glued to lie on. The platen has a series of small slots cut into it, to allow the air under it to be evacuated. The platen must have rounded edges and corners to prevent the vacuum from tearing the bag.
When a curved part is to be glued in a vacuum bag, it is important that the pieces being glued be placed over a solidly built form, or have an air bladder placed under the form. This air bladder has access to free air outside the bag. It is used to create an equal pressure under the form, preventing it from being crushed.

1.9 PRESSURE BAG MOULDING

This process is related to vacuum bag molding in exactly the same way as it sounds. A solid female mold is used along with a flexible male mold. The reinforcement is placed inside the female mold with just enough resin to allow the fabric to stick in place. A measured amount of resin is then liberally brushed indiscriminately into the mold and the mold is then clamped to a machine that contains the male flexible mold.ss The flexible male membrane is then inflated with heated compressed air or possibly steam. The female mold can also be heated. Excess resin is forced out along with trapped air. This process is extensively used in the production of composite helmets due to the lower cost of unskilled labor. Cycle times for a helmet bag moulding machine vary from 20 to 45 minutes, but the finished shells require no further curing if the molds are heated.

1.10 AUTOCLAVE MOULDING

A process using a two-sided mould set that forms both surfaces of the panel. On the lower side is a rigid mould and on the upper side is a flexible membrane made from silicone or an extruded polymer film such as nylon. Reinforcement materials can be placed manually or robotically. They include continuous fibre forms fashioned into textile constructions. Most often, they are pre-impregnated with the resin in the form of prepreg fabrics or unidirectional tapes. In some instances, a resin film is placed upon the lower mould and dry reinforcement is placed above. The upper mould is installed and vacuum is applied to the mould cavity. The assembly is placed into an autoclave. This process is generally performed at both elevated pressure and elevated temperature. The use of elevated pressure facilitates a high fibre volume fraction and low void content for maximum structural efficiency.

1.11 RESIN TRANSFER MOULDING (RTM)

RTM is a process using a rigid two-sided mould set that forms both surfaces of the panel. The mould is typically constructed from aluminum or steel, but composite molds are sometimes used. The two sides fit together to produce a mould cavity. The distinguishing feature of resin transfer moulding is that the reinforcement materials are placed into this cavity and the mould set is closed prior to the introduction of matrix material. Resin transfer moulding includes numerous varieties which differ in the mechanics of how the resin is introduced to the reinforcement in the mould cavity. These variations include everything from the RTM methods used in out of autoclave composite manufacturing for high-tech aerospace components to vacuum infusion to vacuum assisted resin transfer moulding. This process can be performed at either ambient or elevated temperature.

2.1. NATURAL FIBERS

The natural fibers being used from centuries, they began to replace synthetic fibers in recent years. Natural fibers are helpful in the sustainable development of society [1] .The natural fibers possess characteristics that are comparable to conventional materials. Properties like light weight, low material cost, renewability and being environment friendly are most important properties of fibers which make them to use in the engineering applications [2]. Rafia Akter mentioned that, the use of natural fibers in the composite is increasing day by day. Natural fibers increase the biodegradability of composites, reduce the cost and decrease the pollution [3]. D. Chandramohan[4] stated that, the natural fibers are renewable, cheap, easily recyclable, bio degradable and they can be used as reinforcing fibers in the composites. Anna Kicinska- Jakubowska [5] stated that, the natural fibers are considered as the most important part of the human environment, they are used as textile and non textile production. The new applications are being discovered day by day. M.Sakthive [6] mentioned that, the natural fibers have additional advantages when compared to the synthetic conventional fibers; they are renewable raw materials and have relatively high strength, low density, and low specific mass.

The natural fibers can be grown easily in tropical countries. Tara Sen stressed the use of locally available materials for sustainable development [7] . Besides improving the strength of the structure using FRPs as the raw material, it is also necessary to make use of local materials in construction. So far the construction work, retrofitting of structures is confined to using of carbon, glass or aramid fibres etc, very little work is being imparted in improving structures using naturally available materials, or natural fibres. It is necessary to use locally available materials in preparing the engineering structures. The natural fibers are easily available in every place, it is important to use the natural fibers in preparing composites. G.Bogoeva-Gaceva explained the problems of pollution, [8] one of the most important problems, which is to be addressed immediately is that, the pollution from plastic waste. The tremendous use of the plastic in every stage of life increased the huge plastic waste. Now lot many researchers have focused on eco friendly composites that can be degraded easily. N. Cordeiroa explained the importance of natural fibers [9], the biodegradability of natural fibers contributes to healthier ecosystem, the renewability, low cost and their reasonable engineering properties are attracting to use the natural fibers in automotive industry. Scott W. Beckwith explained the advantages of natural fibers [10]. The natural fibers have many advantages over synthetic fibers, the natural fibers have 30-50 % lower density as compare to the glass fibers. The stiffness can also be higher than or equal to the E-glass fibers. C. Santulli tried to find out the alternative materials to glass fibers [11].

The cellulose fibers like coir can replace the glass fibers for reinforcing the composite laminates, like the glass fibers, the natural fibers have the crash worthiness and the cellulose fibers have more weight reduction than the glass fibers. Yasser et al. [12] noted that, development of friendly materials based on blends contain major constituent of natural polymers is a continuing area of challenge for food packaging and coating technology.

2.2. CHEMICAL COMPOSITION AND STRUCTURE OF NATURAL FIBERS

In order to maximize the exploration of the non–wood fibers a complete understanding is required of its chemistry, chemical composition and structure [13]. The chemical composition and cell structure of natural fibers are quite complicated [14].The single fiber itself is a composite material consisting cellulose, hemicelluloses and lignin with minor amounts of sugars, starch proteins etc, it is a three dimensional bio polymer. The performance of the natural fiber depends on several factors like the chemical composition, physical properties [15].The mechanical properties reflect the orientation of the micro fibrils to the cell axis. There exists a strong correlation between micro fibril angle and young's modulus of the fiber [16]. The variability of the properties of natural fibers is so high, even with the same plant fibers collected from various parts of the plant will show different properties [17]. The micro fibrils are made of cellulose and have three dimension arrangements; the micro fibrils are arranged in three dimensional network, which consists of mainly cellulose [18].

The cross section is non uniform throughout their length and diameter of fiber shows significant variability in fiber bundle [19]. M.Waikambo found that the properties of natural fibers are dictated by the crystalline packing order, amorphous content and the chemical composition [20] .The micro fibrils contribute strength to the fiber [21].

2.3. SPECTROSCOPY

Natural fibers are widely used as plastic composite reinforcements [22]. The natural materials are renowned for their strength and toughness [23]. The development of new fibrous composites with specific properties has attracted a big interest in the development of new technologies [24]. The FTIR spectroscopy can be used to confirm the results obtained by the conventional methods. The results obtained by WPG (weight Percent gain), TGA (thermo gravimetric analysis) can be verified by the spectroscopic techniques [25]. Both methods FTIR and Raman spectroscopy are suitable for analysis of the structure of the natural fibers [26] .The photo electron spectroscopy can be used to study the chemical composition of material [27]. The Raman spectroscopy can be used to study the fiber in nano scale, the chain orientation, inter chain distances can be found accurately [28]. The SEM and X –ray diffractometer is helpful to find the morphology, percentage of crystallinity and thermal stability of a natural fiber [29].

The physical properties like fiber diameter can be found by Near-Infrared Spectroscopy [30].The spectroscopy were carried out in this work by FTIR and Raman method. These methods have been variously applied for the study of natural fibers. Spectroscopic approaches have been widely used to distinguish the wide varieties of natural fibers. The spectroscopic study can be used to differentiate the chemically similar fibers [31]. Spectroscopic technique requires a minimal amount of sample preparation and is easy to operate. It allows the sample to examine both at laboratory and on field environments. Spectroscopic technique can also be applied to know the maturity of the natural fiber [32].

Raman and IR spectroscopes are on vibrational modes, they are regarded as complementary to each other [33]. The FT I R means, Fourier Transform Infra – Red. It is a suitable method of Infrared spectroscopy. IR radiation will be allowed to pass through the sample, of which some radiation will be absorbed by the material and remaining will be sent back to the transmitter. The resulting IR spectrum represents the finger print of the material [34]. The Fourier transform infrared FTIR spectroscopy was carried out to qualitative identify the constituents of the natural fiber [35] FTIR allows the measurement of constituents of the natural fiber, FTIR spectra was principally observed in between 400 to 4000 cm -1 range. FT IR spectroscopy is used to know the effect of chemical treatment on a natural fiber [37]. FTIR experimental analysis shows the presence of chemical and chemical bonds in the natural fibers [38] Super molecular level of natural fiber investigated with FTIR mainly focused on the hydrogen bonding, crystallinity measurement and cellulose I and II measurement Molecular orientation is one of the most important parameters, affecting the physical properties of molecular system. There are number of methods to find Crystallinity of the cellulose, like XRD, Solid State 13 C NMR, Infrared IR spectroscopy and Raman spectroscopy. Among these techniques the FTIR Spectroscopy is the simplest one [39].

2.4. FIBER SEM

The inspection with manual vision system is costly and time consuming process. Gravimetric mechanical model of removing foreign particles is also costly and less efficient because of more mechanical components [41]. HIS (hue, saturation and intensity) and lumina component, Cb blue difference and Cr Red difference) are the efficient ways of finding the foreign contaminants in the cotton fiber bundles by using image analysis[42].The structure of the natural fiber is complex and confusing. The fibers cover a wide range of sizes, shapes, morphology and internal pores. The study of pores on natural fibers by using 3 D image analysis gives the efficient conclusion and with this the thermal conductivity of the natural fibers can be calculated accurately[43].

Understanding of the basic mechanical properties of natural fibers is important before they are used in making composites. Electron microscopy image analysis is largely feasible to analyze the geometrical data available in the images of the large number of individual fibers in lesser time [44]. SEM (Scanning Electron Microscope) is a modern, fundamental and well suited investigative tool in the characterization of micro – and nano structured materials. 2D visualization of the natural fiber can provide qualitative and quantitative information on any physical parameters like size, morphology, surface texture, roughness [45].

The surface morphology of the plant fibers has been recognized as significant factor for composite interfaces. The surface morphology is changed by the application of Electron beam irradiation [46]. The chemical and special information can be simultaneously obtained by combining light microscopy with infrared spectrometer. The image analysis allows the micro examination of FRP composites. The resin distribution on the fibers and the free surface area due to hygroscopic behavior are most important in the study of the composite materials [47].It is possible to determine the geometrical parameters such as shape of fibers, thickness of cell walls, and the orientation can be studied with the help of image analysis [48]. The fiber should be distributed evenly in the composite while fabricating the composite. In the composite material the distribution of the fiber in resin can be studied with the image analysis [49]. The average diameter of fiber is required to know the performance of the fiber, to price it. Optical fiber diameter Analyzer OFDA is introduced to assess the fiber diameter. The OFDA gives the fiber diameter rapidly and accurately [50].The morphology of the materials used to fabricate or make the composites can be found with the image analysis. The fracture analysis can also be done with image analysis of broken resin and fibers [51]. Raman spectroscopy offers a non destructive technique to identify the plant fiber. The Raman spectroscopy can be used to analyze the fiber and compare the fiber [52]. The spectroscopic analysis confirmed that the chemical treatment improves few specific properties to the fibers [53]. The natural plant fibers can replace the conventional synthetic fibers; natural fibers can be used in automotive, transportation construction and packaging industry [54]. The natural fiber has lot of viabilities in its composition and structure by its inherent nature. There is also variability caused by the experimental testing methods [55]. The natural fibers have their own properties. All the properties can't be improved because of their nature. Fiber has variable properties depending on the region in which they are grown.

The fiber structure influences the strength of the fiber. Like synthetic fibers, the natural fibers are not in cylinder shape along their length, rather it is a cone. The scanning electron microscope SEM is an excellent technique to take the images for the examination of the surface morphology. Scanning electron microscopic (SEM) provides an excellent technique for the study of surface morphology of raw and chemically modified fibers, the image analysis is an important tool, the accuracy can be increased significantly by using image analysis.. Tensile strength of the natural fiber depends on its length, as length increases the tensile strength decreases. The leaf fibers show one similarity and the bast fibers show other similarity when the dependency of the diameter is examined on its tensile strength.

PROPERTIES OF COMPOSITES

3.1 HIGH STRENGTH TO WEIGHT RATIO

Fibre composites are extremely strong for their weight. By refining the laminate many characteristics can be enhanced. A common laminate of say 3mm Chopped strand mat, is quite flexible compared to say a 3 mm ply. However it will bend a long way more than the ply before yielding. Stiffness should not be confused with Strength. A carbon fibre laminate on the other hand, will have a stiffness of many times that of mild steel of the same thickness, increased ultimate strength, yet only be less than 1/4 of it's weight.

3.2 LIGHTWEIGHT

A standard Fibreglass laminate has a specific gravity in the region of 1.5, compared to Alloy of 2.7 or steel of 7.8. When you then start looking at Carbon laminates, strengths can be many times that of steel, but only a fraction of the weight. A DVD case lid was produced using carbon fibre to reduce the case's overall weight so that it could be carried as cabin baggage whilst traveling, and for improved security. It was used by support crew for the All Blacks during their 1999 Rugby World Cup campaign.

3.3 FIRE RESISTANCE

The ability for composites to withstand fire has been steadily improving over the years. There is two types of systems to be considered: Fire Retardant - Are self extinguishing laminates, usually made with chlorinated resins and additives such as Antimony trioxide. These release CO2 when burning so when the flame source is removed, the self extinguish. Fire Resistant - More difficult and made with the likes of Phenolic Resins. These are difficult to use, are cured with formaldehyde, and require a high degree of post curing to achieve true fire resistance. Other materials are also becoming more readily available to be used as in tumescent layers, which expand and blanket the surface, preventing spread of flame. There is a paint on coating usually applied to the back of the product laminate, plus a thin fibre film to go under the Gelcoat giving the outer surface a blanketing coat as well. Fibreglass Developments Ltd produces a Fire Door as part of our SteridorTM range. Use of special Phenolic resin has allowed us to create the only fully tested Composite door in Australasia. Fire rated by BRANZ to 4 hours, this door is also approved by MAF as meeting all their Hygiene requirements.

3.4 ELECTRICAL PROPERTIES

Fibreglass Developments Ltd produced the Insulator Support straps for the Tranz Rail main trunk electrification. The straps, although only 4mm thick, meet the required loads of 22kN, as well as easily meeting insulation requirements.

3.5 CHEMICAL & WEATHERING RESISTANCE

Composite products have good weathering properties and resist the attack of a wide range of chemicals. This depends almost entirely on the resin used in manufacture, but by careful selection resistance to all but the most extreme conditions can be achieved. Because of this, composites are used in the manufacture of chemical storage tanks, pipes, chimneys and ducts, boat hulls and vehicle bodies.

MATERIALS

- Palmyra fibre
- Jute
- Flax
- Ramie
- Sisal and Glass fibre, Steel fibre

REFERENCES

[1] Mallick P.K., Composite Engineering Handbook, 1997, Marcel Dekker Inc., Y, USA.

[2] Gill, R.M., 1973, Carbon Fibers in Composite Materials, Page Bros (Norwich) Ltd, England.

[3] Isaac M. Daniel, Emmanuel E. Gdoutos, Deformation and Failure of Composite Structures, Journal of Thermoplastic Composite Materials 2003; 16; 345.

[4] Jean-Marc Scanzi and Bruno Hilaire "All- Thermoplastic Composite Sandwich Panels – Part II: Modeling of Bending Behavior" Journal of Sandwich Structures and Materials 2004; 6; 423.

[5] Topdar, A. H. Sheikh and N. Dhang Finite Element Analysis of Composite and Sandwich Plates Using a Continuous Interlaminar Shear Stress Model P. Journal of Sandwich Structures and Materials 2003; 5; 207.

[6] Nirmal Saha, Amar Nath Banerjee, "Flexural behavior of unidirectional polyethylene-carbon fibers- PMMA hybrid composite laminates," J. App.Poly. Sci. vol.60, 1996, pp.139-142.

[7] Y.Li, K.J.Xian, C.L. Choy, Meili Guo, Zuoguang Zhang; "Compressive and flexural behavior of ultra-high-modulus polyethylene fiber and carbon fiber hybrid composites," Comp. Sci. & Tech., vol.59, 1999, pp. 13-18.

[8] Rohchoon Park, Jyongisk Jang; "Stacking Sequence effect of aramid- UHMPE hybrid composites by flexural test method," Polymer Testing, vol. 16, 1997, pp. 549-562.

[9] Robert Matteson and Roger Crane, "Flexural testing of steel wire composite beams made with Hardwire unidirectional tape,"NSWCCD-65-TR-2003/48 Nov. 2003 (NASA Technical Report).