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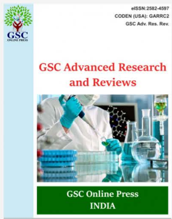

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Properties and application of jute fiber reinforced polymer-based composites

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Abstract

Natural fiber composite is the novel materials in recent decades having a high strength to weight ratio and light in weight are widely used for structural and unstructured applications. Jute fiber is one of the most common biodegradable natural fibers which successfully replaced the synthetic fibers composite and also replaced glass fiber where the high strength is not obliged. Jute is grown in tropical countries and is one of the strongest bast fibers with low cost. Jute fiber composite has several attractive advantages over synthetic and glass fiber like as low processing cost, low density, stiffness and excellent mechanical properties. This advantage makes the jute a very attractive reinforced fiber for composites and increased attention in construction, automotive, aerospace and many others. This paper presented an overview on different jute fiber reinforced based polymer composites with mechanical characterization and their applications. The jute composites involving various thermoset, thermoplastics polymers, bio-based resins, jute hybrid composites and their mechanical properties are elucidated.

Keywords: Jute Fiber; Natural Fiber; Composites; Mechanical Properties; Thermo-set Composite

1. Introduction

Since the 1990s, Natural Fiber Composites (NFC) are emerging as realistic alternatives to the synthetic fiber reinforced composites in many applications. Technologies have been developed to incorporate jute fiber with synthetic polymers/resins for partial replacement of high-cost synthetic fiber for low load bearing applications. The prominent advantages of natural fibers include acceptable specific strength properties, low cost, low density, high toughness and good thermal properties, low specific weight, which results in a higher specific strength and stiffness than expensive synthetic fibers e.g. carbon, aramid, glass etc. [1]. They are also less abrasive with respect to processing tools and, most importantly they are harmless to mankind and society. The main drawback of these fibers is that their mechanical properties depend on several factors like moisture content, cultivation area, and processing methods, and their thermal stability is also poor [2]. The combination of these fibers with the biodegradable matrices, however, are giving environmentally-friendly 'green' products, which are satisfying the needs of society at the present time. Composites are usually fabricated with biodegradable polymers as matrix phase and natural fibers as enhancement phase. Jute fiber has nearly the highest specific strength and modulus in lignocellulosic fiber (jute fiber, hemp fiber, sisal fiber, abaca fiber, and so on) which is especially meaningful to enhance composites [3].

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Some studies demonstrated that the treated jute fiber showed better performance in specific fields (e.g., household accessories, footwear additive, car parts, roof tiles, and packing [4]. Similarly, other studies showed that the treated fiber with radio activation also improved performance in various fields like electrical wire, roofing material like celling, and structural materials like beams and panels [5]. Furthermore, various surface treatments have contributed to better bonding between the jute fiber and polymeric matrix material. They should be bacteria-retardant, flame-retardant, and moisture-retardant to enhance their life span [6].

Jute fibers are very much compatible with epoxy matrix as both the fiber and the matrix adhere to each other very well forming a strong bond between them. The potential to replace the synthetic fibers in the composite manufacturing world as they show similar or better physical and mechanical properties in a wide variety of cases such as window panels, decorative items, cushioning pad, fishing rod, internal parts of aero plane, lampshades, food trays & interior paneling etc. [7] The tensile strength was found to be maximum of starch-jute fiber hybrid composite for the composition of 15% fiber by weight composite as 10.43 MPa with epoxy coating [8]. Hybridization of coir fibers composites with jute fibers can improve the dimensional stability, extensibility and density of pure coir composites [9]. The mechanical properties of a novel hybrid bamboo/jute/polyester composite with five different combinations and its applications have been discussed for small wind turbine blade. Jute fibers find wide applications in polymer-based composites and are used in the manufacturing of carpet and twine ropes, packaging bags, wall decoration items, sanitary items, roof tiles and kitchen sinks, various automotive parts, roofing for residential houses, commercial buildings, and so on [10].

In this paper, a review of jute fiber based reinforced composite and their applications is studied. The paper emphasizes on the type of the jute fiber composite, their physical and mechanical properties and their comparatively application on different aspects.

2. Jute fiber

Jute belongs to Tiliaceae family with nearly 30–40 Capsularis species of jute. The most widely grown are two species: Corchorus Capsularis (white jute) and Corchorus Olitorius (tossa jute). It is one of the low-cost natural fibers and is presently the bast fiber with the maximum production volume. Jute can grow 2–3.5 m in height and are very brittle, with a low extension to break because of the high lignin content (up to 12–16%). Jute fibers have a less resistance to moisture, acid and UV light. Conversely, their fine texture as well as their resistance to heat and fire are providing a widespread range of applications in industries such as textile, construction, and automotive [11]. Figure 1 shows the digital view of different form of jute fiber available.

Figure 1 (a) Jute fiber; (b) Jute yarn; (c) Jute fabric

Climatic circumstances, phase and the degradation procedure affect the configuration of fibers and also the chemical composition. The main constituents of the jute fiber i.e. cellulose, hemi-cellulose and lignin are in the range 61–73%, 13.6–23% and 12–16% respectively for the various jute grades. Small amounts of pectin, fats and waxes are also present. The chemical constituents of the jute fiber vary based on the harvest, soil conditions, retting methods used namely water retting, dew retting or enzymatic retting which shown in table 1. The mechanical properties of the jute are low density (1.30–1.45 g cm-3), good tensile strength (393–773 MPa), good Young's modulus (13–26.5 GPa) and low elongation at break (1.16–1.5 %) depend on region of plantation, method utilized for extraction of fibers, the harvest time, the proportion of chemical constituents, the micro fibrillar angle and the diameter of the fibers. Jute fiber can be used either independently or blended with other fibers and materials. Jute composite materials consist of jute fibers of high strength and modulus embedded in or bonded to a matrix with distinct interfaces (boundary) between them. In this form, both fibers and matrix retain their physical and chemical identities, yet they produce a combination of properties that cannot be achieved with either of the constituents acting alone. In general, jute fibers are the principal load carrying member, while the surrounding matrix keeps them in the desired location and orientation, acts as a load transfer medium between them, and protects them from environmental damages due to elevated temperature and humidity [12].

Table 1 Chemical constituents of Jute fiber

Cellulose (%)	Hemicellulose (%)	Lignin (%)	Wax & Pectin (%)	References
61.2	23.2	13.7	0.5	[13]
61-73.2	13.6-20.4	12-16	-	[14]
71.0	14.0	17.0	0.5	[15]

3. Types of composites

3.1. Jute-based thermoset composites

The mechanical properties of jute-epoxy composites have been widely investigated. Three types of composite laminates from jute preforms (jute woven fabric, jute non-woven mat and jute carded-sliver) and epoxy resin is studied. In terms of stiffness sliver reinforced composite shows the highest stiffness and non-woven composites shows the lowest stiffness. In terms of strength, non-woven reinforced composite shows the lowest values. The strength of woven and sliver reinforced composites have been found to be almost similar [16]. The alkali treated jute/epoxy composite is fabricated and its effect on mechanical properties was determined using water absorption, thickness swelling (TS) and morphology test. Jute mat reinforced composites absorbed less water with time as compared to fiber reinforced samples and were found to have no dimensional change in both the water environments. The alkali treatment given to the fibers played a key role in limiting the undue absorption as well as swelling of the composites [17]. The effect of alkali treated jute fibers, treated with oligomeric siloxane, on mechanical properties of jute/epoxy composite was determined using tensile, flexure and short beam shear test [18].

3.2. Jute-based thermoplastic composites

Of the common thermoplastics used with jute fibers, the polypropylene and polyethylene matrix are widely used. The adhesion between the hydrophilic jute fibers can be improved using physical and chemical modification. The physical modification entails use of plasma, steam, ionizing radiation, etc. while chemical treatment include alkali, acetylation, use of maleate coupling agents such maleic-anhydride grafted PP, silane coupling agents, etc. The fabrication process of long-fiber reinforced unidirectional thermoplastic composites (jute-PLA composite and jute-PP composite) made using jute yarns (both untreated and treated) by Tubular braiding technique was investigated and showed improvements in tensile (stiffness by 18.3%) and bending properties (strength by 5.3% and stiffness by 12.3%) due to coating treatment on the fiber surface, except for tensile strength. For jute/PLA composites, maximum tensile stress and modulus increased with increasing fiber volume fraction, and for jute/PP composites, tensile and bending properties increased significantly [19]. Jute fiber reinforced polypropylene matrix composites by hot compression molding technique with different fiber condition (untreated and treated), fiber sizes and weights were developed and treated with 20% sodium hydroxide. Compared to untreated fiber, no significant change in tensile strength has been observed for treated jute fiber reinforcement but fiber length with 2mm and 10% fiber content showed better tensile strength [20]. Many studies have been carried out on jute-polyethylene composites. The mechanical properties of jute-polyethylene composites are summarized in Table 2.

Table 2 Mechanical properties of jute- polyethylene composites

Fiber content	Chemical treatment	Processing	Tensile strength (MPa)	Flexural strength (MPa)	Flexural modulus (MPa)	Impact strength (j/m)	Reference
300 g/m2	60 W oxygen plasma, 15 min	Hydraulic molding	-	45.6±1.8	1244.5±18.5	-	[21]
30% (wt.)	1% MAPE, 5 min	Melt mixing	40.14	47.97 ± 1.3	-	65.69	[22]

3.3. Hybrid jute composites

The natural fiber hybrid composites fabricated fall in two categories: (a) natural fiber hybrid composites and (b) natural synthetic fiber hybrid composites. The UV radiation effect on tensile and bending properties of bleached Jute, E-glass fiber (mat)-reinforced and unsaturated polyester (USP) resin, hybrid composites made by hand lay-up method is studied and the investigation shows maximum mechanical properties at 25 (% wt.) fibers loading. Radiation treatment on both the jute and glass fiber maintaining 1:3 ratios give the best mechanical property [23]. The effect of stacking sequence on tensile, flexural and impact properties of woven basal-jute-reinforced polyester hybrid composites made by compression molding technic was studied. The oil palm EFB-jute-epoxy hybrid composites was prepared using sandwich structures and their physical properties were evaluated by water absorption, thickness swelling and density test [24, 25].

3.4. Jute based bio-composites

For a completely bio-degradable or green composite, both the fiber and specially the matrix have to be fully bio-degradable. A bio-degradable polymer such as bio-polyester poly lactic acid or PLA, PBS, bio-based epoxy resin, soybean oil resin etc. has been used for such composites. The effect of alkali treatment on mechanical properties jute/PLA composites was studied. The composites were prepared using 3 mm short fibers up to 25wt% in PLA using injection molding process. This study demonstrated that alkali treated jute fiber considerably improved the flexural properties of composites (with 20% fiber loading) compared to that of composite with untreated jute fiber. The rough surface morphology due to alkali treatment reduced the water absorption rate, thermal stability, and degradation rate of composites [26]. The effect of alkali, silane, and combined alkali and silane surface treatment on the mechanical and thermal properties and water absorption of jute/poly (butylene succinate) (PBS) composites were investigated. Among all, the combined alkali and silane treated jute/PBS composites showed the best mechanical properties at 50wt% fiber content, and better thermal stability. However, the surface-treated jute/PBS composites showed relatively lower water absorption behavior compared to untreat ones [27]. Partially degradable alkali treated jute/epoxy based green composite, made by compression molding technic, was developed with different ranging NaOH concentration. This study revealed that successive alkali surface treatment improved the compatibility of jute fiber and epoxy matrix and effective stress transfer between the fibers and matrix [28]. Degradation is a process of breakdown of chemical particles by a biological environment. Natural fibers as well as polymers can be degrading in the presences of oxygen, or anaerobically, without oxygen.

Decomposable polymers and natural fibers begin their life cycle as shown in Figure 2 as renewable resources, generally in the form of starch or cellulose

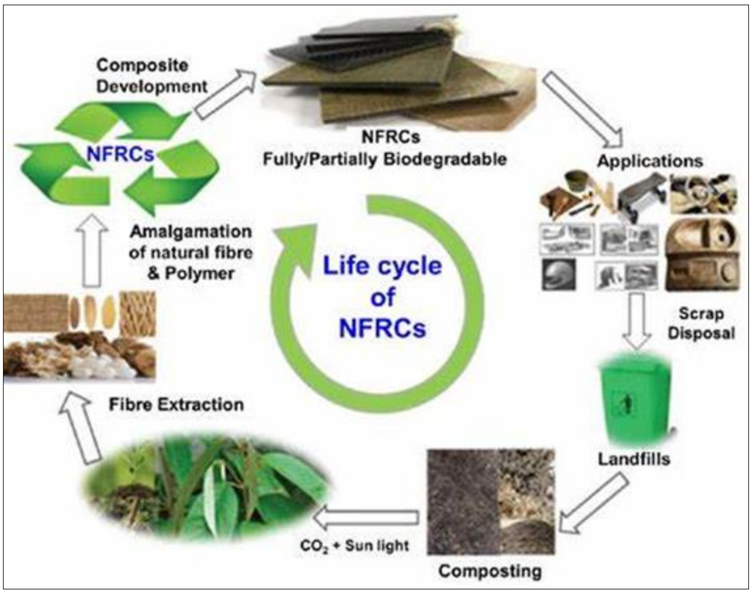

Figure 2 Flow chat of life cycle of natural fiber polymer composites

4. Mechanical Properties of jute fiber composites

4.1. Tensile Strength

With successively alkali treated jute/reinforced PLA composite at 10% NaOH and H2O2 with 20% fiber loading has shown 7.5% increase in tensile strength than that of neat PLA and untreated jute/PLA composite [29]. Tensile test and deflection temperature revealed that an adding of 40% weight of jute fiber to polypropylene increased the tensile strength by 19.7% up to (38.2±4.9) MPa and the heat deflection temperature about 143% up to (143.3±1.14)°C [30]. Aging behavior (uncoated and coated) of short jute fiber/Poly lactic (PLA) composite shows significant decrease in tensile strength of the samples occurs in hydrothermal environment when exposed for longer time. The tensile properties of Jute fiber reinforced polypropylene matrix composites with 10% weight and 2mm fiber length shows maximum increase for untreated jute fiber than the treated ones whereas no significant change in tensile properties has been observed [20, 31].

4.2. Flexural Strength

Flexural strength is the stress developed in the material before it yields in the flexural test. It represents the highest stress which is experienced when the materials yields. Chemical modification of the fiber with alkali for 4 hours, red mud filled jute/polymer composites showed maximum flexural strength that improved the composites mechanical properties. However, less percentage of water absorption was observed after the alkali treatment of fibers. The investigation of the effect of oligomeric siloxane treatment on jute thermoset composites results in an increase in tensile strength as well as flexure strength with 1% siloxane concentration. The jute/PLA composites showed better tensile strength and flexural strength with at 15% fiber loading than the plain PLA [18, 31, 32].

4.3. Compressive Strength

Compressive strength is the capability of the material to resist load. The shafts fabricated E- Glass/Jute hybrid epoxy composite have showed good mechanical strength in both compression and flexural loading than that of E-glass/banana hybrid epoxy composites [33]. Mulberry, cornhusk and commercialize weave jute reinforced epoxy composites were fabricated and the results were obtained through compressive test experiment. Using Buransky model for comparison, the alkaline treated natural fiber composites gave promising improvement in the compressive strength compared with the raw natural fiber composites [34]. The effect of reinforcing raw jute fibers with different volume content on the mechanical properties of cement concrete composites is investigated. 28 days curing period and 0.4 % is the optimum dosage of the fibers in order to achieve the maximum compressive strength of concrete. As the fiber content was increased above 0.4% the compressive strength gets reduced [35].

4.4. Water Absorption

Ability of the water absorption of jute fiber composite affected its mechanical properties. The water absorption behavior of the pultruded jute/glass fiber-reinforced unsaturated polyester hybrid composite was found to follow a non-fickian behavior. The highest values of diffusion coefficient and maximum moisture content value (Mm) were recorded for specimens immersed in distilled water, then the acidic solution, and seawater [36]. Water absorption characteristics for wood dust filler-based jute epoxy composites showed better resistance to water absorption in comparison with unfilled jute epoxy composites. Chemical modification (alkali) of fibers reduced the overall water uptake in red mud filled jute/polymer composites and thus increases the flexural properties [32, 37].

4.5. Impact Properties

Among hybrids of basalt and jute fibers, jute/banana stacking shows a better impact strength including tensile and flexural strength which puts a considerable effect on the mechanical properties of the hybrid composite. The surface treatment with alkali used broadly to measure impact properties in composite. The investigation of jute-epoxy reinforced composites' mechanical properties like tensile, flexural and impact strength, with various NaOH ranging showed that at 7% concentration of NaOH solution revealed maximum impact strength, and maximum strength 22MPa and 43.3 MPa is recorded for tensile and flexural strength respectively. The impact strength of PLA composite was 26% higher at higher fiber loading compared to treated fibers in it. A considerable decrease in impact strength of jute/PLA composite after surface modification whereas flexural properties are found to be increased [24, 28, 26].

5. Thermal Properties

The thermal conductivity of the material is the rate of heat transfer through it in steady state. In terms of thermal properties of composite with more percentage of jute fiber lost more mass in function of temperature and the composite with more percentage of glass fiber lost less weight with increasing temperature [38]. The strong interfacial bonding in Treated jute-bamboo/polyethylene composite (TJBC) was attributed to hydrophobic hybrid fibers facilitated by APTS treatment that had optimum thermal stability than treated jute-bamboo/EGMA/polyethylene composite (TJBEC) [39]. To get optimum molding condition for jute/PLA long fiber pellets pultrusion process 250c melting temperature is much suitable [40].

6. Electrical Properties

The effect of Gama radiation on mechanical and thermal properties of jute reinforced based composites was investigated. Gama radiation treatment on jute and matrices, the dielectric constant and loss tangent of the composites (non-irradiated) were increased but the conductivity of the composites (irradiated) was decreased. Thus, jute reinforced 20% PE + 80% PP based composite performed the best result for thermal properties. Red dye treatment put no significant effect on the dielectric constant and loss tangent of irradiated jute/irradiated PP composites as for both untreated and treated one's electrical properties found to be increased in temperature increasing and finally became almost constant [5, 41]. Hybrid composites (fabricated jute mat with rice and sugarcane) possess good mechanical and electrical properties than BCF-jute composites signifying their importance in low strength and light weight [42].

7. Application of jute fiber composites

7.1. Building interior and construction materials

The use of jute fiber as the reinforcement phase in polymer matrix composites has opened up new possibilities for applications in the area of structural materials. Building & construction technology trends worldwide establish the fact that the composites occupy a prominent position as the building material dislodging many conventional ones. Composites are an attractive proposition considering the embedded energy especially against metals. Other important properties such as impact resistance, corrosion resistance, thermal & acoustic insulation all contribute favorably to composite claiming its position as an ideal building material. The jute composites can be very cost-effective material for 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. Also used in household applications such as chairs, lampshades, roofs, suitcases, tables, bath units, etc. Jute can be used as wood substitute for building interior. The doors made of jute-FRP skins can have potential usage in residential buildings, offices, schools, hospitals, laboratories etc. Figure 3(a,b,c) shows different types of jute-based composites.

Figure 3 (a) Jute composite door; (b) Jute composite furniture; (c) Bamboo-jute composite door.

The doors made by FRP-PUF sandwich composites offer special advantages compared to those manufactured from traditional monolithic materials such as wood & metals with some of the unique features are water proof, fire retardant, corrosion resistance, design flexibility etc. A cost & weight analysis of FRP doors vs. conventional wooden doors revealed that replacing sal wood door with FRP door could result in cost & weight savings of 40% & 60% respectively. Typical products made using jute fiber composite are Partitioning, False ceiling & roofing, Surface paneling, jute-coir composite boards, bamboo-jute composite door, FRP sandwiched door shutters, FRP toilet blocks, door skins, automotive interior trim and architectural moldings. The influence of surface treatments, reinforcement architecture, and applied through-thickness microfiber reinforcement was explored on the interlaminar fracture and delamination resistance of jute fiber/epoxy laminated composite materials. This study showed improvement of the strength and fracture toughness properties of natural fiber composites (NFCs) and ability to bear loads over traditional resin reinforced glass or carbon fiber composite material [12, 43].

7.2. In Automotive industry

Natural fibers (jute) composites are widely used in a broad range of applications in automotive industry such as molded door skins, insulations, headlining, carpets, door pad etc. Hybrid composite materials are used in many applications for their versatile properties like lightweight, strength to weight ratio, low cost, ease of structure development and high strength, shape, mass, stiffness, durability, flexibility etc. Automobile industry utilizes composites and hybrid composites in many of the interior and exterior applications. Jute mat is an example of a non-woven jute fiber composite. The manufacturing process creates a mat that can be molded into creative shapes, such as a car door panel. Manufacturers might consider using a jute fiber composite mat for products that require the characteristics of wood, but have a shape that cannot be made with a standard wood product. These applications of natural fiber composites are increasing and gaining popularity as a sustainable substitute over expensive synthetic fibers e.g. carbon, aramid, glass etc. The study of the LCA analysis of the replacement of glass fibers by jute fibers as reinforcement of composite materials was carried out to produce "green" automotive structural components. In regards to the composite materials, to produce a structural frontal bonnet of an off-road vehicle (Buggy), buggy case study demonstrated that jute fiber composite presents the best solution enhancing the environmental performance of the buggy's enclosures, hence improving the environmental performance of the whole vehicle. This case study is a first step towards the sustainability of the Brazilian buggy industry [12, 44]. The application of jute based composite for 'Headlining', where the properties of jute based composites are compared with those of conventional polyurethane foam + glass fibers based headlining. Based on the study, jute fiber based composite with 1000 GSM was found to be meeting all the end product requirements and hence is very attractive material for headlining, can be considered as an alternative to glass fiber based composite, as it offers potential advantages of weight saving, cost saving and has an ecological advantages of using renewable resources. Jute fibers are compatible with Polypropylene fibers, which enhance the stiffness and the mechanical properties of the composite [45]. Although further research is required to fully exploit the potential of such composite materials. The products are shown in Figure 4 which are manufacturing from jute composite materials.

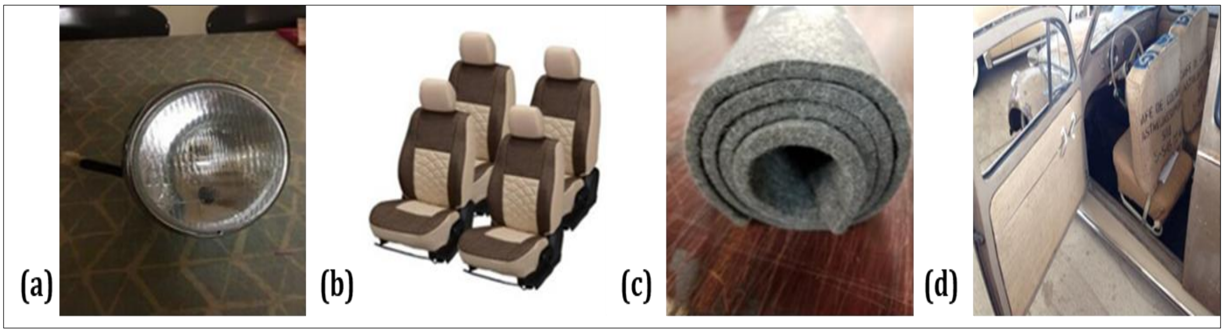

Figure 4 (a) Car headlining; (b) Seat cover; (c) Carpet padding; (d) Car panel

7.3. In Aerospace application

Another important field where hybrid jute composites are used is in the aerospace sector. The Federal Aviation Agency (FAA) stated that since World War II (WW2), composite material has been used widely in aircraft manufacture. Normally, composite material is used for up to 70% of the structure of an aircraft. In the aerospace industries, green composites are very impressive and appropriate materials because of their biodegradability, better strength and stiffness-to-density ratio, Light weight, high reliability, durability, low cost, along with superior physical properties e.g. adhesives used for attaching aero plane components. Natural fiber sandwich composites are typically prepared as thermoset composites, like epoxy resin in the aerospace field. Composites help to reduce fuel consumption, and to improve aircraft performance. The aircraft usually carries high stresses in its structures; therefore, it is important for the composites applied in the structures to have maximum creep resistance and strength. Currently, hybrid composites are used to develop the helicopters, military fighter aircraft, small and big civil transport aircraft, cockpit, satellites, launch vehicles and missiles because those natural composites have properties to reduce the weight of the aircrafts. The emergence of strong reinforcements like glass and carbon fibers and advances in polymers have also benefited in developing suitable materials that can be used in manufacturing of modern aircraft structures [46]. Some beneficial advantages of composite materials such as such as high fatigue and corrosion properties, high strength-to weight ratio, and most importantly high-performance characteristics over so-called conventional metallic materials was discussed that have made them a suitable material for aerospace structures, and myriad applications where they are employed widely and play a very significant role in those applications [47].

7.4. Ship and fishing boats

Jute as a single or hybrid fiber has proved promising as a reinforcement material for sustainable and eco-friendly applications. Laminated fiber-reinforced composite materials are now used throughout the marine industry; composites are ubiquitous in pleasure boat and racing yacht construction, are widely used in the construction of fast ferries, naval and coastguard patrol craft, fishing and work boats, and also in the offshore oil and gas industry. This is because composite materials promise many advantages over the use of steel, aluminum or wood, such as resistance to corrosion and rot, impact resistance, flexural strength, ease of forming complex seamless shapes, and high specific material properties. Among the various natural fibers jute fiber reinforced composite is one of particular interest as this composite have high impact strength besides having moderate tensile and flexural properties compared to other lignocellulosic fibers in shipbuilding. They do not get badly destroyed like the wooden ones. The composite boat lasts for 12-15 years as compared to merely 3 years of service life for wooden ones. Figure 5 shows the jute composite boats. In the event of such unforeseen calamities like tsunami, it is possible to repair & reuse most of them. A review on structural strength of fiberglass and jute is provided in the Acehnese Traditional boat *Jalo Kayoh* where main constituent of the boat is wood. Jute fiber and glass fiber show better strength than wood. Though jute fiber shows better strain than glass fiber, and glass fiber shows better more stress than jute [12, 48]. NFRP composite (bamboo, banana, jute, hemp etc.) is an effective competent for conventional fiber glass. It is beneficial to use NFRP composites for small marine applications because of their low-cost eco-friendly behavior compared to its counter parts like synthetic fibers [49].

Figure 5 Jute composite Boat

8. Conclusion

The research work on the natural fiber-based composite materials has grown by leaps and bounds over the past few years, because of its attractive properties. All varieties of natural fiber (jute fiber, hemp fiber, sisal fiber, abaca fiber, and so on) have their different mechanical properties to be used in different sector. The flexural property among these materials is good for jute. Jute fiber composite is better alternate of synthetic fibers composite due to low cost, low weight, easy availability, and eco-friendly, biodegradable and high flexural strength. From the point of view of wood substitution, jute fiber composites would enjoy wider acceptance. The jute-bio based resin composite and jute hybrid composites were briefly discussed along with jute-thermoset based composites and jute-thermoplastic based composites. Various types of the surface treatment used by several researcher and achieved affirmative results to improve the mechanical strength of the composite, and to improve the interfacial adhesion between the fiber and matrix. The hybridization of jute fiber with glass fiber leads to improvement in properties. The hybridization with other natural fibers also improves the properties. The successful exploitation of the Jute fiber composite involves understanding the characteristics of the basic fiber and its properties. Jute fibers are the present and future raw material not limited to textile applications, but also for green composites which are used in various applications like automotive, structures, aerospace, ship and fishing boats, sports, medical sector, packaging materials, toys and furnitures etc. The use of jute fiber is increasing hurriedly in industrial application. The automotive industry and aerospace industry are the most active user of the jute fiber based composites which manufactures non-structural and semi-structural parts. Still more research is required to find new ways to improve the mechanical strength of jute fiber polymer composites. Future attempts would also be required related to the commercialization of jute fiber reinforced polymer composites.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors state that there is no conflict of interest.

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