CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

This chapter discusses various conventional methodologies for sisal fibers, bamboo fibers and hybrid fibers. The merits and demerits of conventional fibers are discussed with its functional characteristics. The elasticity and tensile strength behaviour of each conventional fiber is discussed with its experimental results.

2.2 SURVEY ON SISAL FIBER

The natural fibers are used in many product manufacturing industries. In this regard, the sisal fiber is the foremost natural fiber that can be used in may industries. Generally, the origin of sisal fibers are from sisal plant where the family name is known as Agave sisalana. Their leaves are in the shape of sword. More fiber contents are available on top of the leaf of sisal plant and less fiber contents are available at bottom of the sisal leaf. These sisal leaves are mainly used for manufacturing automobile products and producing textile products.

The durability property of sisal fiber is high when compared with other natural fibers. Hence, this sisal fiber can be used in manufacturing of wooden tables and production of ropes due to its long time availability. The capability of controlling humidity of the sisal fiber is better which means that the sisal fibers are having dynamic characteristics. The insulation between modules in sisal fibers are having greater characteristics.

Nilsson (1975) developed the composite products using sisal fibers as reinforced materials. The authors extracted 30 mm fiber leaf and tested for tensile strength behaviour improvement. Different fibers with respect to different length were tested on various fiber materials.

Bessel & Mutuli (1982) applied sisal fibers as the agent materials which were added to cement materials in order to improve the construction strength in building constructions. The authors conducted 46 numbers of tensile tests on different sisal and cement composite products to prove the robustness behaviour of these integrated components.

Tolêdo Filho (1997) applied sisal and coconut reinforcement fibers for their experiments. It was found that the authors used different reinforcing bars for various applications. The existing bars were not used by authors in these experiments. The strength of the fiber bars was analyzed on different strength tests to improve the stability and robustness of the products. The authors also used fiber as the crack, avoiding agent which was controlled by the different temperature agent.

Kasama Jarukumjorn et al. (2009) proposed hybridization of the glass materials which have good physical strength. The glass fiber behaviour was analyzed in this work in order to enhance the properties as well as strength of the materials. Hence,these fibers can be used in many manufacturing industries.

Joseph et al. (1999) was studied the sisal composites have high impact strength besides having moderate tensile and flexural properties compared to other lignocellulosic fibres. They were observed Sisal fibre polymer composites with and without hybridization should be developed and characterized so as to arrive at a series of composites which may find use in several areas such as marine, structural, consumer articles and industrials applications.

Girisha et al. (2012) developed a technique based on the hand lay-up process which reinforced different composite materials such as bamboo and bunch fibers with different ratios. The authors treated these materials with respect to alkali components using the proportions of 5% to 30%. The mechanical behaviour namely tensile strength of the composite materials was improved with certain percentage of addition and then, it decreased after certain percentage of reinforcement as stated in Arumuga Prabu et al. (2012).

Chianelli-Juniora et al. (2013) analyzed the behaviour of thermo mechanical recycling properties which were the fundamental properties of High Density Polyethylene (HDPE) components. The reinforcement of the sisal fibers and its composite materials were analyzed with respect to its melt capacity of the composites. It was found that there were no elasticity changes in fibers under any composition.

Dinesh et al. (2013) utilized the characteristics of the sisal fibers for producing durable materials for automobile manufacturing industries. The authors analyzed and tested their materials with respect to different ratios as 10% to 30% with step size of 10%. The low density materials were selected by authors with respect to international standards ASTM D – 3039. The compression test was conducted by the authors on these developed materials for analyzing the behaviour and strength of the products with industrial standards.

The water resistance property of sisal fiber is high and hence it does not absorb water much more.

From the literature survey related to sisal fibers, the following points are observed.

- Sisal is not recommended for areas that receive wet spills, or rain or snow.

- Its fibre absorbs air humidity leading to a small amount of expanding and contracting (rugs and unsecured edges may curl).
- Sisal fibre is too tough for textiles and fabrics. Its fibre is not suitable for a smooth wall finish.
- It is reported that some plantations have destroyed natural forests to agricultural land.
- Sisal is a extremely desirable fiber and is anti statics and can control humidity.
- The flexibility of sisal fibers is good than other fibers for producing materials which is required in industry.
- The strength of the sisal fibers is high when compared with other fibers.

2.3 SURVEY ON BAMBOO FIBER

Bamboo fiber is one type of natural fibers which can be obtained from bamboo tree. The oxidation methods are used to obtain the bamboo fabric from the bamboo materials or fibers in industry. The bio-degradable of these bamboo materials are high when compared with other fibers as natural fibers. The silk materials can be obtained from bamboo fibers as natural fibers due to its non-involvement of chemically treated process with natural fibers. The main advantage of bamboo fibers in industry is its anti-bacterial properties and hence these fibers can be used in manufacturing of medical equipments.

Shin et al. (1989) utilized epoxy components from bamboo materials which can have different seven layers. The behaviour of the bamboo fibers can be analyzed by imposing various testing strategies on the hybrid composite materials. The authors used tensile test on these materials for improving the behaviour of the materials. Jena et al. (2012) was investigated the effect of cenosphere and number of lamina on the impact property of bamboo fibre reinforced epoxy composites and also the impact strength was increased with addition of filler up to a certain limit.

Jain et al. (1992) developed a methodology for improving the functionality of the BFRP (Bamboo Fibre-Reinforced Plastic) materials based on different mat materials. The authors used bamboo fibers for unidirectional components. The performance of the proposed method was improved and analyzed with respect to fiber volume fraction parameters. The authors obtained 65% of the fiber volume fraction parameter. They observed that the mechanical properties of BFRP composite are superior to other known natural fibre-reinforced plastic composites. Rajulu et al (2001) was observed that the chemical resistance and tensile properties of epoxy/polycarbonate blend coated bamboo fibers and also increased certain limit

Lee & Wang (2006) analyzed the behaviour of various materials such as vakka and banana with bamboo fibers. These materials were developed using unsaturated resin. The authors analyzed the tensile strength of the bamboo fiber with respect to various non-linear regression models. The developed methodology were utilized by regression models for testing their products with respect to various design parameters. The mechanical behaviour of these tested materials were finally considered and designed with polyester composite products.

Sanjeevamurthy et al. (2012) used tamarind tree fruits for obtaining good strength of composite natural fibers. The authors applied different chemical treatments for improving the mechanical behaviour of the materials. The epoxy materials were added to these natural fiber products for increasing the mechanical strength for the large fiber volumes. The manual lay-up technique was preferred for these kind of the methods.

Swain et al. (2014) improved the properties of composites with the addition of Al_2O_3 materials by increasing the process functionalities of composite materials. The authors added Al_2O_3 with epoxy materials and natural fibers. The authors also analyzed the mechanical properties of the composite materials.

Ashik et al. (2015) developed a technique to strength the properties of mechanical materials by preventing wastage from them. The composite materials strength was developed by utilizing the red mud wastage from the industrial materials. The molding capacity of these materials were improved by imposing sisal and banana fibers to the existing materials.

Alavudeen et al. (2015) analyzed the mechanical strength of the natural fibers by using kenaf fiber and banana/ kenaf hybrid fiber. This increased the composite behaviour of the materials by hybridization of carnage after implementing the fiber components with respect to banana kernels. The authors analyzed the morphological properties of these materials with the help of SEM machine.

Manoharan et al. (2016) developed the methodology system for disposing the natural fibers which were obtained from industrial waste. In this research, the authors used Polymeric Matrix Composite Materials (PMCM) for increasing the natural behaviour of the fibers. The authors also used the sub leaves from a banana tree as natural fibers. The fibers which were extracted from these materials, were used as transferred agent for improving the behaviour of the mechanical strength. The authors used different natural fibers such as sisal, bamboo and cotton with respect to different portions. The CO emission rate was lower by using these natural fibers. The Kyoto protocol was introduced by this author to give the sustainable solution for all types of fiber products.

The following strength and drawbacks are identified for bamboo fibers from the literature survey and they are stated below.

- It is generally more expensive.
- Also if we switched entirely to it, there would be too much demand for bamboo and it would be planted so much that it would be an invasive species and we would be at risk in some environments from a monoculture farming environment.

The advantages of bamboo fibers are listed in the following statements.

- The anti bacterials properties are high in bamboo materials.
- They are odor free materials which can be used in hospitals products.
- They are high strength of sweat obsorption property than other materials.

2.4 SURVEY ON HYBRID MATERIALS

Gupta et al., (2016) improved the behaviour of the hybrid materials by utilizing reinforced polymer composite which improved the water absorption characteristics by treating them in alkali form. The authors tested these materials in random manner using various non-linear testing methods.

Mwaikambo et al. (2002) analyzed the properties of coir materials using SEM images with respect to its bonding strength. The properties of coir materials were improved by imposing them with glass fibers.

Abu Bakar et al. (2005) tested oil palm fibers for achieving the glass fiber strength. They were having a higher resistance when compared with other materials.

Ketty Bilba et al. (2007) used natural fibers such as banana with coconut for composing botanical properties by heating them to 200 degree celcius by means of nitrogen gas. The increased temperature changes the behaviour of the hybrid materials for the need of industrial applications. Zamri et al. (2012) used SEM images for representing the behaviour of the hybrid materials.

Tara Sen et al. (2011) developed the methodology for deploying the behaviour of the materials structure as raw materials in industries need. In this work, the authors used glass and carbon materials for reinforcing the non-linear materials with linear materials in order to improve the strength of the natural fibers for the manufacturing of the hybrid composites.

They also increased the mechanical behaviour of the raw materials. The authors further extended their research work to analyze the behaviour of the materials by implementing these materials with different materials such as bamboo, sisal, mud and industrial wastage. The abundant materials as fibers coir and fiber sisal with fiber banana were integrated with basic plastic materials to justify their natural properties. Onal et al. (2002) was observed the addition of carbon fibers to the glass-reinforced composites to increase the mechanical properties.

Ashik et al. (2015) analyzed the properties of renewable resources with respect to its absorbing capabilities of carbon dioxide. For the past decades, the authors analyzed the impact of carbon dioxide on absorption characteristics for their efficient material design. The bio-degradability of the natural fibers were analyzed with respect to various properties of capabilities. The authors designed their methodology for reinforced composites as an effective resource sharing technique. The use of various composite fibers used for different applications were also discussed in this work.

Alavudeen et al. (2015) analyzed the sustainable properties of the banana fibers which were used as hybrid composite materials for many different applications in real time. The mechanical behaviour of the banana fibers with the integration of kenaf fibers was analyzed in detail in this work. Various properties such as tensile and flexural properties were analyzed for their impact study due to its flexible properties in many composite applications. Scanning Electron Microscopy (SEM) technique was used to analyze the behaviour of the proposed design.

Chaitanyan et al. (2013) designed a methodology for hybrid composite materials which were mixed by sisal glass fiber and resin. The authors utilized the proportion of combination of the hybrid composite materials as, 50: 50 ratios for obtaining better performance for real time applications. The authors devised that the sisal-glass fiber components were 10 times higher than the tensile strength of sisal-coir-glass fiber combination. Hence, the authors recommended sisal-coir-glass fiber proportion in many real time applications. The flexural strength of resin was also analyzed for hybrid composite with sisal-coir-glass fibers.

Girisha et al. (2012) analyzed chemically treated materials which were used for improving the mechanical behaviour . These materials were extracted from the fruit of tamarind and these were used for different applications. The authors proved that fibers with treating process have more advantages than the fibers without treating process. The authors have improved the volume fraction of fiber by hybridization of different fibers with various proportions. The authors found that the mechanical strength was improved by combining different fibers with proper ratios.

Nilza et al. (2007) investigated the effect of glass fiber hybridization on the properties of sisal–polypropylene composites.

Rao et al. (2007) checked the behaviour of different filters which were highlighted poly materials for improving certain properties of the CO2 degradation. These materials were analyzed with respect to its various shapes and sizes.

Monteiro et al. (2008) studied the behaviour of the mechanical strength of the various structural materials. The authors analyzed flexural strength of these structural materials under different pressure. The results of this paper were compared with various existing methods in terms of flexural strength.

Ahmed et al. (2008) analyzed the usage of hybridized fibers in automobile industries using glass materials. The authors also analyzed the mechanical behaviour of these products. During washing with sodium hydroxide, the wax, cuticle layer and part of lignin and hemi cellulose are removed. The major reaction took place between the hydroxyl groups of cellulose and the chemical used for the surface treatment.

Yan li et al. (2008) analyzed the strength of the properties of the mechanical behaviour of various composite materials. The authors found that the bonding relation between natural fibers and polymer fibers were good for manufacturing the materials for industrial needs. The oxidation behavioiur of both materials were analyzed by improving the strong bond between them in order to improve the behaviour of the natural fibers to industrial standards.

Sezgin & Haluk (2009) developed different sound gathering techniques which were developed by wastage of the industrial products. These products were developed from tea leaves and they were having three different layers, generally used in textile cloth materials. The specifications of the tea leaf product were 1 cm and they consisted different six layers. The frequency specifications of each layer varied from 500 and 3200 Hz.

Jacquemin et al. (2009) studied micro and mechanical behaviour by analyzing fiber strength and its matrix decomposition. The time and space reliant macroscopic anxiety, at pay range, were single-minded by using field mechanics formalism. The stability as well as durability of these materials was analyzed for improving the mechanical behaviour of the enveloped products using epoxy materials with carbon components which were added as equivalent factors.

Hybridization on tensile properties of sisal, bamboo fibers with epoxy resin were studied by Girisha et al. (2012). They observed that the alkali treatment of the natural fibers was to get with moderate mechanical properties as well as better adhesion between fibers and matrix. Studies were made to improve fiber quality or reducing the effect of the presence of fiber defects in the final material via improved processing or fiber treatment. The improvements in properties, especially stiffness, can be obtained using chemical treatments of the fibers. The strength and modulus of the longitudinal composites in tensile and flexural loading increased with fiber content as predicted in accordance with the rule of mixtures. The mechanical properties of jute fiber unsaturated polyester composites prepared by solution impregnation and hot curing methods were studied.

Passipoularidis & Philippidis (2009) carried out detailed studies for alkali treatment of isometric jute yarns.

Azam et al. (2009) developed a model for liquid phase with various mathematical techniques. The authors analyzed different degradation methods for analyzing the behaviour of the materials which were having fine grained mechanical strength with respect to different absorption ratios.

The limitations of bamboo and sisal fibers are overcome by proposing hybrid fibers. The hybrid materials have good water resistance property than the bamboo/sisal fibers. Also, the hybrid materials are cost effective for industrial products.

Joshi et al. (2001) used natural fibers for analyzing the performance of the life cycle of the reinforcement and the authors found that the strength of the natural fibers were based on the reinforcement behaviour of the resin materials. Ray et al. (2001) analyzed the impact of NaOH solution with respect to temperature variations on different composite materials.

Jochen and Bledzki (1999) utilized composite materials for improving the performance of the coupling needs. The authors captured the absorption functionalities of the moisture contents with respect to untreated fibers. The interfacial adhesion charecteristics of the natural fibers were analyzed for improving the performance and strength of the resin materials.

Rana et al. (1998) proved that the capabilities of linear materials which were used for absorbing the water into materials for improving the charecteristics of the bonding between them. The authors also analyzed the strength of various materials.

Shah and Lakkad (1981) used jute-reinforces for improving the behaviour of the reinforced materials to the industrial needs. The rexin matrix with poly composite materials were analyzed with respect to linear behaviour of the materials strength.

2.5 SURVEY ON OPTIMIZATION TECHNIQUES

Abhishek et al. (2014) received speed of the spindle and rate of spindle at which the rate for rotating speed of the spindle for device, as the inputs for predicting the roughness of the materials. The authors used GA with ANFIS classification algorithm to yield better results for improving the prediction rate as linear improvement. The hybrid composites were improved for its performance metrics. The proposed model by authors achieved valid output response rate as the prediction ratio.

Garg et al. (2012) developed design methodology for improving modeling of deposition in order to improve the performance of the design by implementing GA with low error rate. The authors implemented the proposed model with Support Vector Regression (SVR) for analyzing the behaviour of the design materials with respect to its design parameters.

Gill and Singh (2010) used ANFIS soft computing approach for designing a simulation system for removing the drilling process parameters with respect to ceramic materials. The authors analyzed the penetration rate with respect to depth ratio in order to improve the properties of materials.

Jarrah et al. (2002) developed the system or methodology using fuzzy model in order to improve the prediction ratio of different materials. The stress with angle of fiber materials were fed to the input of the fuzzy model. The failure rate was reduced for epoxy hybrid composite materials.

Langella et al. (2005) proposed a linear model for drill geometry for improving the thrust force of the materials with high speed of drilling capability. The authors tested their proposed methodology using different regression model techniques. Kartalopoulos et al. (1996) analyzed the fundamentals of the emerging field of fuzzy neural networks, their applications and the most used paradigms with this carefully organized state-of-the-art textbook.

Bisht and Jangid (2011) endeavored to extend the finest reproduction for forecasting waterway emancipation which facilitates ANFIS system and Linear Multiple Regression (MLR) methods. The urbanized model was empowered on the data of Godavari River and it was pragmatic that the urbanized ANFIS models predicted better consequences than MLR.

Cus et al. (2009) developed optimization models using Ant Colony Optimization technique in order to improve the efficiency of the proposed design methodology. The authors used objective functionalities as input parameters by getting cutting speed and cutting methodology for improving the quality of the materials. The authors compared the response of the GA with respect to Ant Colony Optimization techniques.

2.6 RESEARCH GAP

Sisal fibers are available in large quantities and are renewable and used in conventional methods as reinforced composite materials. Few researchers only analyzed bamboo fibers as composite material for improving the mechanical and physical properties of reinforcing agent. Even though the mechanical properties such as tensile, flexural and impact strength of bamboo and sisal fiber polyester composite were determined by many researchers individually, the effect of fiber length and fiber concentration was not analyzed in detail. Moreover the combined effect of sisal and bamboo fibers on mechanical properties and its water absorption characteristics were not reported so far.

Many researchers have reported that Alkali treatment will enable better adhesion between fiber and matrix. But the effect of such treatment on bamboo and sisal fibers at different alkaline concentration was not reported elaborately. Few works have been done by researchers experimentally and reported the mechanical properties. But no models such as regression model was not reported to estimate the mechanical properties using its main process parameter namely fiber length and fiber content. The optimum condition which enabled maximum mechanical properties such as tensile strength, flexural strength, impact strength were not reported so for forth sisal / bamboo hybrid composites.

2.7 SCOPE AND OBJECTIVE OF THIS RESEARCH

Considering the research gap reported above, this investigation is focused on Bamboo/Sisal reinforced unsaturated polyester hybrid composite. This research, carried out encompasses the following objectives,

- To develop a short sisal fiber reinforced unsaturated polyester composite with different proportions of fiber length and fiber content and matrix proposition by Hand lay-up method.
- To experimentally investigate the mechanical properties of sisal-unsaturated Polyester composites and to find out fiber parameters for optimum mechanical properties.
- To develop bamboo/sisal fibers reinforced polymer composites by hybridizing bamboo at the optimum fiber parameters obtained for sisal-polyester composite and to evaluate mechanical properties and water absorption behaviour of the hybrid composite and to estimate the effect of hybridization.
- To study the effect of NaOH treatment of Bamboo and Sisal fibers and to investigate on mechanical and water absorption properties of such hybrid composites.
- To develop a model for predicting the mechanical properties of above composites using Regression and ANFIS analysis.
- To find out the optimum condition which enables better mechanical properties using a non-traditional optimization technique called Genetic Algorithm (GA).