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A REVIEW ON BIO COMPOSITE MATERIALS

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ABSTRACT:

Bio composites are natural fiber reinforced biopolymers, due to their excellent properties and less weight, Composite materials are considered as a significant part of our day to day life. Bio composites are fabricated by combining natural fibers in a matrix material. The matrix material can be biodegradable, non-biodegradable, or synthetic. Synthetic matrix materials, along with natural fibers, are used to form hybrid bio-composites. Naturals fibers are abundant and have low harvesting costs with adequate mechanical properties, eco-friendly nature and sustainability, so the natural fibers are getting attention from researchers and academician. This review article provides a review of the widely used natural fiber reinforced polymer composites and their applications. Drawbacks of natural fiber composites such as higher water absorption, low fire resistance, and mechanical properties limited its application also the applications of natural bio composites in automobile, construction, marine, aerospace industry arediscussed.

Keywords: Bio-composites, Synthetic matrix, Naturals fibers.

1.INTRODUCTION:

A bio composite material is a combination of matrices such as polymer and reinforced natural fibers. These composites mimic the morphology of the living materials with excellent biocompatibility. The polymer matrix protects the fibers from mechanical damage and environmental degradation. Moreover, bio fibers are natural fibers produced from biological origins such as wood, crops, and regenerated cellulose. Bio composites enhance the safety in their production.

2.BIO COMPOSITE CONSTITUENTS:

The term 'bio-composites' for the most part covers composite materials where in any event one segment ought to be bio-based:

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(a) Bio-polymers (e.g., PLA) reinforced by bio-fibers (jute)
(b) Bio-fiber reinforced petroleum derived polymers which are non-biodegradable e.g., epoxy, polyolefin polyester, vinyl ester, phenolic.
(c) Bio-polymers reinforced synthetic fibers such as glass or carbon.

3.BIO POLYMERS:

These biodegradable polymers include renewable or synthetic input materials for production. Classification of natural bio-degradable polymers are based on the basis of sources;

(1) Directly extracted from biomass. (for example, Starch, cellulose, casein etc.)
(2) Classically synthesized from bio derived monomers (for example, Polylactic acid and other polyesters), and
(3)Directly from Microorganisms (for example,Polyhydroxyalkanoates).

4.BIO-BASED FIBERS:

Natural fibers can be characterized as bio-base filaments which can be utilized instead of traditional fiber-fortifying materials, for example, glass. The types of natural fiber is appeared in below Fig. 1

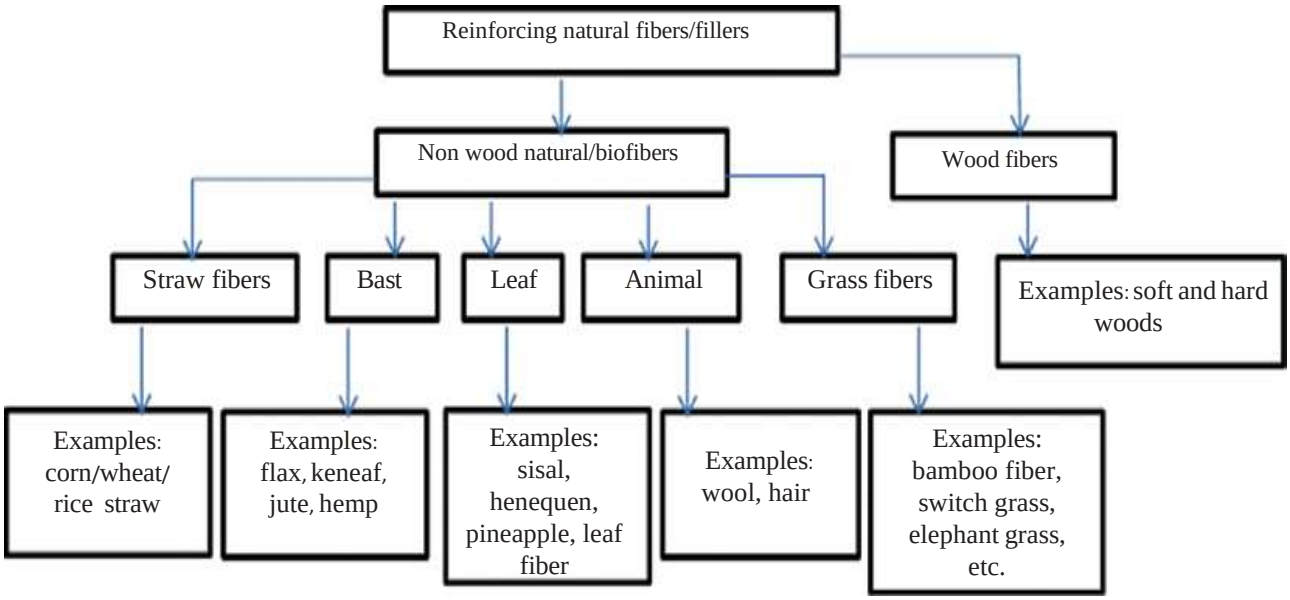

Fig 1 Types of Natural fiber

The Animal nature is loaded with precedents where human hair, chicken plume, sheep, alpaca, camels, rabbits and hairs of different winged creatures and creature are ordinarily

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depicted as a loss side-effect. Hair is a non-biodegradable waste accessible in ample quantity over the world, yet is not found completely for applications in designing field. Tensile strength of human hair ranges from 150 to 220 MPa. While expanding the fiber volume portion up to a specific range the composite materials have demonstrated more noteworthy upgrades in their pliable properties.

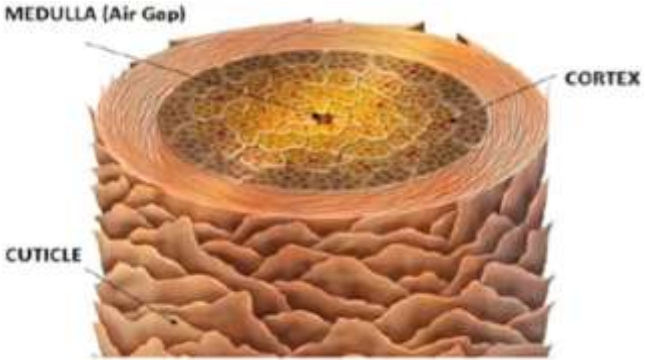

Fig 2 Parts of Hair fiber

BAST FIBERS:

Bast fibers are defined as those obtained from the outer cell layers of the branches of various plants. The fibers find use in textile applications and are gradually being considered as reinforcements for polymer–matrix composites as they are observed to be “sustainable”. Bast fibers which is the costliest and luxurious within this category, are valued for their exceptional coolness and freshness in hot weather. These fibers tend to have high durability and their qualities improve with age and cleaning. It is also able to absorb a good depth of color in the dyeing process and remains more colorfast for a longer period.

FLAX FIBERS:

Flax delivers strong and stiff fibers and it can be grown in moderate climates. It is stronger than cotton due to highly oriented molecular structure. Flax cell is highly companionable with the human cell thereby producing a compassionate effect on the human organism. Flax fabric is an outstanding filter protecting against a chemically aggressive medium, noise and dust. Flax used in bed, table, bath items for residential and commercial use as well as attire and technical products like luggage, bags, purses, sewing thread etc (Figs. 3 and 4).

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Fig 3 Fibers From Flax Plant.

Fig. 4 Fiber from Hemp plant.

HEMP:

Hemp is coarser and stiffer than flax and nearly around 3–15 feet long. Depending on processing, fiber may be creamy white, brown, gray, black, or green. It has high strength which makes it mainly suitable for cordage, twine & thread. It is used in shoes, hats, shirts, t-shirts, & jeans.

KENAF FIBER:

It has been generally utilized as support in composites in the course of recent years which is a most appealing option because of its fast development at various climatic conditions and guaranteeing ease; kenaf fiber has increased some thought- fullness regarding supplanting the glass fiber composite and making it absolutely an eco-accommodating composite. Be that as it may, for improving its properties in various applications. A solitary fiber of kenaf can have an elasticity and modulus as high as 11.9 GPa and 60 GPa, separately. Same like jute, it is used for twine, cordage, & other technical purposes (Fig. 5).

To the extent composite applications are respected, flax and hemp are two strands that have supplanted glass in various parts, particularly in the German car enterprises.

- The elasticity of cloth string is twice as high as that of cotton and multiple times that of wool.
- Linen lessens gamma radiation about significantly and secures the human living being against sunlight based radiation.
- According to therapeutic examinations led by Japanese analysts, wearing material garments disposes of some skin illnesses –from regular rash to perpetual skin inflammations.
- Linen is profoundly hygroscopic as it is proficient to quickly assimilate and yield dampness. That clarifies why material fabric dependably feels crisp and cool.
- Linen has high air penetrability and warmth conductivity properties. Warmth conductivity of cloth is five times as high as that of wool and nineteen times as that of

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silk

Fig 5 Fiber From Kenaf Plant.

COIR:

Coir is the fiber of the coconut husk, it is a thick and coarse however sturdy fiber. It is utilized in ropes, tangling and brushes, The Coir reinforced bio-composite concrete panels have good durability, due to the fact that the composite walls were not affected by the acid or sulphate environment. Hence, these coir reinforced concrete panels can be used as molded concrete slabs for light weight loading structures.(Fig.6).

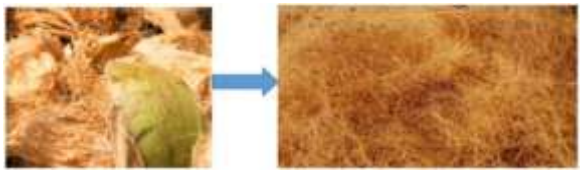

Fig. 6 Coir fiber From Coconut Husk.

BAMBOO FIBER:

Bamboo fiber is a one of a kind biodegradable material. As a characteristic cellulose fiber it tends to be 100% biodegraded in soil by microorganisms and daylight. The decomposition process does not bring about any contamination in the earth (Fig.7).

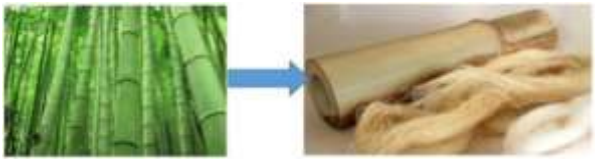

Fig. 7 Fiber from Bamboo Tree.

SEED FIBERS:

Cotton is the most widely recognized seed fiber and is utilized for material everywhere throughout the world. Other seed strands are connected in less requesting applications, for example, stuffing of upholstery. (Fig.8)

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Fig. 8 Fiber From Cotton Plant.

5.FABRICATION PROCESS FOR BIO BASE POLYMERS:

Bio polymer composites created from normal strands is as of now the most promising region in polymer sciences. As a rule, just a single part of the composites, either the filaments or the resin, has been biodegradable. Such semi-green composites have a similar issue of transfer toward an incredible finish. The uncrushed regular strands were cleaned and substance treated utilizing Isocyanate, washing with basic arrangement, acrylic corrosive, and mercerization were connected.

After this process, the common fiber was dried in an oven or air and for reduction in size it is processed in ball milled at 200–300 rpm for 5–6 hrs. The regular fiber and polymer framework were blending in the reactor or thermo kinetic mixer. After the blending composites were compressed under pressure from 6 to 10 MPa at 1501C to 1701C lastly dry the composites in dry air for appropriate relieving.

There are three primary approaches to produce bio-base polymers;

(1) By utilizing normally happening polymer through change, for instance cellulose subsidiaries, thermoplastic starch.
(2) By creating bio-base monomers by maturation and polymerization, for instance Polylactic acid (PLA), bio-based nylon 6.
(3) By creating bio-based polymers with the assistance of hereditarily adjusted harvest as well as micro organism, for instance, poly hydroxyl alkanoates.

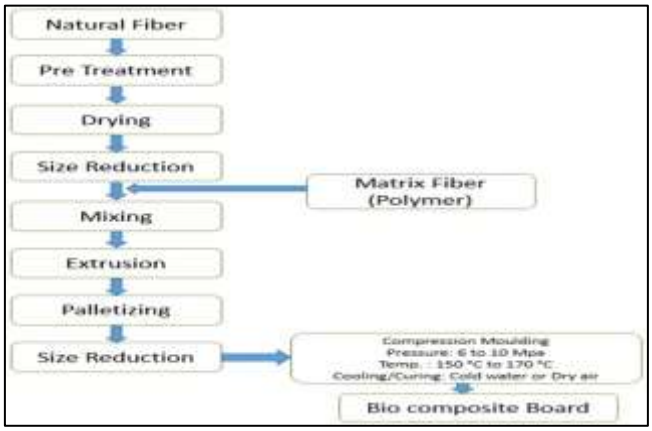

Fig 9 Fabrication Process For Bio Base Polymers

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6.PROPERTIES OF THE COMMON NATURAL FIBERS:

A large variation is found in the properties of natural fibers.The properties are affected by several factors such as type of fibers, moisture content and form of fibers (yarn, woven, twine,chopped, felt, etc). Moreover, the properties are also affected by the place where the fibers are grown, cultivation condition, the part of the plant they are harvested from, growing period and retting or extracting process.

Type of fibers	Density (g/m^3)	Tensile strength (MPa)	Young's modulus (GPa)
Hemp	1.48	514	24.8
Jute	1.3 – 1.45	393-773	13 – 26.5
Flax	1.50	345-1100	27.6
Sisal	1.45	468-640	9.4 – 22
Coir	1.15	131-175	4 – 6
Ramie	1.51	500	44
Cotton	1.51	400	12
Gomuti (Sugar-palm fiber)	1.29	190.29	3.69

Table 1. Types And Properties Of The Common Natural Fibers

The above Table shows the type and properties of the common natural fibers. It is shown in the table that flax and jute have thehighest tensile strength. Although the values are lower than thetensile strength of synthetic fibers, natural fibers offer lower density and competitive Young's modulus.

7.APPLICATIONS OF NATURAL FIBER COMPOSITES:

More interest is now shown in the investigation of the suitability of natural fiber composites in structural and infrastructure applications where moderate strength, lower costand environmental friendly features are required. The application of natural fiber composites has started in automotive industries and productions of non structural elements. In 1986, a study has been published where it is reported that coir/polyester composites have been used to produce mirror casing, paper weights, projector cover, voltage stabilizer cover, mail-box, helmet and roof. In structural applications and infrastructure applications, natural fiber composites have been used to develop load-bearing elements such as beam, roof, multipurpose panel, water tanks and pedestrian bridge.

Traditionally, beams are made of timber, reinforced concrete, steel profiles, laminated veneer lumber (LVL) or glulam. Recent developments have shown the possible cost, weight, installation and time advantages of using fiber composites beams. Therefore, an opportunity exists for the applications of NFC in the development of structural beams and pedestrian bridge

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girders which requires low to moderate design loads. The idea of using natural fiber composites in beam development is prompted by the lower density of natural fibers, lower cost and environmental benefits.

Flax fiber composites show almost the same specific per- formance as that of glass fiber-reinforced composites. This study reveals that in future natural fibers will compete with glass fiber-reinforced composites to get high-performance composite materials for industrial applications. Flax fiber composites are also used in the development of eco- friendly brake friction composites as these composites stabilize the friction coefficient and also increase the wear rate at high temperature Flax fiber composites are used in manufacturing of low cost structural components viz cellular beams and panels based on renewable resources for load bearing applications and this result in a great asset for current and future structural applications. These composites are used as raw materials for particle board, which is a partial substitute of wood.

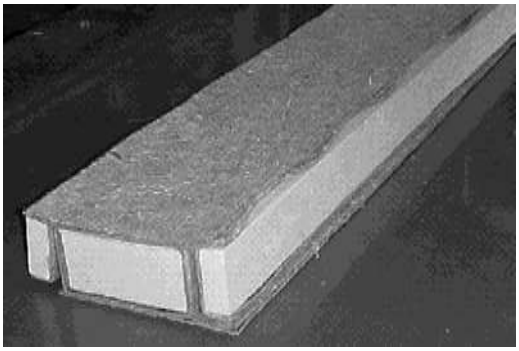

Figure 10: A lay-up of flax mat

The above Figure 10 shows the flax mat and foam as new flax fiber composite structures which are manufactured so as to be used a substitute for conventional wood structures in buildings. A detailed study on stress-strain analysis were made to know the mechanical properties, which further helps in processing and manufacturing of roof for a house.

Jute fiber-reinforced composite materials have found their application in trenchless restoration of underground pipes, so the reinforcements composed of inside jute mats and outside glass fiber were recommended for the shape of the reinforcement for the impending work of trench- less restoration of underground pipes. The growth of natural fiber nonwoven composites for the application of car interiors for noise control is intense. As natural fiber composites are noise-absorbing materials, renewable and biodegradable nonwovens were developed for the

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automotive interiors to reduce noise. The other applications suggested for the developed nonwovens include the acoustic wall coverings for auditoriums, theatres, genera- tor room, and floor mats.

Mechanical characterization of untreated woven jute and glass fabric reinforced with isothalic polyester hybrid composites was studied. This hybrid approach had enhanced the mechanical properties and durability of the composites. These hybrid composites may find the applications in moderate load carrying structures such as cabinets, machine covers, seat backings, bumpers, luggage shelves, and many more. The study on natural fiber such as sisal (Chopped) and jute (textile) along with industrial waste like red mud and fly ash reinforced composites had gained its significance as a potential wood substitute material as they are of low cost and energy effective which can be used in building applications.

Figure 11: A Car Made From Jute Fiber-Reinforced Composite And Hybrid Composites

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The above Figure 11 shows a car made from jute fiber-reinforced composites. Research work was carried out to develop, manufacture, and assemble a small prototype car whose body panels were made of these composites and hybrid composites.

Most of the car companies in the world have done a lot of investigation in order to insert the NFPCs in their products. The car manufacture in Europe has done various researches to increase the applications of NFPCs in automotive industry, especially in car interior such as seat backs, parcel shelves, boot linens, front and rear door linens, truck linens, and door-trim panels . Beside the use for car interior parts in automobile industry, natural fiber embedded in polymers has been used for high requirement applications for Exterior auto body components, such as the middle section between the headlights above the fender of a passenger bus.

German auto companies (BMW, Audi Group, Ford, Opel, Volkswagen, Daimler Chrysler, and Mercedes) utilize the cellulose fibers composites in various automobile part, shown such as using coco nut fibers rubber latex composites for the seats of the Mercedes Benz A-class model and using fax-sisal fiber mat reinforced epoxy door panels of Mercedes Benz E-class model. Audi company uses flax/sisal mat reinforced polyurethane composite with a mix to make door trim panels. Ford is using kenaf fibers imported from Bangladesh in their “Mondeo” model and the door panels of the Mondeo are manufactured from kenaf reinforced PP composites while using flax in floor trays. Kenaf and flax mixture has gone into package trays and door panel inserts for Opel Vectras, Volkswagen Company used.

CONCLUSION

This review article shows the bio composite materials and their usage in various engineering field due to their excellent high strength to low weight ratio. Furthermore, bio composites offer opportunities for environmental gains, reduced energy consumption, insulation and sound absorption properties. Currently the growing use of natural fiber composites is based on the environmental and low cost benefits, Therefore, more research is needed to obtain better strength and modulus properties including optimizing the interfacial bond between the fiber and resin by means of fiber treatment also more research into the application of natural fiber composite in structural and infrastructure is needed especially with regard to the issues of cost of fiber and the supply of fiber for mass production of the composites.

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