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RESEARCH ARTICLE

DESIGN AND FABRICATION OF TWO WHEELER MUD GUARD USING HYBRID COMPOSITE MATERIALS

[1,*]Kannan, S., [2]hema Prasanth, P., [3]Karthik, G., [4]Naveen, E.J. and [5]Sathya Kumar, A.

[1]Faculty of Mechanical Engineering, VEL TECH-Avadi, Chennai-600062, Tamil Nadu, India
[2345]UG Scholar VEL TECH-Avadi, Chennai-600062, Tamil Nadu, India

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ABSTRACT

Composite are produced when two materials are joined to give a combination of properties that cannot be attained in the original materials. Composite materials are widely used nowadays in various fields due to their unique property in weight. Reduction, High strength and rigidity and low cost. In the present communication it deals with fabrication and investigation by hybrid natural composite made from bamboo and aloe Vera fiber as reinforcement with epoxy resins as matrix. The objective is to evaluate the mechanical properties such as tensile strength, flexural test and impact strength and to utilise this composite in real life application example field of manufacturing mudguard to produce advanced properties. It includes five layers of fiber and matrix, here fibers includes 3 layers of glass fiber to increase strength. The process is done by hand layup method.

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INTRODUCTION

The composite materials have received a special attention in the last years, because have unusual properties, sometimes unique, which could lead in different applications in technology domain. Their properties depend on the particle size and therefore the dispersion level of composite particles is a factor that affecting the composite properties. Composites or composite materials are available in nature or engineered fusing two or more materials with considerably different chemical and physical properties which remain distinct at microscopic or macroscopic level within the finished structure.

The constituent material is basically of two categories: Reinforcement and matrix, the matrix supports the reinforcement against mechanical and environmental damage by surrounding and maintaining their relative position, while the reinforcement bestow physical properties and special mechanical such as dielectric, strength, stiffness etc. Metallic oxides and metals in epoxy and other resins prove to be quite effective in providing those characteristics as they (the composites) have good thermal conductivity of the fillers thus increasing their applications in the field of electronics.

Corresponding author: **Kannan, S.,**
Faculty of Mechanical Engineering, Vel Tech-Avadi, Chennai-600062, Tamil Nadu, India.

Types of composite materials: Basically, composites can be categorized into three groups on the basis of matrix material.

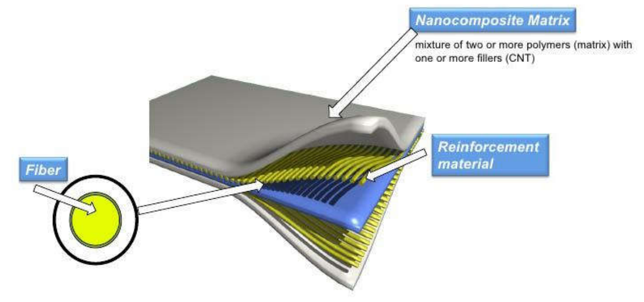
They are

- Metal Matrix Composites (MMC)
- Ceramic Matrix Composites (CMC)
- Polymer Matrix Composites (PMC)

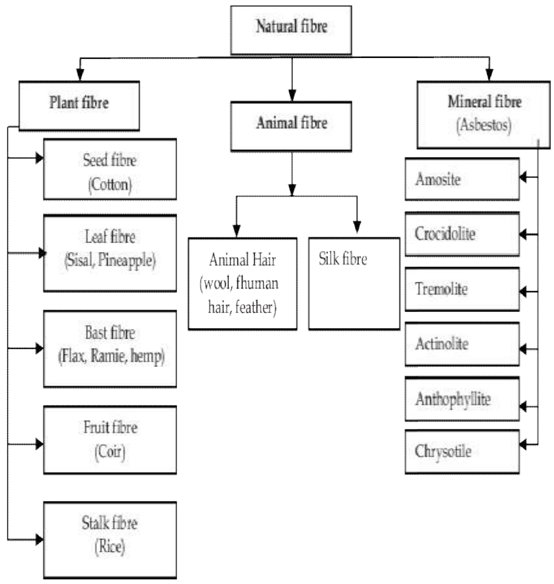
Metal Matrix Composites: Metal matrix composites have many advantages over monolithic metals like higher specific modulus, higher specific strength, better properties at elevated temperatures and lower coefficient of thermal expansion. Due to these characteristics metal matrix composites are considered for wide range of applications like combustion chamber nozzle (in rocket, space shuttle), cables, housings, tubing, structural members, heat exchangers etc.

Ceramic matrix Composites: The main reason behind producing ceramic matrix composites is to increase the toughness. Obviously, it is hoped and indeed often found that there is a concomitant improvement in strength and stiffness of ceramic matrix composites.

Polymer Matrix Composites: These are the most abundantly used matrix material. Generally the mechanical properties of polymers are inadequate for many structural purposes, particularly their low strength and stiffness as compared to metals and ceramics.



STRUCTURAL COMPOSITE: combination of reinforcement material with a matrix (nanocomposite matrix)



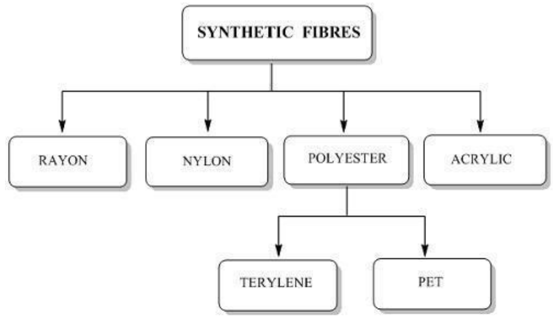
These difficulties are overcome by reinforcing other materials with polymers. Secondly processing of this type of matrix composites does not demand high pressure and high temperature. Simpler equipments are required for manufacturing polymer matrix composites. For this reason polymer composites developed rapidly and soon became popular for structural applications. Polymer composites are used because overall properties of these composites are superior to those of the individual polymers. The elastic modulus is greater than that of the neat polymer but is not as brittle as ceramics.

Two types of polymer composites are:

- Fiber reinforced polymer composite (FRPC)
- Particle reinforced polymer composite (PRPC)

Classification of Natural Fibers

Synthetic Fibers: Synthetic fibers are made from synthesized polymers of small molecules. The compounds that are used to make these fibers come from raw materials such as petroleum based chemicals or petrochemicals. These materials are polymerized into a long, linear chemical that bond two adjacent carbon atoms. Differing chemical compounds will be used to produce different types of synthetic fibers. Synthetic fibers account for about half of all fiber usage, with applications in every field of fiber and textile technology. Although many classes of fiber based on synthetic polymers have been evaluated as potentially valuable commercial products, four of them - nylon, polyster, acrylic and polyoeflin dominate the market.



These four account for approximately 98 percent by volume of synthetic fiber production, with polyester alone accounting for around 60 per cent. There are several methods of manufacturing synthetic fibers but the most common is the Melt spinning process. It involves heating the fiber until it begins to melt, then you must draw out the melt with tweezers as quickly as possible. The next step would be to draw the molecules by aligning them in a parallel arrangement. This brings the fibers closer together and allows them to crystallize and orient. Lastly, is Heat-Setting. This utilizes heat to permeate the shape/dimensions of the fabrics made from heat-sensitive fibers.

Literature review on natural fibres: Increasing environmental awareness throughout the world has greatly impacted materials engineering and design. Renewed interest in the utilization of natural materials addresses ecological issues such as renewability, recyclability and environmental safety. Currently, synthetic fibres like glass, carbon and aramid are being widely used in polymer-based composites because of their high strength and stiffness properties . However, these fibres have serious drawbacks in terms of their biodegradability, initial processing costs, recyclability, energy consumption, machine abrasion, health hazards, etc. Most significantly, adverse environmental impact alters the attention from synthetic fibres to natural/renewable fibres. In recent years, the introduction of natural fibres as reinforcements in the polymer matrix is receiving great attention. The interest of scientists and engineers has turned over on utilizing plant fibres as effectively and economically as possible to produce good quality fibre-reinforced polymer composites for structural, building, and other needs. It is because of the high availability and has led to the development of alternative materials instead of conventional or man-made ones.

Many types of natural fibres have been investigated for their use in polymer such as wood fibre, sisal, kenaf pineapple, jute, banana and straw. The influence of lignin content on the mechanical behavior of jute was studied [9], found a gradual decrease in both the strength and stiffness of the fibre with lignin removal. Similar experiments were carried out on sugarcane fibre and provided additional evidence of the significant contribution of lignin to fibre strength. However studied the physical properties of natural fibre and concluded the physical property of natural fibres depend mainly on the nature of the plant, locality in which it is grown, age of the plant, and the extraction method used. reported on the different natural organic fibre and provides the informations about the composition and physical properties of natural fibre. discussed the factors affecting the agro fibres and found that the chemical composition and physical properties of them depends on part from which fibre is extracted; the age of plant and the extraction methods.

Idicula et al studied the physical properties of natural fibres were mainly determined by their chemical and physical composition such as structure of fibres, cellulose content, angle of fibrils, cross section and the degree of polymerization. Salit studied the background of the importance of natural fibres. The advantages of tropical natural fibres are listed. The information about fibre extraction process, the application of fibres and other important topics are discussed.

Literature review on chemical treatment of natural fibres: Knowledge of the physio-chemical properties as well as mechanical behavior of natural fibres is required in order to optimize the composite performance. Most of the work has been done to clarify the influence of the vegetable fibre composition and the effect of the treatment process on their mechanical characteristics. The properties of composites depend on the matrix, fibres, and on their interfacial bonding. The adhesion between the reinforcing fibres and the matrix in composite materials plays an important role in the final mechanical properties of the material since the stress transfer between matrix and fibres determines reinforcement efficiency. The surface of synthetic fibres is usually modified using various types of processes in order to improve the fibre surface wettability with the matrix and to create a strong bond at the fibre–matrix interface which, in turn, provides an effective stress transfer between the matrix and the reinforcement fibres.

When natural fibre used as reinforcement in composite materials, many problems occur at the interface due to (incompatibility). Therefore, surface modification of the natural fibres by means treatment is one of the largest areas of current research to improve compatibility and interfacial bond strength. It is worth to mention that the chemical treatment of the fibres can either increase or decrease the strength of the fibres, and hence good understanding of what occurs structurally is required On the other hand, poor interfacial interaction leads to 40 strains, porosity, environmental degradation, moisture absorption, poor mechanical properties of composite parts, and de-bonding over time. Chemical modification of cellulose fibres is usually applied to correct for deficiencies of the fibres. Modification may result in improved performance of the composites produced. This can be done through several approaches, including plasma activation and graft polymerization with vinyl monomers. These, however, will increase the fibre cost. The primary drawback of using cellulose fibres is their limited thermal stability with noticeable degradation occurring as the melt processing temperature approaches 200o C. Higher processing temperatures that reduce melt viscosity and facilitate good mixing, however, are possible, but only for short periods. If degradation occurs, cellulose fibres can be responsible for the formation of tar-like products and pyrolysis acids that may have various damaging effects both on the processing equipment and the composite properties. There are some physical fibre treatments like Plasma, but nowadays when we speak about surface treatments we almost mean chemical ones. These treatments can clean the fibre surface, modify the chemistry on the surface, lower the moisture uptake and increase the surface roughness. The contribution of fibres to the final properties of the composite depends on: fibre-matrix interface, nature of interface, mechanical properties of fibres, type (continous/ discontinous) and orientation of fibres in the composite (anisotropy), volume fraction of fibres and processing technique used for composite manufacturing as studied.

Thus to meet all these fundamentals steps for synthesis of composite, the surface of fibres are to be properly bleached or cleaned so that the new sites may developed for interlocking of the fibres and matrix. Many works has been performed to treat the surface of the fibre by different chemical so that the surface of the fibre may modified . But before modification, the surface bleaching of fibre may introduce and shortcomings associated with natural fibres have to be overcome before using them in polymer composites. The most serious concern with natural fibres is their hydrophilic nature due to the presence of pendant hydroxyl and polar groups in various constituents, which can lead poor adhesion between fibres and hydrophobic matrix polymers. As the natural fibres bear hydroxyl groups from cellulose and lignin they are amenable to chemical modification. The hydroxyl groups 41 may be involved in the hydrogen bonding within the cellulose molecules thereby reducing the activity towards the matrix. Chemical modifications may activate these groups or can introduce new moieties that can effectively lead to chemical interlock with the matrix.

Mercerization, isocyanate treatment, acrylation, permanganate treatment, acetylation, silane treatment and peroxide treatment with various coupling agents and other pretreatments of natural fibres have achieved various levels of success for improving fibre strength, fibre fitness and fibre-matrix adhesion. In the following section we report a review of the main pretreatments techniques. Stamm et al studied the effect of acetylation on jute fibres at different reaction times and reaction temperatures. The modified fibres were characterized by FTIR, DSC, TGA and SEM studies. The extent of moisture regains and thermal stability was reported. From the study, the authors found that the thermal stability of acetylated jute is higher than that of untreated jute. Another major drawback of using cellulose fibres as reinforcing agent is the high moisture absorption of the fibres due to hydrogen bonding of water molecules to the hydroxyl groups within the fibre cell wall. This leads to a moisture build-up in the fibre cell wall (fibre swelling) and also in the fibre-matrix interface. Mohanty et al have studied the surface modifications of natural fi 42 increasing the concentration of the alkali. characterized the kenaf (Hibiscus cannabinus) nano fibres by environmental scanning electron microscopy (ESEM) and transmission electron microscopy (TEM), were isolated from unbleached and bleached pulp by a combination of chemical and mechanical treatments. investigated the effect of modification on visco elastic properties of kenaf fibrereinforced polypropylene (PP) composites.

An increase in storage and loss moduli and a decrease in the mechanical loss factor were observed for all treated composites, indicating more elastic behavior of the composites when compared with the pure PP. By treating the fibres with suitable chemicals, the reinforcing efficiency of the fibres in the composite and the interfacial adhesion between fibres and most polymers matrices was solved. Chemical treatment of the fibre cleaned the fibre surface, chemically modified the surface, delayed the moisture absorption process and increased the surface roughness. It has been found that the alkalization treatment improved the mechanical properties of the kenaf fibre significantly as compared to untreated kenaf fibre studied the surface modification method improve the sisal fibre/matrix interaction with alkali treatment, H_2SO_4 treatment, conjoint H_2SO_4 and benzol/alcohol dewax treatment, acetylated treatment, thermal treatment, alkali-thermal treatment and thermal-alkali treatment. Ray et al studied the changes occurring in jute fibres after 5 % NaOH solution treatment for different periods of 0, 2, 4, 6, and 8 hrs. A 9.63 % weight loss was measured during 2 hr of the treatment with a drop of hemicelluloses content from 22 to 12.90 %. The tenacity and modulus of treated fibres improved by 45 % and 79 %, respectively, and the breaking strain was reduced by 23 % after 8 hr of the treatment. The crystallinity of the fibres increased only after 6 hr of the treatment. investigated the influence of silane coupling agent on kenaf fibre-reinforced PLA. The stress on the fibres in the composite under transverse load was monitored in situ and non destructive methods using X-ray diffraction. reported the influence of chemical modification on dynamic mechanical properties of banana fibre-reinforced polyester composites. A number of silane coupling agents were used to modify the banana fibres.

Zulkifli et al studied the effect of chemical treatment on the interlaminar fracture toughness of woven silk composite. The results give the indication of the effect of the fibre surface treatment and number of layers because the thicknesses of all the specimens are the same. investigation reveals that the chemical treatment improved the dielectric strength and thermal conductivity by about 29.37 % and 139 % respectively compared with untreated fibre composites. Finally, the dielectric constant value of the treated fibre composite was found to be lower than the untreated fibre composite and virgin unsaturated polyester. Kalia et al have done a review work on pretreatment of natural fibre and suggests that the graft copolymer of natural fibre with vinyl monomers provide better adhesion between matrix and fibre. have studied a comparison between modified and unmodified high density polyethene /borassus fibre composite. They found that fibre matrix interaction is strong in modified fibre as compare to pure one which is supported by enhanced mechanical properties of the natural fibre. Liu et al reported to modify the surface of jute fibre mat by sodium hydroxide and maleic anhydride in propylene emulsion method and micromechanical properties of jute fibre mat. They have found that the surface of jute fibre mat have been very effective in improving fibre-matrix adhesion. The result has demonstrated a new approach to use natural materials to enhance the mechanical performance of composites. investigated the surface properties of chemically modified natural fibre using inverse gas chromatography on natural fibre like eucalyptus, bagassee and wheat straw with 1% NaOH.

The result shows that alkaline treatment achieves the overall improvement in the properties of natural fibre composite. Ahad et al studied the chemical treatment on banana fibre with 5%,10%,15% NaOH and found that the treated fibres has good mechanical strength as the surface of the fibre is chemically bleached and modified with the alkaline treatment. treated natural fibre to synthesize the concrete composite from jute fibre which provides high mechanical performance to the natural fibre composites. have studied the effect of surface treatment on some mechanical properties of sisal fibre using alkaline treatment method with NaOH at different 44 concentrations and time at a constant temperature of 65oC. The surface morphology and characteristics of the treated and untreated sisal fibre samples was studied using Scanning Electron Microscope (SEM). The result shows that, the extent of surface modification depends on the concentration of NaOH solution and time of treatment. The changed fibre surface properties observed from SEM images of the treated sisal fibres were responsible for better adhesion.

Testing Of Composites

Tensile Test: Tensile testing, is also known as tension testing, is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics

Universal testing machine: Universal testing machine (UTM) is called so because of the versatility of its application. The following test can be performed with it:

- Tension test
- Compression test
- Bending test

Advantages of composite material

Advantages

- Low specific weight, resulting in a higher specific strength and stiffness than glass fiber.
- The production requires little energy, and CO2 is used while oxygen is given back to the environment. Producible with low investment at low cost
- Reduced wear of tooling, healthier working condition, and no skin irritation.
- Thermal recycling is possible
- It has Good thermal and acoustic insulating properties.

Applications

Building and construction industry: Panels for partition and false ceiling, partition boards, wall, floor, window and door frames, roof tiles, mobile or pre-fabricated buildings which can be used in times of natural calamities such as floods, cyclones, earthquakes, etc.

- **Storage devices**: Post-boxes, grain storage silos, bio-gas containers, etc.
- **Furniture:** chair, table, shower, bath units, etc.
- **Electric devices**: Electrical appliances, pipes, etc.
- **Everyday applications**: Lampshades, suitcases, helmets, etc.
- **Transportation:** Automobile and railway coach interior, boat, etc.

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