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A Review on Bio-Composites: Fabrication, Properties and Applications

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ABSTRACT: Polymers form the backbones of plastic materials, and are continually being employed in an expanding range of areas. As a result, many researchers are investing time into modifying traditional materials to make them more user-friendly, and into designing novel polymer composites out of naturally occurring materials. A number of biological materials may be incorporated into polymer materials. In recent years, there has been a marked increase in interest in biodegradable bio-composite material for use in packaging, agriculture, medicine, and other areas. The belief is that polymer bio-composite materials will reduce the need for synthetic polymer production (thus reducing pollution) at a low cost, thereby producing a positive effect both environmentally and economically. This review is intended to provide a brief outline of work that is under way in the area of polymer bio-composite research and development, the scientific theory behind these materials, areas in which this research is being applied, and future work that awaits.

KEYWORDS: bio-composites; biodegradable, biological materials.

I. INTRODUCTION

Plastics have become the choice for many applications due to their long life and attractive properties. Due to its tremendous growth in applications, plastics are one of the fastest growing segments of the waste stream. Majority of plastic products are made from petroleum-based syntheticpolymers that do not degrade in land fill site or in a composite like environment. Ecological concerns have resulted in a renewed interest in natural and compostable materials, and therefore issues such as biodegradability and environmental safety are becoming important [1]. Tailoring new products within a perspective of sustainable development or eco-design is a philosophy that is applied to more and more materials. It is the reason why material components such as natural fibres, biodegradable polymers can be considered as 'interesting'—environmentally safe—alternatives for the development of new biodegradable composites. Nowadays production of natural biodegradable polymer composites is an important research topic on the stage of renewable sources implementation instead of petrochemical sources. Large variety of natural fibres and their developed surface which increases adhesion to matrix makes them an attractive filler material. In fibre-reinforced composites, the fibres serve as reinforcement by giving strength and stiffness to thestructure while the polymer matrix holds the fibres in place so that suitable structural composites can be made.Composites consist of two (or more) distinct constituents or phases which when married together result in a material with entirely different properties from those of the individual components.

Most plastics by themselves are not suitable for load-bearing applications due totheir lack of sufficient strength, stiffness, and dimensionalstability. Two of the main functions of the matrix are to transmit externally applied loads, via shear stresses at the interface, to the reinforcement and to protect the latter from environmental and mechanical damage. The advantage of such a coupling is that the high strength and stiffness of the fibres (which in most practical situations would be unable to transmit loads) may be exploited. Typically, a manmade composite would consist of a reinforcement phase of stiff, strong material, frequently fibrous in nature, embedded in a continuous matrix phase. The latter is often weaker and more compliant than the former. The so-called advanced composites made from carbon, aramid, silicon carbide, boron, or other higher modulus fibres have been widely used in the aerospace and recreational industries, and their use in the automotive and construction industries has also been explored, where general composites

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incorporating glass or other relatively low modulus fibres are used. The matrix and reinforcements in advanced and general composites are mostly petroleum based materials and synthetic fibres from organic or inorganic materials, respectively. Nowadays, as industry attempts to lessen its dependence on petroleum based fuels and products; there is an increasing need to investigatemore environmentally friendly, sustainable materials to replace the existing ones. Thecommonly named bio-composite is one of the results of such attempts. The bio-composites referred to herein are composites that combine natural fibres such as kenaf, jute, hemp, and sisal with either biodegradable or non-biodegradable polymers. In terms of the reinforcement, this could include plant fibres such as cotton, flax, hemp and the like, or fibres from recycled wood or waste paper, or even by-products from food crops. Regenerated cellulose fibres (viscose/rayon) are also included in this definition, since ultimately they too come from a renewable resource, as are natural 'Nano fibrils' of cellulose and chitin. Matrices may be polymers, ideally derived from renewable resources such as vegetable oils or starches. Alternatively, and more commonly at the present time, synthetic, fossil-derived polymers preponderate and may be either 'virgin' or recycled thermoplastics such as polyethylene, polypropylene, polystyrene and polyvinyl chloride, or virgin thermosets such as unsaturated polyesters, phenol formaldehyde, isocyanates and epoxies. Natural fibres have many advantages over synthetic ones; no harm to the environment, enhanced energy recovery and biodegradability, low density, high toughness, acceptable specific strength, reduced dermal and respiratory irritation, low cost, renewable resources, etc. As regards the matrix used for bio-composites, polyolefin thermoplastics such as polypropylene and polyethylene have been used due to the limited development of biodegradable polymers, in particular for structural applications. The matrix in fibre-reinforced composite holds fibres together, transfer applied loads to those fibres and protects them from mechanical damage and other environmental factors. However, fibrespossess high strength and stiffness but are difficult to use in load-bearing applications because of their fibrous structure. Composites based on natural fibres have light weight, high strength to weight ratio and good stiffness. However, there can be problems with the technical properties of reinforced materials – moisture absorption is generally high and impactstrength is relatively low. The price differencebetween bio-composites and synthetic plastics is expected to narrow as a result of continued breakthroughs in production and processingtechnology, increases in base crude oil and close substitute energy prices and government regulations favouring greater use of renewable energy and waste materials [2, 3]. This review paper will show that bio-composites on the filled by natural fibres, can be an interesting alternative for conventional polymeric material based on gas or oil.

II. DISCUSSION

Fabrication:

Various fabrication methods have been investigated for bio-composites. These may be classified [4] into two categories according to the types of reinforcement used: (i) particle or short fibres and (ii) continuous fibres. For continuous fibre reinforced bio-composites, woven fabric preforms processed from natural fibres have been introduced as the reinforcements. Fabrication of laminated composite with four layers of jute [5] woven fabrics has been done. Prior to their impregnation in the resin matrix, the jute fabrics were treated with alkali in the biaxial tensile stress state. A significant improvement of the mechanical stiffness was achieved in the composite with the fibres treated with alkali under applied stress. The two main drawbacks of presently developed bio-composites from its rival glass fibre composites are: poor moisture resistance and low impact strength. Recent research results show that there is a large lays either in pre-treatment of the fibres, engineering of fibres or in improving the chemistry while impregnating the fibres with the matrix polymer. Three-corner approach in designing bio-composites of superior/desired properties include: bio-fibre treatment, matrix modification and novel processing. Aim towards the "synergism" is through above three-corner approaches [6]. From research results it was found that bastfibre (Kenaf, Hemp etc.) based bio-composites exhibit superior flexural and tensile properties while leaf fibre (Henequen, Pineapple leaf fibre or PALF)) based bio-composites show very high impact strength. Again through suitable pre-treatment of bio-fibres like alkali treatment (AT) and/or silane treatment (ST), the water absorption of the resulting bio-composites could be reduced. Through suitable blend of such surface treated bio-fibres, engineered natural/bio-fibres could be achieved, as shown in scheme 1.

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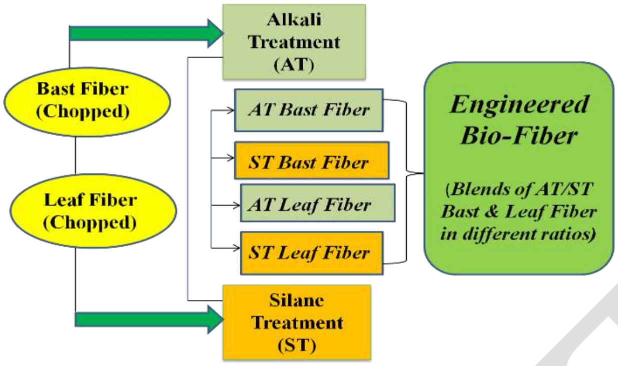
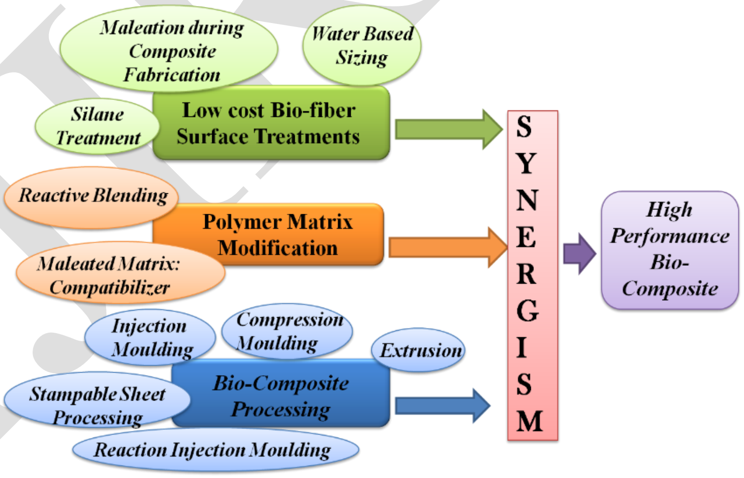


Scheme 1: The concept of Engineered Bio-fibres

For use in unsaturated polyester bio-composite, a woven fabric from banana [7] and glass fibres have been prepared. In their woven fabric, banana yarns were used for all of the warp yarns, whereas glass yarns comprised the weft yarns by alternating them with the banana yarns. On the other hand, the low velocity impact testing [8] of hemp fibre reinforced composites, which were prepared using an unsaturated polyester resin and a needle punched non-woven mat of hemp fibres has been carried out. It was demonstrated in that the total energy absorbed by the Hemp fibre reinforced bio-composites was comparable to that absorbed by E-glass fibre reinforced unsaturated polyester composites.

The fabrication of super strength bio-composite has been described in the scheme 2. Chopped natural fibre reinforced PP composites have been widely studied in an attempt to benefit from the cost and mechanical properties of these natural fibres. The fabrication of Kenaf [1] fibre reinforced polypropylene sheets that could be thermoformed for a wide variety of applications using a compression moulding process utilizing the layered sifting of a micro fine polypropylene powder and chopped kenaffibres has also been done. Preparation of kenaffibre reinforced PP composites using compression moulding [9] by sandwiching PP film with kenaf mats and fabrication of the same composites from PP and kenaffibres by the press forming [10] of stacked layers of their mats have been achieved. On the other hand, extrusion technology was also adopted to process chopped (50-80 mm) natural fibres [11] with micron size PP powder.



Scheme 2: The Concept of Superior Strength Bio-Composite

For the preparation of thermoplastic composites such as PP, a commingled technique was developed for fabricating continuous or discontinuous fibre reinforced composites. For the preparation of continuous fibre composites, both the reinforcement and matrix fibres are commingled into yarns or fabrics, while both fibres are entangled into nonwoven mats for the preparation of chopped fibre composites. To convert them into solid composites, heat and pressure are applied to the commingled preforms such that only the resin fibres within them melt and flow, forming a continuous matrix phase between the reinforced fibres. This fabrication method has been utilized to manufacture bio-composites using a carding process [12], which is used to make uniform blends of discontinuousnatural fibres such as kenaf or jute with synthetic fibres for use as the matrix (Fig. 1& 2). The commingled fabrication method using the carding process may be an effective means of processing bio-composites using long and discontinuous natural fibres, because it can avoid the process of converting them into continuous yarns, which allows the cost to be reduced and the fibres to be uniformly distributed in the composites. Here long fibres refer to fibres whose length is large compared to short fibres with a length of a few millimetres at most.

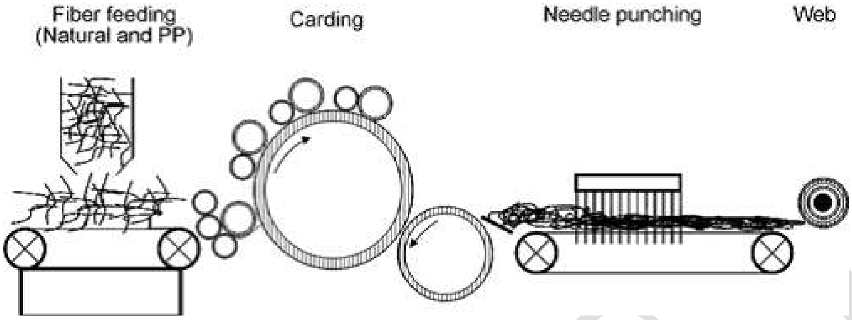
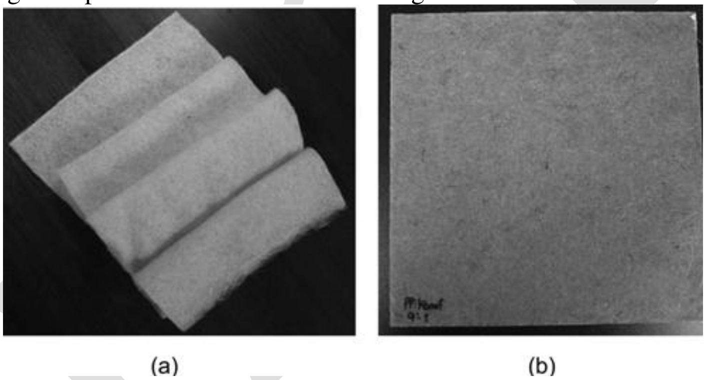


Fig. 1: Carding process for mixing natural fibres with PP staple fibres



(a) (b)

Fig. 2: (a) Carded preforms of natural and PP fibres and (b) its consolidated composite

The limited fibre fraction [4] can be explained by the void content in the bio composites, which may be caused by the non-uniform packing or the deficiency of the matrix fibres. To incorporate more natural fibres into the bio-composites, the fibre length of both the natural and matrix fibres may need to be shortened; however, too short fibres may spoil the processibility of the carding operation, thus further experimental or theoretical studies are necessary to determine the optimum fibre fraction. New process development for bio-composite fabrications for commercial applications is the real challenge of research at the current level of technology so far developed for bio-composites.

Properties:
The selection of suitable fibres is determined by the required values [13-15] of the stiffness and tensile strength of a composite (Table 1). Further criteria for the choice of suitable reinforcing fibres are, for example, elongation at failure, thermal stability, adhesion of fibres and matrix, dynamic and long-term behaviour, price and processing costs. The study and utilization of natural polymers is an ancient science.

Table 1: Mechanical Properties of different Bio-Fibres

Material	Density (g/cm3)	Tensile Strength (Mpa)	Young's Modulous (Gpa)	Elongation at Break (%)
Spiker Silc	1.3	1300-2000	30	28-30
Flax	1.45	500-900	50-70	1.5-4.0
Hemp	1.48	350-800	30-60	1.6-4.0
Kenaf	1.3	400-700	25-50	1.7-2.1
Jute	1.3	300-700	20-50	1.2-3.0
Bamboo	1.4	500-740	30-50	2
Sizal	1.5	300-500	10-30	2-5
Coconut	1.2	150-180	4-6	20-40
Glass Fiber	2.5	1200-1800	72	2.5
Carbon Fiber	1.4	4000	235	2
Kevlar 49	1.44	3600-4100	130	2.8

Fibres provide strength and stiffness and act as reinforcement in fibre-reinforced composite materials; ultimately the properties of a composite are governed by the inherent properties of these fibres. Careful selection of the reinforcing fibres and matrix polymers, in light of the intended application, is the first step in obtaining a composite with the desired properties. Natural fibres are of basic interest since they have the ability to be functionalized and also haveadvantages from the point of view of weight andfibre-matrix adhesion, specifically with polarmatrix materials. They have good potential for use in waste management due to their biodegradability and their much lower production of ash during incineration. Nevertheless, the properties of a bio-composite may be controlled and indeed enhanced by altering those factors that control composite properties, namely fibre architecture [16] and thefibre–matrix interface. Uses of these materials have rapidly evolved over the last decade primarily due to the issue of the environment and the shortage of matrix. The surface chemical modifications [6] of natural fibres like dewaxing, alkali treatment, vinylgrafting, cyanoethylation,acetylation, bleaching,peroxide treatment, sizing with polymeric isocyanates, treatment with silane and other coupling agents have achieved various levels of success in improving fibre-matrix adhesion in natural fibre composites (Fig. 3). The SEM micrograph of the untreated fibre shows the presence of natural waxy substances on the fibre surface. Such waxy substances contributed to the ineffective fibre-matrix bonding and poor surface wet-out. The micrographs on figures reveal that all chemicalmodifications smooth the fibre surface. This is probably due to the removal of the fibre's outer surface layer through dissolution in chemical solutions during treatments. The smooth surface is observed among silane- and acrylic acid-treatedfibres, showing the best effect on the removal of the waxy layer. Sodium chlorite treatment not only smoothed the fibre surface, but also bleached the fibre. Compared with other treatments, potassium permanganate treated fibre has the roughest surface. As the waxy layer was being removed, oxidation took place between permanganate and the fibre. Aliphaticpolyesters and hydrophilic natural polymers

(a) untreated (b) alkali-treated (c) silane-treated


(d) acrylic acid-treated (e) potassium permanganate-treated (f) sodium chlorite-treated

Fig. 3: Scanning electronic micrographs of flax fibre surface after different surface modifications

arethermodynamically immiscible, leading to pooradhesion between the two components. Variouscompatibilizers and additives have been developedto improve their interface. One alternative way isthe technology of multilayer extrusion. It must, however, be borne in mind that fibre architecture, and to some extent the interface, are affected by the manufacturing technique adopted and that, depending upon the desired performance characteristics and production volumes, this will control the extent to which performance can be improved. Starch reinforced by cellulose [17] is a typical example of natural polymer composites. Nano composites consisting of Nano clays and biodegradable polymers have also been investigated more recently and have shown to exhibit superior mechanical and thermal properties. The dispersions of Nano clays in polymers from renewable resources have been enhanced via chemical surface modification and the use of novel ultrasonic methods. Considering the potential of natural fibres for composites and comparing the tensile strength, elasticity and elongation at failure with synthetic fibres, hemp and flax fibres can potentially compete with E-glass fibres, which serve as a reference because of their great importance in composite technology.

Application:
Research into bio-based products such as bio-composites is increasing in the hopes of developing alternatives to petroleum-based plastics and synthetic reinforcing fibres. Bio-composites present several environmental advantages, including reduction of fossil fuel use and lower green-house gas emissions. They also present functional benefits, with adequate tensile strength, stiffness as well as competitive costs. Examples of bio-composites include cellulosic, starch and soy-based plastics, polylactides, lignin-based epoxy and soy-based resins as well as polyhydroxyalkanoates. These are being explored as alternatives to petroleum-based plastics. Reinforcing bio fibres such as cotton, jute, flax, hemp, sisal, kenaf and more recently corn and soy are increasingly replacing synthetic fibres.Presently, the main markets for bio- composites are in the construction and automotive sectors.

- Unfortunately, the automotive industry is also responsible for producing a lot of non-recyclable and non-biodegradable waste in addition to green-house gas emissions. Plastics such as polypropylene, polyethylene, polystyrene and polyvinyl chloride, and synthetic fibres made of glass, carbon and aramid are especially cumbersome due to their potential environmental and human toxicity as well as their persistence. The so-called advanced composites made from carbon, aramid, silicon carbide, boron, or other higher modulus fibres have been widely used in the aerospace and recreational industries, and their use in the automotive and construction industries has also been explored, where general composites incorporating glass or other relatively low modulus fibres are used [1]. Present scenario is to develop both thermoset and thermoplastic natural fibre/resin composites with “challenging” properties. The term “challenging”included good chemical resistance, surface finish, complex manufacturing high mechanical properties (stiffness, impact, strength, etc.) and addressed a number of industries including medical devices, industrial, automotive, marine and construction.To verify these composites, several model products and demonstrators were produced and evaluated using modelling and structural tests.

The use of fibre-reinforced plastic composites in the automotive industry has grown significantly in recent years because of their low weight, design flexibility, corrosion resistance and cost-effectiveness. With further developments and improvements in performance, however, new opportunities and applications will likely arise. For composite

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materials made from renewable materials, the greatest advantage, environmentally, is to be gained by having natural fibres and natural resins. Natural fibres, such as hemp, flax and wood have already found

Fig. 4: Flax/PLA interior floor-well panel Fig. 5: Frame for holding the foot-well panel

applications in the automotive industry (Fig. 4 & 5), primarily in non-structural parts such as interior panels, parcel shelves, etc. This is often because variability in the fibre properties can lead to variability of mechanical properties. In general, natural fibres are chopped and randomly distributed but they need to be used in mats or continuous fibre formto achieve significant advantages from reinforcement of the resin system. At present, the natural fibres are generally usedwith conventional resins such as unsaturated polyester and polypropylene, so the advantage to their use is limited. The use of continuous fibre composites and long fibre thermoplastics (LFTs) have been favoured for low volume, niche vehicles whereas chopped fibres in sheet or bulk moulding compounds (SMC and BMC) have strongly entered the high volume production markets.

Fig. 6: Exterior engine components from Natural FibreFig. 7: Vehicles incorporating bio-based materials: Toyota RaumPolyester compositesuses Eco Plastics in its spare tire cover and floor mats

Due to on-going research and incentives, automotive manufacturers are developing and using bio-based materials in vehicles(Fig. 6, 7, 8 & 9). Plant-based cars are the wave of the future. Researchers are working on developing materials from plants like Hemp, Kenaf, Corn, straw and grass to replace plastic and metal-based car components. Automakers now see strong promise in natural fibre composites. Natural fibre like Hemp has higher strength to weight ratio than steel and is also considerably cheaper to produce. Natural fibre composites are emerging as a realistic alternative to glass-reinforced composites. While they can deliver the same performance for lower weight, they can also be 25-30 percent stronger for the same weight. Moreover, they exhibit a favourable non-brittle fracture on impact, which is another important requirement in the passenger compartment. Currently, there is a significant drive to switch to more sustainable and renewable materials, whilst still reducing weight and cost and maintaining reliability. In addition, with some renewable materials, end-of-life vehicle issues are more easily addressed because the materials are biodegradable or easily recycled. Thermoset resins derived from plant oils such as soybean and linseed are also under development for commercial application. The furan-based [18] resins are being developed by TransFurans Chemicals under the trade-names BioRez™ and Furolite™ now are used in some interior panels. The resins are synthesized from pre-polymers of furfuryl alcohol, which is derived from biomass sources including sugar cane bagasse. Furan resins offer a number of interesting properties such as high stiffness, fire resistance and chemical resistance to organic and inorganic acids. While this material is a natural, renewable material, it does not easily biodegrade. Toyota, DaimlerChrysler and Ford [19] are progressively incorporating bio-based materials into some of their models. It is clear that more research and facilities are needed to increase the competitiveness of bio-based materials as feasible alternatives. Bio-composites will only increase in mainstream use through government resources, public education and academic and industrial attention.

Fig. 8: Mercedes S-Class uses 27 bio-based Components [19]Show in 2003

Fig. 9: The Ford Model U presented at the Detroit Auto

Bio-composites (or biodegradable eco-composites) are created by incorporating natural fibres into green polymer materials. Advantages of bio-composites include compostable materials and zero impact on global warming. Limitations of these materials include the listed disadvantages of the bio-composites. A network of salvage and shredder facilities process about 96 percent of these old cars, about 25 percent of the vehicles by weight, including plastics, fibres, foams, glass andrubber, remains as waste. A car made mostly of heated, treated and moulded bio-fibre would simply bury at its lifetime, which would be consumed naturally by bacteria. The ultimate goal is to eventually use bio-composites in automotive manufacturing, promoting cost reduction through and environmental impact.

- Green buildings are planned to be environmentally responsible, economically viable, and healthy places to live and work. One of the main materials that is currently used in green buildings is bio-composite. Generally, we can claim that bio-composites have received increasing attention from both of the academic world and industries. Among all existing applications, a high growth is clear for the building applications. In other words, bio-composites have been used widely for making building products such as window, door, siding, fencing, roofing, decking, and so on. Benefits can be explained from the following aspects: (i) environmental, (ii) biological, (iii) production, (iv) component weight issues, (v) financial and (vi) general.

Bio-composites have been classified with respect to their applications in building industry into two main groups: structural and non-structuralbio-composites [21]. A structural bio-composite can be defined as one that is needed to carry a load in use. For instance, in building industry, load bearing walls, stairs, roof systems, and subflooring are examples of structural bio-composites (Fig. 10). Structural bio-composites can range broadly in performance from high performance to low performance materials. A non-structural bio-composite can be defined as one that is not needed to carry a load in use. Materials such as thermoplastics, wood particles, and textiles are used to make this kind of bio-composites. Non-structural bio-composites are used for products such as ceiling tiles, furniture, windows, doors, and so on.

Flax and hemp fibres can be used in several applications such as composite fillers, geotextiles, nonwovens, insulation, textile segments, pulp, paper, fibreboards, soil amendments, drilling muds, animal bedding, and absorbents. Wheat straw is also one of the competitors for hemp and flax in some of these applications. Hemp and flax fibres can be used as replacements for fibre glass due to their good properties such asstiffness and strength, lower cost, lower weight, and easier recyclability. However, these bio-fibres are not price competitive with wood and other agricultures residues. Traditional crop straw (wheat, rye, and corn), oilseed flax straw, wood residues, and swithgrass are the cheapest bio-fibres. Then, cotton and e-glass fibres are considered as the most expensive ones together with kenaf and hemp bast fibres. The residue fibre from the sugar cane processing (bagasse) is utilized in much of the Americas. In 1920, Celotex built the first bagasse composition panels [3]. Bagasse is available all over North America and is composed of pith and fibre which is long (1 to 4 mm) and thick walled. Bagasse fibres are used for particleboards, fibreboards, and composition panel production in North America. In 1958, in Venezuela, Tablopan de Venezuela produced a line of bagasse fibreboards. In addition to bagasse, other agricultural fibres are also currently used in composites in various applications. In Peru, bamboo and wood fibres have been used in prefabricated panelised construction [22]. In this kind of construction (Fig. 10), low technology methods are used for prefabricated panels of bamboo and wood fibres. In the northwest region of theUnited States, wheat and ryegrass straw fibres are utilized for the production of panels [23]. In Minnesota, hulls and sunflower stalks are also used for the panel applications [24].

Cereal straw is the second most usual agro-based fibre to make panel production. The high percentages of silica in cereal straw make them naturally fire resistant [25]. Also, the low density of straw panels has made them resilient. Results show that houses built by these panels are resistant to earthquake. Straw is also used in particleboards. The largest particleboard plant in the United States is in La Grande, Oregon. Rice husks are also fibrous and need little energy input to make the husks ready for use. Rice husks or their ash are used in fibre cement blocks and other cement products. The presence of rice husks in building products helps to increase acoustic and thermal properties [25].In Asia, utilization of bamboo fibres is widespread. After World War II, a building centre created in Japan and Kyoto for the development of building materials using bamboo fibres [26]. Bamboo fibres have been used in a variety of composition panels. The possibility of making three layer boards from the bamboo and wood waste has been studied in Taiwan [27]. A stress-skin panel-type product has been made by using polyurethane or polyester foam in the core and ply-bamboo in the faces [28]. In Asia, other natural fibres are also used for applications such as particleboards made from bagasse and soybean stalks and hardboards made from Thai hardwood and coconut fibres [29].

In India, inorganic boards have been also developed. In addition, researchers have developed a variety of building materials utilizing industrial and agricultural wastes that integrate cement and cementations materials as binders. These combinations are utilized to make composition boards, flooring tiles, roof sheathing, and weatherproof coatings. In the Middle East (Egypt), rice straw is the most important lignocellulose material. Rice straw is used to produce fibreboards. In comparison to wood fibres, rice straw has low quality due to its high percentages of no fibrous materials included in it. But, with care to rice straw fabrication, the properties of board can be increased considerably [30]. In addition, in the Middle East, other agricultural fibres such as bagasse, hemp, cotton, and kenaf have been used to produce hardboards and have shown better properties compared to the rice straw composition boards [31]. In Saudi Arabia, manufacturers use bagasse fibres as an alternative in composites for building materials [32]. In Philippines, the focus of the research is on using coconut coir, banana, and pineapple fibres with wood wastes for the particleboard productions [33].Use of bio-composites in building materials offers several advantages such as they are cheap, lightweight, environmental friendly, bio-renewable, and more durable.

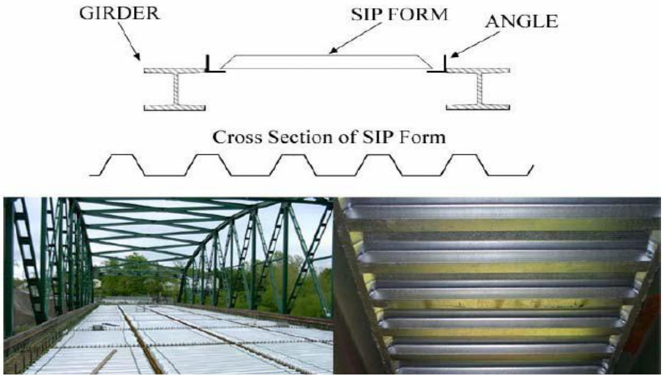

Fig. 10: Stay-In-Place Bridge Form

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For applications in marine industries, bio-composites are sensitive to water, and flax reinforced PLLA showed a large drop in mechanical properties after immersion in sea water, a strategy to reduce the influence of wet ageing by adding extra layers of PLLA on the bio-composite surface. The moulding of the bio-composite and coating is carried out in one operation. After use, the component is still recyclable and can be composted and coatings can effectively protect bio-composites after ageing in seawater.

- Starch-based [20] materials are currently being used, as are products based on recycled fibres, which are used for boxes and other rigid packing media.

III. CONCLUDING REMARK

Many problems have been associated with the utilization of petroleum based products such as increasing costs, and environmental degradation due to extraction, processing, and disposal. Therefore, researchers have recently focused attention on bio-composites. Development of bio-composites as an alternative to petroleum based materials is addressing the dependence on imported oil, reducing carbon dioxide emission, and generating more economical opportunities for the agricultural sector. Achieving this objective will require further multidisciplinary research in the fields of engineering, biology, agriculture and economy along with government support through education, subsidies and tax breaks. Eco-friendly bio-composites from plant derivedfibre and crop-derived plastics would be the novelmaterials of the 21st century not only as a solution to the growing environmental threat but also as a solution to alleviating the uncertainty of the petroleum supply which is expected to decline between 2010 to 2020. Natural fibres offer a possibility to developing countries to use their own natural resources in their composite processing industries. Natural/Bio-fibre surface modifications, development of bio-plastic as a suitable matrix for composite fabrication and processing techniques all play vital roles in designing and engineering bio-composites of commercial interest.Use of bio-composites in building materials offers several advantages such as they are cheap, lightweight, environmental friendly, bio-renewable, and more durable. However, in addition to these advantages, they have some disadvantages as well, such as moisture absorption and photochemical degradation because of the UV radiations. For this purpose, some research is going on to address these issues.New environmental regulations and societalconcern have triggered the search for new products andprocesses that are compatible to the environment. Theincorporation of bio-resources in to composite materialscan reduce further dependency of petroleum reserves. Themajor limitations of present bio-composites are their high cost. Again renewable resource based bio-plastics are currently being developed and need to be researched more to overcome the performance limitations.

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