Available Online at http://www.journalajst.com

ISSN: 0976-3376

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

Asian Journal of Science and Technology
Vol. 09, Issue, 04, pp.7976-7980, April, 2018

RESEARCH ARTICLE

EFFECTIVE UTILIZATION OF NATURAL FIBERS (SISAL, JUTE AND BANANA) IN FRAMING COMPOSITE MATERIAL FOR REPLACEMENT OF COMPRESSED WOOD

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ARTICLE INFO

Article History:
Received 14th January, 2018
Received in revised form
28th February, 2018
Accepted 24th March, 2018
Published online 30th April, 2018

Key words:
Composite Material, Resin, Mechanical Properties, Tensile, Flexural

ABSTRACT

The usage of natural fiber composites is growing at a faster rate and is actively being measured as an alternate material for synthetic fiber and wood. In the present work, an attempt has been made to fabricate the sisal-jute-banana fibers by knitting together and placed unidirectional mixed with polyester resin composite and to evaluate the mechanical properties such as tensile strength and flexural strength. Five types of hybrid laminates composites are fabricated using manual layup technique. Polyester resin is used as matrix material in the present work. The specimens are prepared according to ASTM standard and the experiments were conducted on a universal testing machine (UTM). From the experimental results it has been perceived that the sisal-jute-banana fiber hybrid composites showed superior properties when compare to pure composites.

INTRODUCTION

In recent years, the natural fiber reinforced composites have concerned substantial importance as a potential structural material. The attractive features of the natural fibers jute, sisal and banana have been their low cost, light weight, high specific modulus, renewability and biodegradability. Non-conventional fibers such as jute, sisal, banana, palm fibers etc. are extracted from stem/leaf/fruit of plants. Among all these fibers, jute and sisal have a benefit over other fibers. Banana fiber can be gained easily from the plants which are condensed as a waste after the fruits had seasoned. Jute fiber is extracted from jute plant. Jute is easily available for all the rural area. Sisal is extracted from sisal plant by using sisal extracting machine (Anaidhuno *et al.,* 2017). Madhukiran *et al.* 2017 evaluate the mechanical properties of sisal-coir composites the usage of natural fiber reinforced composites are growing at a faster rate and is actively being considered as an alternative material for synthetic fiber. The specimens are prepared according to ASTM standards and the experiment was conducted on a universal testing machine (UTM). Amitkumar *et al.* 2014 calculated the tension test, compression test of the jute-bamboo-coir fiber composites in which they concluded that the bamboo fiber composites have more tensile and compression strength.

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Madhukiran *et al.* (2013) in which work has been carried out to investigate the flexural properties of composites made by reinforcing banana and pineapple as the new natural fibers into epoxy resin matrix. The natural fibers were extracted by retting and manual process. The hybridization of the reinforcement in the composite shows great flexural strength when compared to individual type of natural fiber reinforced composites. Senthil *et al.* (2014) in their work focuses on the fabrication of polymer matrix composites by using natural fibers like jute, coir, hay which all abundant in nature in desire shapes by the help of various structures of patterns and calculating the material characteristics by conducting test like flexural test, hardness test and water absorption test. Venkateshwaran *et al.* (2013) in which natural fibers offer many advantages over synthetic fibers but the notable disadvantage of natural fibers is its hydrophilic nature. This hydrophilic nature decreases the properties of the composites. In this work, alkali (NaOH) of various concentrations was used to treat the fiber surface and the effects on these concentrations on the mechanical and viscos-elastic behavior of the composites were carried out. Sanjay *et al.* (2016) observed the present scenario of natural fiber composite field due to its better formability, cost effective and eco-friendly. This paper execution out line on natural fibers and its composites utilized as a part of different commercial and engineering applications. It helps to provide details about the potential use of natural fibers and its composite materials and physical properties and some of the applications in engineering sectors.

Sathish *et al.* (2014) reviewed on the tensile and impact properties of natural fiber hybrid composites. Natural fibers having good mechanical properties, high specific strength, low cost. In this paper two different hybrid composites were manufactured by compression moulding and properties of tensile and impact results are conducted as per ASTM standard. Savita Dixit *et al.* (2017) in which chemically treated natural fiber shows better improvement in properties than untreated fibers. This review aims at explaining about the research and development in the improvement in properties of natural fiber reinforces polymer composites along with its applications. Ashik *et al.* 2015 in which natural fibers will take a major role in the emerging green economy based on energy efficiency and it reduces carbon emissions and recyclable materials that minimize waste. This review paper summarized the history of natural fibers and its applications. Also these papers focused on different properties of natural fibers and its applications which were used as substitute glass fiber. Arpitha *et al.* (2014) this paper presents a brief over view of the tensile properties of fiber reinforce polymer materials. Natural fibers and particle fiber composites results in lighter properties compare to SFRPCs with equivalent mechanical strength. Subbareddy *et al.* 2017 which evaluates the tensile, flexural, impact strength of the banana fiber composites. They concluded more tensile strength obtained from 35% of fiber volume.

Chandramohan *et al.* (2013) in this research natural fiber like sisal banana and rosella are used. Sisal and banana (hybrid), Rosella and banana (hybrid) and rosella and sisal (hybrid) of fabricated with bio epoxy resin using moulding method. Green materials are very important to form environmental friendly from renewable resources. In this work,tensile and hardness of sisal and banana, rosella and banana, rosella and sisal composite at dry and wet condition were studied. Kayode *et al.* (2017) this study was done with the aim of accessing the feasibility of mechanically recycled glass fiber particleboards made from wood particle with epoxy as binder. An increase of over 80% in MOE values was obtained for the board with 10 weight % glass fiber inclusion. Ramesh *et al.* (2014) in which the present experiment banana fiber reinforced epoxy composite are prepared and the mechanical properties of this composites are evaluated the sample were subjected to the mechanical testing such as tensile, flexural and impact loading. Yasunari *et al.* (2017) Effects of ultrasonic vibrations on mechanical properties of fiber reinforced plastics were investigated during molding resin impregnation processing vacuum assisted resin transfer molding. The results revealed that ultrasonic waves improved transverse tensile flexural interlaminar shear and compressive strength of the carbon fiber laminates and interlaminar shear and compressive strength of the glass fiber laminates.

MATERIALS AND METHODS

The banana fibers purchased from Coimbatore green fibers through courier. Jute fibers purchased at agro market of Town Tirunelveli. Sisal fibers purchased from cast foundation Tirunelveli. These fibers were collected successfully after three fibers knitting by manually from cast foundation Tirunelveli. Finally let us arranged unidirectional knitted fibers by using fevicol then the polyester resin, hardener and accelerator were purchased from Madurai.
The composite dye was prepared by us in SCAD College of engineering and technology at cheranmahadevi. Sisal-jute-banana hybrid polymer composite at 3:1, 3:1, 3:1 mixture ratio, 0.1, 0.2 volume fraction mixture using unsaturated polyester resin, Methylethylketone (catalyst), cobalt (accelerator), Vaseline (releasing agent) brought from SCAD College of engineering and technology. Fibers strands were reinforced with unsaturated polyester resin. The unsaturated polyester low temperature curing resin and corresponding harder Methylethylketone hardener and cobalt accelerator at a ratio of 10:1:0.5 by weight as recommended. The different composites are fabricated for tensile, flexural, compression, hardness and impact test. The casting of each composite was consolidated with a roller load weight of 50g and cured under room temperature at 4hours before the sample was removed from the mould. Then the specimens were cured in the air for another 12hours after removing from the mould. Test specimens were subjected to various mechanical tests as per ASTM standard using instron 3369 Universal testing machine.

Methodology

Raw materials sisal, jute& banana fiber collection

↓

Polyester resin, accelerator and hardener used as binding solution

↓

Wooden dye fabrication to act as medium. Combined fibers are knitted as mat and kept in medium.

↓

Binding the mat with resin at 3:1, 3:1, 3:1 mixture ratio

↓

Dry the fibers at room temperature for 30 minutes and shaped it as per ASTM for evaluation of Mechanical Properties.

Figure 1. Proposed Methodology

RESULTS

The samples of four different combinations tested for their tensile, flexural and compression strength showed better result with sisal/banana/jute which has been used in both tests.

BEFORE KNITTING

Fig (1a) Banana fiber

Fig (1b) Jute fiber

Fig (1c) Sisal fiber

KNITTING PROCESS (Manually)

Fig (1d)

AFTER KNITTING

Fig (1e)

UNIDIRECTIONAL MAT

Fig (1f)

COMPOSITE PREPARATION

Fig (1g) Bottom plate

Fig (1h) Top plate

Table 1: Experimental result of the sisal-jute-banana polyester resin composites

Mechanical Properties	10 % fibers 90% resin	20% fibers 80% resin
Max tensile strength	33.9658 Mpa	36.6432 Mpa
Max flexural strength	84.5648 Mpa	86.773 Mpa
max compression strength	99.6587 Mpa	101.365 Mpa
Max impact strength	10.6 joules	11.1 joules
Brinell hardness number value	210.3	212.5740

Table 2. Tensile Strength

S.No	Length Mm	Width Mm	Thickness Mm	Tensile Strength Mpa
1	165	12.60	4.00	58.16
2	165	12.80	3.50	30.34
3	165	12.60	3.80	55.92
4	165	12.90	4.20	37.40

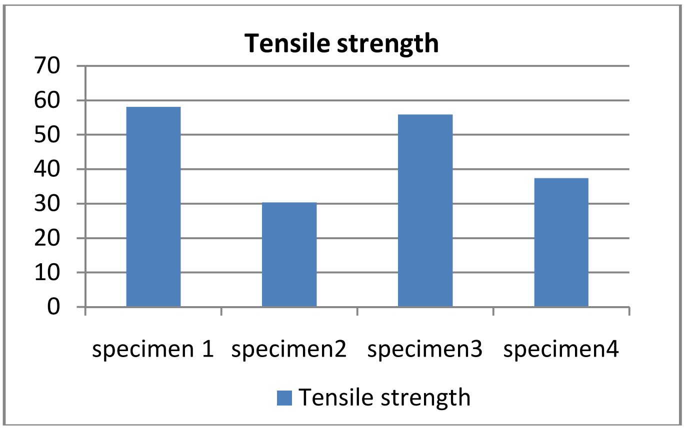

Fig. 2. Result of Tensile Strength Test

Table 3. Flexural Stength

S. No	Span Length mm	Brzeadth mm	Thickness mm	Flexural Strength Mpa
1	120	18.25	4	165.20
2	120	20	3.20	138.15
3	120	21.60	3.80	120.52
4	120	24.25	3.80	124.25

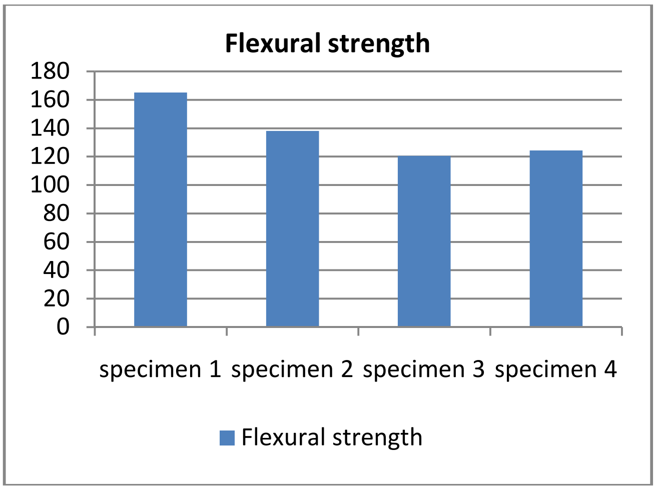

Fig 3. Result of Flexural Strength Test

Table 4. Compression Strength

S.no	Length mm	Width mm	Thickness mm	Compression strength Mpa
1	79	12.60	4	93.74
2	79	12.40	3.40	91.25
3	79	12.80	3.80	87.56
4	79	12.90	3.50	85.30

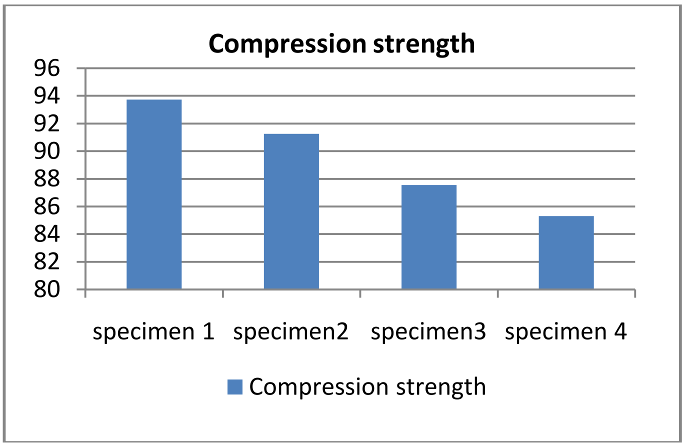

Fig 4. Result of Compression Strength Test

Table 5. Physical Properties of Natural Fibers (Sisal, Jute, Banana)

S.No	Property	Range
1	Cellulose (%)	71-74
2	Hemi cellulose (%)	22
3	Lignin (%)	8
4	Moisture (%)	12-13
5	Density (g/cm^3)	2-2.5
6	Elongation at break (%)	6.5-8.5
7	Young's modulus (Gpa)	35
8	Microfibriller angle (deg.)	14
9	Lumen size (mm)	8

Table 6. Material comparison for Brinellhardness test

Material	Brinell hardness test
Sisal	442.5
Jute	323.0
Banana	583.1

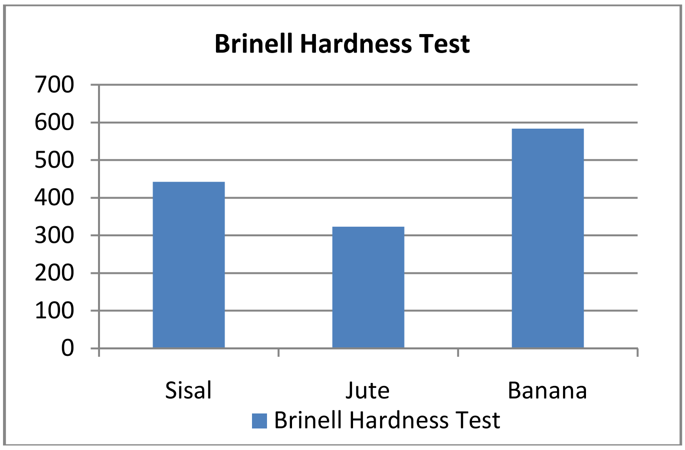

Fig. 5. Result of Brinell hardness Test

Conclusion

By experimental investigation, it is concluded that the usage of natural fiber composites is growing at a faster rate and is actively being measured as an alternate material for synthetic fiber and wood. In the present work, an attempt for fabricate the sisal-jute-banana fibers by knitting together and placed unidirectional mixed with polyester resin composite and to evaluate the mechanical properties such as tensile strength and flexural strength. Five types of hybrid laminates composites are fabricated using manual layup technique.

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