CHAPTER 2

LITERATURE SURVEY

The purpose of this literature review is to provide background information on the issues to be considered in this thesis and to emphasize the relevance of the present study. The purpose of this chapter is also to provide a broad understanding of effect of fiber loading and fiber length on mechanical properties of fiber reinforced polymer composites. In polymer composites, the reinforcing phase can either be fibrous or non-fibrous (particulates) in nature and if the fibers are derived from natural resources like plants or some other living species, they are called natural fibers.

2.1 ON NATURAL FIBER REINFORCED COMPOSITES

Mansur and Aziz (1983) studied Bamboo mesh reinforced cement composites. In that an experimental investigation was conducted on cement mortar reinforced with woven bamboo mesh in a manner similar to Ferro cement. The main parameter of the study was the volume fraction of bamboo and its surface treatment. The effect of casting pressure was also included. The results of the tests conducted in direct tension, flexure and impact strength indicated that inclusion of bamboo mesh imparts considerable ductility and toughness to the mortar, and increases significantly its tensile, flexural and impact strengths.

Satyanarayana et al. (1986) have investigated Jute fabric-reinforced polyester composites for the evaluation of mechanical properties and compared with wood composite, and it was found that the jute fiber composite had better strengths than wood composites.
Maldas et al. (1988) experimented on PS 201-based composites and found that the impact strength improved to a comparable level to even that of the original polymer when silicate along with isocyanate was used as a coating component of the fiber.

Satyanarayana et al. (1990) have investigated the Bamboo-mesh reinforced cement composites, and found that this reinforcing material could enhance the ductility and toughness of the cement matrix, and increase significantly its tensile, flexural, and impact strengths.

Cazaurang et al. (1991) carried out a systematic study on the properties of henequen fiber and pointed out that these fibers have mechanical properties suitable for reinforcing thermoplastic resins.

Joseph et al. (1993) studied the effect of chemical treatment on the tensile and dynamic mechanical properties of short sisal fiber reinforced Low Density Polyethylene (LDPE) composites. It was observed that the Cardanol derivative of Toluene Diisocyanate (CTDIC) treatment reduced the hydrophilic nature of the sisal fiber and enhanced the tensile properties of the sisal-LDPE composites. They found that peroxide and permanganate treated fiber-reinforced composites showed an enhancement in tensile properties. They concluded that fiber with a suitable fiber surface treatment could improve the mechanical properties and dimensional stability of sisal-LDPE composites.

Karmaker and Schneider (1996) developed composites using jute and kenaf fiber with polypropylene resins and they reported that jute fiber provides better mechanical properties than kenaf fiber.

Karnani et al. (1997) have reported that, the natural fibers such as sisal, coir, jute, ramie, pineapple leaf, and kenaf have the potential to be used
as a replacement for glass or other traditional reinforcement materials in composites. Natural fiber reinforced composites have attracted the attention of research community mainly because they are turning out to be an alternate solution to the ever depleting petroleum sources. They are increasingly adopted to replace synthetic polymers in the industrial applications. The mechanical properties of a natural fiber-reinforced composite depend on many parameters, such as fiber strength, modulus, fiber length and orientation, in addition to the fiber-matrix interfacial bond strength. A strong fiber-matrix interface bond is critical for high mechanical properties of composites. A good interfacial bond is required for effective stress transfer from the matrix to the fiber whereby maximum utilization of the fiber strength in the composite is achieved.

Pothan et al. (1997) have investigated the short banana fiber reinforced polyester composite. This study concentrated on the effect of fiber length and fiber content. The maximum tensile strength was observed at 30 mm fiber length while maximum impact strength was observed at 40 mm fiber length. Incorporation of 40% untreated fibers gave a 20% increase in the tensile strength and a 34% increase in impact strength. On treatment with silane coupling agent, composites showed a 28% increase in tensile strength and a 13% increase in flexural strength.

Fuad et al. (1998) investigated a new type wood based filler derived from Oil Palm Wood Flour (OPWF) for bio-based thermoplastic composites by thermo gravimetric analysis and the results are very promising.

Iannace et al. (1999) have studied bio-composites based on sea algae fibers and biodegradable thermoplastic matrices. In that composites were prepared by mixing thermoplastic biodegradable polymers with sea algae fibers. Tensile mechanical properties were analyzed as a function of fiber concentration. The effect of processing, such as compression molding
and calendering, on the mechanical properties of the materials was investigated. Composites showed higher elastic modulus and lower strength than the matrix components. Fiber damaging, characterized by a reduction of both length and diameter, was observed in the composites.

Luo and Netravali (1999) studied the tensile and flexural properties of the green composites with different pineapple fiber content and compared to the virgin resin. Sisal fiber is fairly coarse and inflexible. It has good strength, durability, ability to stretch, affinity for certain dyestuffs, and resistance to deterioration in seawater. Sisal ropes and twines are widely used for marine, agricultural, shipping, and general industrial use. Incorporation of 40% untreated fiber provides a 20% increase in the tensile strength and a 34% increase in impact strength.

Mohanty et al. (2000) studied the influence of different surface modifications of jute on the performance of the bio composites. More than a 40% improvement in the tensile strength occurred as a result of reinforcement with alkali treated jute. Jute fiber content also affected the bio composite performance and about 30% by weight of jute showed optimum properties of the bio composites.

Sreekala et al. (2000) have studied the mechanical performance of treated oil palm fiber-reinforced composites. They studied the tensile stress-strain behavior of composites having 40% by weight fiber loading. Isocyanante, silane, acrylated, latex coated and peroxide-treated composite withstood the tensile stress to higher strain level. Isocyanate treated, silane treated, acrylated, and latex coated composites showed yielding and high extensibility. Tensile modulus of the composites at 2% elongation showed slight enhancement upon mercerization and permanganate treatment. The elongation at break of the composites with chemically modified fiber was
attributed to the changes in the chemical structure and bond ability of the fiber.

George et al. (2001) made review on interface modification and characterization of natural fiber reinforced plastic composites. It was observed that the quality of the fiber-matrix interface is significant for the application of natural fibers as reinforcement for plastics. Since the fibers and matrices are chemically different, strong adhesion at their interfaces is needed for an effective transfer of stress and bond distribution throughout an interface. A good compatibilization between cellulose fibers and non-polar matrices is achieved from polymeric chains that will favor entanglements and inter-diffusion with the matrix.

Corbiere Nicollier et al. (2001) studied life cycle assessment of biofibers replacing glass fibers as reinforcement in plastics, which aims to determine the environmental performance of China reed fiber used as a substitute for glass fiber as reinforcement in plastics and to identify key environmental parameters. China reed bio-fibers are finally compared with other usages of biomass, biomaterials in general, can enable a three to ten times more efficient valorization of biomass than mere heat production or biofuels for transport.

Ichazo et al. (2001) have studied the properties of polypropylene (PP) wood flour composites Treatments. It was found that adding silane treated wood flour to PP produced a sustained increase in the tensile modulus and tensile strength of the composite.

Van de Velde and Kiekens (2002) reported that, mechanical properties of natural fibers, especially flax, hemp, jute and sisal, are very good and may compete with glass fiber in specific strength and modulus.
Feng Daan et al. (2001) studied the effect of compatibilizer on the structure-property relationships of kenaf-fiber/polypropylene composites. The use of Maleated-Polypropylenes (MAPP) is found to be important to improve the compatibility between the fiber and matrix. A significant improvement in impact strengths was observed when the MAPP was used in the composites. Results also indicate that the impact copolymer blends with coupling agent have better high temperature moduli and lower creep compliance than the uncoupled systems. The coupling agent also changes the crystallization and melting behavior of these blends.

Joseph et al. (2002) have compared the mechanical properties of phenol formaldehyde composites reinforced with banana fibers and glass fibers. Composites were fabricated using banana fiber and glass fiber with varying fiber length and fiber loading. The analysis of tensile, flexural and impact properties of these composites revealed that the optimum length of fiber required for banana fiber and glass fiber are differentiated in phenol formaldehyde resole matrix. Both banana fiber and glass fiber reinforced composites show a regular trend of increase in properties with fiber loading.

Ray et al. (2002) have studied the impact fatigue behavior of vinyl ester composites reinforced with alkali treated jute fibers. In that an impact fatigue study has been made for the first time on 35% jute/vinylester composites containing both untreated and alkali treated fibers. The results reveal that longer alkali treatment removed the hemi-cellulose and improved the crystallinity and gave better fiber dispersion.

Jochen Gassan (2002) studied fiber and interface parameters affecting the fatigue behavior of natural fiber composites. It was found that composites were made of flax, jute, yarn and woven as reinforcement for epoxy resins, polyester resins and polypropylene. Tension-tension fatigue behavior of different natural fiber reinforced plastics was investigated. It was
observed that natural fiber reinforced plastics with higher fiber strength and modulus, strong fiber-matrix adhesion or higher fiber fractions possess higher critical load for damage initiation and higher failure loads, In addition damage propagation was reduced.

Mwaikambo and Ansell (2002) studied Chemical modification of hemp, sisal, jute, and kapok fibers by alkalization. In that Hemp, sisal, jute, and kapok fibers were subjected to alkalization by using sodium hydroxide and then the thermal characteristics, crystallinity index, reactivity, and surface morphology of untreated and chemically modified fibers have been studied using Differential Scanning Calorimetry (DSC), X-Ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), and Scanning Electron Microscopy (SEM), respectively. It was observed that following alkalization the DSC showed a rapid degradation of the cellulose between 0.8 and 8% NaOH, beyond which degradation was found to be marginal. There was a marginal drop in the crystallinity index of hemp fiber while sisal, jute, and kapok fibers showed a slight increase in crystallinity at caustic soda concentration of 0.8–30%.

FTIR showed that kapok fiber was found to be the most reactive followed by jute, sisal, and then hemp fiber. SEM showed a relatively smooth surface for all the untreated fibers. However, after alkalization, all the fibers showed uneven surfaces. These results showed that alkalization modifies plant fibers promoting the development of fiber resin adhesion, which then will result in increased interfacial energy and hence improvement in the mechanical and thermal stability of the composites.

Lundquist et al. (2003) have assessed that, a pulp fiber reinforced thermoplastic composite has a combination of stiffness increased by a factor of 5.2 and strength increased by a factor of 2.3 relative to the virgin polymer.
Laly et al. (2003) have conducted the dynamic mechanical analysis on banana fiber reinforced polyester composites and found that the optimum content of banana fiber is 40%.

Aziz and Ansell (2003) investigated the effect of alkalization and fiber alignment on the mechanical and thermal properties of kenaf and hemp bast fiber composites. In that Long and random hemp and kenaf fibers were used in the as-received condition and alkalized with a 0.06 M NaOH solution. They were combined with polyester resin and hot-pressed to form natural fiber composites. The mechanical properties of the composites were measured to observe the effect of fiber alignment and alkalization.

A general trend was observed whereby alkalized and long fiber composites gave higher flexural modulus and flexural strength compared with composites made from as-received fiber. Alkalized long kenaf-polyester composites possessed superior mechanical properties to alkalized long hemp-polyester composites. For the hemp-polyester composites a high flexural modulus and a high flexural strength are associated with a low work of fracture. SEM of the treated hemp and kenaf fibers showed the absence of surface impurities which were present in the untreated fibers.

Joseph et al. (2003) conducted thermal and crystallization studies on short sisal fiber reinforced polypropylene (PP) composites. The thermal and crystallization behavior of sisal/PP composites were studied by Thermo-Gravimetry (TG), Differential Scanning Calorimetry (DSC) and polarizing optical microscopy. Chemical modifications were made to sisal fiber using a urethane derivative of Polypropylene Glycol (PPG), Maleic Anhydride modified Polypropylene (MAPP), and KMnO₄ in order to improve the interfacial adhesion between the fiber and matrix. It was found that treated fiber composites show superior properties compared to the untreated system.
Laly et al. (2004) studied stress relaxation behavior of banana fiber-reinforced polyester composites with special reference to the effect of fiber loading, fiber treatment, hybridization with glass fiber and also as woven fabric composites. It was observed that incorporation of fiber in the polyester matrix reduces the rate of relaxation. The nature of the relaxation curve was found to depend on the quantity of fiber as well as the surface characteristics of fiber used as reinforcement. The decrease in stress relaxation modulus was greatest for the neat polyester sample whereas it was at a minimum for composites with 40% fiber loading.

Mohanty et al. (2004) studied the influence of fiber treatment on the performance of sisal–polypropylene composites which concerns the effectiveness of MAPP as a coupling agent in sisal–polypropylene composites. It was observed that composite prepared at 21 volume percent of fibers with 1% MAPP concentration exhibits optimum mechanical strength. The thermal properties of the composites were analyzed through DSC and TGA measurements. SEM investigations confirmed that the increase in properties is caused by improved fiber-matrix adhesion for two ethylene-propylene impact copolymers. The uncoupled systems had much higher Young's moduli than the coupled systems. The dynamic storage moduli of the uncoupled impact polymers were higher than the coupled composites at temperatures up to about 50°C. At higher temperatures the presence of the coupling agent resulted in higher storage moduli.

Mohd Edeerozey et al. (2004) analyzed chemical modification of kenaf fibers. Different concentrations of NaOH were used and the morphological changes were examined by SEM. It was observed that treated kenaf fibers exhibited better mechanical properties than untreated fibers. Also, the optimum concentration of NaOH was found to be 6%.
Zampaloni et al. (2007) reported that the Kenaf–maleated polypropylene composites have a higher modulus/cost and a higher specific modulus than sisal, coir, and even E-glass thereby providing an opportunity for replacing existing materials with a higher strength, lower cost alternative that is environmentally friendly.

Annie Paul et al. (2008) investigated the effect of fiber loading and chemical treatments on thermo physical properties of banana fiber/polypropylene commingled composite materials. In these thermo physical properties of the composites were investigated as a function of the banana fiber loading and for different chemical treatments given to the banana fiber. It was found that the thermal conductivity and thermal diffusivity of the composites decrease with fiber loading. It was also observed that the NaOH concentration has an influence on the thermo-physical properties of the composites. A 10% NaOH treated banana fiber composites showed better thermo-physical properties than 2% NaOH treated banana fiber composites.

Shinji Ochi (2008) investigated Mechanical properties of kenaf fibers and kenaf/PLA composites which described the cultivation of kenaf and application of biodegradable composite materials. In that the unidirectional biodegradable composite materials were made from kenaf fibers and an emulsion-type PLA resin. The results reveal that, tensile and flexural strength and elastic moduli of the kenaf fiber-reinforced composites increased linearly up to a fiber content of 50%. The biodegradability of kenaf/PLA composites was examined for four weeks using a garbage-processing machine. Experimental results showed that the weight of composites decreased 38% after four weeks of composting.

Thiruchitrambalam et al. (2009) studied tensile, flexural and impact properties of banana/kenaf polyester hybrid composites using sodium lauryl sulfate treatment. In that the fibers are treated with 10% of sodium hydroxide
(NaOH) and 10% Sodium Lauryl Sulfate (SLS) for 30 minutes. It was observed that the surface modification by SLS has improved the mechanical properties than alkali. The morphological changes were also examined using scanning electron microscopy. The SLS treatment has improved the mechanical properties, tensile, flexure and impact strength of both the random mix and woven hybrid composite.

Siregar et al. (2010) have studied the effect of alkali treatment on the mechanical properties of short Pineapple Leaf Fiber (PALF) reinforced High Impact Polystyrene (HIPS) composites. In that NaOH is used as an alkali. The fibers were treated with different concentration of NaOH (0%, 2% and 4%) solution. It was observed that adhesion of fiber/matrix can be improved by treating the short PALF fibers with an alkali solution before production of a composite.

Mylsamy and Rajendran (2011) have studied the mechanical properties such as tensile, compressive, flexural, impact strength and water absorption of the alkali Treated Continuous agave fiber reinforced Epoxy Composite (TCEC) and Untreated Continuous agave fiber reinforced Epoxy Composite (UTCEC). It was observed that tensile strength, tensile modulus, compression strength and compression modulus were significantly high due to alkali treatment of the fiber. It is also proved that good chemical bond between alkali treated fiber and epoxy resin play a role in increasing the flexural strength, flexural modulus and impact strength of composites. In Dynamic Mechanical Analysis (DMA) the effect of TCEC and UTCEC was studied and it was found that composites with poor interfacial bonding tend to dissipate more energy than that with good interfacial bonding.

Mansour Rokbi et al. (2011) have studied the effect of chemical treatments of fibers by alkalization on flexural properties of polyester matrix composite reinforced with natural fibers. The used reinforcement consists of
alfa fiber, which is subjected to alkali treatments with NaOH at 1, 5 and 10% for a period of 0, 24, and 48 hr at 28 °C. It was observed that for a fiber processing Alfa 10%NaOH in 24h, the flexural strength and flexural modulus improved by 23 MPa to 57MPa and from 1.16 to 3.04 GPa. However, the flexural properties of composites decreased after alkali treatment with 5% NaOH for 48 h.

Denise Cristina et al. (2012) have studied the characterization of piassava fibers and their epoxy composites. Composites of continuous and aligned piassava fibers with and without alkali treatment dispersed in epoxy matrix were subjected to three point bend, tensile, and Izod impact tests. It was observed that Composites with fibers above 20 volume % showed an effective reinforcement behavior both in flexural and tensile tests, while the impact energy linearly increased with the amount of piassava fibers and spiny surface protrusion in the piassava fibers was found to be responsible for the reinforcement of the epoxy composites.

2.2 ON COIR FIBER REINFORCED COMPOSITES

Satyanarayana et al. (1982) reported that, coir is an abundant, versatile, renewable, cheap, and biodegradable lingo-cellulosic fiber used for making a wide variety of products. Coir has also been tested as filler or reinforcement in different composite materials. Furthermore, it represents an additional agro-industrial non food feedstock (agro industrial and food industry waste) that should be considered as feedstock for the formulation of eco compatible composite materials. Coconut coir is the most interesting products as it has the lowest thermal conductivity and bulk density.

Owolabi et al. (1985) have studied the characteristics of coconut fiber reinforced thermosetting plastics. In that thermosetting plastic composites have been prepared with phenol-formaldehyde resins as well as
Unsaturated Polyesters (UP) as binders and coconut hair as fibrous reinforcement. Using resole-type phenol–formaldehyde resins, the effect of coconut fiber pretreatment by NaOH, the pre condensation time of the impregnated fibrous press material, the resin–fiber ratio, and pressing parameters have been studied. To achieve better coupling between coconut fiber and UP matrix, coconut fiber was pretreated by NaOH and/or gamma-preirradiation. It has been found that in glass-fiber-reinforced UP press materials a significant part of glass fiber could be changed for shortcut coconut fiber.

Abdul Khalil et al. (2000) have studied the potential of acetylation of plant fibers to improve the properties of polyester composites. The chemical modification of oil palm Empty Fruit Bunch (EFB), coconut fiber (Coir), Oil Palm Frond (OPF), jute, and flax using non catalyzed acetic anhydride were investigated. The mechanical properties of acetylated EFB and coir fibre reinforced polyester composites were evaluated at different fiber loadings. It was observed that the tensile strength and modulus were improved, but elongation at break was slightly reduced upon acetylation, particularly at high fiber loading. Impact properties were moderately increased for those composites with fiber loadings up to 45%.

Hill and Abdul Khalil (2000) studied the treated fiber–polyester composites, with volume fraction ranging from 10% to 30% and found to have better properties than composites with untreated fibers, but the flexural strength of these composites was consistently lower than that of the bare matrix. A maximum value of 42.3MPa is reported against a value of 48.5MPa for the neat polyester. Acetylation of coir fibers increases the hydrophobic behavior, increases the resistance to fungi attack and also increases the tensile strength of coir–polyester composites. However, the fiber loading has to be fairly high, 45 weight% or even higher, to attain a significant reinforcing
effect when the composite is tested in tension. Moreover, even with high coir fiber loading fractions, there is no improvement in the flexural strength.

Rout et al. (2003) have studied the SEM Observations of the fractured Surfaces of Coir Composites. Coir composites had been prepared using coir fiber (both continuous and short fibers) as reinforcement with both thermosetting and thermoplastics as matrices. The composite specimens were prepared using both untreated and chemically modified such as defeated, PMMA grafted, PAN grafted and cyan ethylated coir fibers. The specimens were subjected to tensile and impact tests and the fractured surfaces were observed under SEM. The SEM micrographs of the fractured surfaces of composites showed varied extents of fiber pullouts under both failure modes.

Geethamma et al. (2005) have studied the dynamic mechanical behavior of natural rubber and its composites reinforced with short coir fibers. The effect of chemical treatment of coir fiber on damping of composites was studied and it was found that composite with poor interfacial bonding tend to dissipate more energy than that with good interfacial bonding.

Bujang et al. (2005) have studied the dynamic characteristic of Coconut fiber reinforced composites. In that study composites were fabricated by using polyester matrix and coconut fibers and the influence of fiber volume on the mechanical properties and dynamic characteristic of the composites were also evaluated. Composites with volumetric amounts of coconut fiber up to 15% were fabricated and they were arranged in randomly oriented discontinuous form. It was observed that the effects of reinforcing polyester matrix with the coconut fibers caused the composites to be more flexible and easily deformable due to high strain values and reduction of high resonant amplitude.
Agopyan et al. (2005) studied the developments on vegetable fiber–cement based materials. In that vegetable fibers, which are widely available in most developing countries, can be used as convenient materials for brittle matrix reinforcement, even though they present relatively poor durability performance. It was observed that coir fibers demonstrate to be more suitable vegetable fibers for the reinforcement of large components as can be proved by in-use durability performance evaluation of an 11 year old prototype house. More recently, pulp from eucalyptus waste and residual sisal and coir fibers have been studied as a replacement for asbestos in roofing components.

Asasutjarit et al. (2005) have studied the development of coconut coir-based lightweight cement board. Coconut coir-based lightweight Cement Boards (CCB) were fabricated from coconut coir, cement and water. The investigations focused on parameters, mainly, fiber length, coir pretreatment and mixture ratio that affect the properties of the boards. The physical, mechanical and thermal properties of the specimens were determined after 28 days of hydration. The results of this study indicated that the best pretreatment of coir fibers was to boil and wash them as it can enhance some of the mechanical properties of coir fiber.

Arup Choudhoury et al. (2007) have studied the recycled milk pouch and virgin Low Density Polyethylene (LDPE)/Linear Low Density Polyethylene (LLDPE) based coir fiber composites. The mechanical, thermal, morphological, and water absorption properties of recycled milk pouch polymer/coir fiber composites with different treated and untreated fiber contents were evaluated and compared with those of virgin LDPE–LLDPE/coir fiber composites. It was observed that a small quantity of a coupling agent (2 weight %) significantly improved all the mechanical, thermal, and moisture-resistance properties of both types of composites.
Harisha et al. (2009) have investigated the mechanical properties of natural fiber coir composite. Coir composites were developed and their mechanical properties were evaluated. SEM obtained from fractured surfaces were used for a qualitative evaluation of the interfacial properties of coir/epoxy and compared with glass fiber/epoxy. These results indicate that coir can be used as a potential reinforcing material for making low load bearing thermoplastic composites.

Jayabal and Natarajan (2010) have shown that the mechanical properties of natural fiber composites depend on many parameters such as fiber strength, modulus, fibre content, fiber length, and orientation, in addition to the fiber-matrix interfacial bond strength. In this work, coir fibres with different fiber length were selected as reinforcements to prepare polymer based matrices. The length of the fibers was varied for different percentages of weight content of fiber. The mechanical properties of coir fiber/polyester composites were evaluated as per the ASTM standard test methods. The presence of fiber and fiber breakage were characterized using scanning electron microscope. The effect of fiber length and weight percentage of fiber on the tensile strength and flexural strength were analyzed using statistical techniques. The results showed that the tensile and flexural strength increased with increase in fiber length.

Hemsri et al. (2012) have studied the characteristics of wheat gluten composites reinforced with coconut fiber. Coconut fiber-reinforced Wheat Gluten (WG) bio composites were fabricated, and the Coconut Fibers (CCFs) were chemically modified by either NaOH or silane treatment, followed by the alkali surface treatment with a silane treatment. (3-triethoxysilylpropyl)-t-butyrcarbamate (carbamate silane), which is a masked isocyanate functional silane, was used for the first time to improve interfacial adhesion between WG and natural fibers. X-ray Photoelectron Spectroscopy
(XPS) and Gas Chromatography/Mass Spectroscopy (GC/MS) analyses were employed to prove the presence of the silane on Silane-treated Coconut Fiber (SCCF) and Alkali-followed by Silane-treated Coconut fiber (ASCCF). It was found that ASCCF has more silane content on the fiber surface than SCCF. The mechanical properties of composites with 15 mass% fiber loading were assessed by three-point bending tests. Results indicated that the alkali followed by silane treated fiber had better mechanical property than untreated fiber.

2.3 ON COIR FIBER REINFORCED COMPOSITES WITH ALKALI TREATMENT

Prasad et al. (1983) have studied the Alkali treatment of coir fibers for coir-polyester composites. In this treatment fibers were soaked in 5% aqueous solution of NaOH at 28±1°C for 72 to 76 hrs. This investigation showed that flexural strength, modulus and impact strength of the treated fiber composite were 40% higher than those containing the same volume fractions of untreated fibers and also longitudinal ultrasonic velocity and sound attenuation measurements indicated less fiber segregation and better fiber-matrix bonding.

Rout et al. (2001) have studied the influence of fiber treatment on the performance of coir polyester composites. This study deals with the surface modifications of coir fibers involving alkali treatment, bleaching, and vinyl grafting in view of their use as reinforcing agents in general-purpose polyester resin matrix. Bleaching of deflated fibers was done by the following process: The fibers were carefully kept in 0.7% textone (sodium chlorite) solution in the liquor ratio 50:1 buffered by 1% acetic acid and sodium acetate solution at pH 4 and temperature range 65–85°C for 2 hrs. This investigation concluded that, the adhesion between coir fiber and polyester matrix is poor. However, the adhesion can be improved by surface modification of coir
fibers. All modifications of the fiber surfaces have increased the mechanical properties of composites.

Among the alkali treated coir fiber polyester composites, 2% alkali treated coir composites showed better tensile strength (26.80 mPa) whereas 5% alkali treated coir composites showed better flexural (60.4 mPa) and impact strength (634.6 J/m). Grafted coir fibers (10%) improved the tensile strength and flexural strength of composites by 14 and 15%, respectively, in comparison to untreated coir composites. Bleached (65°C) coir composites showed better flexural strength (61.6 mPa) which is 20% more than the flexural strength of untreated fiber composites.

Mizanur Rahman and Mubarak (2007) have studied the surface treatment of coir fibers and its influence on the fibers’ physico-mechanical properties. In this study the coir fiber was incorporated into polymers like polyacrylate in different ways to achieve desired properties and texture. Fiber surface was modified by Ethylene di Methyl Acrylate (EMA) and cured under UV radiation. It was observed that fiber shrinkage was higher at low temperature and 20% alkali treated coir fibers yielded maximum shrinkage and weight losses.

Huang Gu et al. (2009) have studied the tensile behaviors of the coir fiber and related composites after NaOH treatment. A decreased trend of the fiber tensile strength with increased NaOH density was found. This would improve the adhesive ability of the coir fiber with the matrix in the fabricated composites, resulting in a greater tensile strength of the material. The investigation showed that the higher alkali concentration would deteriorate the fiber strength, the higher the concentration, the greater the damage to the fiber. After alkali treatment, the elongation at break of the composites increased. This implied that the ductility of the alkali-treated coir fiber had been improved.
Rosa et al. (2009) have studied the effect of fiber treatments on tensile and thermal properties of coir bio composites. Coir fibers received three treatments, namely washing with water, alkali treatment (mercerization) and bleaching. Treated fibres were incorporated in starch/Ethylene Vinyl Alcohol Copolymer (EVAC) blends. Mechanical and thermal properties of starch/EVAC/coir bio composites were evaluated. Fiber morphology and the fiber/matrix interface were further characterized by SEM. All treatments produced surface modifications and improved the thermal stability of the fibres and consequently of the composites. The best results were obtained for mercerized fibres where the tensile strength was increased by about 53% as compared to the composites with untreated fibres, and about 33.3% as compared to the composites without fibres. The mercerization improved fiber–matrix adhesion, allowing an efficient stress transfer from the matrix to the fibres. The increased adhesion between fiber and matrix was also observed by SEM. Treatment with water also improved values of Young’s modulus which was increased by about 75% as compared to the blends without the fibres. Thus, starch/EVAC blends reinforced with the treated fibres exhibited superior properties than neat starch/EVAC.

Asasutjarit et al. (2009) have investigated the mechanical properties of coir based green composites prepared using coir fiber treated with varying pre-treatment conditions. The changes in the proportion of chemical composition and morphological properties of coir fibres with different coir pre-treatment conditions were discussed. It was observed that the mechanical properties of coir-based green composites namely, modulus of rupture and internal bond, increased as a result of chemical composition modification and surface modification. SEM investigations showed that surface modifications improved the fiber/matrix adhesion.
Cervalho et al. (2010) studied the effect of chemical modification on the coconut fibre composites lignocellulose fibres. Green coconut fruits were treated with alkaline solution (NAOH 10% m/v) and then bleached with sodium chlorite and acetic acid. Alkali treated bleached fibres were mixed with High Impact Strength Polystyrene (HISP) and placed in injector chamber to obtain the specimen for tensile test. Specimens were tested in tensile mode and fracture surfaces of composites were analysed by SEM and XRD. The results showed that the addition of 30% alkali-treated and bleached fibres reinforced in HISP matrix provide considerable change in mechanical properties in comparison of pure HISP.

Zuradia et al. (2011) investigated the effect of fibre length on mechanical properties of coir fibre reinforced cement-album composites. The experiment presented that the increasing length of fibre increases the flexural strength. But incorporation of long fibre into the cement paste reduced the workability thus introducing voids resulting in low density. In fact water absorption and water content also increased.

Nam et al. (2011) have studied the effect of alkali treatment on interfacial and mechanical properties of coir fiber reinforced poly(butylene succinate) biodegradable composites. In that the Poly Butylene Succinate (PBS) biodegradable composites reinforced with coir fibers were developed. The effect of alkali treatment on the surface morphology and mechanical properties of coir fibers, Interfacial Shear Strength (IFSS) and mechanical properties of coir fiber/PBS composites were studied. It was observed that the coir fibers which were soaked in 5% sodium hydroxide solution at room temperature for 72 h showed the highest IFSS which is 55.6% higher than that of untreated coir fibers. The mechanical properties of alkali-treated coir fiber/PBS composites were significantly higher than those of untreated fibers. The best mechanical properties of alkali-treated coir fiber/PBS composite were achieved at fiber mass content of 25% in this study, which showed an
increase of tensile strength by 54.5%, tensile modulus by 141.9%, flexural strength by 45.7% and flexural modulus by 97.4% compared to those of the pure PBS resin.

Pakanita Muensri et al. (2011) have studied the effect of lignin removal on the properties of coconut coir fiber/wheat gluten bio composite. The effect of fiber lignin content on bio composite properties was investigated. Coconut fiber was treated with 0.7% sodium chlorite to selectively decrease the amounts of lignin. The fiber lignin content was then reduced from 42 to 21 weight%.

Chandra Rao et al. (2012) investigated the wear behavior of treated and untreated coir dust filled epoxy resin matrix composites. The effect of treated and untreated coir dust concentration (10%, 20% and 30%), varying loads (10, 20 and 30N) and varying velocities on the abrasive wear rate of composite had been analysed. The abrasive wear property of the composite was examined on a pin-on-disc machine against 400μm grit size abrasive paper. To minimize the experimental time and cost of investment taguchi method model L9 was selected. It was found that the treated fiber composite showed better wear resistance than the untreated fiber composites. Abrasive wear rate decreased with increasing coir dust amount. As the load increased the wear rate also increased.

Although there are several reports in the literature which discuss the mechanical behavior of natural fiber reinforced polymer composites, very limited work has been done on the effect of fiber length on tensile, flexural and impact property of coir fiber reinforced epoxy composites with alkali treatment. Against this background, the present research work has been undertaken, with an objective to improve the mechanical (tensile, flexural and impact) behavior of coir fiber reinforced epoxy composite using NaOH treatment and SLS treatment.