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Review on Mechanical Properties of Various Natural Fibers Reinforced Composites.

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ABSTRACT

In industrial applications and research, the use of Natural Fiber-Reinforced Polymeric composites in recent years has gone up. Natural fiber is becoming an important alternative to man-made fibers due to their abundant availability, being economical, recyclable and biodegradable as well as high mechanical strength. For reinforcement for NFRP composites cellulosic plant fibers like bamboo, sisal, kenaf, cotton, jute, pineapple, banana, etc. are used. NFRP composites have various uses as in transportation, defense, civil engineering applications, packaging, consumer products, etc. Natural fibers are more advantageous than synthetic fibres on many fronts. Mechanical properties of strength and modulus are excellent in bamboo. Only polymeric composites with biodegradability can lead to the evolution of next generation materials. For eco-friendly products to compete with products made of petroleum feedstock and capture the changing markets Biodegradable plastics is the only viable option. In the field of automotive and civil engineering applications natural or bio fiber composites are emerging as a feasible alternative to synthetic fiber reinforced composites. Special attention is required for combining bio fibers such as bamboo with polymer matrices produce composite materials that are competitive with synthetic composite materials; however due to the non-biodegradable nature of the polymer matrix bamboo fiber polyester composites are not fully eco-friendly. A lot of environmental problems will be solved by the use of natural fibres with such polymers. Natural fibers containing unsaturated polyester matrix is greatly advantageous than those of the unreinforced plastics due of the resulting strength and toughness of the composites. Besides, cellulosic natural fibers are strong enough, light in weight, inexpensive, abundant, and renewable.

Keywords: natural fibers, reinforced composites, NFRP.

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INTRODUCTION

The development of synthetic fibers has attracted materials researchers to develop composite materials and had resulted in tremendous growth of these materials. Recently, due to environmental concerns and growing cost of synthetic materials, the focus of research on natural fibers and their applications have created an enormous interest. Particularly, the study of lingo cellulosic fibers had attracted researchers due to their comparable properties at certain instances to glass, polymeric, carbon fibers, etc. Today, there is a growing environmental awareness to develop renewable, biodegradable, and environmental friendly products that are more affordable from natural sources. It was found that natural fibers can be used in several engineering applications and also had potential replacement for synthetic fibers. Natural lingo cellulosic fibers such as sisal, hemp, and flax have been used as reinforcements but lacks inadequate strength for most high-end applications particularly in fatigue and high-temperature environments [1]. Other properties such as high moisture uptake and low compatibility with matrix polymer had made them unsuitable form any engineering applications. Addition-ally, lingo cellulosic fibers were reinforced in synthetic resin systems and thereby affecting the biodegradability of the material. Despite all of these challenges, there is still a huge market potential for these composites in the automotive, aerospace (interior), civil, and textile industries mainly due to the growing cost of synthetic raw materials, diminishing natural resources, Bio-based materials are leading the current research in the field of composite. Research on composites reinforced with natural fibers has been getting an increasing attention over the past years. The incorporation of plant fibers as a reinforcing agent into composites in an environmentally friendly way was the major aim of the study. As composites reinforced with natural plant fibers can be used as alternative materials for glass-fiber reinforced composites in structural applications has brought interest from the automotive industries and construction companies [2]. Composite material based on a natural fibers reinforced in polymer matrix is called bio composites. Polymer composites with different fillers and/or reinforcements are greatly used in the automotive industry. A lot of such composites are being developed in the recent years for their use in the interior and exterior parts due to their advantages in reducing the overall lower weight of the vehicle and increase the sustainability of the manufacturing process. The problems faced in large scale manufacturing of natural fiber composites are that of poor adhesion between the fiber and matrix and the hydrophilic nature of fibers. Due to the weak adhesion of the fibers and the matrix acting as binder in the composite the desired mechanical properties in the composite is not achieved. Its key CO_2-related aspects are avoidance, reuse, mitigation and minimization [3].

Banana fiber composites

Banana fibres are obtained from the stem of banana plant called as Musasapientu [4]. When 50 percent of Banana fiber and 50 percent of chemically functionalized polypropylene are mixed they have tensile strength of 60.17 MPa, Tensile modulus of 1.87 GPA, % Increase in Tensile strength is 79.3%, and % Increase in tensile modulus is 105.4%. When 50 percent of Banana fiber and 50 percent of chemically functionalized polypropylene are mixed they have Flexural strength of 103.0 MPa, Flexural modulus of 5.82 GPa, % Increase in flexural strength is 82.3% and % Increase in flexural modulus is 177.1%. When 50 percent of Banana fiber and 50 percent of chemically functionalized polypropylene are mixed they have Charpy impact strength of 36.5J/m, Izod impact strength of 32.2 J/m, % Improvement in charpy strength 160.7 % and % improvement in izod strength is 114.6%. Natural fiber/polyolefin composites show poor fiber/matrix interfacial adhesion due to hydrophilic natural ber and hydrophobic polyolefin matrix. Feasibility of processing BF/chemically functionalized MAH-grafted polypropylene composites (BF/CFPP) by Palsule process, within situfiber /matrix interfacial adhesion, without any need of fiber treatment and without any need for a compatibilizer, is established successfully by processing 10/90, 20/80, 30/70, 40/60, and50/50 BF/CFPP by conventional twin screw extrusion and injection molding, by using CFPP in place of PP with MAPP as matrix [5]. The composite compositions show higher tensile and flexural modulus and higher tensile and flexural strengths relative to the CFPP matrix, and also show increasing modulus and strengths with increasing amounts of BFs in the respective composite compositions.

Kenaf fibre composites

The cultivation of kenaf fibres in India and also in Asian countries are increasing because of its usage in Automotive. The major constituents of kenaf are cellulose (44_67wt. %), hemicelluloses (20.9wt. %), lignin (7.5-14wt. %), and pectin (2-6wt. %).We preferred Kenaf fibre as the base fibre for the hybrid composite since it has promising Impact and tensile strength which makes it applicable in various components in automotive industries[6]. Kenaf fibres with Epoxy resin shows tensile strength of 63 MPa and tensile modulus of 555 MPa. The flexural strength of kenaf fibre composite is 167MPA and flexural modulus is 4460MPa. The impact energy absorbed by the kenaf fiber composite is 4. The kenaf based composite hardness of 73 RHN [7].

Sisal fiber composites

The Tensile Modulus, tensile strength and % Elongation at break for untreated sisal fiber with 50% of sisal fiber with mixture of polypropylene is 16.8±.015, 49±1.5 and 16.8± 0.3 respectively Whereas the tensile strength, Tensile Modulus and % Elongation at break for treated sisal fiber with 50% of sisal fiber with mixture of polypropylene is 57±3, 19±.015 And 17.7± .03 respectively [8]. The Tensile Modulus, tensile strength and % Elongation at break for untreated sisal fiber with 50% of sisal fiber with mixture of Epoxy is18±.015, 60±2and 6.5± 0.2 respectively Whereas the Tensile Modulus, tensile strength And % Elongation at break for treated sisal fiber with 50% of sisal fiber with mixture of polypropylene is 20.3±.015, 71±2, And 6.8± .02 respectively [9].

Coir Fibre composite

The coir fibre is taken from the outer shell of coconut. The fibers of coir were soaked in fresh water for 2 h and then washed with fresh water for three times. By doing so, the dust and the impurities that were covering the outer surface of the fibres, were removed. It is better to have a cleaner and rougher fiber surface by removal of impurities such as dust and waxes [10]. This increases the bond of the fiber with the cement matrix. Fibre length and content was 50 mm and 1% of the mass of the cement, respectively.

Hemp fibre composites

Natural fibre composite has a potential to be widely applied in the alternative to a fibre glass composites in sustainable energy. Impact absorption structures, Hemp reinforcement's natural composite laminates with epoxy shows 188MPa Flexural strength and 7.45 GPa Flexural modulus [11]. Flax textile and hemp textile have measured surface densities of 292 and 234, respectively. The warp and weft yarns have a balanced configuration in these reinforcements. 4 layers of biaxial textiles have been stacked together to produce hemp, according to a [0/90]2S lay-out. Fibre volume fraction was 20.16 (±1.37) %. For all hybrids, the fibre direction into each textile network is 0/ 90[12].

Flax fibre composites

Bidirectional flax fabric with a plain woven structure was used with epoxy resin to make composites. The average tensile strength and modulus of the single-strand flax yarns extracted from the fabric was 153.8 ± 17.5 MPa and 16.4 ± 1.2 GPa, respectively. The tensile strength, modulus and strain to failure of the epoxy provided by the supplier was 87.8 MPa, 3.6 GPa and 4.5%, respectively. 6 LAYER flax fabric reinforced epoxy polymer has a tensile strength of 142 MPa with a tensile modulus of 10.4 GPa & tensile strain of 4.4%. Its flexural strength is 134 MPa & flexural modulus is 8.7GPa. The 4 point bending test group with 3 specimens with a peak load of 31.0 kN flexural stress of 55.8 MPa deflection at the peak load of 5.2mm with shear and flexure failure mode. In column, "3 PB" and "4 PB" indicates three-point bending test and four-point bending test, respectively. "2L", "4L" and "6L" indicates different numbers of FFRP layers. The measured surface density of the flax textile was equal to 292. All these reinforcements have a balanced configuration on warp and weft yarns [13]. Flax have all been produced by stacking together 4 layers of biaxial textiles, according to a [0/90]2S lay-out. Fibre volume fraction was 24.82 (±0.83) % for flax. For all hybrids, the fibre direction into each textile network is 0/ 90[14].

Jute Fibre Composites

The Tensile modulus, Tensile strength , %Increase in tensile modulus and % Increase in tensile strength are 1.05 Gpa,36.52MPa,156% and 60% respectively for 30% of jute fiber and 70% of chemically functionalized high density polyethylene[15]. The Tensile modulus, Tensile strength , % Increase in tensile modulus and % Increase in tensile strength are 1.03 Gpa, 34.42 MPa, 758.3% and 61.06% respectively for 30% of jute fiber,70% of chemically functionalized high density polyethylene and 1.2% of maleican hydride grafted polyethylene[16]. The Flexural modulus, Flexural strength , %Increase in Flexural modulus and % Increase in Flexural strength are 2.2 Gpa, 45.6MPa,134% and 81% respectively for 30% of jute fiber and 70% of chemically functionalized high density polyethylene. The Flexural modulus, Flexural strength , %Increase in Flexural modulus and % Increase in Flexural strength are 1.87 Gpa, 40.11MPa,125.2% and 63.71% respectively for 30% of jute fiber,70% of chemically functionalized high density polyethylene and 1.2% of maleican hydride grafted polyethylene[17]. The tensile strength of the heated jute textile composite is 189.479 MPa, the flexural strength is 208.705 MPa & the fibre is main and cross direction woven. The jute textile FRP exhibited a tensile strength of 189.479 N/mm^2, which is 21% of the tensile strength of carbon FRP (923.056 N/mm^2) and 28% of the tensile strength of glass (E-glass) FRP (678.571 N/mm^2). The jute textile FRP exhibited flexural strength of 208.705 N/mm^2, which is 13% of the flexural strength of carbon FRP (1587.134 N/mm^2) and 32% of the flexural strength of glass (E-glass) FRP (666.871 N/mm^2). JFRP strengthening displayed highest deformability index and proved that jute textile FRP material has huge potential as a structural strengthening material [18].

CONCLUSIONS

Natural FFRP composites with environmental and cost benefits can be used to replace synthetic glass or carbon fibre [19]. Building composites based on the cellulosic fibers like hemp, flax, jute, banana, sisal, pineapple leaf fiber within organic matrix (cement, lime, hydraulic lime, gypsum and other alternative binders) are often exposed to humid conditions during their life time. Technical hemp, because of its health benefit is used in green housing is getting major focus. It is external strengthening material enhances load carrying capacity, flexural strength, deflection and fracture energy of PC and CFRC remarkably. NaOH-clay-treated sisal fiber composites showed condensed water mass uptake due to clay being a barrier medium.

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