Introduction

As a part of our project aimed at understanding and fabrication of a green laminate of Bamboo and later testing the above obtained laminate for Mechanical properties based on the applications

1.1 History of composites

- Wattle and daub is one of the oldest manmade composite materials, at over 6000 years old.
- Concrete was described by Vitruvius, writing around 25 BC in his Ten Books on Architecture, distinguished types of aggregate appropriate for the preparation of lime mortars.
- The first artificial fibre reinforced plastic was Bakelite which dates to 1907, although natural polymers such as shellac predates. Wood is a natural composite that was used prehistorically by mankind and is still used incredibly widely

Composite material is also defined as a heterogeneous mixture of two or more heterogeneous phases which were bonded together. Fiber-reinforced composite materials consist of fibers of high strength and modulus embedded in or bonded to a matrix with distinct interfaces (boundaries) between them. In this form, both fibers and matrix retain their physical and chemical identities, yet they produce a combination of properties that cannot be achieved with either of the constituents acting alone. In general, fibers are the principal load-carrying members, while the surrounding matrix keeps them in the desired location and orientation, acts as a load transfer medium between them, and protects them from environmental damages due to elevated temperatures and humidity, for example. Thus, even though the fibers provide reinforcement for the matrix, the

latter also serves a number of useful functions in a fiber reinforced composite material.

Composite materials were divided into natural occurring composite and synthetic composites. Many natural occurring materials were classified as composite materials. Examples of natural composites were wood which was made up of cellulose molecules in a lignin matrix, teeth and bone which were composed of hydroxyapatite in a matrix of collagen, insect exoskeleton and to name a few. Synthetic composites were concrete which a combination of stone and cement, asphalt and also fibreglass which was a glass fibre reinforced unsaturated polyester matrix. We used Carbon-Nomex fibres for our fabrication process.

The key characteristics of these composites are:

- Specific strength (strength to weight ratio)
- Specific stiffness (stiffness to weight ratio)
- Tailored material i.e. it can be formulated to meet the needs of specific applications

1.2. Need For a Natural Fibre Composite Material

The theory behind the construction of composite materials comes from the need to create a strong stiff and light material.

Polymer composite materials have been widely used in various industries such as aircraft, automotive and submarine due to their great mechanical and thermal properties. However, the end of life disposal of polymer and synthetic materials is unknown and non-biodegradable. Therefore, the utilization and the manufacturing procedure of these materials will harm the nature. In contrast, natural fibres are renewable and environmentally friendly materials; they have

low density, low price, and acceptable mechanical properties. Hence, many scientists are interested in replacing them with synthetic materials to conserve the environment. Natural fibres base on their sources are divided into three categories: plant fibres (sisal, hemp, flax, bamboo, etc.), animals parts involving protein (silk, hair, wool, etc.) and minerals. The main parts of Plant fibres are cellulose, hemicellulose, lignin, and pectin. In the structure of plant fibres lignin and hemicellulose matrix held cellulose fibrils together. By increasing the amount of cellulose the mechanical properties of fibres increase. Cellulose fibre has been applied as reinforced polymer composite in building, bridge construction and automotive.

Although researchers have attempted to utilize natural fibres in aerospace industry in the recent years, they have faced a great challenge to overcome the fire resistance during working with natural fibres. The first natural fibre composite which was used as one part of airplane component to reduce the weight was between 1920s and 1930s. Some studies revealed that natural plant fibres are environmentally better than glass fibres; hence the cellulosic fibre-reinforced composite is able to be replaced with glass fibre. Bamboo in comparison with other natural fibres is eco-friendly with high growth rate and fixing the carbon dioxide of atmosphere, which makes it the most important plant fibres. It is found that more than 1000 species of bamboo and around 70 genera grow naturally in diverse climates, especially in Asia and South America abundantly. Bamboo has several advantages such as light weight, high strength, stiffness, biodegradability, and even its roots and leaves keep the soil together and protect it against the sun respectively. These properties are caused that bamboo to be used traditionally for manufacturing of living tools. Beside the massive utilization of bamboo in building construction and living tools, it also can be used as reinforced composite materials base on extracting appropriate

fibres in a controlled manner. However, there are some problems that provide barriers to a broad usage of bamboo fibres.

These are as follow:

• Moisture resistance of bamboo is low and its mechanical and chemical properties are inadequate at the fundamental stage.

• The existing extraction process of the fibres from bamboo culm is not appropriate for industrial and commercial production.

Bamboo is a naturally occurring composite material which grows abundantly in most of the tropical countries. It is considered a composite material because it consists of cellulose fibres imbedded in a lignin matrix. Cellulose fibers are aligned along the length of the bamboo providing maximum tensile flexural strength and rigidity in that direction. Over 1200 bamboo species have been identified globally. Bamboo has a very long history with human kind.

Bamboo chips were used to record history in ancient China. Bamboo is also one of the oldest building materials used by human kind. It has been used widely for household products and extended to industrial applications due to advances in processing technology and increased market demand. In Asian countries, bamboo has been used for household utilities such as containers, chopsticks, woven mats, fishing poles, cricket boxes, handicrafts, chairs, etc. It has also been widely used in building applications, such as flooring, ceiling, walls, windows, doors, fences, housing roofs, trusses, rafters and purlins; it is also used in construction as structural materials for bridges, water transportation facilities and skyscraper scaffoldings. There are about 35 species now used as raw materials for the pulp and paper industry. Massive plantation of bamboo provides an increasingly important source of raw material for pulp and paper industry in China.

1.3. Composition of Fiber Reinforced Composites (FRP)

Common fiber reinforced composites are composed of fibers and a matrix. Fibers are the reinforcement and the main source of strength while the matrix '**glues**' all the fibers together in shape and transfers stresses between the

reinforcing fibers. Sometimes, fillers or modifiers might be added to smooth manufacturing process, impart special properties, and/or reduce product cost.

The FRP's constitute of:

1. Resins (POLYMERS)
2. Fibres
3. Fibre Reinforcement
4. Fillers
5. Additives
6. Sandwich Panels
7. Adhesives
8. Composite Designs

1.3.1 Resins

Primary Function: "To transfer stress between reinforcing fibres and to protect them from mechanical and environmental damage"

Characteristics of matrix:

- Low viscosity
- Solvent free room temperature curing system
- Excellent water resistance

Functions of matrix:

- It protects the individual fibres from surface damages as a result of mechanical abrasion or chemical reaction with the environment.
- It binds the fibres together.
- It transfers the applied load to the fibres.

- It separates the fibres by virtue of its plasticity and relative softness it prevents the propagations of brittle cracks from fibre to fibre, which can result in failure.

Types:

I. Thermoset Resin

a. Polyester

b. Vinyl Resin

c. Epoxy

d. Phenolic

e. Polyurethane

II. Thermoplastic

a. Acetal

b. Acrylonitrile Butadiene Styrene (ABS)

c. Nylon

d. Polyethylene (PE)

e. Polypropylene (PP)

f. Polyethylene Terephthalate (PET)

I. a. Polyesters:

- Phthalic Anhydride (GP)
- Dicyclopentadiene (DCPD) Types
- Isophthalic Acid
- Terephthalic Acid
- Polyethlyene Terephthalate (PET)

1.3.2 Fibers

Primary Function:

"Carry load along the length of the fiber, provides strength and or stiffness in one direction" Can be oriented to provide properties in directions of **primary loads.**

Functions of fibres:

- The fibre should have a greater ultimate strength.
- The fibre should be stable and retain their strength during handling and fabrication.
- The variation of strength between individual fibres should be low.
- The fibre should have a high modulus of elasticity in order to give efficient reinforced

Fiber Types:

I. Natural

II. Man-Made

III. Many Varieties Commercially Available

Natural Fibers:

- Cellulose
- Sisal

Man-Made Fibers:

- Aramid
- Boron
- Carbon/Graphite
- Glass
- Nylon
- Polyester