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COCONUT AND JUTE FIBRE REINFORCED POLYMER COMPOSITES – A REVIEW

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Abstract

In this fibres provide advantages of high stiffness and strength to weight ratio as compared to conventional construction materials, i.e., wood, concrete, and steel. The increase interest in using natural fibres as reinforcement in plastics to substitute conventional synthetic fibres in some structural applications has one of the studies the potential of using natural fibres as reinforcement for polymers. The researchers have focused their attention on natural fibre which is composed of natural or synthetic resins, reinforced with natural fibres. The manufacturing of high-performance engineering materials from renewable resources has been pursued by researchers across the world owning to renewable raw materials are environmentally sound and do not cause health problem. This paper outlines some of the recent reports published in journals on polymer composites based on coconut fibre reinforced polymer composites and jute fibre reinforced polymer composites and its comparative study on properties with synthetic fibres.

Keywords: Polymer, Composites, Coir, Jute Fibre, Natural Fibre.

Introduction

The materials are to reduce the cost of traditional fibres (i.e., carbon, glass and aramid) reinforced petroleum-based composites; new bio-based composites have been developed. Researchers focus attention on natural fibre composites they are a low-density material yielding relatively lightweight composites with high specific properties. These fibres turn to reducing the dependency on foreign and domestic petroleum oil. Recent advances in the use of natural fibres (e.g., wax, cellulose, jute, hemp, straw, switch grass, kenaf, coir and bamboo) in composites have been reviewed.

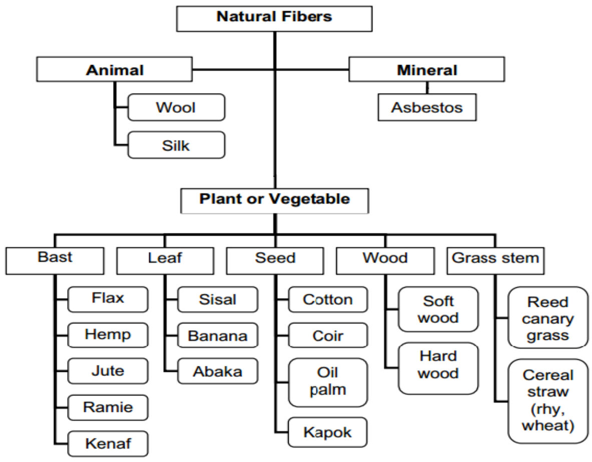

Fig 1 Classification of natural fibres

Wang and Huang [1] had taken for experiment coir fibre stack; characters of the fibres were analysed. The length range between 8 and 337 mm. In therange of the fibre in length wise is 15~145 mm was 81.95% of all measured fibres. The length range of 35~225 mm accounted for 88.342% of all measurement. The fineness of the coir fibres was 27.94 tex. Longer fibres usually had higher diameters. By using a heat press machineComposite boards were fabricated with the coir fibre as the reinforcement and the rubber as matrix. Tensile strength of the composites was investigated.

Harish et al. [2] was developed in coir composite and mechanical properties were evaluated. To obtain from fracture surfaces for a qualitative evaluation of the interfacial properties of coir /epoxy and compared with glass fibresby using Scanning electron micrographs.

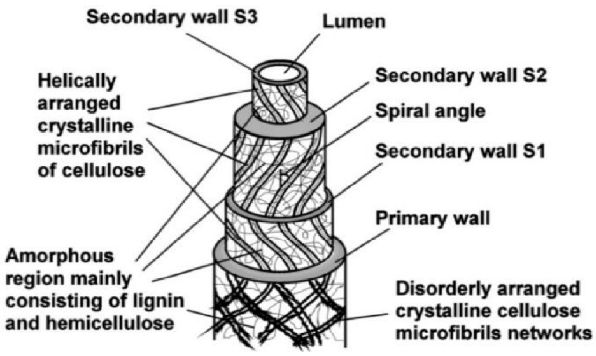

Fig 2 Structure of Natural Fibre

Nilza et al. [3] used three Jamaican natural cellulosic fibres for the design and manufacture of composite material. The sugar cane, banana trunk from banana plant and coconut coir from the coconut husk. The standardized tests such as ash and carbon content, water absorption, moisture content, tensile strength, elemental analysis and chemical analysis.

Bilba et al. [4] used from banana-treesfibres and coconut-treefibres before their incorporation in cementitious matrices, in order to prepare insulating material for construction. This fibre was studiedin thermal degradation between 200 and 700 °C under nitrogen gas flow. Temperature of pyrolysis was the experimental parameter investigated. The solid residues obtainedwereanalysed by classical elemental analysis, Fourier Transform Infra-Red (FTIR) spectroscopy and were observed by Scanning Electron Microscopy (SEM). Thefibre in the tree and type of tree, the rapid and preferential decomposition of banana fibres with increasing temperature of pyrolysis and the rough samples are made of hollow fibre.

Fig 3 Raw and short Coconut Fibre

Conrad [5] investigates lignin and pectin and the loading of Pb and Zn on coir. The distributed in the cell walls of the fibre sheath, but in the xylem, there was no detectable content in the compound middle lamella of the fibre sheath. The fibre sheath walls was in the middle lamella, cell corners and extracellular matrix, while in the xylem, the pectin was almost evenly distributed in the wall, with a higher concentration in the middle lamella and cell corners. In this investigation no correlation with lignin and a positive correlation with pectin.

Rao et al. [6] aims the new natural fibres used as fillers in a polymeric matrix enabling production of economical and lightweight composites for load carrying structures. In this research done by extraction procedures of vakka, date and bamboo fibres has been undertaken. The established fibresare determined experimentally under similar conditions and compared. The effective reinforcement for making composites, which have an added advantage of being lightweight.

Dick et al. [7] Conduct tests on glass-filled polycarbonate, to collect results for evaluation of a theoretical model on its capability to predict the fatigue life and the residual strength after the cyclic loading and study quantifies the effects of loading conditions, i.e., the maximum stress level damage development is happened.In this research demonstrates the possibility of expressing each of the model parameters as a function of single variable that is maximum stress level, or a material-dependent constant.

Ersoy and Kucuk [8] investigated the sound absorption of an industrial waste, developed during the processing of tea leaves. Three waste materials with and without backing provided by a single layer of woven textile cloth was tested for their sound absorption properties. The data indicate that a 1 cm thick tea-leaf-fibre waste material with backing provides sound absorption which is almost equivalent to that provided by six layers of woven textile cloth. Twenty millimetres thick layers of rigidly backed tea-leaf-fibres and non-woven fibre materials exhibit almost equivalent sound absorption in the frequency range between 500 and 3200 Hz.

Jacquemin et al [9] proposed an analytical micromechanical self-consistent approach dedicated to mechanical states prediction in both the fibre and the matrix of composite structures submitted to a transient hygroscopic load. The reliability of the new approach is checked, for carbon–epoxy composites, through a comparison between the local stress states calculated in both the resin and fibre according to the new closed-form solutions and the equivalent numerical model.

Fig 4 Specimen of coconut fibre reinforced epoxy composites

Wang et al. [10] investigated the effective thermal conductivity enhancement of carbon fibre composites using a three-dimensional numerical method First a more realistic three-dimensional distribution of fibres dispersed in a matrix phase is reproduced by a developed random generation-growth method to eliminate the overrated inter-fibre contacts by the two-dimensional simulations. The energy transport governing equations are then solved through the three-dimensional structures using a high-efficiency lattice Boltzmann scheme. The resultant predictions agree well with the available experimental data.

Yetgin et al. [11] studied the compression and tensile tests for five different adobe mixtures. The important part of this study consisted of uniaxial compressive tests done with natural fibre mixtures. Thus, the results were presented in the form of stress–strain graphs. In addition, mechanical properties were related to the water content for workability, unit weight and fibre contents and discussions were given. The fibre content increases, compressive and tensile strengths decrease, and shrinkage rates decrease.

Rahman et al. [12] studied the surface treatment of the coir fibre and its mechanical properties. Fibre surface modification by ethylene dimethyl acrylate (EMA) and cured under UV radiation. Pre-treatment with UV radiation and mercerization were done before grafting with a view to improve the physic mechanical performance of coir fibres. The effects of mercerization on shrinkage and fibre weight losses were monitored at different temperature and alkali concentration. They observed that, fibre shrinkage is higher at low temperature and 20% alkali treated coir fibres yielded maximum shrinkage and weight losses. It was found that higher shrinkage of the polymer grafted fibre showed enhanced physico-mechanical properties. The grafting of alkali treated fibre shows an increase of polymer loading (about 56% higher) and tensile strength (about 27%) than 50% EMA grafted fibre. The fibre surface topology and the tensile fracture surfaces were characterized by scanning electron microscopy and were found improved interfacial bonding to the modified fibre–matrix interface.

Albuquerque et al. [13] evaluated the effect of fibre surface wettability, alkali treatment and different ageing conditions on the tensile properties of longitudinally oriented jute roving reinforced polyester composites as a function of fibre content. It was found that the tensile properties of longitudinal composites increased with fibre content.

Das et al. [14] reported that the tensile strength of the bio composite films (5, 10 and 15 wt.% filler loaded) increased by 51%, 130% and 197%, respectively in comparison to the unreinforced one. This improvement in the tensile strength was due to very fine nature of jute micro/Nano fibrils (JNF) and also due to effective stress transfer at the interface between the matrix and JNF.

Doan et al. [15] studied the effect of coupling agent (maleic anhydride grafted polypropylene) on the tensile behaviour of short jute fibre reinforced polypropylene composites. It was found that thetensile strength of jute/PP composites increased in humid ageing conditions, which was attributed to both improved polymer-matrix and interfacial adhesion strength.

Gowda et al. [16] evaluated the tensile behaviour of jute fabric reinforced polyester composites in both longitudinal and transverse direction. It was found that the tensile strength and modulus of composites obtained in longitudinal direction were almost five times the strength and modulus of polyester resin and twice that for the transverse laminate. The differences in ultimate stress between the same laminate specimens are due to the highly non-uniform and inconsistent nature of the jute fibres.

Hong et al. [17] investigated the tensile properties of jute-polypropylene composites in order to detect the reinforcement effects of the untreated and silanized jute fibres.

Jawaid et al. [18] fabricated tri layer hybrid composites based on chopped mat of oil palm EFB and jute fibres with two different stacking sequences i.e. EFB/Jute/EFB and Jute/EFB/Jute. The tensile properties were slightly higher for the composites having jute as skin and oil palm EFB as core material.

Jawaid et al. [19] reported that the incorporation of jute woven fibre in pure EFB composite enhances the tensile property of hybrid composites.

Khan et al. [20] studied the tensile behaviour of jute-polycarbonate composites with 13 %, 23 %, 26 %, 32 %, 35 % and 42 % jute content. It was found that as the fibre content raised the tensile strength of the composites increased up to 32% jute content, butfurther increase in the jute content led to decrease in the strength values.

Liu et al. [21] evaluated the effect of surface modification on the tensile properties of jute poly (butylenes succinate) (PBS) bio composites. It was found that the tensile strength and modulus increased gradually from 0 wt. % to 20 wt. % of fibre and at 30 wt. % there is a drop in tensile properties. The decreased tensile strength at 30 wt.%fibre loading may be due to the presence of so many fibre ends in the composites that cause crack initiation and hence potential composite failure as well as no uniform stress transfer due to grouping of the fibres within the matrix.

Mohanty et al. [22] studied the effect of jute fibre content on the tensile behaviour of jute fabrics-polyester amide composites. Jute content was varied from 20 to 53 wt. % to determine its effect on the tensile properties. The tensile strength of composite increased from 20 to 32 wt. % fibres loading and afterward with further increase of jute content properties tend towards lower values.

Mohanty et al. [23] reported that the tensile strength of jute-Biopol composites was enhanced by more than 50% relative to pure Biopol sheets.

In another study, **Mohanty et al. [24]** investigated the effect of fibre loading on the tensile strength of untreated jute fibre reinforced high density polyethylene (HDPE) composite. It was observed that the tensile strength of the composite increased with increase in fibre loading from 0 to 30 wt. %, above which there was a significant decline in the strength. An increase in tensile strength of the composite was observed with the increase in concentration of maleic anhydride grafted polyethylene (MAPE) up to 1 %.

Plackett et al. [25] studied the tensile behaviour of jute fibre reinforced L-polylactide composites. It was found that the tensile strength and stiffness of the composites was almost doubled when jute fibre reinforcement was used on 40 wt. % basis.

Rahman et al.[26] investigated the tensile behaviour of the raw and oxidized jute fibre reinforced polypropylene (PP) composites and urotropine post-treated composites at different fibre loading. It was observed that the tensile strength of the raw jute fibre reinforced composites decreases with increase in fibre loading which may be due to the increase in the weak interfacial area between the fibre and matrix. In order to increase the compatibility of jute fibre with PP, raw fibre was oxidized and manufactured composites were post-treated with urotropine. The result indicates that the tensile strength of the composites with 20 wt. % fibre loaded post treated composite is increased when compared to the PP matrix itself.

Seki [27] studied the effect of siloxane treatment on the tensile properties of jute-thermoset composites. It was found that the siloxane treatment on the alkalized jute fabrics results in improved tensile properties of both jute epoxy and jute-polyester composites.

Stocchi et al. [28] studied the effect of treatment on the tensile behaviour of woven jute fabric/vinyl ester composites at two different times of treatment. It was exhibit significant improvement in the stiffness compared to composites with 24 h alkali treated mats under biaxial stress and untreated mats.

Fig 5 Raw and Short Jute Fibre

Tao et al. [29] investigated the tensile properties of natural fibre/PLA composites with short jute and ramie as reinforcement. The fibre loading of jute-PLA and ramie-PLA composites were varied from 10-50 %. It was found that the tensile strength of composites increased up to 30 % fibre content and after that it decreased.

Vilaseca et al. [30] reported that the increase in fibre loading results in increased tensile properties of untreated jute fibre reinforced starch polymer composites. The alkali treatment of jute fibre results in enhanced tensile properties of composites.

Ishiaku et al. [31] investigated the effect of weld line on the tensile properties of shortfibre reinforced jute/poly butylene succinate biodegradable composites. The weld lines are formed on fabrication of polymer composites by injection moulding process which often involves the use of multiple gates.

Khan and Hinrichsen [32] studied the influence of coupling agents on mechanical properties of jute fibre reinforced polypropylene composites. It was found that composites prepared with EHA treated fibre exhibit superior tensile properties than untreated and HEMA treated fibre composites.

Khondker et al. [33] studied the tensile behaviour of unidirectional jute/polypropylene composites fabricated by film stacking method. The experimental investigation revealed that the tensile strength and modulus of PP resin increased by approximately 285 % and 388 % respectively, due to 50 wt.% reinforcement by natural jute yarns. The 14% and 10% in strength and modulus, respectively were achieved when treated yarns were used.

Mantry et al. [34] investigated the tensile behaviour of both unfilled and SiC particles filled jute epoxy composites. It was found that the tensile strength of unfilled jute epoxy composite increased with increase in fibre loading. On the other hand, the strength of particle filled jute composites decreased with the increase in the particle content.

Yang et al. [35] was studied the effect of fibre content and hot water immersion on tensile properties of injection moulded jute/polypropylene composites. Firstly, the tensile strength of composite increased with increase in fibre loading but latter it decreased after 30 wt.% of fibre. As FRP composites has found increasing application in the aerospace, automobile, aviation and marine industries, they are susceptible to such loading conditions and catastrophic failure of the components may occur due to increase in the external load. Thus, it is necessary to understand the flexural behaviour of the composites. Several authors have studied the flexural behaviour of jute fibre-based polymer composites.

Ahmed et al. [36] is an increase in flexural properties of jute-glass polyester composites with the increase in fibre content from 0 to 40 wt.% of the fibre. But, no further improvement in the flexural properties was observed with the increase in fibre weight to 60 %. Analysis of the effect of fibre surface wettability, alkali treatment and different ageing conditions on the flexural properties of longitudinally oriented jute roving reinforced polyester composites as a function of fibre content was done. It was observed that the flexural property of longitudinal composites increases with fibre content.

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Fig 6 Specimen of jutefibre reinforced epoxy composites

Conclusion

This paper has provided an in-depth review of the previous investigations on various aspects of polymer composites based on natural fibers like coconut fiber and jute fiber reported by the researchers

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