Investigation of Mechanical Properties of Borassus Flabillifer Fruit and Sisal Fibers Composite Material with Addition of Nano Carbon

R. Chittibabu[1] M. Lava Kumar[2]
[1]M.Tech. Student [2]Assistant Professor
[1,2]Department of Mechanical Engineering
[1,2]SIETK, Puttur, AP, India

Abstract— The main objective of the project is to develop the natural fiber composites primarily to explore value application avenues. The natural fiber composites is developed in India on the basis of two pronged strategy of preventing depletion of forest resource and also ensuring good economic returns .Borassus and sisal based composites material with the addition of Nano carbon have been developed substitutes for plywood & medium density fiber boards. In this project the natural fiber composites were fabricated by combining materials of sisal & borassus in copped from hand lay method. Epoxy resin was used as the matrix material. The composite material with and without Nano carbon have been prepared with borassus & sisal fiber reinforcement. The mechanical properties of these samples were investigated according to ASTM standards. From the result it was observed that the borassus and sisal fiber reinforcement with Nano carbon showed that the results are increase in the tensile. Strength, flexural strength& impact strength has been compared to without addition of Nano carbon composite material has been observed.

Key words: Nano Carbon, Sisal Fibers

I. INTRODUCTION

Natural fibers have played a very important role in human civilization since prehistoric times. The NFR composites has recently attracted the attention of researchers because they are environmental friendly, being light weight, strong, cheap nonabrasive, high specific mechanical & thermal properties and abundantly available. In the present research, we have been characterized the behaviour of borassus and sisal fiber composite with and without addition of Nano carbon and also evaluate the mechanical properties and thermal properties. The borassus fiber is abundantly available in nature. It is a genus of six species of fan palms, native to tropical regions of Africa, India &Gunea. They are growing up to 30m high and 2to 3 long. The flowers are small in densely clustered spikes, followed by large, brown, roundish fruits. The sisal fiber is the natural fiber which comes from agave sisalana of agavaceae family yields a stiff fiber traditionally used in making twine and rope. The composite with 50%wt of sisal fiber has the optimal charpy impact strength and also good in tensile, flexural strength.

A carbon Nano tube is a tube shaped material made of carbon, having diameter measuring on the nanometer scale. A nanometer is one-billion of a meter (or) about one ten-thousandth of the thickness of a human hair. The Nano carbon materials added to the composite materials that are being developed to take advantage of the high tensile strength, lightweight and strong when the carbon Nano tube reinforcement can be used to enhance the mechanical, electrical & thermal properties of the composites.

A composite material consists of two (or) more constituents with physically separable phases. However, a material system collection of different physically distinct phases whose mixture produces aggregate properties that different from those of its constituents. Composites are materials that comprise strong load carrying material imbedded materials in weaker material. The two or more dissimilar materials can be combined and form a composite material which provides high strength, rigidity but it does not change their identities and properties. The fiber reinforcement composite consists of several layers with different fiber orientations called the laminate composite (or) multilayer composite.

The composite laminates are several layers of composite materials that can be joined to providing the stiffness, bending strength, and the co-efficient of thermal expansion the individual layers consists high modules, high strength fibers in a polymeric, metallic (or) ceramic matrix material. When the matrix is a polymer, the composite are called polymer composite. The fiber reinforced polymer composite are the commonly used as composites. The properties of composites mainly depend on the matrix fibers and other interfacial bonding. Several researchers used the natural fibers as reinforcement to develop the green composites.

In the present work, we have characterized the behaviour of composite material with and without addition of carbon Nanotubes. The sisal and borassus fibers were with Nano carbons is new to composite research. We studied some of its properties such as tensile strength, flexural strength and impact strength of hybrid composite material was found out experimentally.

II. MATERIALS & METHODS

A. Matrix

Epoxy is a thermosetting polymer that cures (polymerizes& cross links) when mixed with a hardener. Epoxy resin of the grade LM-556 with a density of 1.1-1.5g/cm^3 was used in this research. The hardener HV-9.51 was used to fabricate the composite. The matrix material was prepared with the mixture of epoxy and hardener at a ratio of 10:1.

B. Sisal fiber

Sisal is a natural fiber (scientific name is Agave sisalana) of Agavaceae (Agave) family yields a stiff fiber used in making twine & rope. Sisal fiber is one of the renewable resources in the nature and fully bio-degradable. The sisal fiber is exceptionally durable and with minimal wear & tear. It is extracted by a process known as decortications, where leaves are crushed & beaten by a rotating wheel set with blunt knifes, so that only fibers will remain.

C. Borassus Fruit

Borassus is a natural fiber (science name is caryota urens) of Arecaceae family and is used for making strong ropes. The borassus fiber is also having several advantages like strong, more durable, but less pliant and elastic then the coir. The extraction of fibers involves the retting process followed by the decortications. The borassus fruits were taken and immersed in the water tank for two weeks. Then they are taken out from the water and remove the outer shells of the fruits and the fibers were stripped from the stalks by hand, washed and dried in the sun. After drying, any extraneous matter that may still be adhering to them was removed.

III. FIBER SURFACE TREATMENT

Washed and dried sisal fiber and borassus fiber were taken in separate trays; to these trays 10% NAOH solution was added. Then the fibers were soaked in the solution for 10hours. After that the fibers were washed thoroughly with water to remove excess of NAOH sticking to the fibers.

IV. PREPARATION OF SPECIMEN

A GI sheet mounding is used for making the sample as per ASTM standards with required dimensions. Then the mould sheet is coated with a mould releasing agent for the easy removal of the sample. After that the resin and hardener is mixed with the ratio of 10:1 respectively. Before mixing of resin and hardener, the Nano carbon tubes were mixed with the hardener and stirring for proper mixing. Then the pre-calculated amount of hardener is mixed with epoxy resin and stirred for 20 minutes before pouring into the mould. The hand layup technique is used to impregnate the composite structure. A stack of sisal and borassus fibers were carefully arranged in a unidirectional manner and then the epoxy resin with hardener is pouring on the fiber or coating on the fiber slowly. The remaining mixture is completely poured up on the surface of the fibers. The brush and roller is used to impregnate fibers and after that close the glass sheet. The mould was kept under pressure for 24 hours at room temperature.

The test specimens of required size were cut out from the composite manufactured after curing. The five identical test specimens were prepared for each test and subjected to each test.

V. MECHANICAL PROPERTIES TESTING

A. *Tensile Test*

Tensile test were conducted by using Universal Testing Machine with across head speed of 5 mm/min. In each case five samples were tested and average value tabulated. Tensile test samples were cut as per as ASTM D638 test procedure. The samples were tested at room temperature and each test was performed until tensile failure occurred.

B. *Flexural Test*

Flexural test were conducted by using Universal Testing Machine with across head speed of 5 mm/min. In each case five samples were tested and average value tabulated. Flexural test samples were cut as per as ASTM D790 test procedure, the specimens were tested at room temperature and each test was performed until flexural failure occurred.

C. *Impact Test*

The notched charpy impact tests were performed according to ASTM D256 on an impact tester with pendulum energy of 0.4j and a span of 3m.the 5 samples were tested at ambient conditions and the average of impact strength value was calculated.

VI. RESULT AND DISCUSSION

A. *Tensile Test*

Tensile strength of boras we and sisal composite with and without Nano carbon values was presented in below table.

S.No	Tensile Test	
	Without NanoCarbon (Mpa)	With Nanocarbon (Mpa)
S1	8.5	11
S2	9.5	12
S3	10	12
S4	10	12
Avg	9.5	12

Table 1:

B. *Flexural Test*

Flexural strength of borasus and sisal composite with and without Nano carbon values are presented in below table.

S.No	Flexural Test	
	Without Nanocarbon (Mpa)	With Nanocarbon (Mpa)
S1	14	28
S2	15	27
S3	15	26
S4	16	27
Avg	15	27

Table 2:

C. *Impact Test*

The impact test is done on the specimen by applying a sudden load on it .The various test result for composite material with and without Nano carbon is tabulated as below.

S.No	Impact Test	
	Without Nanocarbon (Joules)	With Nanocarbon (Joules)
S1	1.40	1.44
S2	1.36	1.52
S3	1.36	1.44
S4	1.40	1.44
Avg	1.38	1.46

Table 3:

VII. CONCLUSION

From the results it can be seen that there is an appreciable increase in mechanical properties of the composite with addition of Nano carbon. When compared to without addition of Nano carbon composites which can observe from the above table. This new composite material is used as a spare parts in automobile industries. The natural composite material doesn't require any corrosion or painting.so, longer life is achieved and also pre-fabricated in to different shapes. The natural composite are favorable reinforcing materials for the development of load-bearing lightweight materials.

1) The tensile strength of a composite without addition of Nano carbon is 9.5 M Pa. and the tensile strength of composite with addition of Nano carbon is 12 M Pa.

2) The flexural strength of composite without addition of Nano carbon is 15 MPa and the flexural strength of composite with addition of Nano carbon is 27 MPa.
3) The impact strength of a composite without addition of Nano carbon is 1.38 Joules. And the impact strength of a composite with addition of Nano carbon is 1.46 Joules.

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