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A review study of natural fiber reinforced composite material: Types and properties

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ABSTRACT

Reinforced natural fiber composite is rapidly growing in both areas in terms of scientific research and industrial application for their specific properties such as partially or completely biodegradable, economical and easily available. In natural fiber reinforced composites, various types of chemical modification improve the interfacial fiber-matrix bonding, which results in shows to increase the mechanical properties. In various natural fiber used in composites, the material is jute hemp sisal etc due to their availability at low cost with various properties. natural fiber already used the first time approximately 3000 years ago in ancient Egypt, where straw and clay were mixed together to build walls. This review study deals with different types of existing natural fiber and updated status of their research work with properties and application.

Keywords— *Natural fiber reinforced composites, Properties*

1. INTRODUCTION

Natural fiber composites have got a lot of attention in the last some decades because of their high specific strength and modulus. A fiber composite is a structural material which consisting more than one constituents which are combined at the microscopic stage by different reinforcement method. Natural fiber gets from various resources, on the basis of origin it can be classified as:

(a) Animal Fibers: Contain wool, silk, avian fibers it includes sheep's wool, horse hair, feathers, and feather fibers.
(b) Mineral Fibers: Mineral are naturally occurring fibers or partially modified fibber procured from minerals. These are also categorized as asbestos, ceramic, metal fiber.
(c) Plant fiber: Plant fibers are those fibers which get from plants like bamboo jute etc.

2. PROPERTIES OF NATURAL FIBER

Natural fiber composites having various properties by which it becomes the substitute of other material it having both type of mechanical and chemical properties which briefly described as below

2.1 Mechanical properties: A natural fiber having good mechanical properties, for example, tensile strength and elastic modulus.

Table 1: Mechanical properties of main natural fibers

Fibre	Density g/cm^3	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	393-774	26.5
Flex	1.5	2.7-3.2	500-1500	27.6
Hemp	1.47	2-4	690	70
Kenaf	1.45	1.6	930	53
Ramie	N/A	3.6-3.8	400-940	61.4-128
Sisal	1.5	2.0-2.5	511-640	9.4-22
Coir	1.2	30	593	4.0-6.0

2.2 Chemical properties: With these mechanical properties also having various chemical properties. Chemical properties of natural fiber depend upon calluses, hemicelluloses, lignin, and waxes etc. The ratio of these shows the behavior of natural fiber. Percentage of these vary from on to another natural fiber which shows as below in table:

Table 2: Chemical properties

Fiber	Cellulose (wt%)	Hemi-cellulose (wt%)	Lignin (wt%)	Waxes (wt%)
Abaca	55-63	21-25	7-9	3
Kenaf	72	20.3	9	--
Jute	60-71	14-20	12-13	0.5
Hemp	68	15	10	0.8
Ramie	68.6-76.2	12-16	0.6-0.7	0.3
Sisal	65	12	9.9	2
Coir	33-43	0.15-0.25	40-45	--
Flax	71	18.6-20.6	2.0	1.5

3. TYPES OF NATURAL FIBER

Basically, six types of natural fibers exist which are as follows:

- Bast fibers (jute, flax, and hemp etc.),
- Leaf fibers (abaca and pineapple etc.)
- Seed fibers (Coir and cotton etc.),
- Core fibers (hemp and jute etc.),
- Grass and reed fibers (wheat and rice etc.)
- All other types (wood and roots).

Important natural fibers are as described below:

3.1 Flax Fiber: Flax is one of the oldest natural fiber which having various properties like low density, relatively high toughness, high strength, and biodegradability

3.2 Kenaf Fiber: Kenaf use as reinforcement in polymer matrix composite Kenaf exhibits low density, non-abrasiveness during processing, high specific mechanical properties, and biodegradability. Nowadays kenaf is used in paper products, building materials, absorbents, and animal feeds and it is also used as nonwoven mats in the automotive industries and textiles

3.3 Hemp Fiber: Hemp is a bast fiber crop which related to the Cannabis family. It is an annual plant that grows in temperate climates. It has the excellent mechanical strength and Young's modulus, hemp fiber consists of cellulose (55-72%), hemicelluloses (8-19%), lignin (2-5%), wax (<1%) hemp fiber mainly used in textile industry.

3.4 Jute Fiber: It is produced from plants of the genus *Corchorus*, Jute fibers are easily available in fabric and fiber forms which having good mechanical and thermal

3.5 Bamboo Fiber: basically **Bamboo** is a plant, which grows in monsoon climates, up to 40m height. A bamboo plant gets its mature size is almost eight months. It grows very fast growing grass

3.6 Sisal Fiber: Sisal fiber is used as natural fiber the sisal fibers having various mechanical properties (like high tenacity and tensile intensity, abrasion resistance) and chemical properties (like acid and alkali resistance, seawater resistance and corrosion resistance etc).

3.7 Abaca: Abaca fiber comes from the banana plant. It is durable and resistant to seawater. Abaca is one of the strongest commercially available cellulose fibers. It is very economical and easily available natural fiber.

3.8 Pineapple Leaf Fiber: leaf of pineapple is another useful natural fiber actually it is waste of pineapple it having a rich source of cellulose and it having the potential for reinforcement of polymer

3.9 Coir Fiber: Coir fiber comes from the husk of the coconut fruit. It is more durable as compared to other natural fibers because it having high lignin content. It had various chemical and mechanical properties like good acoustic resistance, moth-proof, nontoxic, resistance to microbial and fungi degradation etc.

4. LITERATURE REVIEW

Eeday. Saranya et al [1]: In this study author to check the variation in various properties like specific heat and thermal conductivity of composite with respect to temperature, fiber and fly ash. The fly ash varies from 10 to 30% and the temperature range from 30 to 120°c. Reinforce Composites acts as a thermally insulating component and it does not require any corrosion so, the longer life is achieved and also pre-fabricated to different shapes, installation time is very less. According to the author, they are favorable reinforcing materials for the development of load-bearing lightweight materials.

A. Gowtham et al [2]: In this paper, according to the author, the composite with & without silica have 100% biodegradable sisal fibers as reinforcement in the polyester matrix. And the effect of silica on tensile strength and tensile modulus shows better

properties as compared to without silica and pure resin. the specific heat capacity increases in all samples with an increase of temperature, so the addition of silica shows in both mechanical and thermal properties and author also work on the effect of fire behavior of composite which is under process

Subhankar Biswas et al [3]: In this paper, the author summarized the Mechanical, Thermal and Physical Properties of Jute and Bamboo Fiber Reinforced Unidirectional Epoxy Composites. The tensile strength of the bamboo fiber is increased. The jute fiber reinforced epoxy Bamboo and jute fiber composites increase flexural strength. The fibers distribution is not equal in both bamboo and jute fiber reinforced composites.

Saravana Bavan D et al [4]: In this paper, the author concluded that it is necessary need to get good adhesion between fiber and matrix, to get a good composite material fiber should change from hydrophilic to hydrophobic characters. The maize fiber and polyester resin coated maize fiber provides a useful information on thermal degradation values of composites.

M K Gupta et al [5]: In this paper, according to the author, the result shows that the hybrid composites having 50% sisal and 50% jute has higher thermal, mechanical properties and lower absorption property than sisal fiber, glass fiber. These hybrid composites can be used in the field of building, packaging, and automobile.

R.Sakthivel et al [6]: In this experiment author investigated and Analyses a Mechanical properties of natural fiber Composite Plates, In which hybrid composite laminates Banana-Glass-Banana, & Glass-Banana-Glass shows higher mechanical properties due to chemical modification of natural fibers, among all the hybrid fiber composites the banana reinforced epoxy hybrid composites shows higher mechanical property and also used in eco-friendly fibers in the automobile parts for example car bumper, panels etc.

5. CONCLUSIONS

Natural fibers are rapidly growing in term of their industrial application as well as fundamental research. Natural fibers are completely or partially recyclable and biodegradable. It is comparatively economical and eco-friendly. Various researches show with the help of chemical treatment we can get desired properties.

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