

Design and Fabrication of Two Wheeler Scoop using Composite Material

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Abstract

The use of plant fiber reinforced composite has continuously increased during recent years. Because it has more advantages such as low weight, low density, high strength, high stiffness, faster assembly, corrosion resistance, higher environmental friendly, reduced cost, biodegradable, low energy consumption, they are used as a material for various purposes such as aircraft, medical equipment's, space vehicles, electronic equipment's, and home appliances. When compared to that of the conventional composite it has more advantages. When compared to the glass fiber it has more advantages such as biodegradable, recyclability, renewability, so the usage of natural fiber was increased more. Thus the good quality, cost effectiveness, manufacturing of NFHRC become imperative. In the present contribution, the alkali treated Roselle and sisal fibers are fabricated and the mechanical properties such as tensile, flexural, impact were determined based on the weight and length of the fibers, and the fiber of different weight proportion were also fabricated and characterized. The treated fiber as high mechanical properties when compared to the untreated fiber reinforced hybrid polyester composite. The positive hybrid effect was observed that the tensile, the flexural strength increased with fiber length and content. The negative hybrid effect is observed that the impact strength decrease with the fiber length and content. This result suggests that the correct and optimum weight % and length of treated Roselle and sisal fibers the expected mechanical properties can be achieved. By using the above result, the vehicle scoop was fabricated using natural fiber and the impact test was performed and it was compared with the glass fiber composite scoop.

Keywords: sisal fiber, Alkali Treated Sisal End Roselle, SEM

I. INTRODUCTION

Introduction to composites:

A. Polymer:

It is a macromolecule formed by repeated linking of many monomers obtained by polymerization. In polymers the material which we used comes under the plastic category

B. Plastics:

It can be defined as an organic polymer, which can be molded into any desired shape on application of heat, pressure or both. Plastic includes natural and synthetic. Low price, Toughness, Ease of fabrication

C. Thermoplastic:

These are also known as thermoplastics, whose plasticity increase with increase in temperature. Properties;

- These are formed by additional polymerization.
- They are soft, weak and less brittle.
- Example: polythene, polystyrene.

D. Thermosetting Plastics:

These are also known as thermosets. This becomes permanently hard when heat or pressure is applied and do not soften subsequently heating. Properties:

- These are formed by condensation polymerization.
- They are hard, strong and more brittle.
- Example: polyester, urea formaldehyde, etc.

Composite materials (or composites for short) are engineered materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct on a macroscopic level within the finished structure.

E. Scope of the Study:

This project includes the study of the reports already published on works focusing towards the natural fiber reinforced polyester composites. The selection of the fiber for our composite was done based on the study this includes the various test includes tensile, flexural, Impact test. The samples of alkali treated and untreated fiber is compared with the glass fiber and also fiber of different weight proposition also fabricated and tested, and preparing the vehicle scoop and in impact test is performed on it. The duration of testing was within 3 weeks. This study involves 5 phase of work. The preliminary work was extraction of fibers and testing of fibers. The second one was preparation of the specimens. The third one was the testing of samples. And the theoretical calculation was fourth one. The SEM images for he fractured surface is included in the fifth phase. Thus the vehicle was fabricated and characterization is also done by using the above result and conclusion.



Fig. 1: Roselle plant



Fig. 2: Roselle after extraction

The plants are harvested and dried. Then they are soaked in water for weeks. The center core of the stem got diffused and it is washed in fresh water and then it is rinsed so as to remove the husk. The fiber now got separated from the stem portion.

F. Extraction of the Sisal Fiber:

The nature fleshy leaves are harvested from the plant carefully and thorns were removed. These are then left water for easy removal of the fleshy portion of the leaf-retting process. Then the retted leaves are taken off from water and dried normally. Then the fleshy portion is removed with the help of some special blades and is dried in the temperature. Then the fibers are separated with the combing tool. Then these fibers are combined further after drying for final fiber preparation.



Fig. 3: Sisal plant



Fig. 4: Sisal after extraction

G. Tensile Properties of Fiber:

1) Properties of Roselle Fiber:

The leaf stem base fibers of ROSELLE are strong stiff and dark brown in color. The shape varies from fiber to fiber, and also it is not uniform. Normally they are circular or elliptical. The length varies from 1m to 2m. Fiber as thickness varies from 0.14mm to 0.24mm.the density is 1.45Kg/m³.

2) Tensile Strength:

The cleaned and dried single fiber it's mounted on the single yarn testing machine with a gauge length of 20mm and mid-section is cut off during loading. Speed of the machine is 1mm/min.

The ten samples are tested in the machine and the results are tabulated.

Table – 1
Determinations of Fiber Properties -Roselle

Sl.NO	diameter	load	deflection	strength	strain	% elongation	Young's modulus
	Mm	N	Mm	MPa			GPa
1	0.13	2.450	0.250	184.676	0.005	0.5	36.935
2	0.16	3.330	0.275	165.705	0.006	0.6	30.128
3	0.18	4.116	0.325	161.831	0.007	0.7	24.896
4	0.23	6.370	0.350	153.396	0.007	0.7	21.914
5	0.20	5.488	0.350	174.775	0.007	0.7	24.968
6	0.22	6.080	0.400	160.025	0.008	0.8	20.003
7	0.19	4.905	0.275	173.086	0.006	0.6	31.470
8	0.19	4.120	0.350	145.385	0.007	0.7	20.769
9	0.18	3.924	0.300	154.282	0.006	0.6	25.714
10	0.15	0.250	0.250	149.922	0.005	0.5	29.984

From the observed results further manipulation are done to find the strength and modulus values are calculated. The elongation will be 0.5 to 0.8. The strength mainly depends on structure. Cellulose content, micro fibrillar angle.

II. PROPERTIES OF SISAL

The fibers obtained from the leaf stem base are brownish/golden brownish in color. They can be twisted in to yarns and ropes in wet condition. Fiber thickness, length and strength depend upon the location of the plant. The length varies from 1 to 1.5m and diameter is between .21 to .29 mm. the density of the fiber is found to be around 1,15g/cm³.

A. Tensile Strength:

The cleaned and dried single fiber is mounted along the clamp of the single yarn testing machine with the gauge length of 20mm and its mid-section is cut off during loading. Speed of the machine is 1mm/min

The ten samples are tested in the machine and the results are tabulated.

From the observed result the strength and modulus values are calculated. The strength of the fibers is not uniform. The percentage of elongation varies between 1.0 to 1.5mm. The strength mainly depends on structure. Cellulose content, micro fibrillar angle.

Table – 2
Determination of Fiber Properties -Sisal

Sl.No	Diameter	load	deflection	strength	strain	% Elongation	Young's modulus
	Mm	N	mm	MPa			GPa
1	0.29	10.79	0.750	163.545	0.015	1.5	10.897
2	0.29	10.59	0.700	160.470	0.014	1.4	11.462
3	0.23	3.727	0.550	89.750	0.011	1.1	80159
4	0.26	8.730	0.750	164.512	0.015	1.5	10.967
5	0.24	4.020	0.600	80.193	0.011	1.1	7.402
6	0.22	3.531	0.500	92.936	0.010	1.3	8.347
7	0.21	8.316	0.625	235.019	0.011	1.4	18.802
8	0.23	4.116	0.575	99.117	0.012	1.1	8.619
9	0.25	5.782	0.550	117.850	0.015	1.2	6.744
10	0.29	10.78	0.700	163.288	0.012	1.3	14.199



Fig. 5: Single Yarn Testing Machine

B. Chemical Treatment of Fibers:

The surface has some impurities and wax segment so the surface requires the surface treatment to increase the strength the specimen. Surface treatment improves the bonding strength between the fiber and the resin, it decrease the fiber properties but increase the specimen strength. Here I have chosen the alkali as a treatment for the fiber and the three parameters considered as a concentration of the solution and duration, alkali used. The fibers were subjected to a 10% sodium hydroxide solution and then treated for 2 hrs at room temperature. Improvements in mechanical properties of short Roselle and sisal fiber hybrid polyester composites fabricated using alkali treated Roselle and sisal fibers

1) Alkali Treated Sisal End Roselle:



Fig. 6: Alkali Treated Sisal End Roselle

C. Resin:

Polyester resin, tends to have yellowish tint, and is suitable for most backyard projects. Its weaknesses are that it is UV sensitive and can tend to degrade over time, and thus generally is also coated to help preserve it. It is often used in the making of surfboards and for marine applications. Its hardener is a MEKH, and is mixed at 14 drops per oz. MEKP is composed of methyl ethyl ketone peroxide, a catalyst. When MEKP is mixed with the resin, the resulting chemical reaction causes heat to build up and cure or harden the resin. It was a good corrosion resistance, low cost, good bonding property and surface smoothness.

- Mechanical properties:
- High strength
- High shear strength
- High modulus
- High 5toughness
- Thermal expansion near fiber
- Low thermal conductivity
- Chemical properties:
- Good bond to fiber
- Resistance to solvents and chemicals
- Low moisture absorption
- Good flow characteristic

Table – 3
Technical Description of Isophalic Polyester

Property	Value
Density	1.1 gm/cm ³
Modulus of elasticity	4.375GPa
Poison ratio	0.46
Shear modulus	1.49GPa
Tensile strength	26MPa
Flexural strength	141Mpa
Elongation at break	3.5%

D. Study of Fibers and Resin:

Effect of Fiber Content on Mechanical Properties of Short Roselle and Sisal Fiber Hybrid Polyester Composite

The randomly oriented fiber reinforced composite shows good result in all possible directions mechanically when compared to the longitudinal and transverse directions. The properties of the composite ascend when weight % of the fiber increases. When the percentage exceeds certain limits the bonding between the fibers and the matrix decreases

As the specimens were prepared by hand lay-up method the compressive strength offered for fabrication will be low so the suitable composition of fiber must be taken. The fiber of different weight % as 30, 35, 40,45,50,55 and fiber length 5cm, the polyester resin is taken here as 70,65,60,55,50,45. The tensile strength of Roselle fiber is comparatively higher than the sisal fiber, while the sisal has higher impact strength than the Roselle. In order to have optimum level in both tensile and impact strength both the fibers were chosen in same proportion 1:1ratio. The specimens of different weight proposition were analyzed. Hence range of fabrication parameters were selected

E. Testing of Fibers:

Testing the mechanical properties of the composite.

This chapter deals with the experimental details of our project, here we are going to discuss about the testing methods to test our specimen for their tensile strength, impact strength and flexural strength. The following details will be discussed in this chapter.

- Methodology
- Testing

The mechanical characteristic characteristics of the composite are determined by standard testing procedures, the various properties are Tensile strength, Flexural strength, and Impact strength.

The tensile strength of the composites was measured with a computerized FIE universal testing machine in accordance with the ASTM D638 procedure at a cross head speed of 10.5mm/min. The flexural tests were performed on the same machine, using the 3-point bending method according to ASTM D790 at a cross head speed of 10.5mm/min. In impact test, the strength of the samples was measured using an Izod impact test machine. All test samples were notched. The procedure used for impact testing was ISO 180. the test specimen was supported as a vertical beam and broken by a single swing of a pendulum. The pendulum strikes the face of the notch. For statistical purpose, a total of six samples for each tests were carried out at room temperature.

F. Tensile Strength Test:

A tensile test also known as tension test is probably the most fundamental type of mechanical test performed on material. Tensile tests are simple, relatively inexpensive, and fully standardized, by pulling on something; you will very quickly determine the material will react to force being applied in tension.

As you continue to pull on the material until it breaks, you will obtain a good complete tensile profile. A curve will result showing how it react to the force being applied the point of failure is of much interest and is typically called its “ultimate strength”.

1) Yield Strength:

Yield strength of a material is defined as the stress applied to the material at which plastic deformation starts to occur while the material is loaded.

2) Ultimate Tensile Strength:

One of the properties that can determine about a material is its ultimate tensile strength. This the maximum load the specimen sustain during the test, the UTS may or may not equate to the strength at break. This all depends on what type of material being tested like brittle, ductile, or a substance that even exhibit both properties.

G. Flexural Strength Test:

The flexural test method measures behaviour of material subjected to simple beam loading. It is also called a transverse beam test with some materials. Maximum fiber stress and maximum strain are calculated strains are calculated for increase of load. Results are plotted is a stress-strain diagram. Flexural strength is defined as the maximum stress in the outermost fiber. This is calculated at the surface of the specimen on the convex on tension side. Flexural modulus is calculated from the slope of the stress vs. deflection curve

H. Types of Flexural Tests:

It is done on a flexible material such as polymers; wood and composites, there are two types.
3-point flex 4-point flex

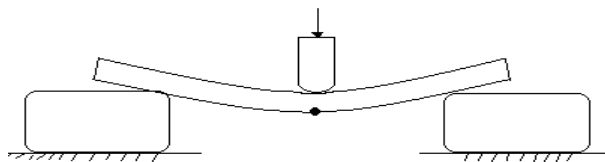


Fig. 7: Three point flexural strength test

In a 4-point test, they are of uniform stress is quite small and concentrated under the center loading point, in a 4-point test, the area of uniform stress exist between the inner span loading points

The 3-point flexural test is the most common for polymers. Specimen deflection is usually measured by the crosshead position. Test results include flexural strength and flexural modulus. The specimens were tested for the characteristic discussed above and the result are tabulated and compared.

III. CHARACTERISTICS AND COMPARISON

A. Effects Of Fiber Treatment And Concentration On The Mechanical Properties Of The Natural Fiber Reinforced Hybrid Polyester Composite

The tensile strength, flexural strength, impact strength of the untreated and the treated fiber, glass fiber reinforced composite are tested according to the standards. From the result that the properties of the 4 alkali treated fiber reinforced composite are better in tensile, flexural and impact properties. Thus the optimum value can be determined from the following result.

B. Tensile Strength:

The tensile strength of the composites were measured with a computerized FIE universal testing machine in accordance with the ASTM D638 procedure. Tensile strength of glass fiber is 110 MPa and for untreated fiber is 50 MPa of 30 weight %, though it is slightly greater than treated fiber. Hence while increase the treated sisal and Roselle fiber content and length, strength will increase simultaneously. The expected mechanical properties can be achieved by using correct and optimum wt% and fiber concentration and treatment time. Thus effect was achieved in tensile strength.

Table – 4

Tensile strength of the composite in MPa

Sl.NO	Weight %	Composite Specimen Length		
		5cm	10cm	15cm
1	10	40.2	50.6	60.3
2	20	50.5	59.5	70.7
3	30	65.8	70.4	79.8

C. Flexural Strength:

The flexural tests were performed on the same machine using the 3- point bending method according to ASTM D70 standards.

Flexural strength of glass fiber is 125 MPa and for untreated fiber is 62.35 MPa of 30 weight %, though it is slightly greater than treated fiber. Hence while increase the treated Roselle and Sisal fiber content and length, strength will increase simultaneously. The expected mechanical properties can be achieved by using correct and optimum wt% and fiber concentration and treatment time. Thus the positive effect was achieved in flexural strength.

Table - 5

Flexural strength of the composite in MPa

Sl.NO	Weight %	Composite Specimen Length		
		5cm	10cm	15cm
1	10	60.4	70.8	80.4
2	20	70.5	78.4	84.5
3	30	78.9	82.3	92.1

IV. SCANNING ELECTRON MICROSCOPY

The fractured surfaces of the composite specimens were investigated using Scanning Electron Microscopy (SEM). SEM images of the fractured surface of Roselle and sisal fibers hybrid polyester composite with 40wt% in tensile, flexural and impact test SEM image indicates the broken sisal fibers during tensile test. The composite failures during tensile, flexural and impact tests due to debonding and the fiber pullout. The fiber pull-out combined with matrix failure in Roselle and sisal fiber hybrid polyester composites is based on the length of the Roselle and sisal fibers.

Fractured surfaces of the hybrid polyester composite specimen for treated and untreated are studied by using SEM. The alkali treated fiber composite specimen as less defects and less moisture content than untreated specimen.

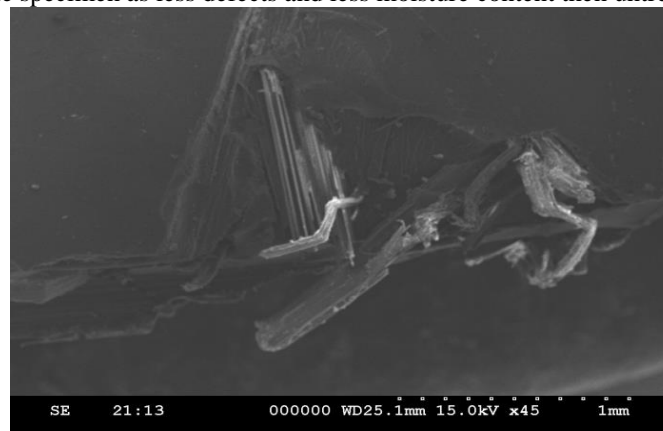


Fig. 7: Untreated fiber composite specimen

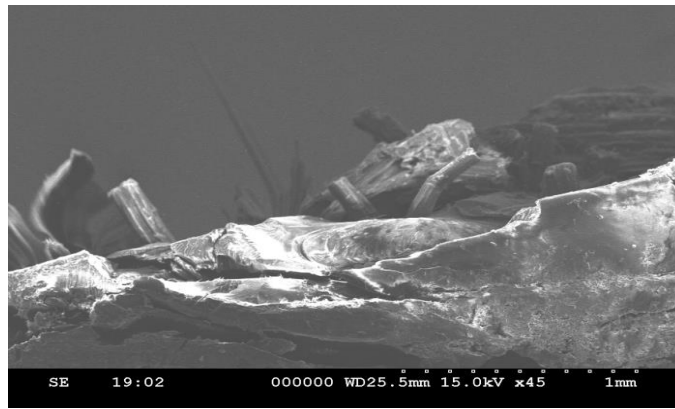


Fig. 8: Alkali treated fiber composite specimen

A. SEM Images for the Tested Specimen:

- 1) It indicates the unbroken Roselle fibers and broken sisal fibers during flexural test and tensile test.
- 2) The fiber pull-out is clearly observed during impact test.
- 3) The clear images can be viewed in the SEM analysis.
- 4) Fiber bonding strength and alignment can be seen through SEM images.
- 5) The unbroken sisal and broken Roselle fibers are observed in impact test.
- 6) These are the images of tensile, flexural and impact tested specimen.

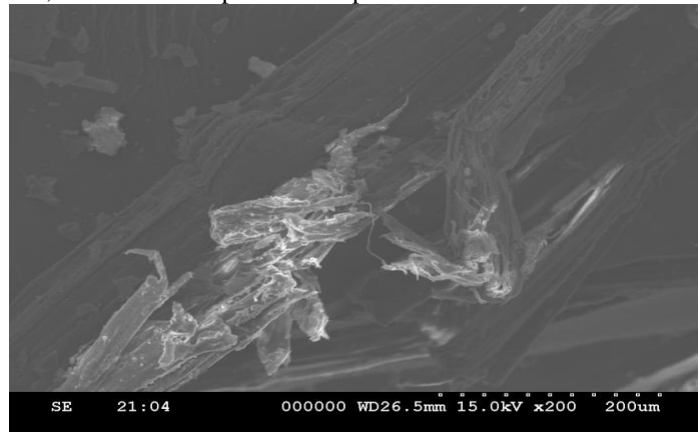


Fig. 9: Tensile test

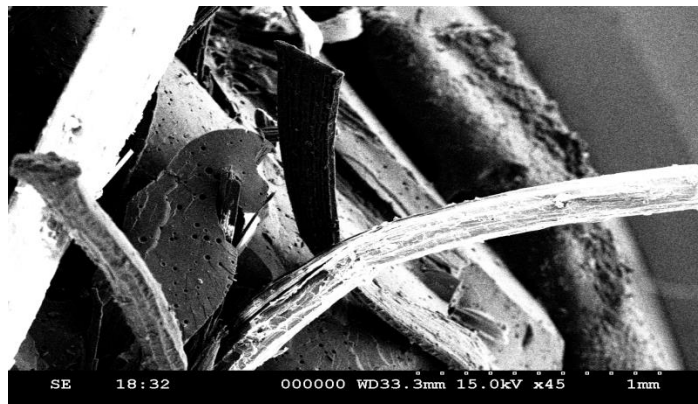


Fig. 10: Flexural test

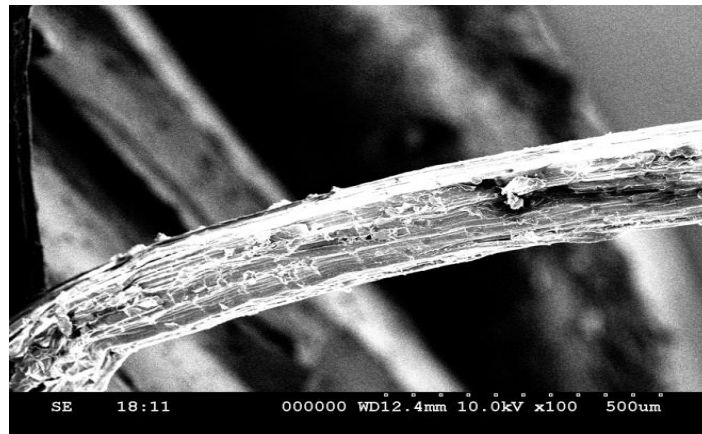


Fig. 11: Impact test

B. Fabrication and Analysis of Splender Scoop:

Now a day's natural fiber plays a major role in the automobile field to reduce the weight and it is a best alternative to the metal and glass fiber. Usage of natural fiber increased day to day life because it is eco-friendly and biodegradable. The splendor scoop was fabricated and drop test was performed on the scoop. Actually the from the previous review and result the optimum weight percentage of fiber and the length, orientation was selected to fabricate the scoop.

C. Fabrication Process of Specimen:

Generally sisal is preferred for the impact strength and Roselle is preferred for the tensile and flexural strength, using the sisal scoop has been fabricated. And Roselle and sisal also used for the fabrication. Hence from the previous result the 40% fiber and 60% resin is suitable for the all the test result so it is selected for the fabrication

Here the original fiber scoop is taken as a pattern and from that the mold is prepared, the sisal is cutted into 5cm length and 40% weight, remaining 60% resin-polyester. The scoop was prepared with the thickness of 0.2cm.. Methyl ethyl ketone and cobalt used as accelerator and catalyst.

D. Drop Test on the Scoop:

Drop test is performed on both the sisal and glass scoop. Thus the 9Nm load is applied on the 1m height .5m, .75, .25m height and indentations is formed on the glass and sisal fiber composite, though the sisal and polyester composite as a brittle nature fracture occurred on the surface. Hence the required dimension and shape are achieved. Color can obtain by adding suitable coloring agent. These is indentation marks on the sisal fiber and glass fiber composite scoop from the various heights.



Fig. 12: Drop Test On The Scoop

V. CONCLUSION

The brittle nature of the sisal scoop will be changed by adding some elastic substance on the composite. By adding the some rubber material or plastic the properties of the scoop will be improved. While compared to the glass fiber it is biodegradable, eco-friendly in nature. And by increasing the thickness and optimum weight percentage, by adding the rubber material strength

and stiffness will be improved nearly to the glass fiber composite scoop. From this project we propose that using natural fiber instead of glass, thermosetting plastics. Using natural fiber great strength to the component of the automobile parts. By using this natural fiber we can make any automobile parts by which we can strength its property.



Fig. 13:

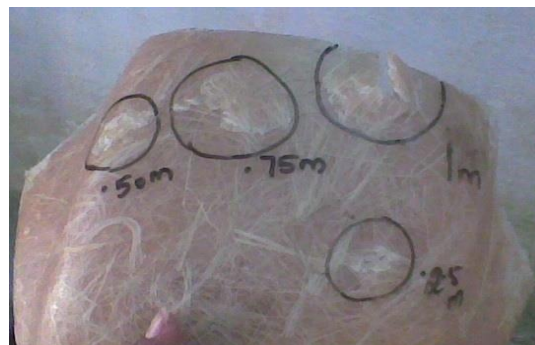


Fig. 14:



Fig. 15:

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