JOURNAL FOR INNOVATIVE DEVELOPMENT IN PHARMACEUTICAL AND TECHNICAL SCIENCE

Volume-2,Issue-6 (June-2019)
ISSN (O) :- 2581-6934

Hybrid composite material

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Abstract: The role of natural and man made fibers reinforced hybrid composite materials are growing in a faster rate in the field of engineering and technology due to its favorable properties. In the present unsustainable environmental condition natural fibers are serving better material in terms of biodegradability, low cost, high strength and corrosion resistance when compared to conventional materials. The benefits of components and products designed and produced in hybrid composite materials instead of metals recognized by many industries. The main objective of this experimental study is to fabricate the glass fibers,knef and bnana fibe reinforced hybrid composites and to evaluate the mechanical properties such as tensile strength, and impact strength, hardness and water absorption . The hybrid laminates are fabricated by hand lay-up method by using glass, banana and knef fibers as reinforcing material with epoxy resin. The specimen is prepared according to ASTM standards and the experiment has been carried out by using universal testing machine (UTM), Impact testing machine, hardness tester etc. From the experimental results, it has been observed that the banana-kenaf -glass fibers reinforced hybrid epoxy composites exhibited superior properties and used as an alternate material for synthetic fiber reinforced composite materials.

Keywords: Mechanical properties, Hybrid composites, Banana-Kenaf-Glass fiber composites,

1. Definition of composite

A Composite material consists of two or more chemically not the same constituents, on a macroscopic level, having a different interface separating them. One or more interrupted phases therefore are embedded in a continuous phase to form a composite.[1]

The discontinuous phase is usually stronger and harder than the continuous phase and is called the reinforcement, whereas, the permanent phase is termed the matrix. A matrix material can be ceramic, polymeric and metallic When the matrix is a polymer, the composite is said polymer matrix composite (PMC). The reinforcement phase may be either be fibrous or non-fibrous (particulates) in nature and if the fibers are orignate from plants or some other living species, they are called natural fibers. The conventional materials are subsituting by composite materials, because of its prevaient properties like high strength,high tensile strength to weight ratio, low thermal expansion and they reduced completely by composting process and do not emit any toxic or noxious component [2]

According to NPTEL “A composite material is superior at a microscopic scale but statistically homogeneous at macroscopic scale” [3].

In other book the author R. Asthana et al. composite is defined as “Composite materials are material systems that include a discrete constituent (the reinforcement) distributed in a permanent phase (the matrix) and that derive their distinguishing characteristics from the properties and behaviour of their constituents, from the geometry and arrangement of the constituents and from the properties of the interfaces between the constituents” [4].

The definition is given by MP Groover “A composite material is a material system composed of two or more physically defined phases whose combination produces aggregate properties that are different from those of its constituents.” [5].

According to D. Verma defined as “The composite materials which differ from alloys by the fact that the individual components regain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings‖, in order to obtain improved materials" [6].

A composite material is defined as the mixture of two or more than two materials having distinct properties,combination of materials having various would give results having better properties than those of theproperties of the single components if used alone. In recent years, the conception of natural resources has gained key importance due to the necessity to preserve our natural environment.

1.2ADVANTAGE OF COMPOSITE

Composites consist of one or more discontinuous phases embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the 'reinforcement' or 'reinforcing material', whereas the continuous phase is termed as the ' matrix'. Properties of composites are strongly dependent on the properties of their constituent materials, their distribution and the interaction among them. The composite properties may be the volume fraction sum of the properties of the constituents or the constituents may interact in a synergistic way resulting in improved or better properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and size distribution) influences the properties of the composite to a great extent. The concentration distribution and orientation of the reinforcement also affect the properties.

The shape of the discontinuous phase (which may by spherical, cylindrical, or rectangular cross-sanctioned prisms or platelets), the size and size distribution (which controls the texture of the material) and volume fraction determine the interfacial area, which plays an important role in determining the extent of the interaction between the reinforcement and the matrix. Concentration, usually measured as volume or weight fraction, determines the contribution of a single constituent to the overall properties of the composites.

It is not only the single most important parameter influencing the properties of the composites, but also an easily controllable manufacturing variable used to alter its properties.

1.3 Composition of a composite material

In its most basic form a composite material is one, which is composed of at least two elements working together to produce material properties that are different to the properties of those elements on their own. In practice, most composites consist of a bulk material (the 'matrix'), and a reinforcement of some kind, added primarily to increase the strength and stiffness of the matrix.

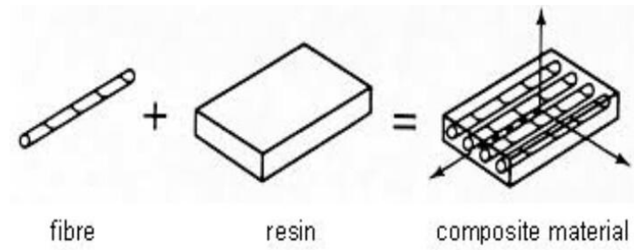

FIG. 1.1 - COMPOSITION OF COMPOSITE MATERIAL

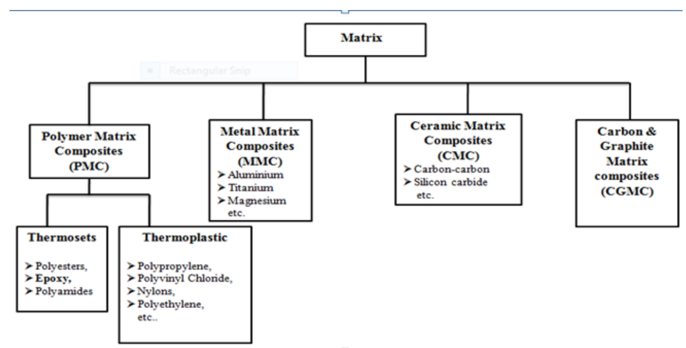

FIG.1.2 – CLASSIFICATION OF COMPOSITE ON THE BASIS OF MATRIX MATERIAL

1.3.1 Matrix

Many materials when they are in a fibrous form exhibit very good strength property but to achieve these properties the fibres should be bonded by a suitable matrix. The matrix isolates the fibres from one another in order to prevent abrasion and formation of new surface flaws and acts as a bridge to hold the fibres in place. A good matrix should possess ability to deform easily under applied load, transfer the load onto the fibres and evenly distributive stress concentration.

1.3.2 Reinforcement

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 fibres used in composites have different properties and so affect the properties of the composite in different ways. For most of the applications, the fibres need to be arranged into some

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form of sheet, known as a fabric, to make handling possible.

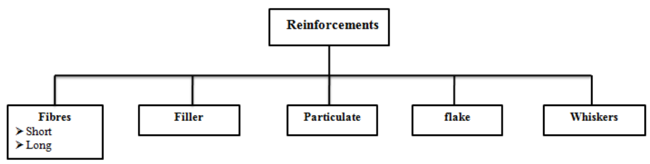


FIG. 1.3 - CLASSIFICATION OF COMPOSITE ON THE BASIS OF REINFORCEMENT

1.3.3 Classification of fibres

Particulate composites

Particle reinforced composites consist of a matrix reinforced by a dispersed phase in the form of particles. It can beeither of random orientation or preferred orientation.As the name itself indicates, the reinforcement is of particle nature (platelets are also included in this class). It may be spherical, cubic, tetragonal, a platelet, or of other regular or irregular shape, but it is approximately equiaxial. In general, particles are not very effective in improving fracture resistance but they enhance the stiffness of the composite to a limited extent. Particle fillers are widely used to improve the properties of matrix materials such as to modify the thermal and electrical conductivities, improve performance at elevated temperatures, reduce friction, increase wear and abrasion resistance, improve machinability, increase surface hardness and reduce shrinkage.

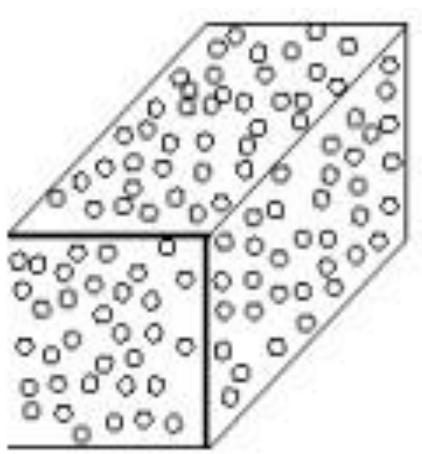
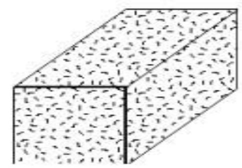


FIG. 1.5.PARTICULATE COMPOSITES



facilitating applications of conventional compress techniques to mould the compounds. Resins reinforced with thermoplastics now comprised an emerging group of composites. The theme of most experiments in this area to improve the base properties of the resins and extract the greatest functional advantages from them in new avenues, including attempts to replace metals in die-casting processes.

In crystalline thermoplastics, the reinforcement affects the morphology to a considerable extent, prompting the reinforcement to empower nucleation. Whenever crystalline or amorphous, these resins possess the facility to alter their creep over an extensive range of temperature.But this range includes the point at which the usage of resins is constrained, and the reinforcement in such systems can increase the failure load as well as creep resistance. This has facilitated easy fabrication of bulky components, doing away with the more cumbersome moulding compounds.

1.4 Hybrid Composites

The incorporation of several different types of fibres into a single matrix has led to the development of hybrid biocomposites. The behavior of hybrid composites is a weighed sum of the individual components in which there is a more favorable balance between the inherent advantages and disadvantages. Also, using a hybrid composite that contains two or more types of fibre, the advantages of one type of fibre could complement with what are lacking in the other. As a consequence, a balance in cost and performance can be achieved through proper material design . The properties of a hybrid composite mainly depend upon the fibre content, length of individual fibres, orientation, extent of intermingling of fibres, fibre to matrix bonding and arrangement of both the fibres. The strength of the hybrid composite is also dependent on the failure strain of individual fibres. Maximum hybrid results are obtained when the fibres are highly strain

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compatible**.**The term hybrid effect has been used to describe the phenomenon of an apparent synergistic improvement in the properties of a composite containing two or more types of fibre [3]. The selection of the components that make up the hybrid composite is determined by the purpose of hybridization, requirements imposed on the material or the construction being designed. The problem of selecting the type of compatible fibres and the level of their properties is of prime importance when designing and producing hybrid composites. The successful use of hybrid composites is determined by the chemical, mechanical and physical stability of the fibre / matrix system **.**

1.4.1 Types Of Hybrid Composites

There are several types of hybrid composites characterized as:

- **InterplyOr Tow By-Tow -**In which tows of the two or more constituent types of fiber are mixed in a regular or random manner;
- **Sandwich Hybrids-** Also known as core-shell, in which one material is sandwiched between two layers of another;
- **InterplyOr Laminated**-where alternate layers of the two (or more) materials are stacked in a regular manner;
- **Intimately Mixed Hybrids**- where the constituent fibers are made to mix as randomly as possible so that no over-concentration of any one type is present in the material;

hich the diameter is negligible in comparison with the length. Natural fibres can be classified according to their origin. The vegetable, or cellulose-base, class includes such important fibres as cotton, flax, and jute; the animal, or protein-base, fibres include wool, mohair, and silk; an important fibre in the mineral class is asbestos.

1.5.1 Synthetic Fibre

Synthetic fibers (British English: synthetic fibres) are fibers made by humans with chemical synthesis, as opposed to natural fibers that humans get from living organisms with little or no chemical changes. They are the result of extensive research by scientists to improve on naturally occurring animal fibers and plant fibers. In general, synthetic fibers are created by extruding fiber-forming materials through spinnerets into air and water, forming a thread. These fibers are called synthetic or artificial fibers. Some fibers (such as the diverse family of rayons) are manufactured from plant-derived cellulose and are thus semisynthetic, whereas others are totally synthetic, being made from crudes and intermediates including petroleum, coal, limestone, air, and water. In the textile industries, cellulose fibers are usually differentiated from synthetic fibers in the sense of fully synthetic ones.

3.1.3 Epoxy Resin

Epoxy resin is used as a matrix material which is a copolymer and is formed from two different chemicals. These are referred to as the “resin” and the “hardener”. The resin consists of monomers or short chain polymers with an epoxide group at either end. Most common epoxy resins are produced from a reaction between-epichlorohydrin and bisphenol-A, though the latter may be replaced by similar 45 chemicals.

1.5.2 Banana Fibre

Banana fiber is a natural bast fiber which has wide range of uses in handicraft product developments such as mat, rope and twines, but only 10% of its pseudo stem is being used for making products and remaining is waste or used as fertilizer.

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FIG NO 3.1 BANANA PLANT AND BANANA FIBRE

1.5.3 KenafFibre

Kenaf has a unique combination of long bast and short core fibers which makes it suitable for a range of paper and cardboard products. Scientists at the ARS have tested several kenaf pulping techniques, with the pulps being used to make several grades of paper including newsprint, bond, coating raw stock and surfaced sized. Results have been positive, particularly in terms of paper quality, durability, print quality and ink absorption.

FIG NO.3.2 KENAF PLANT AND KENAF FIBRE

1.5.4 Glass Fibre

These fiber mesh Roll is non adhesive coated and ideal for minimizing the risk of cracks between column and bricks wall joint ,this mesh roll is used before plaster on the wall . which give protection to the wall and the joint and minimizes the risk of crack on the wall and give strength to the wall very easy to use , replaces the traditional iron mesh which was used for this purpose. Fiberglass mesh is woven by fiberglass yarn and then coated by alkaline resistant latex. It has alkaline resistance, high strength, etc. It is an ideal engineering material in construction. It is mainly used to reinforce cement, stone, wall materials, roofing and so on. Plastering fiber glass mesh is used for reinforcement surfaces during plastering, installation leveling floors, waterproofing, restoration of cracked plaster in order to prevent cracking or fraying of the plaster. Fiberglass mesh is cheap material that does not burn and is characterized by both low weight and high strength. These properties allow it to be successfully used in the formation of plaster facades, as well as use on internal wall and ceiling surfaces. This material is widely used for fastening the surface layer at the corners of the room. Most widely used standard fiberglass plaster mesh is the density of 145 GSM for interior and extcladding and facade work.

FIG.3.3 GLASS FIBRE

1.5.5 Epoxy Resin

Bondtite Super strength epoxy adhesive (Astral AY 105) made by ResinovaChemie Limited having the following outstanding properties has been used as the matrix material.

i. Low coefficient of thermal expansion & low shrinkage during curing

ii. Excellent adhesion to different materials.

iii. High resistance to chemical and atmospheric attack.

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iv. High dimensional stability.

v. Free from internal stresses.

vi. Excellent mechanical and electrical properties.

Fig no. 3.4 Epoxy

1.5.6 Hardner

Hardener is a curing agent for epoxy resin. Epoxy resins require a hardener to initiate curing. It is also called the catalyst, the substance that hardens the adhesive when mixed with resin. It is the specific selection and combination of the epoxy and hardener components that determine the final characteristics and suitability of the epoxy coating for a given environment. Optimum levels of a hardener are used to formulate epoxy coatings. The ratio differs from product to product. The use of an improper hardener may result in an undercatalyzed or overcatalyzed product. In the present work hardener (HY951) is used. This has a viscosity of 10-20 MPa at 25ºc.

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