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Product Design and Development of Hybrid Composite Walker

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Abstract

Now-a-days, Natural fiber composites are widely used instead of synthetic fibers due to their advantages like biodegradability, low weight, low cost and good mechanical properties. Synthetic fiber composites have better mechanical properties than natural fiber composites but since they are highly expensive, they are justified only for aircraft and military applications. The development of Synthetic fiber composite is the challenges for researchers have focused to needs of domestic, medical and industrial applications due the higher cost. Hence, we are focusing to develop the natural fiber composite with minimum cost and better property for domestic, medical and industrial applications.

Introduction

Now-a-days, the world is focusing on the new class of materials that are biodegradable in nature. Natural fiber composites attract the attention of many researchers and engineers because they offer low density, low cost, low environmental impact and improved mechanical properties. They are used in the fields of automotive, ship building, food packaging, aerospace and construction, etc. The most frequently used in composites are natural fibers such as flax, cotton, hemp, jute, kenaf, sisal, banana, ramie, etc. These natural fibers, despite their benefits, have poor resistance to moisture resulting in fiber swelling [1]. However, this can be overcome by hybridizing natural fibers with synthetic fibers. This approach not only enhances the mechanical properties but also improves the moisture resistance of the hybrid composite. The natural fiber used in this study is Hibiscus cannabinus. This plant belongs to the Malvaceae family and is popularly known as Kenaf. They are mostly grown in Asian countries. Kenaf has a single, straight, branchless stalk. It is extracted from the outer fibrous bark. Due to their low cost and better flexural strength, they are used to make ropes, bags, rugs and paper. E-Glass is the synthetic fiber used [4]. This fiber is a material made of extremely fine glass fibers. They provide advantages such as light weight, high tensile strength and excellent insulating properties, which have a wide range of applications in the fiber reinforcement industry. Current work is directed towards the manufacture of kenaf and glass fiber hybrid composites using an epoxy matrix. The variations in mechanical properties (Tensile, Flexural, Impact) are studied.

Composites

Composites is defined as “the engineering materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct on a macroscopic level within the finished structure [3]. Materials are selected for a given application based principally on the material’s properties. Composites have high stiffness, strength, and toughness, often comparable with structural metal alloys. Further, they usually provide these properties at substantially less weight than metals their “specific” strength and modulus per unit weight is near five times that of steel or aluminum. Composites can be excellent in applications involving sliding friction, with tribological (“wear”) properties approaching those of lubricated steel. Classification Of Composite Materials According To Constituent: According to the different constituent forms, composite materials may be classified into the following five types: Fiber-Reinforced Composite: Composed of continuous or chopped fibers. Particulate Composite: Composed of particles dispersed in a matrix. The particles are distinguished from the filamentary type, and may be round, square or even triangular, but the side dimensions are approximately equal. The material properties are dependent on not only the constituent, but also the interfacial properties and geometric shapes of the array. Flake Composites: Composed of flat flakes, or platelets. Flakes can be more tightly packed than other type composites. Metal flakes touching each other in a polymer matrix can conduct heat or electricity. In some cases, flakes are easier and less expensive to produce than fibers. However, flakes may be difficult to line up parallel to one another in a matrix resulting in uneven strength and other properties. The disadvantages of flake composites are the quality control of the sizes, shape and distribution flaws in the final product. Filled Composites: Filler materials are added to a plastic matrix to replace part of the matrix or to add to or to change the overall properties of the composite. In some cases, the fillers actually offer an increased strength of the composite, a reduction in weight and the quantity of plastic used. However, fillers also have disadvantages, and may limit the method of fabrication or inhibit curing of certain resins. Laminar Composites: Composed of two or more layers or lamina constituents held together by the matrix binder. There are as many possible laminar composites as there are combinations of materials, such as metal/metal, metal/plastic, and metal/ceramic laminates etc. At present, the greatest emphasis is on structural laminates or laminates with useful mechanical properties.

According To The Fiber Placement Directions: According to the fiber placement in different directions, the fiber composites may be classified into the following four types. Continuous Fiber Composites: The fiber may be arranged either in a unidirectional orientation or in a multi axial orientation. A laminate formed by continuous fibers has the highest strength and modulus in the longitudinal direction of the fibers, but in the transverse direction, its strength and modulus are relatively low. Woven Fiber Composites: The delimitation or separation of the laminates is still a major problem due to the fibers not being as straight as in the continuous fiber laminate. Hence, strength and stiffness are sacrificed. However, the woven fiber composites are not relevant to delimitation because they do not have dependent laminate [14]. Chopped Fiber Composites: With random orientation of fibers, it is possible to obtain nearly uniform mechanical and physical properties in all direction. Chopped fiber composites are used extensively in high-volume applications such as building materials, because of low manufacturing cost. Hybrid Fiber Composites: Mixed chopped and continuous fibers, or mixed different fiber types such as glass/carbon fiber and natural/synthetic as well. Hybrid fiber composites provide the chance of achieving a balance of mechanical properties and cost[3]. Fiber composite types are shown schematically in Figure1.1

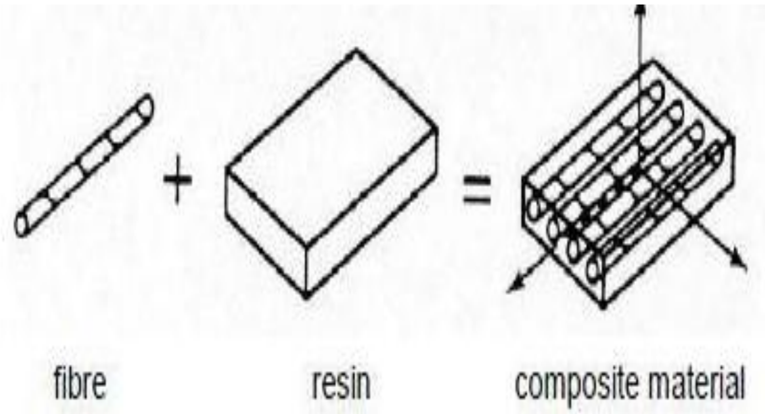

FIGURE 1. Composite Material

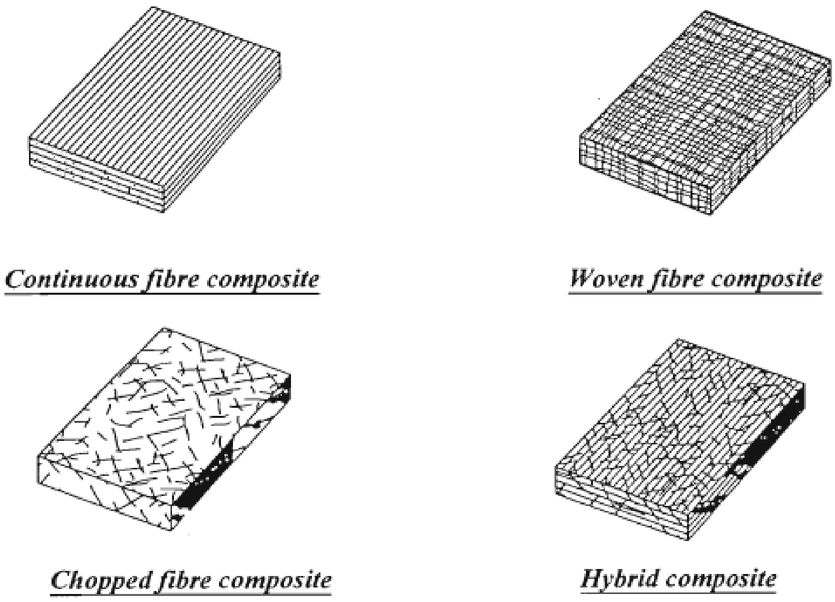

FIGURE 2. Types of Composite

The Matrix

The primary phase, having a continuous character, is called matrix. Matrix is usually more ductile and less hard phase. It holds the dispersed phase and shares a load with it Dispersed (Reinforcing) Phase The second phase (or phases) is Embedded in the matrix in a discontinuous form. This secondary phase is called dispersed phase. Dispersed phase is usually stronger than the matrix, therefore it is sometimes called reinforcing phase. In other way we can also define composite materials like fiber and resin and if they get added make composites. The other major constituent in fiber composites are the matrix, serves two very important functions that is it holds the fibrous phase in place and under an applied force it deforms and distributes the stress to the high modulus fibrous constituent. The load is borne longitudinally by the reinforcements. The choice of a matrix for a structural fiber composite is limited by the requirement that it have a greater elongation at break than the fiber. Reinforcement In Composite Material: The role of the reinforcement in a composite material is fundamentally one of increasing the mechanical properties of the neat resin system. All of the different fibers used in composites have different properties and so affect the properties of the composite in different ways [4]. However, individual fibers or fiber bundles can only be used on their own in a few processes such as filament winding. For most other applications, the fibers need to be arranged into some form of sheet, known as a fabric, to make handling possible. Different ways for assembling fibers into sheets and the variety of fiber orientations possible lead to there being many different types of fabrics, each of which has its own characteristics [7]. nmProperties Of Reinforcing Fibers: The mechanical properties of most reinforcing fibers are considerably higher than those of un-reinforced resin systems. The mechanical properties of the fiber/resin composite are therefore dominated by the contribution of the fiber to the composite. The four main factors that govern the fiber's contribution are, The basic mechanical properties of the fiber itself. The surface interaction of fiber and resin (the 'interface'). The amount of fiber in the composite ('Fiber Volume Fraction'). The orientation of the fibers in the composite. The surface interaction of fiber and resin is controlled by the degree of bonding that exists between the two. This is heavily influenced by the treatment given to the fiber surface [2]. Inter Phase: When composite is manufactured a small region (1μm) known as the fiber matrix Inter phase form between the fiber and the matrix. This region exhibits properties distinguishably different from the properties of the bulk matrix. The fiber matrix inter phase transfer stress between fiber and matrix, the efficiency of this stress transfer process and a composite's and durability are controlled by this region's properties. The inter phase stiffness, fiber topography and fiber matrix chemical bonding are critically important to the stress transfer process and composite performance. The efficiency of this process is determined directly by micromechanics test and quantified by a value termed the fiber matrix interfacial shear strength. In addition, micro mechanics test is used to probe a composite's strength, durability and failure behavior. The inter phase of composites is the region where loads are transmitted between the reinforcement and the matrix [5]. Fiber Matrix Composites: Of all composite material, the fiber type specifically the inclusion of fibers in a matrix has evoked the most interest among engineers concerned with structural applications. Initially most work was done with strong, stiff fibers of solid, circular cross section in a much weaker, more flexible matrix, i.e., glass fibers in synthetic resins. Then development work disclosed the special advantages offered by metal and ceramic fibers, hollow fibers, fibers of noncircular cross section and stronger, stiffer and more heat resistant matrices. Types Of Polymeric Matrix: A polymeric solid material may be considered to be one that contains many chemically bonded parts or units that themselves are bonded together to form a solid. There are many types of plastics such as polyethylene and nylon. Plastics can be divided into two classes that are thermoplastics and thermosetting plastic (thermo sets) depending on how they are structurally chemically bonded. Thermoplastics: Thermoplastics require heat to make them formable and after cooling, retain the shape they were formed into. These materials can be reheated and reformed into new shapes a number of times without significant change in their properties. Most thermoplastics consist of very long main chains of carbon atoms covalently bonded together. Sometimes nitrogen, oxygen, or sulfur atoms are also covalently bonded in the main molecular chain. Pendant atoms or groups of atoms are covalently bonded to the main chain atoms. In thermoplastic the long molecular chains are bonded to each other by secondary bonds. Thermosetting Plastic: Thermoset formed into a permanent shape and cured or "set" by chemical reaction cannot be re melted and reformed into another shape but degrade or decompose upon being heated too high a temperature. Thus, thermosets cannot be recycled. The term thermosetting implies that heat is required to permanently set the plastic. There are, however, many so called thermosets that set or cure at room temperature by a chemical reaction only. Most thermosets consist of a network of carbon atoms covalently bonded to form a rigid solid. Sometimes nitrogen, oxygen, sulfur, or other atoms are also covalently bonded into a thermoset network structure. Elastomers: Elastomers or rubbers can be elastically deformed a large amount when a force is applied to them and can return to their original shape or almost when the force is released. Natural rubber is obtained from the latex from tree HeveaBrasiliensis and is over 98% polyisoprene. Polyisoprene exists in two forms and it is the cis form that is the main constituent of natural rubber. Nowadays wide ranges of synthetic rubber are available and these dominate market.

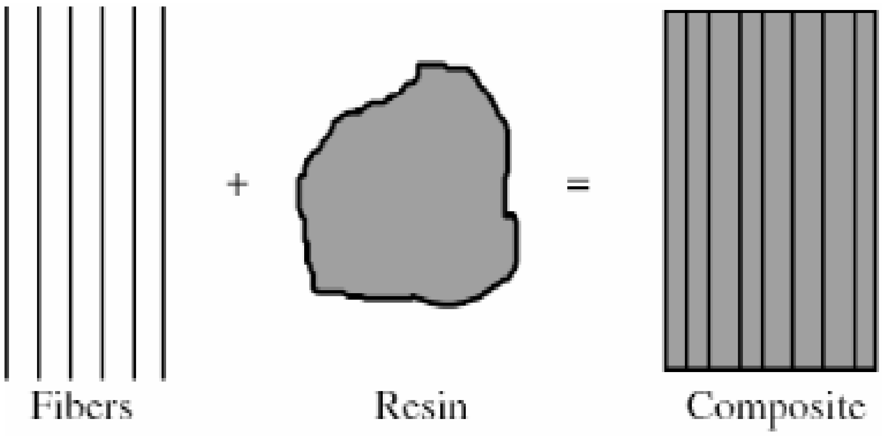

FIGURE 3. Fibers and Resin Make Composite Material

Experimental Procedure

Selection of matrix: Epoxy resin used-araldite ly556 density-1.15 to 1.20 [g/ cm3]. Hardener used-hy951 Density1.13 [g/ cm3] curing temperature-room temperature. the epoxy resin and hardener are mixed by 10:1 weight ratio. Raw material used in hand lay-up method Matrix-epoxy ly556. Reinforcement-glass fiber (cloth-10mill) and Kenaf fiber (cloth) Hardener-araldite hy951. Preparation of epoxy and hardener The matrix used to fabricate the fiber specimen was epoxy ly556 of density 1.13 g/cm3 at 25°c mixed with hardener hy951 of density 0.97 to 0.99 g/cm3. The weight ratio of mixing epoxy and hardener was followed as per the supplier norms that is 100ml of epoxy resin with 10ml. Fabrication of composite (hand lay-up method) Hand lay-up method is followed for fabrication. A 3mm thick silicon rubber mould is been created with 300mm length and width. The composite is been fabricated further as shown. Hand lay-up method procedure: The Releasing agent is applied uniformly on the lower mould surface. The resin and hardener are mixed in a separate glass jar at a ratio of 10:1. The resin and reinforcement are applied alternatively to get the final product. The mould is closed and the composite material is pressed uniformly for 32 hours under room temperature. After this composite are fully dry, then it is separated from the mould. [3] Calculation Of Process Sheet: Density of Glass Fiber = 2.5×10-3 gm/mm3 Density of kenaf Fiber = 1.3×10-3 gm/mm3 Density of Epoxy Resin = 1.2×10-3 gm/mm3. Total Volume of Plate = Length × Breadth × Height. = 300 × 300 × 3. = 270000 mm3. Volume of Matrix= 270000 × (40/100). = 108000 mm3. Mass of Matrix = Volume × Density. =108000× 1.2 × 10-3 = 129.6gm. Volume of Fiber = 270000 × (60/100) = 162000mm3 Mass of Fiber= 162000 × (1.93×10-3) = 312.66 gm. Total Mass of the Plate= 221.13 gm.

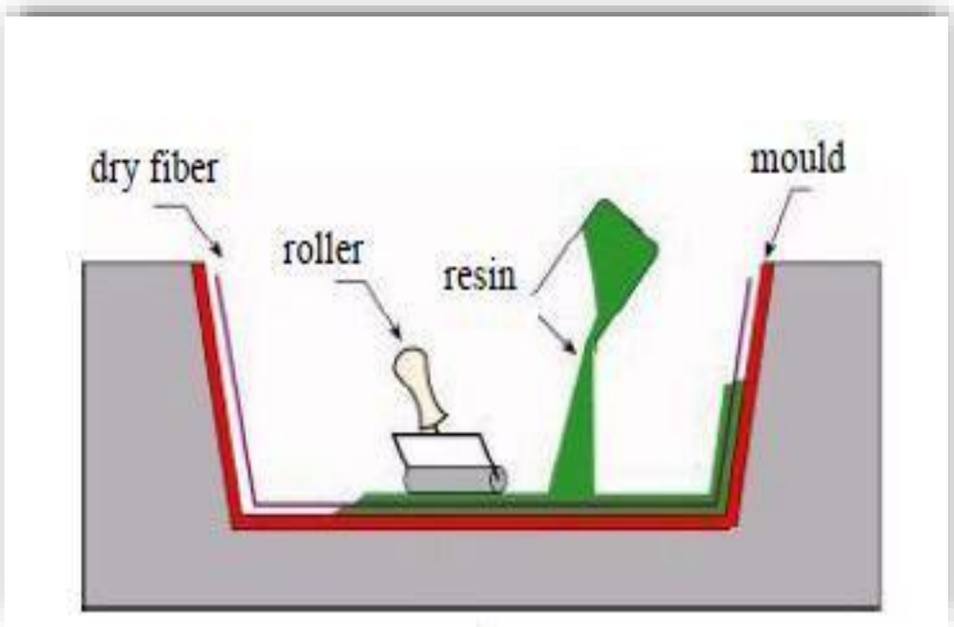

FIGURE 4. Hand Lay-Up Method

Preparation of Composite

Merits: Natural fibers are easily affordable. Natural fibers are safe for human skin and are biodegradable. These are renewable & cheap. They are eco friendly, biodegradable, available in large amounts. Low specific weight which results higher specific strength and stiffness than glass. Friendly processing, no wear of tooling, no skin irritation. Applications: Automotive Vehicles Examples of polymer matrix composite use include tires and various belts and hoses as well as polymer matrix composite component in automotive bodies. Aerospace Vehicles: Polymer matrix composites are also used in aircraft tires and interiors. The aerospace industry to enhance performance while reducing weight. Most importantly, fiber-reinforced polymer matrix composites can be optimized to combine high strength, stiffness, and toughness, and low density. Marine Vehicles: Polymer matrix composites find many uses in marine vehicles. Fiber glass boats are among the most familiar examples. The growing use of lighter, stiffer, and stronger is an emerging trend in boat building.

FIGURE 5. Working Procedure.

FIGURE 6. Automobile Parts

FIGURE 7. Aerospace and Aircraft Vehicles; **FIGURE 8.** Marine Vehicles

FIGURE 9. Photography Hybrid Composite Walker

Conclusion

In this work, we get better mechanical properties for hybrid kenaf/glass epoxy composite material than kenaf/Epoxy and glass/Epoxy. This hybrid kenaf/glass epoxy composite material is used in Walker and we get better result like tensile, flexural and impact tests. This will cheaper than existing walker and it have less weight with good mechanical properties. Hence it also very much useful to Domestic, Medical and Industrial applications.

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