

# Analysis of Composite Material on Natural Fibre and Natural Resin

Dharsan Kishore B

Department of Mechanical Engineering

Guided by Assistant Professor Sivasubramanian S

**Abstract:** *Over the last decade, composites of Natural resin reinforced with natural fibres have received increasing attention, both from the academic world and from several industries. There is a wide range of natural fibres which can be applied as reinforcements or fillers thanks to their properties and availability; i.e. flax, hemp, jute, kenaf and sisal. Natural composite materials are mainly attractive for the following reasons: specific properties, price, health advantages and recyclability. Despite such good premises, these fibres have also some negative characteristics: they are highly hydrophilic and their properties may vary in time. The natural fibres have a complex structure of elementary fibres, consisting of cellulose, hemicellulose, pectin, lignin and others and thus they should not be considered as monofilament fibres. Mechanical, physical and even chemical properties of these fibres are strongly harvest dependent, influenced by climate, location, soil characteristics, and weather circumstances. They are affected also by fibre processing (i.e. retting, scutching, bleaching, spinning) and by their incorporation into composites: handling, impregnation and consolidation may introduce supplementary changes. Obviously, such variability complicates the prediction and the evaluation of the composite properties. Another known problem in natural fibre reinforced composites is the poor interface quality between the fibres and the polymer matrix. Chemical pre-treatments are often applied in order to enhance the adhesion between these components.*

**Keywords:** Retting, scutching, fibres, polymer matrix and adhesion

## 1. Introduction

### 1.1 Overview of Composites

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle. It is essential that there be an integrated effort in design, material, process, tooling, quality assurance, manufacturing, and even program management for composites to become competitive with metals.

A composite material consists of two or more physically and/or chemically distinct, suitably arranged or distributed phases, with an interface separating them. It has characteristics that are not depicted by any of the components in isolation. Most commonly, composite materials have a bulk phase, which is continuous, called the matrix, and one dispersed, non-continuous, phase called the reinforcement, which is usually harder and stronger. The function of individual components has been described as:

### Matrix phase

The primary phase, having a continuous character, is called matrix. Matrix is usually more ductile and less hard phase. It holds the dispersed phase and shares a load with it.

### Dispersed (reinforcing) phase

The second phase (or phases) is embedded in the matrix in a discontinuous form. This secondary phase is called dispersed phase. Dispersed phase is usually stronger than the matrix, therefore it is sometimes called reinforcing phase. Many of common materials (metal alloys, doped Ceramics and Polymers mixed with additives) also have a small amount of dispersed phases in their structures, however they are not considered as composite materials since their properties are similar to those of their base constituents (physical properties of steel are similar to those of pure iron). There are two classification systems of composite materials. One of them is based on the matrix material (metal, ceramic, and polymer) and the second is based on the material structure

### 1.2 Types of Composites

For the sake of simplicity, however, composites can be grouped into categories based on the nature of the matrix each type possesses. Methods of fabrication also vary according to physical and chemical properties of the matrices and reinforcing fibres.

### Metal Matrix Composites (MMCs)

Metal matrix composites, as the name implies, have a metal matrix. Examples of matrices in such composites include aluminium, magnesium and titanium. The typical

Volume 10 Issue 8, August 2021

[www.ijsr.net](http://www.ijsr.net)

Licensed Under Creative Commons Attribution CC BY

fiber includes carbon and silicon carbide. Metals are mainly reinforced to suit the needs of design. For example, the elastic stiffness and strength of metals can be increased, while large coefficient of thermal expansion, and thermal and electrical conductivities of metals can be reduced by the addition of fibres such as silicon carbide

### Ceramic Matrix Composites (CMCs)

Ceramic matrix composites have ceramic matrix such as alumina, calcium, alumina silicate reinforced by silicon carbide. The advantages of CMC include high strength, hardness, high service temperature limits for ceramics, chemical inertness and low density. Naturally resistant to high temperature, ceramic materials have a tendency to become brittle and to fracture. Composites successfully made with ceramic matrices are reinforced with silicon carbide fibres. These composites offer the same high temperature tolerance of super alloys but without such a high density. The brittle nature of ceramics makes composite fabrication difficult. Usually most CMC production procedures involve starting materials in powder form. There are four classes of ceramics matrices: glass (easy to fabricate because of low softening temperatures, include borosilicate and aluminosilicates), conventional ceramics (silicon carbide, silicon nitride, aluminium oxide and zirconium oxide are fully crystalline), cement and concreted carbon components.

### Polymer Matrix Composites (PMC)

Most commonly used matrix materials are polymeric. The reasons for this are two-fold. In general the mechanical properties of polymers are inadequate for many structural purposes. In particular their strength and stiffness are low compared to metals and ceramics. These difficulties are overcome by reinforcing other materials with polymers. Secondly the processing of polymer matrix composites need not involve high pressure and does not require high temperature. Also equipment's required for manufacturing polymer matrix composites are simpler. For this reason polymer composites developed rapidly and soon became popular for structural applications. Polymer composites are used because overall properties of the composites are superior to those of the individual polymers. They have a greater elastic modulus than the neat polymer but are not as brittle as ceramics. Polymeric matrix composites are composed of a matrix from thermoset.

### 1.3 Based on reinforcing material structure

Classification of composites: three main categories · particle-reinforced (large-particle and dispersion strengthened)

- Fiber-reinforced (continuous (aligned) and short fibers (aligned or random))
- Structural (laminates and sandwich panels)

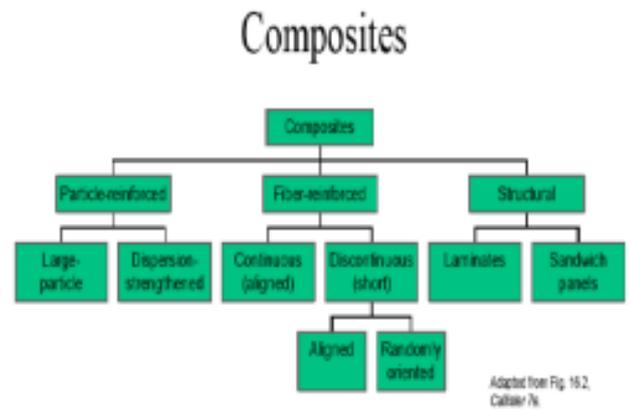


Figure 1: Reinforced based composites

### Particulate Composites

Particulate Composites consist of a matrix reinforced by a dispersed phase in form of particles. These are the cheapest and most widely used. They fall in two categories depending on the size of the particles.

- Composites with random orientation of particles.
- Composites with preferred orientation of particles

Dispersed phase of these materials consists of two-dimensional flat platelets (flakes), laid parallel to each other.

### Fibrous Composites

Short fiber reinforced composites:

Short-fiber reinforced composites consist of a matrix reinforced by a dispersed phase in form of discontinuous fibers (length < 100\*diameter). They are classified as;

- Composites with random orientation of fibers
- Composites with preferred orientation of fibers.

Long-fiber reinforced composites:

Long-fiber reinforced composites consist of a matrix reinforced by a dispersed

Phase in form of continuous fibres.

- Unidirectional orientation of fibers.
- Bidirectional orientation of fibers (woven).

### Laminate composite

When a fiber reinforced composite consists of several layers with different fiber orientations, it is called multilayer composite.

### 1.4 Introduction to Reinforcements

Reinforcements for the composites can be fibers, fabrics particles or whiskers. Fibers are essentially characterized by one very long axis with other two axes either often

circular or near circular. Particles have no preferred orientation and so does their shape. Whiskers have a preferred shape but are small both in diameter and length as compared to fibers.

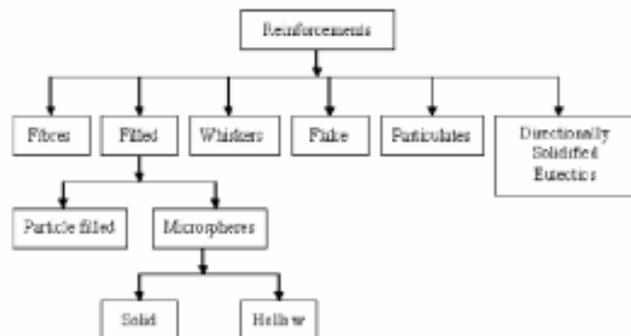


Figure 2: Types of reinforcement

Reinforcing constituents in composites, as the word indicates, provide the strength that makes the composite what it is. But they also serve certain additional purposes of heat resistance or conduction, resistance to corrosion and provide rigidity. Reinforcement can be made to perform all or one of these functions as per the requirements

**1.5 Natural Fiber Reinforced Composites** Fiber-reinforced polymer composites have played a dominant role for a long time in a variety of applications for their high specific strength and modulus. The manufacture, use and removal of traditional fiber-reinforced plastic, usually made of glass, carbon or aramid fibers-reinforced thermoplastic and thermoset resins are considered critically because of environmental problems. By natural fiber composites we mean a composite material that is reinforced with fibers, particles or platelets from natural or renewable resources, in contrast to for example carbon or aramid fibers that have to be synthesized. Natural fibers include those made from plant, animal and mineral sources. Natural fibers can be classified according to their origin.

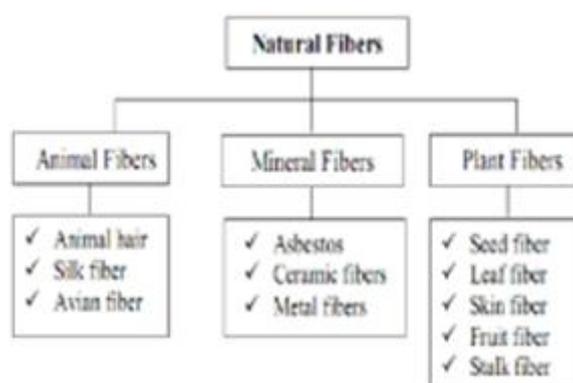


Figure 3: Classification of natural fiber

### Animal Fiber

Animal fiber generally comprise proteins; examples mohair, wool, silk, alpaca, angora. Animal hair (wool or hair) are the fibers taken from animals or hairy mammals.

E.g. Sheep's wool, goat hair (cashmere, mohair), alpaca hair, horse hair, etc.

### Mineral fiber

Mineral fibers are naturally occurring fiber or slightly modified fiber procured from minerals. These can be categorized into the following categories: Asbestos is the only naturally occurring mineral fiber. Variations are serpentine and amphiboles, anthophyllite. Ceramic fibers includes glass fibers (Glass wood and Quartz), aluminium oxide, silicon carbide, and boron carbide. Metal fibers includes aluminium fibers.

### Plant fiber

Plant fibers are generally comprised mainly of cellulose: examples include cotton, jute, flax, ramie, sisal and hemp. Cellulose fibers serve in the manufacture of paper and cloth. This fiber can be further categorizes into following as Seed fiber are the fibers collected from the seed and seed case e.g. cotton and kapok.

### 1.5 Surface treatment of fibers

The influence of fiber treatment on the properties of bio composites derived from grass fiber and soy based bio plastic has been investigated with environmental scanning electron microscopy, thermal and mechanical properties measurements. Grass fibers were treated with alkali solution that reduced the inter-fibrillar region of the fiber by removing hemicellulose and lignin, which reduce the cementing force between fibrils. This led to a more homogenous dispersion of the biofiber in the matrix as well as increase in the aspect ratio of the fiber in the composite, resulting in an improvement in fiber reinforcement efficiency. This led to enhancement in mechanical properties including tensile and flexural properties as well as impact strength. Additionally, the alkali solution treatment increased the concentration of hydroxyl groups on the surface, which led to a better interaction between the fibers and the matrix. Against this background, the present research work has been undertaken, with an objective to explore the potential of coir fiber as a reinforcing material in polymer composites and to investigate its effect on the mechanical behaviour of the resulting composites. The present work thus aims to develop this new class of natural fiber based polymer composites with different fiber lengths and to analyse their mechanical behaviour by experimentation.

### 1.6 Manufacturing Processes of Composite Material

Manufacturing of a composite material is to combine the polymeric resin system with the fiber reinforcement. Since the orientation of the fibers is critical to the end properties of the composite, manufacturing process is utmost important to align the fibers in desired direction. A good manufacturing process will produce a higher, uniform fiber volume fraction along with a higher production of a large volume of parts economically and have repeatable dimensional tolerances.

The composite manufacturing techniques can be classified into two categories:

### A. Open mould process

- Hand lay-up process
- Spray up process
- Vacuum-bag auto clave process
- Filament winding process

### B. Closed mould process

- Compression moulding
- Injection moulding
- Sheet moulding compound (SMC) process
- Continuous pultrusion process

### Natural Resins

Resin secretion occurs in special cavities or in many plant species. They are formed in the specialized structures called passages ducts. Resins exude or ooze out from the bark of the trees and tend to harden on exposure to air. With the exception of lac, which is produced by the lac insect (*Kerria lacca*), all other natural resins are of plant origin. Natural resins of particular importance to the furniture coatings are rosin, damar, copal, sandarac, amber and manila.

### The principal characteristics of resins are:

- They are insoluble in water.
- They are soluble in ordinary solvents like alcohol, ether and turpentine.
- They are brittle, amorphous and are transparent or semi transparent.
- They have a characteristic luster, are ordinarily fusible and when ignited, resins burn with a smoky flame.

### Natural Gums

Gums are a group of plant products, formed primarily due to the disintegration of plant cellulose. This process is known as gummosis. Gums are produced by members of a large number of families but exploitation is restricted to of commercial a few tree species Leguminosae, Sterculiaceae and Combretaceae families. The important gum yielding trees are Acacia nilotica (babul), A catechu (chairs), Sterculia urens (kullu), Anogeissus latifolia (dhawra), Butea monosperma (palas), Bauhinia retusa (semal), Lannea coromandelica (lendia) and Azadirachta indica (neem). Gums is also extracted from seeds of certain plants like guar, tamarind, Cassia tora etc. Guar gum is the prominent seed based natural gum.

## 2. Materials and Methods

This chapter describes the details of processing of the composites and the experimental procedures followed for their mechanical characterization. The raw materials used in this work are

### 2.1 Materials Used

- 1) Natural resin (GUM ROSIN)
- 2) EGG shell Calcium
- 3) Natural Fibers (Coconut Coir)

#### Natural resin (GUM ROSIN)

Rosin, also called colophony or Greek pitch (Latin: *pix graeca*), is a solid form of resin obtained from pines and some other plants, mostly conifers, produced by heating fresh liquid resins to vaporize the volatile liquid terpene components. It is semi-transparent and varies in color from yellow to black. At room temperature rosin is brittle, but it melts at stove-top temperature. It chiefly consists of various resin acids, especially abietic acid. The term "colophony" comes from *colophonias resina*, Latin for "resin from Colophon", an ancient Ionic city.

### 2.1 Production

Rosin is the resinous constituent of the oleo-resin exuded by various species of pine, known in commerce as crude turpentine. The separation of the oleo-resin into the essential oil (spirit of turpentine) and common rosin is accomplished by distillation in large copper stills. The essential oil is carried off at a temperature of between 100 °C (212 °F) and 160 °C (320 °F), leaving fluid rosin, which is run off through a tap at the bottom of the still, and purified by passing through straining wadding. Rosin varies in color, according to the age of the tree from which the turpentine is drawn and the degree of heat applied in distillation, from an opaque, almost pitch-black substance through grades of brown and yellow to an almost perfectly transparent colorless glassy mass. The commercial grades are numerous, ranging by letters from A (the darkest) to N (extra pale), superior to which are W (window glass) and WW (water-white) varieties, the latter having about three times the value of the common qualities.

Tall oil rosin is produced during the distillation of crude tall oil, a by-product of the kraft paper making process. When pine trees are harvested "the resinous portions of fallen or felled trees like longleaf and slash pines, when allowed to remain upon the ground, resist decay indefinitely."<sup>[12]</sup> This "stump waste", through the use of destructive distillation or solvent processes, can be used to make products including rosin. This type of rosin is typically called wood rosin.

Because the turpentine and pine oil from destructive distillation "become somewhat contaminated with other distillation products", <sup>[12]</sup> solvent processes are commonly used. In this process, stumps and roots are chipped and soaked in the light end of the heavy naphtha fraction (boiling between (90 °C (194 °F) and 115 °C (239 °F)) from a crude oil refinery. Multi stage counter-current extraction is commonly used so fresh naphtha first contacts wood leached in intermediate stages and naphtha laden with rosin from intermediate stages contacts unleached wood before vacuum distillation to recover naphtha from the rosin, fatty acids, turpentine, and other

constituents later separated through steam distillation. Leached wood is steamed for additional naphtha recovery prior to burning for energy recovery.<sup>[13]</sup> After the solvent has been recovered, "the terpene oils are separated by fractional distillation and recovered mainly as refined turpentine, dipentene, and pine oil. The nonvolatile residue from the extract is wood rosin of rather dark color. Upgrading of the rosin is carried out by clarification methods that generally may include bed-filtering or furfural treatment of rosin-solvent solution."

On a large scale, rosin is treated by destructive distillation for the production of rosin spirit, pinoline and rosin oil. The last enters into the composition of some of the solid lubricating greases, and is also used as an adulterant of other oils.

## 2.2 Process of making Egg shell calcium

The calcareous egg is produced by all birds and most reptiles. Current understanding of eggshell formation and mineralization is mainly based on intensive studies of one species - the domesticated chicken *Gallus gallus*. The majority of constituents of the chicken eggshell have been identified. In this article we review eggshell microstructure and ultrastructure, and the results of recent genomic, transcriptomic and proteomic analyses of the chicken eggshell matrix to draw attention to areas of current uncertainty such as the potential role of amorphous calcium carbonate and the specific nature of the molecules that initiate (nucleate) mammillary cone formation and terminate palisade layer calcification. Comparative avian genomics and proteomics have only recently become possible with the publication of the *Taeniopygia guttata* (zebra finch) genome. Further rapid progress is highly anticipated with the soon-to-be-released genomes of turkey (*Meleagris gallopavo*) and duck (*Anas platyrhynchos*). These resources will allow rapid advances in comparative studies of the organic constituents of avian eggshell their functional implications.



**Figure 4:** Rinse the eggshells

Place about 12 eggshells in a colander and put the colander in the sink. Wash thoroughly, but leave the membrane in the shells.



**Figure 5:** Boil the eggshells

Bring a pot of water to a boil. Then - using a slotted spoon - place the eggshells into the boiling water. Watch and monitor the eggshells, using the spoon to keep them submerged. Boil for 10 minutes to safely remove bacteria and pathogens. While they boil, preheat your oven to 200 degrees Fahrenheit. After boiling, place the shells back into the colander to drain.



**Figure 6:** Bake the eggshells

Place the boiled and drained eggshells on a cookie sheet. Bake in the oven for 15 minutes, until crispy.



**Figure 7:** Grind the eggshells

Allow the eggshells to cool. In a blender or coffee grinder, grind the eggshells until they become a fine, white powder.

## 2.3 Preparation of Coconut coir

The name coir comes from kayar, a Dravidian word for cord, used in both Malayalam and Tamil, with neither language clearly proven to be the origin.<sup>[13][4]</sup> Ropes and cordage have been made from coconut fibre since ancient

times. Indian navigators who sailed the seas to Malaya, Java, China, and the Gulf of Arabia centuries ago used coir for their ship ropes. Arab writers of the 11th century AD referred to the extensive use of coir for ship ropes and rigging.<sup>[5]</sup>

A coir industry in the UK was recorded before the second half of the 19th century. During 1840, Captain Widely, in co-operation with Captain Logan and Mr. Thomas Treloar, founded the known carpet firms of Treloar and Sons in Ludgate Hill, England, for the manufacture of coir into various fabrics suitable for floor coverings structure



**Figure 8:** Coir Fibres

**Coir** fibres are found between the hard, internal shell and the outer coat of a coconut. The individual fibre cells are narrow and hollow, with thick walls made of cellulose. They are pale when immature, but later become hardened and yellowed as a layer of lignin is deposited on their walls. Each cell is about 1 mm (0.04 in) long and 10 to 20  $\mu\text{m}$  (0.0004 to 0.0008 in) in diameter.<sup>[7]</sup> Fibres are typically 10 to 30 centimeters (4 to 12 in) long.<sup>[8]</sup> The two varieties of coir are brown and white. Brown coir harvested from fully ripened coconuts is thick, strong and has high abrasion resistance. It is typically used in mats, brushes and sacking. Mature brown coir fibres contain more lignin and less cellulose than fibres such as flax and cotton, so are stronger but less flexible. White coir fibres harvested from coconuts before they are ripe are white or light brown in color and are smoother and finer, but also weaker. They are generally spun to make yarn used in mats or rope.

The coir fibre is relatively waterproof, and is one of the few natural fibres resistant to damage by saltwater. Fresh water is used to process brown coir, while seawater and fresh water are both used in the production of white coir. It must not be confused with coir pith, or formerly cocopeat, which is the powdery material resulting from the processing of the coir fibre. Coir fibre is locally named 'coprah' in some countries, adding to confusion.

## 2.4 Processing

Green coconuts, harvested after about six to 12 months on the palm, contain pliable white fibres. Brown fibre is obtained by harvesting fully mature coconuts when the

nutritious layer surrounding the seed is ready to be processed into copra and desiccated coconut. The fibrous layer of the fruit is then separated from the hard shell (manually) by driving the fruit down onto a spike to split it (dehusking). A well-seasoned husker can manually separate 2, 000 coconuts per day. Machines are now available which crush the whole fruit to give the loose fibres. These machines can process up to 2, 000 coconuts per hour.

## Properties of Natural Fiber:

**Table 2:** Properties of natural fiber

Plant Fibers	Density (Kg/m <sup>3</sup> )	Tensile Strength (MPa)	Young's Modulus (GPa)
Jute Fiber	1300-1500	200-450	20-55
Sisal Fiber	1300-1500	80-840	9-22
Coconut Coir	1150-1250	106-175	6-8
Areca Nut	1050-1150	300-530	30-60

## Methodology

### Step 1: Selection of Gum material

Gum rosin is a Natural resin extract from Pine tree is used as the Resin

### Step 2: Selection of reinforcement and Natural fibers

Natural fibers such as Sisal, Coconut coir, Arecanut, Ridge gourd and Tamarind were taken to fill as reinforcements in the Polymer composite.

### Step 3: Extraction of fibers

#### Sisal Fiber:

Sisal is commercially available.

- Sisal is a natural fiber (Scientific name is *Agave sisalana* of Agavaceae (Agave) family yields a stiff fiber traditionally used in making twine and rope.
- Sisal is fully biodegradable and highly renewable resources
- Sisal fiber is exceptionally durable and a low maintenance with minimal wear and tear.

#### Jute Mat Fiber:

Into coarse, strong threads. It is produced from plants in the genus *Corchorus*. Second only to cotton in amount produced and variety of uses.



Figure 9: Sisal Fiber

**Areca Nut:**

- Areca nut is also known as Betel nut
- The areca nut husk fibers are predominantly composed of cellulose and varying
- Proportions of hemicelluloses, lignin, pectin and

proto-pectin.

- The fibers adjoining the inner layers are irregularly lignified group of cells called hard fibers, and the portions of the middle layer below the outermost layer are soft fibers.



Figure 10: Areca Nut

Cellulose and lignin. Jute is a rainy season crop, growing best in warm, humid climates, degradable & recyclable

and thus environment friendly.

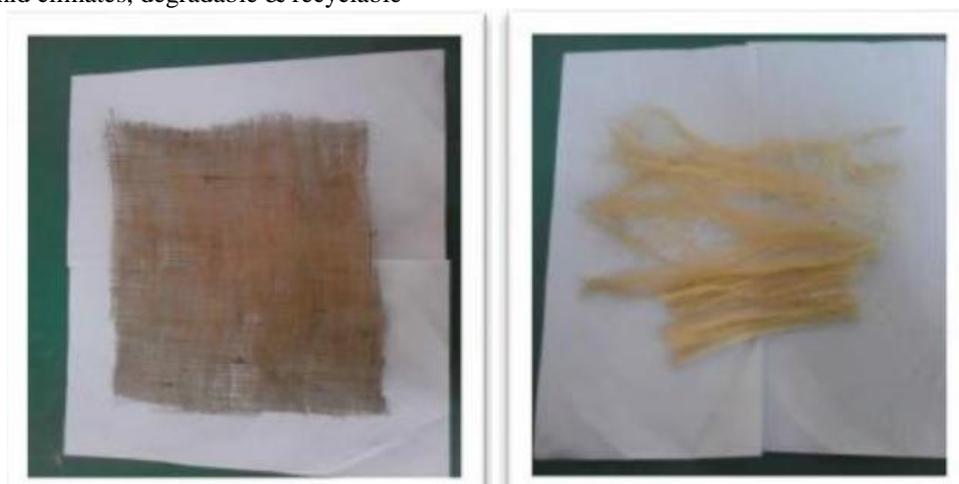


Figure 11: Jute mat Fiber

**Banana fiber:**

Banana Fiber contains cellulose, hemicelluloses and lignin. Available at reasonable prices, our Banana Fiber is

widely appreciated for its characteristics such as high strength, strong moisture absorption, good luster, light weight, fast moisture absorption and release, small elongation, easy degradation and many more.



**Figure 12:** Banana Fiber

**Coconut Coir Fiber**

Coconut coir- Coconut fruit peel were gathered and

soaked in water. Later clean fibers were drawn manually from them.



**Figure 13:** Coconut Coir

**Step 4: Surface treatment of fibers:**

Freshly drawn fibers generally include lots of impurities that can adversely affect the fiber matrix bonding. Consequently the composite material made from such fibers may not possess satisfactory mechanical properties. Therefore it is desirable to eliminate the impurity content of the fibers and perhaps enhance the surface topography of the fibers to obtain a stronger fiber-matrix bonding.

- 1) Melting of Gum rosin
- 2) Adding Egg shell calcium
- 3) Adding coconut fiber

**Step 5: Wet Hand lay-up technique**

The natural resin is heated at stove temperature with a desired ratio and Egg shell calcium, Coconut coir is added with that and made stir for 5mins and poured into mould

**Samples Compositions**

The Natural resin is first taken and made melted in stove temperature and a desired ration of Egg shell calcium and coconut coir is added to form a semi solid structure and finally it poured into a mould.



**Figure 14:** Melting of Gum rosin

The process is described below:

**Volume 10 Issue 8, August 2021**

[www.ijsr.net](http://www.ijsr.net)

Licensed Under Creative Commons Attribution CC BY



Figure 15: Adding Egg shell calcium



Figure 16: Adding coconut fiber

We are making three samples of Composite material with different ratio on materials:

Table 3: Samples of Composite material with different ratio on materials

Sample No	Gum rosin %	Egg powder %	Coconut coir%
Sample 1	60	15	25
Sample 2	70	10	20
Sample 3	50	20	30

### 3.1 Fabrication of a simple Block using these bio composites:

Fabrication of the Composite Block was carried out by adopting the following hand lay process procedure. Initially a layer of Natural resin is mixed with Egg shell calcium and coconut fiber and made to heat with stove temperature and poured into the mould, subsequently the natural fiber reinforcements such as coconut coir fibers are placed respectively. Finally, a layer jute mat is placed as a top layer. Now these fibers are compressed with help of inner mould .To ensure the proper bonding between reinforcement and fibers. Subsequently, allowed for settling time of about 6 – 8 hours, then mould was released. the extra projections were cut, filed and smoothed with help of sand paper to achieve the desired shape



Figure 17: Heating the Natural resin (Gum Rosin)



Figure 18: Adding Coconut fiber into the natural resin



Figure 19: Adding Egg shell calcium into the mixture



Figure 20: Stir Operation



Figure 21: Finally the Mixture is poured into a Plastic mould and kept in drying condition for 6 to 8hours



Figure 22: Mould into a composite material

Three samples are made with different ratios of Natural resin, Egg shell and Natural fiber. To Achieve the Different Hardness level in three Samples.

## Testing and Results

### 4.1 Specimen preparation as per ASTM standards

The samples are cut to the following dimensions as per ASTM standards for testing

Totally we are doing three level of testing on Three Samples we made:

- 1) Compression Load
- 2) Shore d Hardness
- 3) Density

#### Compression load

A **universal testing machine (UTM)**, also known as a **universal tester**, <sup>[1]</sup>**materials testing machine** or **materials test frame**, is used to test the tensile strength and compressive strength of materials. An earlier name for a tensile testing machine is a **tensometer**. The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures (in other words, that it is versatile).



Figure 23: UTM

#### Shore D Hardness

The **Shore durometer** is a device for measuring the hardness of a material, typically of polymers, elastomers, and rubbers. Higher numbers on the scale indicate a greater resistance to indentation and thus harder materials. Lower numbers indicate less resistance and softer materials.

The term is also used to describe a material's rating on the scale, as in an object having a "Shore durometer" of 90." The scale was defined by Albert Ferdinand Shore, who developed a suitable device to measure hardness in the

1920s. It was neither the first hardness tester nor the first to be called a *durometer* (ISV *duro-* and *-meter*; attested since the 19th century), but today that name usually refers to Shore hardness; other devices use other measures, which return corresponding results, such as for Rockwell hardness.



Figure 24: Durometer

#### Sample 1:

Test Name	Test valve
Compression Load	33.74, 35.26, 34.80
Shore D Hardness	60, 65, 67, 69, 70
Density	0.972

#### Density:

L = 39.0mm, 38.8mm = 38.90/10 = 3.8900  
 B = 51.12mm, 51.34mm = 51.23/10 = 3.5050  
 T = 35.24mm, 34.86mm = 3.5050  
 M= 67.8974  
 V= 69.84  
 M/V= 0.9720

#### Sample 2:

Test Name	Test valve
Compression Load	28.76, 28.86, 28.7
Shore D Hardness	47, 49, 60, 65, 68
Density	0.9723

#### Density:

L = 48.46mm, 47.22mm = 4.784  
 B = 49.44mm, 51.44mm = 5.0440  
 T = 30.4mm, 29.9mm = 3.015  
 M= 70.7370  
 V= 72.7534  
 M/V= 0.9723

#### Sample 3:

Test Name	Test valve
Compression Load	28.36, 28.5, 28.46
Shore D Hardness	56, 59, 60, 60, 62
Density	0.9751

#### Density:

L = 41.34mm = 4.094  
 B = 43.22 mm = 4.3210  
 T = 28.64mm, 28.62mm = 2.8630  
 M= 49.3865  
 V= 50.6469  
 M/V= 0.9751

### Other Applications of Bio-Composites

The bio-composite obtained can be used mainly for the fabrication of the interiors of the aircraft like

- 1) Floors
- 2) Ceilings,
- 3) Sidewalls and
- 4) Stowage bins

Composites, it is the fastest growing "materials" market segment. Sporting goods, Aircraft, automobile, shipbuilding, are just a few examples. Tennis rackets, golf clubs, bumpers, door panels, dashboard, even engine components of modern automobiles; look closely at a Boeing 777etc. Some applications are given below;

- 1) Paints and coatings
- 2) Electrical systems and electronics
- 3) Aircraft industry, Ex: Doors and elevators
- 4) Consumer and marine applications
- 5) Aerospace applications
- 6) Chemical industry, Ex: Tanks, Pipes, Pressure vessels
- 7) Automotive body frames, engine components

### 3. Conclusion

The natural fibers have been successfully reinforced with the Natural resin by simple wet hand lay-up technique. The aim of this project is to find the Load, Hardness and Density strength of natural fiber reinforced bio-composites.

- 1) The fibers like jute fibers, coconut coir, areca nut fibers, sisal fibers were successfully used to fabricate bio-composites with varying the fiber percentage.
- 2) The new hybrid composite produced with Natural resin and natural fibers as reinforcements gives good mechanical properties as compared with pure matrix material. These hybrid bio-composite can be used in Aerospace and automobile applications.

In the present work, bio-composite with multiple natural fibers such as jute fibers, Coconut coir, areca fibers, sisal fibers, banana fibers have been successfully reinforced with the Natural resin by simple and inexpensive hand lay-up technique. The mechanical testing results of fabricated bio composite block indicate that, concept of using multiple natural fibers in different application. However, there is a scope to optimize the volume fraction of natural fibers as reinforcements to achieve enhanced mechanical properties of composite block. So, it is clearly indicates that reinforcement of natural fibers have good and comparable mechanical properties as conventional composite materials.

### References

- [1] A Review on Sisal Fiber reinforced Polymer Composites. Kuruvilla Joseph<sup>1</sup>, Romildo Dias Tolêdo Filho<sup>2</sup>, Beena James<sup>3</sup>, Sabu Thomas<sup>4</sup> & Laura Hecker de Carvalho<sup>5</sup> Revista Brasileira de Engenharia Agrícola e Ambiental, v.3, n.3, p.367-

- 379, 1999 Campina Grande, PB, DEAg/UFPB
- [2] Properties of SBS and Sisal Fiber Composites: Ecological Material for Shoe Manufacturing José Carlos Krause de Verney\*, Martha Fogliato Santos Lima, Denise Maria Lenz
- [3] Tensile Properties and SEM Analysis of Bamboo and Glass Fiber Reinforced Epoxy Hybrid Composite sH. Raghavendra Rao\*<sup>1</sup>, A. Varada Rajulu<sup>2</sup>, G. Ramachandra Reddy<sup>3</sup>and K. Hemachandra Reddy<sup>4</sup>
- [4] Biodegradable Polymers: Past, Present, and Future M. Kolybaba<sup>1</sup>, L.G. Tabil <sup>1</sup>, S. Panigrahi<sup>1</sup>, W.J. Crerar<sup>1</sup>, T. Powell<sup>1</sup>, Wang<sup>1</sup>
- [5] Yan Li, Yiu-Wing Mai, Lin Ye, 'Sisal fiber and its composites: a review of recent developments'. Composites Science and Technology, volume 60, (2000), 2037- 2055.
- [6] K. Murali Mohan Rao, K. Mohana Rao 'Extraction and tensile properties of natural fibers: Vakka, date and bamboo'. Composite Structures volume 77, (2007), 288–29.
- [7] A. Alavudeen, M. Thiruchitrambalam, N. Venkateshwaran and A. Athijayamani "Review of natural fiber reinforced Woven composite" Advances in Material science, volume -27: 2011.
- [8] H.M.M.A. Rashed, M. A. Islam and F. B. Rizvi, "Effects of Process Parameters on Tensile Strength of Jute Fiber Reinforced Thermoplastic Composites", Journal of Naval Architecture and Marine Engineering, June, 2006.