

## Study of Natural Fibre Reinforced Composites

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**Abstract.** The need of eco friendly material or specific use in automobiles and construction industries has lead to the development of natural fibre composites. Most of the available natural fibres are renewable and posses relatively high strength, stiffness and thermal stability etc. Presently natural fibres are focus of many designers and research scholar due to its low cost and abundant availability in nature. Moreover, processing of these fibres is still going on using conventional production method. Natural fibre composites are being used since ancient Egypt, where straw and clay were mixed together to build walls. The most important type of natural fibre used as composites are flex hemp, jute, straw, bamboo stick etc. which are used due to their desired properties and easy availability. In this paper review of different properties such as Mechanical, Chemical and Thermal properties of natural fibre composite is presented. The main objective of this paper is to study and investigate the existing properties of natural and common composite fibres and to promote the use of natural fibre which is economical and against environmental aggressive material.

### 1. Introduction

Basically natural fibres got its importance because of their low cost high availability with various desirable properties. Natural fibers are being used from ancient age at different level. Natural fibre can be classified on the basis of their origin. Natural composites are a structural material that consists of two or more constitute that are combined at a microscopic level and are not soluble in each other. Animal fibre Contains wool, silk etc. Avian fibres include sheep's wool, goat hair, horse hair, feathers and feather fibbers etc. Mineral fibres are naturally occurring fibers or slightly modified fiber procured from minerals. These can be further categorized as asbestos, ceramic, metal fibres. Plant fibre is generally comprised of cellulose.

Natural fibre finds its origin since 1000 BC for construction of historical structure in an Egypt. Straw and clay formed first natural composite and were used to build walled structure. During couple of decade composites reinforced with natural fibres have become point of focus for researchers and for industrial application there are different of reinforcement and fillers for different natural fibres like flax, hemp, jute, kenaf, sisal due to their distinguished properties, easier availability and economical usability. Furthermore, they do not have any adverse affect on environment [1].

New composites explored have new application and have contributed in markets for packaging, automotive industries, aviation and shipping sectors etc. Natural fibres reinforced composites are good substitute of metal or ceramic based materials in applications that may be automotive, aerospace, marine, sporting goods and electronic etc areas and their composites. The use of natural fiber as reinforcement in polymer matrix focused the attention towards environmental awareness among all over the world. Various automotive components are already produced natural composites, mainly based on polyester and fibres like flax, hemp, or sisal. Mercedes-Benz used an epoxy matrix with the addition of jute in the door panels in its E-class vehicles, Audi used the door trim panels were made of polyurethane reinforced with a mixed flax/sisal material and Toyota used eco-plastic made from sugar cane and will use it to line the interiors of the cars. Biodegradable bark cloth reinforced green epoxy composites are developed with view of application to automotive instrument panels.

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Jute-based natural fibre composites would be suitable for even primary structural applications for example indoor elements in housing, temporary outdoor applications like low-cost housing for rehabilitation and transportation. Wood fibre composites are being used in a large number of applications in decks, docks, window frames. Automobile parts like rear view mirror, visor in two wheeler, billion seat cover and indicator cover etc made with the use of sisal etc natural fibre composites. Recently banana fibre reinforced composites used under-floor protection for passenger cars.

## 2. Literature review

**Ryosuke, et al [2]:** Author has experimentally analysed the thermal conductivity and behaviour of natural fire reinforced composites by using manila hemp fibre as a reinforcing fibre because of their high strength and excellent thermal stability. In this experiment a poly lactic acid (PLA) and epoxy resin were used as a matrix material. The samples were mixed with PLA resin and dried for 20 hours at 70°C in circulation type oven and then pressed by hot pressing machine to complete the fabrication of PLA composites. It was concluded that thermal conductivity decreases by increasing fibre content and thermal conductivity of the composites with fibre content of 76wt% is 0.190 W/(mK).

**Braga R. A, et al [3]:** In this paper authors have presented the comparative study of mechanical and thermal properties of polyester hybrid composites (i.e. jute and glass fibre) to enhance mechanical properties. Tested Samples were analysed for flexural, thermal, density and impact properties. In this experiment the polyester resin and hardener resin with jute and glass fibre composites were synthesised. Analysis of this paper shows that density of composite with more percentage of jute fibre is a better composite. The composite without glass fibre lost mass as a function of temperature and the composite with more percentage of glass fibre loses less weight with increasing temperature.

**MallaSurya Teja et al[4]:** In this paper the effect of SiC (as filler) on mechanical and thermal properties of natural sisal fibre composites was investigated. The polyester as bonding material was used. In this experiment hand lay-up technique was adopted in the preparation of unidirectional composites. Clean the mould with shellac NC thinner solution. Apply a thin coating of poly-vinyl alcohol on the interior tile surface and along the edges of the rubber sheet and then dry it for a day. The samples were also post cured at 70 °C for 8 h after removing from the mould. In the same above process composites are also prepared by adding SiC (5%,10%) to resin and proper mixing were done before poured on fibers. Material compositions of samples are as below

Sample code	Polyester	Sisal fiber	silicon carbide (SiC)
A	70	30	0
B	65	30	5
C	60	30	10

Result shows that the tensile strength is increases with the increase of SiC ,that it obtains maximum tensile strength at 10% Sic. The composite with 10 % SiC has the maximum impact strength and it reaches 14.25 N/m<sup>2</sup>. Thermal diffusivity of composite decreases with increase of temperature. Temperature at maximum weight loss is nearly constant (350°C-380°C).The results have shown that sample C has higher tensile strength (i.e. 72.5 MPa) than sample A (28.6 MPa). Sample B has tensile strength of 45.7 MPa.

**Poddar P, et al [5]:**The author has examined the thermal and mechanical properties of short areca nut leaf sheath fibre reinforced polypropylene composites. Experimental result shows that a composite with 10% areca nut leaf sheath fibre possesses higher mechanical properties. Increasing the fibre content has reduced mechanical properties. However better fibres matrix adhesion was seen

**V. Muthukumar[6]:** In this study, the composite materials are reinforced with natural fibres such as Jute, Sisal, Banana, and Palmyra in the Epoxy (LY 556) Matrix. Because of their properties of excellent adhesion, high resistance to chemical and atmospheric attack, High dimensional stability, Free from internal stresses, Excellent mechanical and electrical properties, Odourless, and completely nontoxic. In this experiment the materials used in fabrication process are Epoxy resin-LY556,

Hardner-HY951, Polythene Sheets, ASTM Rubber, Polythene Sheets, Banana, sisal, Palmyra and jute fibres.

Experiment done by hand layup technique which is simplest as well as oldest method of composite fabrication. Hand layup process involve following steps

Step 1: Cut down the fibres as per the required Length.

Step 2: Place the ASTM rubber along the sides.

Step 3: Lay up the mixture of separate parent fibres and hybrid combinations of required proportions over the polythene Sheet. Figure 2 shows process of hand layup method.

Step 4: Pour the polyester resin uniformly and place another polythene sheet over it.

Step 5: Allow a Curing time of about 3 to 6 hours and then separate the composite plate.

### 3. Discussion

Result shows that the hand layup method can be used for the preparation of composites specimen successfully and The comprehensive mechanical properties are increased to different extents compared with those of parent fibres and hybrid composites; for instance, ultimate breaking strength, Ultimate stress, displacement and Impact strength.

Palmyra individual fibre is better choice than other seven different composites studied because it shows highest ultimate tensile stress under various tests performed. According to the author In future, there is tremendous investments on natural fibre, to bring an great impact on manufacturing sectors.

**S. John Paul Devaseelan, et al[7]:** Author check the mechanical and thermal properties of various types natural fibre composites like jute, sisal, betel nut polymer because of their higher specific strength at low cost. Sample can be prepared by compression moulding method with 10, 15 wt% sisal and betel nut fibre into polymer mixture. Result shows 10 wt% sisal and betel nut fibre the tensile and compressive properties found to be maximum. The failure morphology is investigated by scanning electron microscope. The natural fibre composites are tested for three properties which are as follows;

- (a) *Tensile Strength:-* Various experimental study shows the tensile strength of natural fibre composites is high and it can be improved also
- (b) *Young's modulus:-* As shown in various research it is depending on the fibre weight ratio. Young's modulus increased when the fibre weight ratio is increases up to a maximum value after that it will decrease.
- (c) *Flexural strength:-* It is also depend upon the fibre loading. If fibre load is increasing flexural strength is increases up to optimal level then decrease.

**Table 1.** Mechanical Properties of Natural Fiber [8].

Fibre	Density g/cm <sup>3</sup>	Elongation	Tensile Strength (Map)	Elastic Modulus (GPa)
Cotton	1.5-1.6	7.02-8.0	400	5.5-12.6
Jute	1.3	1.5-1.8	393-773	26.5
Flex	1.5	2.7-3.2	500-1500	27.6
Hem	1.47	2-4	690	70
Kenaf	1.45	1.6	930	53
Ramie	N/A	3.6-3.8	400-938	61.4-128
Sisal	1.5	2.0-2.5	511-635	9.4-22
Coir	1.2	30	593	4.0-6.0

**Chemical Properties:-** Chemical properties of natural fiber are those which defined the reactivities with others it show the chemical response when it comes with another material. In various studies basically check the chemical properties of cellulose hemicelluloses legion .Cellulose is an important structural component of natural fiber. It doesn't have any taste and odorless. Hemicelluloses is mixture of several plant polysaccharides of smaller molecular weight than cellulose hemicelluloses are embedded in the cell walls of plant legion is a class of organic polymer. Cellulose and hemicellegion percentage is vary from one to another material, tabulated below.

**Table 2.** The Chemical Composition of Natural Fibers [9].

Fiber	Cellulose (wt %)	Hemi-cellulose (wt%)	Lignin (wt%)	Waxes (wt%)
Abaca	56-63	20-25	7-9	3
Kenaf	72	20.3	9	--
Jute	61-71	14-20	12-13	0.5
Hemp	68	15	10	0.8
Ramie	68.6-76.2	13-16	0.6-0.7	0.3
Sisal	65	12	9.9	2
Coir	32-43	0.15-0.25	40-45	--
Flax	71	18.6-20.6	2.0	1.5

**Thermal Properties:-** In thermal properties we can investigated thermal conductivity. Specific heat capacity thermal degradation and thermal diffusivity etc. brief introduction these properties are as below-

(a) Thermal Conductivity: Thermal conductivity is property of material to conduct heat it can be defined as the quantity of heat transmitted through a unit thickness in a direction that normal to a surface of unit area due to a unit temperature gradient under a steady state conditions

(b) Specific Heat Capacity: Differential scanning calorimeter technique using double furnace setup is used for measuring specific heat capacity DSC is a thermo analytical technique in which the difference in the amount of heat required to increase the temperature of sample and reference is measured as a function of temperature.

(c) Thermal Degradation: Thermal degradation by TGA thermo gravimetric analysis is a technique in which the mass and substance is monitored as a function of temperature and time as the sample specimen is subjected to a controlled temperature program in a controlled atmosphere.

TGA measures as a samples weight as it is heated or cold in the Furnace the weight loss for temperature range give the denotes of the sample composition and thermal stability including filler materials and volatiles Thermal diffusivity: although thermal diffusivity can be experimentally measured by flash method in this work it is calculated after knowing thermal conductivity specific heat and density.

#### 4. Conclusion and Scope of Natural Fiber Composites

Natural fiber is renewable raw material which is eco-friendly and renewable material. Natural fiber has good thermal insulation properties. But Strength of the fiber depends upon the fiber loading and young modulus. It also depends on the fiber weight ratio. Natural fiber can be treated by various methods like treatment is most efficient method of chemical modification. It has been used to treat almost all types of natural fiber with successful result. By the combination of the useful properties of two different materials make them as a versatile material in the field of engineering and technology.

This paper gives a summary about the mechanical, thermal and chemical properties of natural fiber with focus on the advantages of natural fiber over all other materials of such categories.

Natural fiber is rapidly growing in both term of their industrial application and fundamental research as they are renewable. They are completely or partially recyclable and biodegradable. It is highly economical as compare to others and suitable for our environment. Partially natural fiber used in automotive industries and bullet proof panels was made from arsines fiber reinforced composition by hand layup process with epoxy as a matrix composition based natural fiber has very good implication in the automotive and transportation industries [10-12].

Further research and investigation are required to overcome obstacles such as moisture absorption toughness and reduced long term stability for outdoor application. Even now natural fiber composition have a potential to be used in many application that do not require very high load bearing capabilities or high temperature working capacity.

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