Vol. XIII & Issue No.3 March - 2020
INDUSTRIAL ENGINEERING JOURNAL

A REVIEW ON NATURAL FIBER AND ITS CHARACTERISTICS

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Abstract

Natural fiber materials are increasing rapidly in a modern technology because of its low cost, biodegradable, eco-friendly nature, good mechanical properties. It is used many applications. Natural fibers are investigated for work it is cotton, jute, flax, hemp, sisal, coir, abaca, banana, oil palm, pineapple, bagasse, bamboo. The fibers are identified using various testing and its applications.

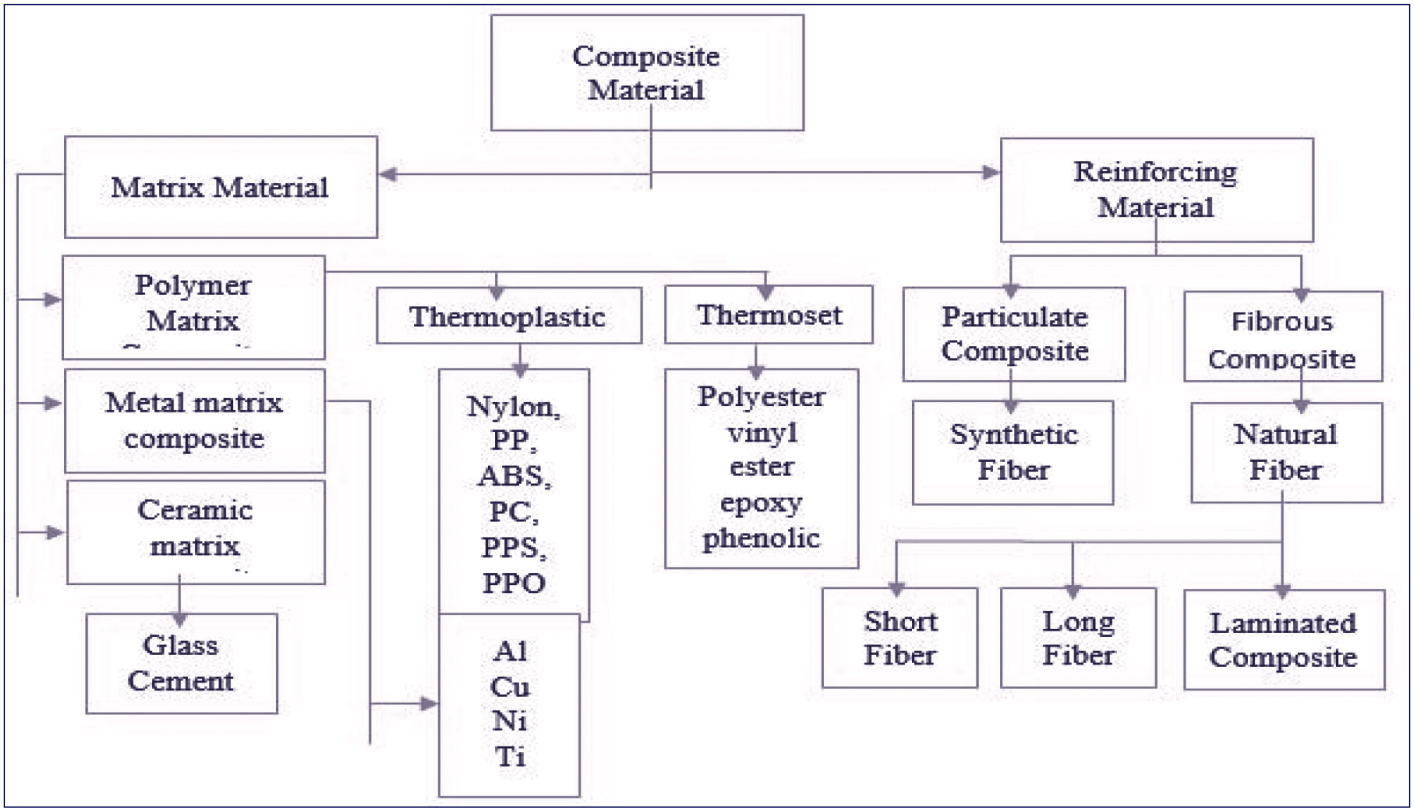
Keywords: Composite, Natural Composite, Natural Fibres

1. INTRODUCTION

1.1 Composite: Composite is a material which is made up of two or more physically distinct materials with at least one material providing reinforcing properties on strength and modulus. Composite is a addition of matrix and reinforcement is known as composite.

1.2 Classification of Composite : Composite material can be classified at three types on basis of matrix material.

a. Polymer matrix composite (PMC),
b. Metal matrix composite (MMC)
c. Ceramic matrix composite (CMC)



a. Polymer Matrix Composite : Polymer matrix composite is the material consisting of a (resin) matrix combined with a fibrous reinforcing dispersed phase. Polymer matrix composites are popular due to their low cost and simple fabrication methods. It also referred as fiber reinforced plastics (FRP). In these fiber reinforced plastics, the plastic is reinforced with fibers to make a light and strong material. The material in which the fibers are embedded, is called the matrix, while the fibers are called reinforcement. On the basic type of polymer resin used, composite material can be classified into two categories. 1. Thermoset polymer & 2. Thermoplastic polymer

1. **Thermoset:** Thermoset are polymer that are cured into a solid form and cannot be returned to their original uncured form. Composite made with thermoset matrices are strong and have a very good fatigue strength. They are extremely brittle and have low impact toughness making. They are commonly used for high heating applications because the thermoset matrix doesn't melt like thermoplastics. The example of thermoset is Polyester, Vinyl ester, Epoxy, Phenolic.

2. **Thermoplastic:** Thermoplastic are polymer that can be molded, melted, and remolded without altering its physical

properties. Thermoplastic matrix composites are less brittle than thermosets, with very good impact resistance and damage tolerance. the example of thermoplastic is Nylon, PP, ABS, PC, PPS, PPO.

b. Metal Matrix Composite

Metal matrix composite is a type of composite material with at least two constituent parts, one being a metal. The material may be a dissimilar metal or another material, such as a ceramic or organic compound. Metal matrix composite become interesting for use as constructional and functional materials, the advantage of metal matrix composite is high strength, high stiffness, dimensional stability, high temperature and toughness and the example of metal matrix composite is Al, Cu, Ni, Ti.

c. Ceramic Matrix Composite

Ceramic matrix composite involve high temperature can only be employed with high temperature reinforcements. Ceramic matrix composite is designed to improve toughness of monolithic ceramics, the main disadvantage of which is brittleness. The attractive properties of ceramic matrix composite are high stiffness, hardness, compressive strength and relatively low-density example of ceramic matrix composite is glass and cement.

1.3 Advantages of Composite

Light weight - Composite material are light in weight compare to other materials wood and metal. Their less weight is better advantage of automobile and aircraft industries for better fuel efficiency. High strength– composite materials are stronger than aluminum and steel. Corrosion resistance– composite material has a high corrosive resistance compare to other metal, composite provide long term resist damage from chemicals and they stand up to severe weather and wide changes in temperature. High impact strength – composite material to withstand a suddenly applied load or force. It has high strength compare to other metal, steel and aluminum. Low maintenance – composite have a long life and excellent fatigue, impact, environmental resistance and reduce maintenance. Low thermal conductivity – composite material are good insulators, they resist heat and the materials are used for building applications doors, panels, roof and window.

1.4 Application of Composites

They are widely used different applications as marine industries, aircraft industries, automobile industries, medical, sports, chemical industries. Marine: in a marine industry some of the parts are manufacture as composite. They are shafts, hulls, spars and racing boats, etc. Aircraft: aircraft industries are mainly used composite material at various parts they are rudder, fuselage, wings, flaps, etc. Automobile: in an automobile industry many parts are manufactured as composite they are drive shaft, window glass, etc.

Medical: in medical field dental materials, etc. are used composite. Sports: in a sport some of the playing equipment's are manufactured as composite they are tennis rackets, etc. Chemical: in a chemical industry the composite used materials are pipes, pressure vessel and tanks.

2. NATURAL FIBER COMPOSITES

Development of a natural fiber materials is a important role on material science. The natural fibers are more advantage it is low cost eco-friendly and its availability. The natural fiber are mainly used coir fiber, banana fiber, almond shell fiber, sugarcane bagasse fibers, coconut fiber, oil palm fiber, Pine apple leaf fiber, hemp fiber are natural fibers composites.

The compressive strength of coir fiber reinforced concrete (CFRC) is a high tensile strength and high flexural strength, compare to plain cement concrete (PCC) [1]. The composite has better creep stability at elevated temperature than PVC. The natural fiber like banana particulate reinforced polyvinyl chloride was manufactured. It is light in weight with better mechanical properties. It is done with the help of compressing moulding. The thermal stability is increased by components of reinforcement in the composite. This is analysed by thermogravimetric method [2]. sugarcane leaves and almond shells are wed to manufacture epoxy polymer composite. This is manufacture by hand layup method. It is found that it shows superior flexural strength [3]. Recycled polymeric wastes and sugarcane bagasse is used in building materials like paints. Polymer/filler ratio ranges from 100/0 to 60/40 [4]. The properties of coconut, oil palm, bagasse fibers are investigated to use in soil blocks. The testing is done and fount that the above natural fibers have similar in wet and damp climate [5].

Absorbtion capacity of coir polyester is done as per ASTM D256. 30% fiber volume fraction yielded largest impact strength of1.570N-M. it is used in mud guard manufacturing [6]. Pineapple and banana leaf fibers is used as reinforcement in polyester resin with different volume fraction of (0.112, 0.166, 0.213, 0.274, 0.346), it has good thermal insulating properties [7]. Different fibers configurations of banana and their respective mechanical properties are evaluated. It is fount that pp/banana yarn composites posses a high tensile strength with increment of 294% [8]. Sugarcane bagasse fiber were pretreated and added to PP matrix. More rigid material with 10% fiber content [9]. Fenugreek banana composite was developed. The thermal conductivity of composite material at maximum volume fraction of fenugreek is 0.259w/mk [10].

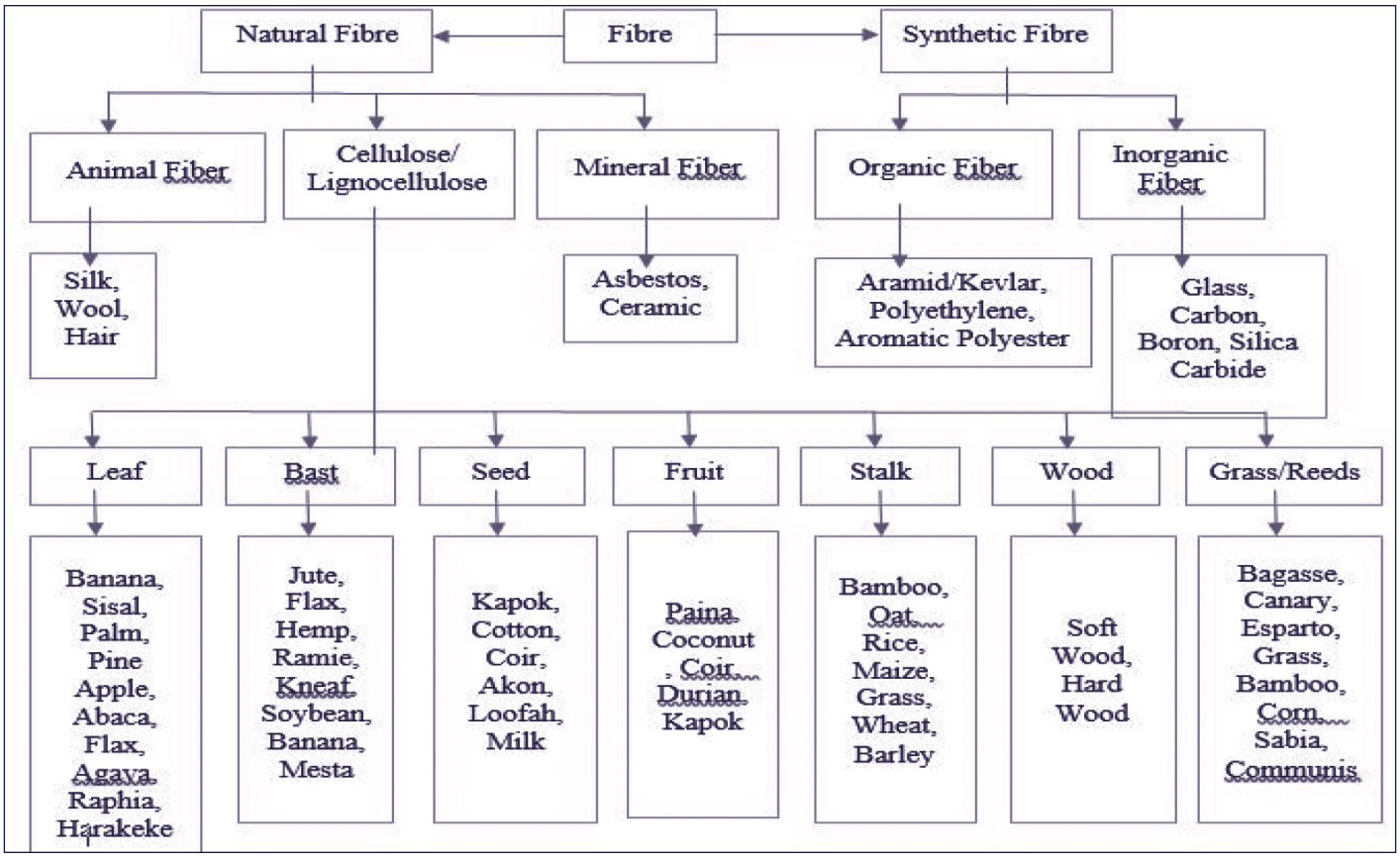
Low density polyethylene is a hazard to environment. So it is used along with sugarcane fibers which is already subject to steam explosion process [11]. Sugarcane fiber waste is used in construction field. It is fount that 0.5% sugarcane fiber with concrete did not affect the compressive strength of concrete [12]. By layup method a composite panel was fabricated to a size of 300mm*200mm*100mm with coconut coir 5%, bagasse 45% and epoxy resin. It can be used in wall ceiling and interior of automobiles [13]. Compatibilize materials like polypropylene with BSP composites are analyzed. Increase in SCB filler content decreased the tensile strength of PP/SCB composite [14]. chopped and un chopped banana fibers are

used in low density polyethylene composites. Analysis shows that fibers at a length of 20cm are fount to be stronger at 40%wt [15].

Coir micro fillers are reinforced in polyester micro composites. The analysis by dynamic light scattering shows that the average coir size is 0.255µm [16]. fiber retardant boron solutions it imparted with coir fiber boards. Test shows the resistance to flammability is fount to be very high in this panels [17]. coir from coconut husk is delignified with alkaline peroxide. This delignified coir fiber reinforced composites tensile strength increased from 1.85 to 3.82mpa [22]. natural hemp fiber is reinforced in rigid polyurethane hemp fiber composite has good insulating properties [23]. M40 concrete was prepared with flyash, coconut fiber and coir fiber. Addition of coconut shell as partial replacement of coarse aggregate increases the compressive strength of the concrete [24]. abaca and kenaf based composite panels are prepared and used instead of plywood, 35% of kenaf and 35% abaca fiber reinforcement has high tensile in strength [25].

Banana - glass fiber reinforced polypropylene composite are prepared by using hot press with different types of stacking sequence. The test shows that banana – glass fiber reinforced composite has enhanced by 302.27% of tensile strength [26]. Bit coir fiber and sugarcane bagasse fiber are subjected to steam explosion treatments and polymer matrix is produced, it was found that onset degradation temperature is increased up to 135.5c [27]. thermoplastics are reinforced with nano banana fiber powders. To understand the structure of thermal analysis is done, it is fount that banana fiber composite with E-glass composites exhibited better thermal stability than neat composites [28]. glass fiber, pineapple, banana leaf reinforced hybrid polyester composites are fabricated. It is found that adding fiber content affects the dynamic mechanical properties of polyester [29]. coir fiber green concrete usage of coir fiber with green composite is analyzed, It is found that inclusion of coir fiber in the concrete decreases the slump factor, it can be used in construction of roads [30].

Doping of nano graphite in natural coir fiber in the natural coir fiber reinforced polymer composite, 45% natural coir fiber and 3.2% nano graphite is used in epoxy resin matrix [31]. banana fiber is reinforced with vinyl ester resin matrix. Hand layup technique is used for manufacture this, it can be used in door panels, dash boards [32]. sugarcane bagasse fiber reinforced polypropylene composite was prepared by compression molding process. 51% increase in tensile strength is seen [33]. hybrid composite are prepared by using oil palm empty fruit bunch and sugarcane bagasse fiber, test result shown that 7OPEFB:3SCB hybrid test high tensile strength [34]. at 180c different SCB loading (5,15 and 30 per hundred resin) composite are prepared using heated two roll mill, SCB fiber has good interfacial bonding with PP/NBRr matrices [35].



2.1 Classification of Natural Fiber Composite

Natural fiber is classified as plant fiber, animal fiber, mineral fiber. It is defined as delicate, hair portion of the tissues of a plant or animal or thin thread like structure made synthetically or from minerals.

2.2 Types of Natural Fiber: Plant Fiber: Plant fibers, the fibers derived from plants. the fibers are harvested from many of these plants are bast fibers, the fibers are come from the phloem tissue of the plant. The other fiber crop fibers are hard/ leaf fibers. Seed Fibers: fibers collected from seeds. Example: cotton, etc. Leaf Fiber: fibers collected from leaves. Example: abaca, sisal, banana and agave, etc. Bast Fiber/Skin Fiber: fibers are collected from the skin are bast surrounding the stem of their respective plant. Example: hemp, flax, jute, etc. Fruit Fiber: Fibers are collected from the fruits from living organics. Example: coconut coir fiber, etc. Stalk Fiber: fibers are mostly used at stalk of the plants. Example: rice, barley, wheat and other crops are bamboo and grass, etc.

2.3 Animal Fiber: Animal fibers are natural fibers and most commonly used fibers, although sheep wool is most common woolen fibers, these include camel, alpaca, cashmere. Animal Hair: animal fiber or wool taken from animals and hairy mammals. example: sheep, goat. Silk Fiber: fiber are secreted by glands. example: alpaca hair, horse hair, camel hair, etc. Avian Fiber: fibers are collected from birds. Example: feather fiber

2.4 Mineral Fiber: Mineral fibers are glass, graphite and asbestos. Asbestos occurs naturally as fibers. Minerals fibers are used as fillers in thermal insulation and fire proofing materials. The properties of fibers are acid proof, flame proof and rust proof.

2.5 Application of Natural Fiber: Natural fibers can be used for application of automobile industries, electrical devices, building and construction industries, etc, Building materials: wall panels, ceiling, doors, roof, etc., Automobile: engine guard, light doom, door panel, bumpers, etc. Aircraft: interior parts, flaps, elevator, aileron, stabilizers, etc. Railway: coach interior, seats, etc. Furniture: chair, table, bath units, etc. Storage device: bio gas containers, post boxes, etc. Electrical devices: panels, insulators, pipes, electrical appliances, etc. This are the various application used in various areas.

2.6 Advantages of Natural Fiber: Environmental aspects: Renewable resources, low energy induced during the production, carbon dioxide neutrality, and disposal by composting. Biological aspects: Nature organic products, no thermal issue for their handling. Production aspects: nonabrasive, great formability. Component weight issues: light weight (less than half the density of other fibers). Financial aspects: low cost. Strength: good thermal insulation and acoustic properties due to their hollow tubular structures, high specific strength.

Natural fiber	Product	Application	Reference
Coir	Coir fiber reinforced concrete	Building material in civil engineering	[1]
Banana stem	Banana stem reinforced PVC composite pipe	Petroleum industries	[2]
Almond shell, Sugar cane leaves	Composite board	Automobile industries	[3]
Sugarcane bagasse	Recycling polymeric to produce building material boards and bricks	Building material	[4]
Coconut, oil palm, bagasse fibers	Reinforcement in Soil blocks	Construction purpose in building material	[5]
Coir	Coir polyester composite (light doom, engine guard, wall panels, light weight alternative building material, Panels and insulators.	Automobile industries, Building material, Electrical industries.	[6]
Banana, pine apple leaf fiber	Banana, pineapple leaf fiber reinforced polyester composite	Automobile interior parts, Electronic packages, Building constructions.	[7]
Banana	Mat, yarn	Automobile, Aerospace parts	[8]
Fenugreek and banana composite	Circular disc	Steam pipes, Automobile interior parts, Building construction materials.	[10]
Sugarcane fiber	Concrete block, increase strength of normal concrete	Building construction materials	[12]
Coconut coir, bagasse fiber	Composite panel	Wall ceiling, Automobile interior.	[13]
Banana fiber	Composite panel using local plastic and agricultural waste	Construction material	[15]
Coir	Fiber boards	Furniture and construction industries.	[19]
Hemp	Thermal insulating board	Building and public work sectors	[25]
Coir	Concrete	Buildings, road pavements, bridge decks.	[33]

Table 1: Natural Fiber Products and Applications

Natural fiber	Products	Various Testing applied	Reference
Coir	Coir fiber reinforced concrete	Compressive test Tensile test Flexural test	[1]
Banana stem	Banana stem reinforced PVC composite pipe	Thermal test	[2]
Almond shell, Sugar cane leaves	Composite board	Tensile test Flexural test Impact test	[3]
Sugarcane bagasse	Recycling polymeric to produce building material boards and bricks	Water absorption test	[4]
Coconut, oil palm, bagasse fibers	Reinforcement in Soil blocks	Water absorption test Tensile test	[5]
Coir	Coir polyester composite (light doom, engine guard, wall panels, light weight alternative building material, Panels and insulators.	Impact test	[6]
Banana, pine apple leaf fiber	Banana, pineapple leaf fiber reinforced polyester composite	Thermal conductivity test	[7]
Banana	Mat, yarn	Tensile test Flexural test	[8]
Fenugreek and banana composite	Circular disc	Thermal conductivity test	[10]
Sugarcane fiber	Concrete block, increase strength of normal concrete	Compressive test Tensile test	[12]
Coconut coir, bagasse fiber	Composite panel	Thermo gravimetric analysis Water absorption test	[13]
Banana fiber	Composite panel using local plastic and agricultural waste	Tensile test	[15]
Coir	Fiber boards	Flammability test burning test	[19]
Hemp	Thermal insulating board	Thermal conductivity test Tensile test Flexural test	[25]
Coir	Concrete	Quasi static strength test Impact resistance test Microstructure test	[33]

Table 2: Natural Fiber Products and Testing Methods

3. CHARACTERISTIC OF TEST ON COMPOSITE

Due to the design of composite material it is natural fiber composite and synthetic fiber composite such various behavior and properties of material are identified due to testing, mechanical test, thermal test, chemical test, etc. under which composite will perform.

3.1 Tensile Test: The tensile properties of composite laminate are fount among the mechanical properties. The difficulty of performing an acceptable tensile test. The unidirectional composite can be tested by following procedure on tensile test.

3.2 Compression Test: The compression strength is obtained by direct and loading of the specimen. If the sample is thin, lateral supports are to be provided to prevent buckling. The specimen shape is dog bone shape it is ensure the increased load bearing area at the ends which eliminates the end crushing.

3.3 Shear Test: A shear test is performed on the composite laminate to know in shear modulus or shear strength. The shear test method and specimen configuration is made as procedure. As analysis of specimen under load reveals that a state of uniform shear stress exists in the centre of the notched specimen on the cross section through the notches.

3.4 Flexural Test: Flexural test is bending test, the flexural specimen is simply a strip of test material of constant width and thickness and the deflection is measured using a calibrated linear variable differential transform at the mid span.

3.5 Impact Test: Impact test is Charpy test, Izod test and drop weight impact test the impact test is carried out at the type of test machines.

3.6 Bio Degradation Test: The properties of the composite depend on properties, and their behavior when they were composed to make the composite laminates. The volume fraction of fiber and resin in the composite, the natural fibers composite have lesser flexural strength. All the natural fibers are hydrophilic in nature. The flexural modulus and flexural properties of these composite is less than their tensile properties.

3.7 Water Absorption Test: The water and moisture take up properties for natural composites is considerable. The natural fibers and the synthetic fibers should also be used to retain the strength with water absorption. The water absorption test was conducted on the room temperature. The samples were soaked in pure water. The moisture absorption helps to increased crack propagation in the matrix region.

3.8 Hygrothermal Test: The action of heat and moisture has a combined effect on the composite laminate. In determine the hygrothermal effect, the tensile test is conducted on a sample and the remaining samples are stored in separate place in six months, during this time the sample are affected with moisture and heat, then the samples are conducted on tensile test. The final result areanalyzed.

Fiber	Density (G/Cm^3)	Elongation (%)	Tensile Strength(MPA)	Youngs Modulus
Cotton	1.6	3-10	287-800	5.5-12.6
Jute	1.3	1-1.8	200-450	20-55
Flax	1.5	1.2-3.3	343-1800	27-45
Hemp	1.5	1-3.5	270-900	50
Sisal	1.3	2-7	363-700	9-16
Coir	1.2	15-51.5	140	6
Abaca	1.5	1-10	400	41
Banana	1.35	1.5-9	529-914	27-32
Oil Palm	0.7-1.5	25	248	3.20
Pine Apple	1.5	1-3	400-627	49
Bagasse	1.25	1.1	290	17
Bamboo	0.6-1.1	2.5-3.7	140-230	11-17

Table 3: Properties of Natural Fibers

CONCLUSION

The reason for the selection of natural fibers instead of synthetic fiber due to high tensile strength, elongation and young's modulus. This paper provides the information about the natural fibers for the engineering applications. This paper gives the data of some of fibers which are getting from agriculture waste. More materials have to be discovered for various application than the commonly used applications. Research has to be involved more in this field.

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