

MECHANICAL TESTING OF NEW NATURAL FIBRE REINFORCED COMPOSITE MATERIAL

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Abstract- The present uses of natural fibers as a partial replacement for the synthetic fibers and there by utilizing eco-friendly materials in various automotive applications namely bumpers, wind shields, doors, ceilings etc. Although there are many research findings related to natural fiber composites. These fibers are also having high strength to weight ratio as well as high stiffness to weight ratio, etc. With increasing environmental concerns natural fibers are once again being considered as reinforcements for polymer composites. Due to the environmental awareness and economical considerations, natural fiber reinforced polymer composites seems to present a viable alternative to synthetic fiber reinforced polymer composites such as glass fibers. In this present work cocainiagrandis fiber composites with polyester resin are fabricated by using compression molding process. The mechanical properties like tensile, hardness, density, surface roughness and wear test are carried out as per ASTM standards for the developed composites. The test result shows that cocainiagrandis composite alkaline treated fiber plate in tensile test in higher value and had shore D hardness of 87.5 which are superior to all the other developed composites. The average density of this polymer composite is 1.0172 g/cc.

1. INTRODUCTION

The use of natural fibers as a replacement for synthetic fibers has received attention. While high performance carbon fibers remain superior to natural fibers in high-end applications, however natural fibers have comparable properties to glass fibers in high volume applications depending on their origin, natural fibers can be grouped into seed, bast, leaf and fruit qualities. Bast and leaf (the hard fibers) qualities are the most commonly used in composite applications. Examples of bast fibers include hemp, jute, flax, ramie, and kenaf. Leaf fibers include sisal and banana leaf fibers. Properties for these fibers include excellent tensile strength and modulus, high durability, low bulk density, good mold ability and recyclability. These natural fibers have an advantage over glass fibers in that they are less expensive, abundantly available from renewable resources and have a high specific strength.

The main objective of this project is to thermal conductivity of natural fiber reinforced plastics. Natural fiber used in thermal conductivity to identify various properties compare to synthetic fiber. The various tests like water adsorption test, SEM test, Alkali test to find the thermal conductivity of natural fiber

Fiber-reinforced-plastic materials are considered as replacements for metals in situations where we need excellent specific strength properties, e.g. strength/weight and or stiffness/weight ratios. While such composites have other advantageous properties over metals, they also have characteristics which may not be so beneficial in some applications. Among the latter is the thermal conductivity, where the magnitude of conductivity of composites, on average, is much lower than that of metals and is also anisotropic. Hence, in general, it is much more difficult to dissipate heat in a fiber reinforced-plastic than in a metal, and in some situations this may be an important consideration, particularly if electronic components are situated very near to the material. Therefore, it is important to tailor the thermal conductivity and thermal diffusivity of composites prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.

2. METHODS TO MANUFACTURING COMPOSITE MATERIALS

2.1 Moulding Methods

Firstly, samples were collected from nine different volunteer's hands by using five types of sampling. They are before hand washing without soap, after hand washing with carbolic soap and disincentive Dettol soap using tap water, and after hand washing without carbolic soap and Dettol soap using sterile water. And then, nutrient medium and sterile cotton swab were prepared for testing in this experiment. The portion of the palm and small fingers of volunteer's hands were swabbed and streaked on the sterile plates and then incubated at 35°C for overnight. After incubation, the isolated colonies were confirmed by using Gram's staining and microscopic examination. In general, the reinforcing and matrix materials are combined, compacted and processed to undergo a melding event. After the melding event, the part shape is essentially set, although it can deform under certain process conditions. For a thermo set polymeric matrix material, the melding event is a curing reaction that is initiated by the application of additional heat or chemical reactivity such as organic peroxide. For a thermoplastic polymeric matrix material, the melding event is solidification from the melted state. For a metal matrix material such as titanium foil, the melding event is a fusing at high pressure and a temperature near the melt point.

For many moulding methods, it is convenient to refer to one mould piece as a "lower" mould and another mould piece as an "upper" mould. Lower and upper refer to the different faces of the moulded panel, not the mould's configuration in space. In this convention, there is always a lower mould, and sometimes an upper mould. Part

construction begins by applying materials to the lower mould. Lower mould and upper mould are more generalized descriptors than more common and specific terms such as male side, female side, a-side, b-side, tool side, bowl, hat, mandrel, etc. Continuous manufacturing processes use a different nomenclature.

The moulded product is often referred to as a panel. For certain geometries and material combinations, it can be referred to as a casting. For certain continuous processes, it can be referred to as a profile. Applied with a pressure roller, a spray device or manually. This process is generally done at ambient temperature and atmospheric pressure. Two variations of open moulding are Hand Layup and Spray-up.

2.2 OTHER TYPES

Other types of moulding include press moulding, transfer moulding, pultrusion moulding, filament winding, casting, centrifugal casting and continuous casting. There are also forming capabilities including CNC filament winding, vacuum infusion, wet lay-up, compression moulding, and thermoplastic moulding, to name a few. The use of curing ovens and paint booths is also needed for some projects.

3. PROBLEM IDENTIFICATION

composites are not suitable in thermal field due to its low melting point. In the field of Engineering Design and Manufacturing, the increased product weight is one of the major drawback. Normally the good quality fibers having highest cost. The availability of the fiber is difficult. The cost of the synthetic fibers is too high. Synthetic fibers are non-renewable fiber.

3.1 Methodology

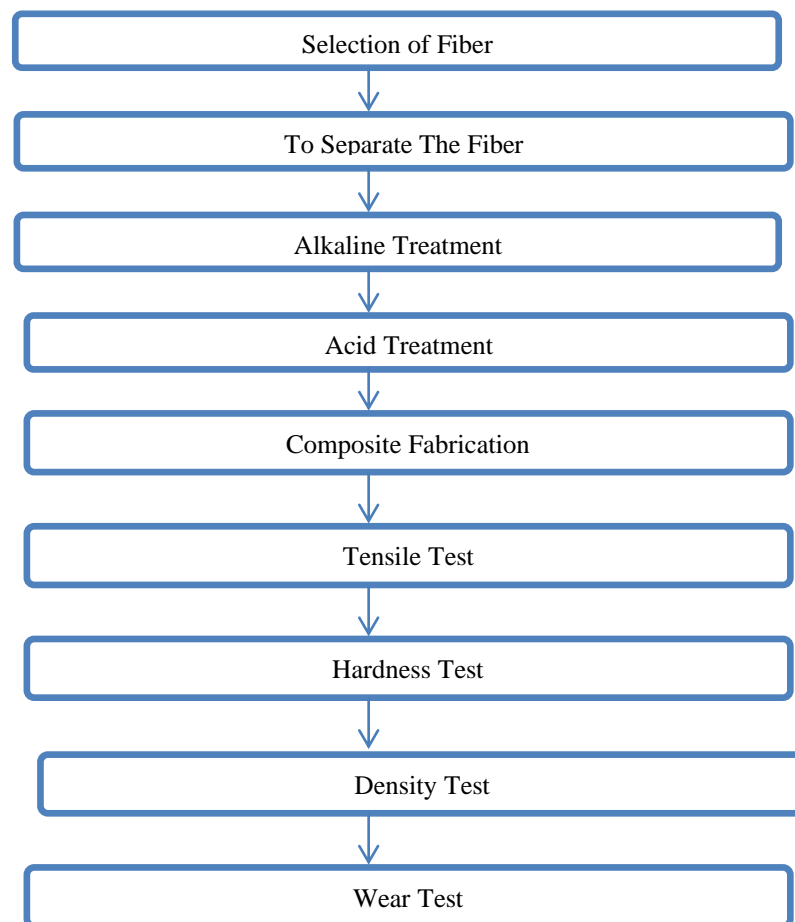


Fig. 3.1 Flow Chart for Steps Involved in Fabrication of Fibre

The usage of glass fiber or fabrics are non degradable and disposal of composites would be tough task when they are used as reinforcement. Moreover, the glass fibers are non renewable. To make environmental friendly composite, the trend is slowly shifting towards using natural fiber/fabric as reinforcement. To separate coccinia grandies fiber from coccinia grandies tree stem. To treat coccinia grandie fibers with NaOH and HCL.

3.2 Materials Selection

Plants of coccinia grandies were collected from hill of Kattathevanpatti, Madurai District, Tamilnadu, India. It is a diffusely much branched small climbers in the cucurbitaceous family growing to a height of 10 to 15 feet. It is native of tropical and sub-tropical areas and found in India, Srilanka, tropical region of America and Malaysia. The stem is yellow and pale white in color, 0.3-5.0cm in diameter with soft and flexible.

3.2.1 Extraction of Fibres

The extraction of fibers involves retting process followed by decorticating. The stems of coccinia grandies were cut at their base and immersed in a water- retting tank for two weeks. Later, they are removed; the fiber 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. The extracted fiber's were used for composite making.



Fig. 3.2 Extraction of Fibre

3.2.2 Alkali Treatment

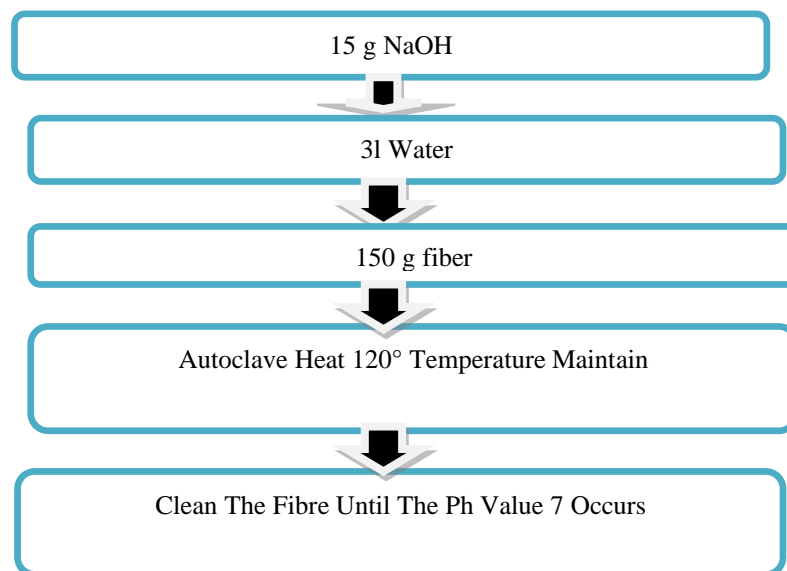


Fig 3.3 Alkali Treatment

3.2.3 Acid Treatment

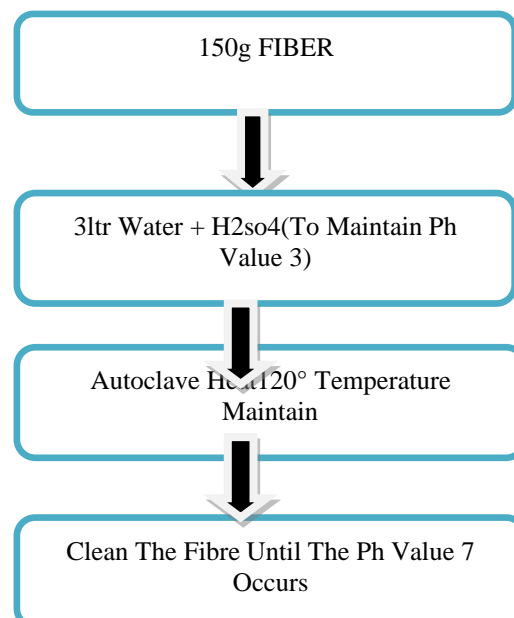


Fig. 3.4 Acid Treatment



Fig. 3.5 Autoclave Machine



Fig. 3.6 Dessicator



Fig. 3.7 Fiber Cleaning Process

3.2.4 Moulding Box Preparation

In general composite plates are prepared by using moulding box. The moulding box contains, Material is mild steel plate dimension 200*125*3 (All Dimension are in mm).



Fig. 3.8 Moulding Box

3.2.5 Selection of Resin

Polyester resin material is a three-component material. However, the manufacturer mixes the two reactive parts. At the time of application, a catalyst is added to start the reaction. Then the material is sprayed onto the roadway. Reflective beads are added using a separate gun located directly behind the paint gun.

Specification of fabricated plate,

Dimension: 200x125x3mm & 200x125x5mm, Fiber quantity utilised:30 g, Fiber quantity utilised:30 g, Resin used:150g, Catalyst used:3ml, Oxylator used:3ml



Fig. 3.9 3mm Composite Plate

3.2.6 Density Testing

ASTM D792 has been used to find out density of the specimen. Density is the mass per unit volume of a material. Specific gravity is a measure of the ratio of mass of a given volume of material at 23°C to the same volume of deionized water. Specific gravity and density are especially relevant because plastic is sold on a cost per pound basis and a lower density or specific gravity means more material per pound or varied part weight. The unit of density is g/cc. Archimedes principle is the fundamental theory for the measurement of specific gravity, and hence density of the specimen. It states that the weight of the displaced fluid is directly proportional to the volume of the displaced fluid (if the surrounding fluid is of uniform density). In simple terms, the principle states that the buoyant force on an object is going to be equal to the weight of the fluid displaced by the object, or the density of the fluid multiplied by the submerged volume times the gravitational constant, g. Thus, among completely submerged objects with equal masses, objects with greater volume have greater buoyancy. The specimen is weighed in air then weighed when immersed in distilled water at 23°C using a sinker and wire to hold the specimen.



Fig. 3.10 Weight of the Sinker



Fig. 3.11 Weight of the Sinker Along With Cup

3.2.7 Hardness Testing

The Rockwell hardness number represents the additional depth to which a test ball or sphere conical penetrator is driven by a heavy (major) load beyond the depth of a previously applied light (minor) load. Top hardness numbers that are obtained from hard materials indicate a shallow indentation while low numbers found with soft materials indicate deep indentation. The increment of penetration depth for each point of hardness on the Rockwell mount is 0.00008 inch. Shore D hardness test was performed using a durometer as per ASTM D256. Initially cleaned and dried samples were pinged with the indenter of the Shore D hardness tester. The sample specimen which were used for wear is also used for the hardness tested.



Fig. 3.12 Hardness Testing Machine

3.2.8 Wear and Frictional Behavior

ASTM G99 has been used using Pin-On-Disc wear testing machine. The Pin-On-Disc machine is a versatile unit designed to evaluate the wear and friction characteristics a variety of materials exposed to sliding contacts in dry or lubricated environments. The sliding friction test occurs between a stationary pin stylus and a rotating disk. Normal load, rotational speed, and wear track diameter can be varied. Electronic sensors monitor wear and the tangential force of friction as a function of load, speed, lubrication, or environmental condition. The specimen which were cut into the dimension of 10 x 10 x 3mm as per ASTM G99 standard. The wear test is conduct on the specimen of size 10x10x3mm on a pin on disc wear test rig. The sliding velocity of 1m/s, 2m/s, 3m/s were tested with the sliding load of 10N, 20N, 30N. The distance which the wear where run is 1000m for a rig distance is 60mm. The specimen needed for the test is 9. The specimen is wear tested in a dry condition. The wear test is carried out on a pin on disc wear rig as per the ASTM G99 standard. The frictional force, specific wear rate and coefficient of friction. where discussed in the report with a graph. The frictional force and specific wear rate is calculated by a formula.

4. RESULT AND DISCUSSION

The composite material plate of 3mm thickness is made from the natural fiber coccinagradies and Polyester Resin.

4.1 Tensile Test for Acid Treatment

As per the ASTM D-638 specimen is prepared and tensile test have been carried out. In the chemical treated of composite fiber plate in the tensile test is alkaline better then acid treated plate.

Table-4.1 Tensile Test Result for Acid Treated Fibre

S.no	Load (W)(N)	Area A(mm ²)	Extension dl(mm)	Stress (N/mm ²)	Strain	Modulus of elasticity (N/mm ²)
1	25	39	0.095	1.281	0.0002	168.61
2	50	39	0.125	2.6	0.0003	263
3	100	39	0.185	5.26	0.0004	355.57
4	150	39	0.263	7.89	0.0005	375.89
5	200	39	0.35	10.53	0.0007	384.72
6	250	39	0.428	13.15	0.0008	381.34
7	300	39	0.518	15.788	0.0104	390.25
8	350	39	0.59	18.42	0.0118	400.23
9	400	39	0.658	21.05	0.0132	408.31
10	450	39	0.725	23.68	0.015	415.06
11	500	39	0.793	26.31	0.0145	418.28
12	550	39	0.86	28.94	0.0159	409.63

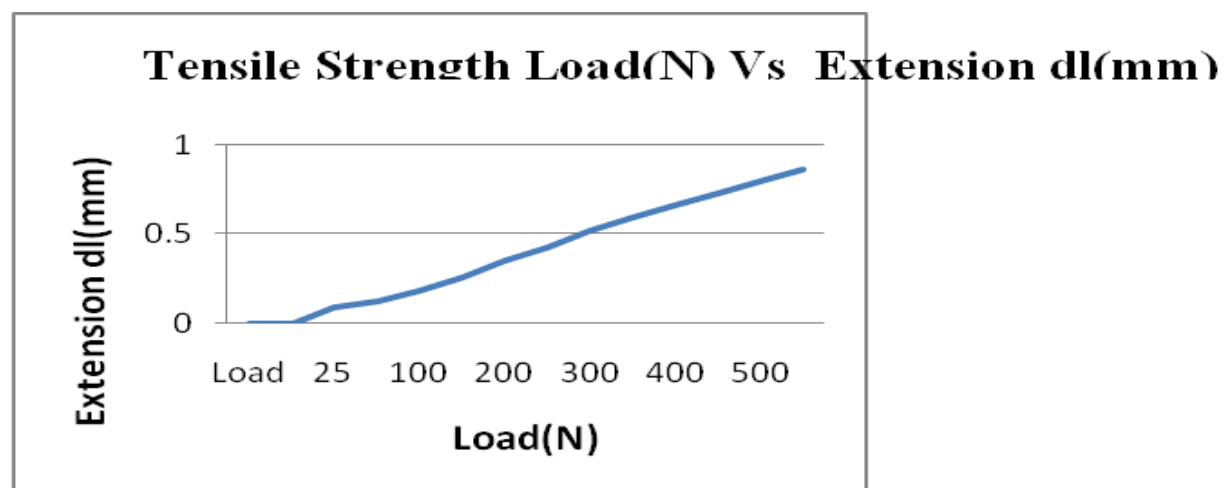


Fig. 4.1 Load Vs Extension Graph For Acid Treated Fibre

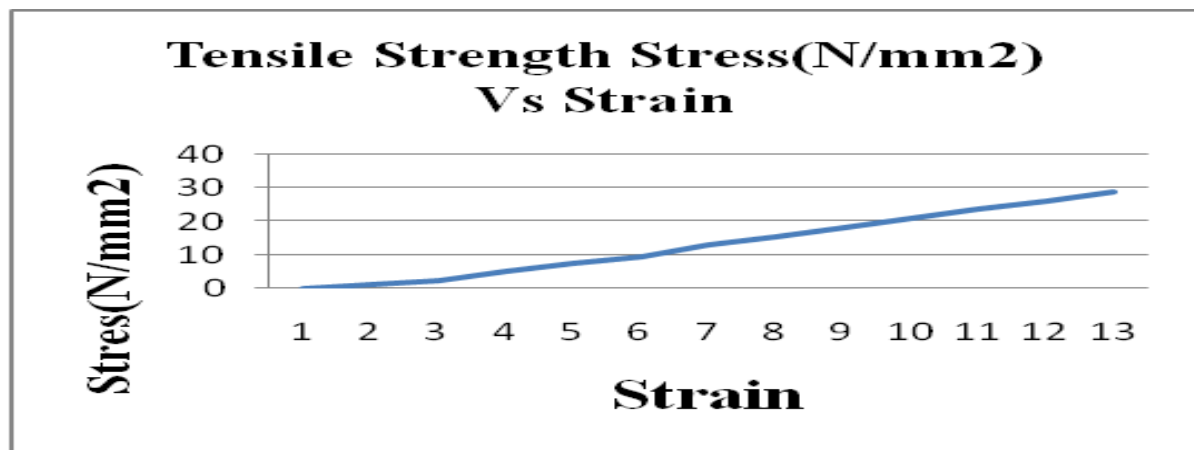


Fig. 4.2 Stress Vs Strain Graph For Acid Treated Fibre

4.2 Tensile Test for Alkaline Treatment

Table-4.2 Tensile Test Result For Alkline Treated Fibre

S.no	Load (W)(N)	Area A(mm ²)	Extension dl(mm)	Stress (N/mm ²)	Strain	Modulus of elasticity (N/mm ²)
1	25	39	0.085	1.180	0.0002	18.60
2	50	39	0.115	1.4	0.0001	253
3	100	39	0.175	4.20	0.0003	345.54
4	150	39	0.253	5.86	0.0002	365.84
5	200	39	0.340	7.53	0.0004	374.70
6	250	39	0.418	10.15	0.0005	371.32
7	300	39	0.508	12.788	0.0100	380.21
8	350	39	0.58	14.42	0.0112	390.22
9	400	39	0.648	18.05	0.0130	400.30
10	450	39	0.715	20.68	0.01	405.03
11	500	39	0.783	23.31	0.0143	408.25
12	550	39	0.85	26.94	0.0150	400.60

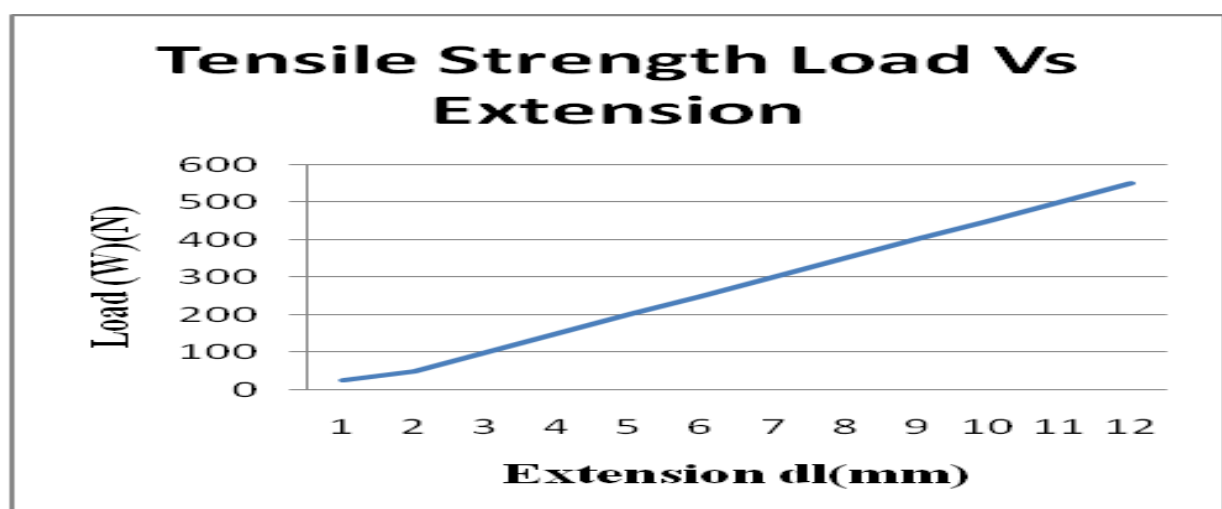


Fig. 4.3 Load Vs Extension Graph For Alkaline Treated Fibre

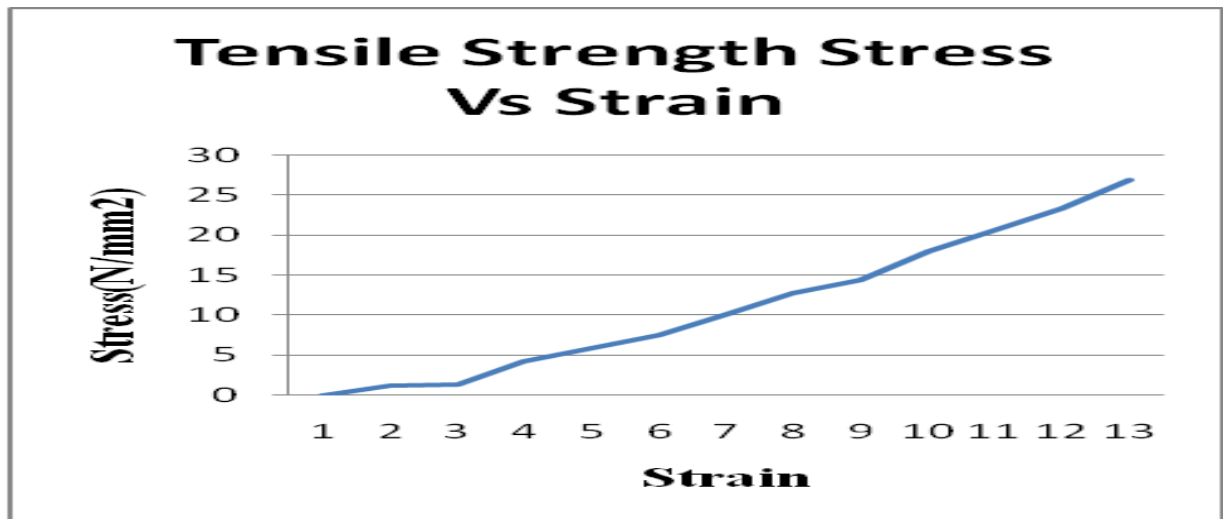


Fig. 4.4 Stress Vs Strain Graph For Alkaline Treated Fibre

4.2.1 Hardness Result

The number of trails taken for the hardness test are in the order of random process. When we compare the acid treated specimen with the alkali treated specimen the hardness amount is much better. This is due to the chemical treatment with the addition of NaOH. The increment of penetration depth for each point of hardness on the Rockwell mount is 0.00008 inch. Shore D hardness test was performed using a durometer as per ASTM D256

Table-4.3 Hardness Test for Alkali And Acid Treated Result

Number of Trials	Acid treated	Alkaline treated
1	88.2	85.8
2	90.2	83.6
3	90.8	92.6
4	90.2	86.5
5	90.1	93.8
6	89.6	86.7
7	77.1	90.5
8	83	87.8
9	85.8	90.8
10	88.6	82.9
Average	87.25	88.1

4.3 Density Test

The specimen for density test has been prepared as 20x20 x3 mm. Then it is dipped into water and kept it on the pin stand set up. Then the reading will be displayed for the specimen. ASTM D792 has been used to find out density of the specimen. The density of the acid treated and the alkali treated fabricated plate is shown in the graph. The obtained value is the optimum value when compared to the other polymer composite plate. The density results show that the mechanical properties were increased on the alkali treated polymer composite.

Table-4.4 Density Test For Alkali And Acid Treated Result

S.NO	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average
Density in g/cc for acid treatment plate	1.064	0.995	1.039	0.995	0.995	1.0176
Density in g/cc for alkaline treatment plate	1.335	1.264	1.308	1.309	1.349	1.313

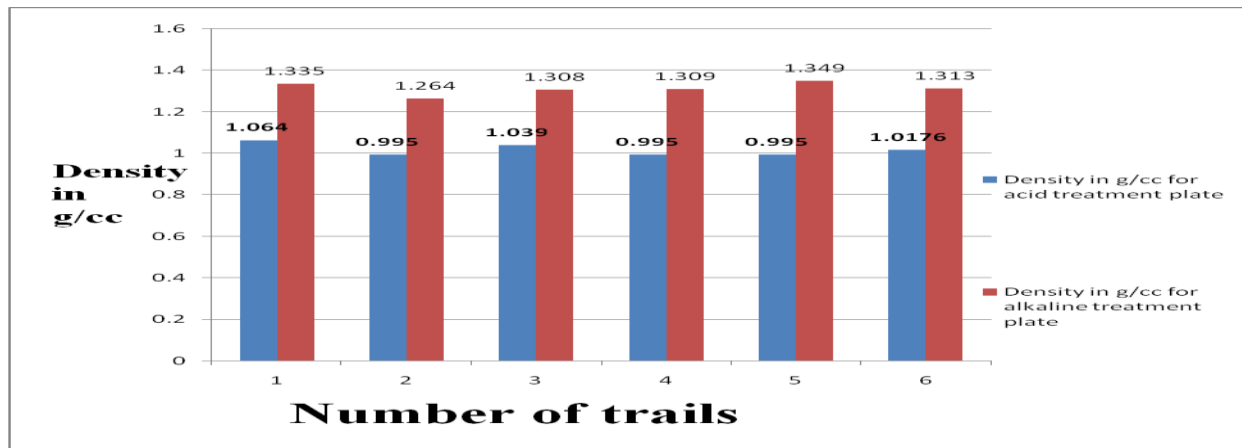


Fig. 4.5 Density Result For Alkaline Vs Acid Treated Fibre

4.4 Wear And Frictional Result Of Treated Fibres

Pin-on-Disc wear testing is a method of characterizing the coefficient of friction, frictional force, and rate of wear between two materials. During this tribological test, a stationary disk articulates against a rotating pin while under a constant applied load.

4.5 Wear and Frictional Result Of Acid Treated For 1000m Distance

Table-4.5 Wear Test for Acid Treated

Velocity in m/s	Load in N	Specific wear rate	C.O.F
1	10	7.862 e-4	0.25
2	10	4.039 e-3	0.28
3	10	5.02 e-3	0.33
1	20	3.583 e-3	0.18
2	20	3.12 e-3	0.28
3	20	2.177 e-3	0.17
1	30	1.89 e-3	0.13
2	30	2.57 e-3	0.12
3	30	1.212 e-4	0.11

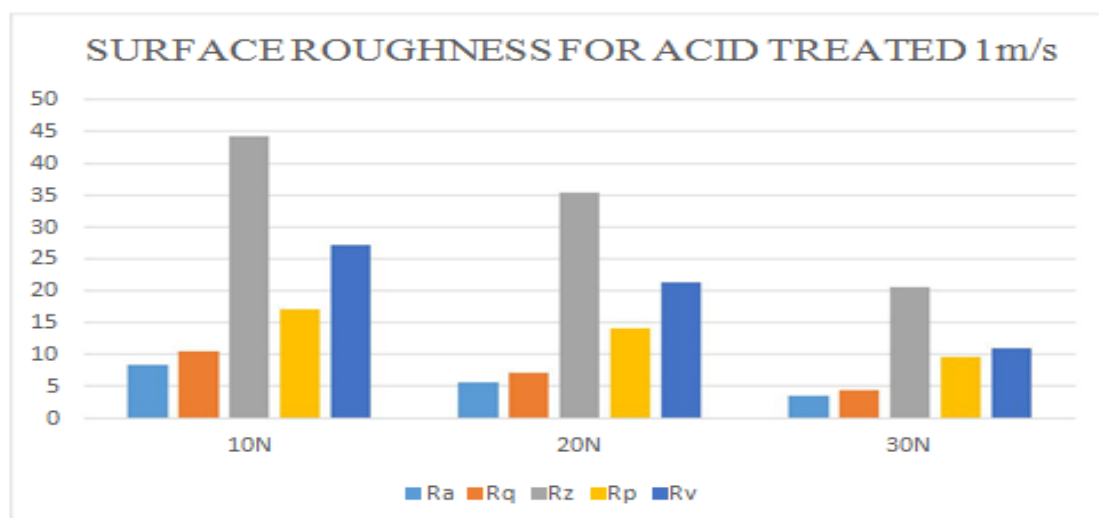


Fig. 4.6 Wear Test For Acid Treated 1 m/s

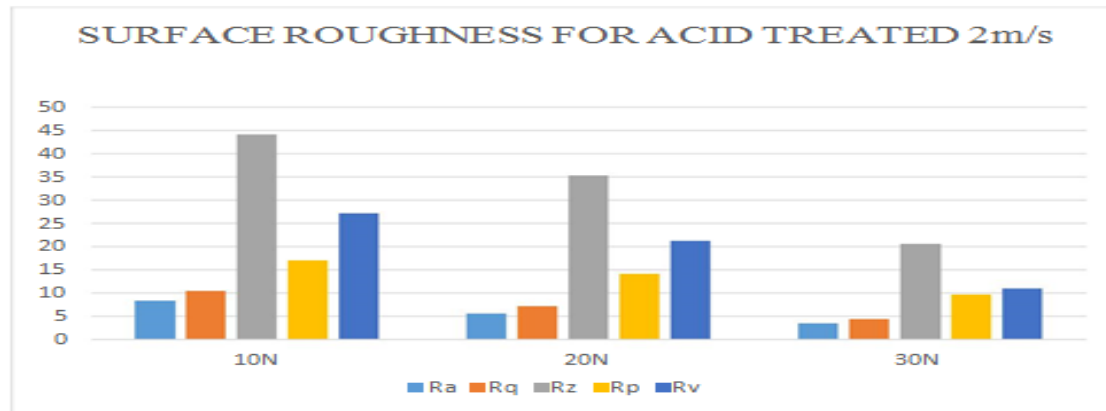


Fig. 4.7 Wear Test for Acid Treated 2 m/s

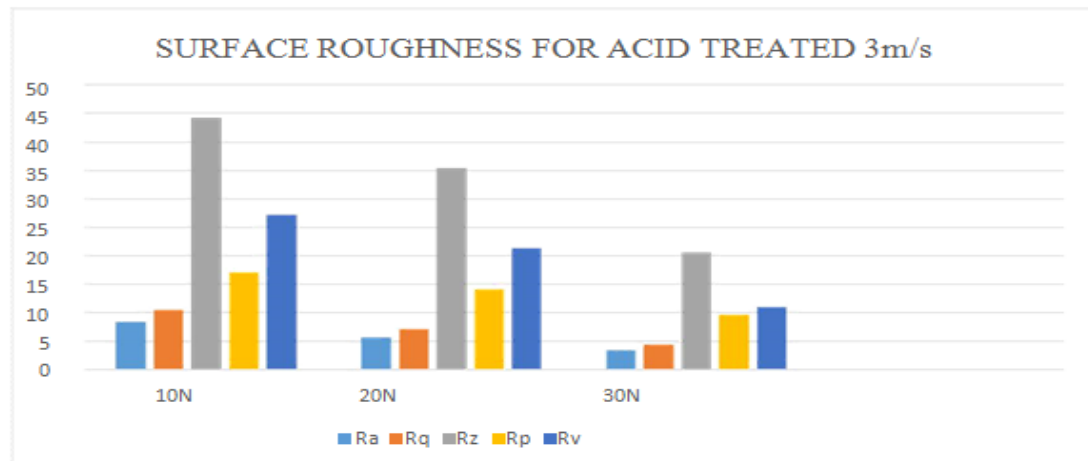


Fig. 4.8 Wear Test For Acid Treated 3 m/s

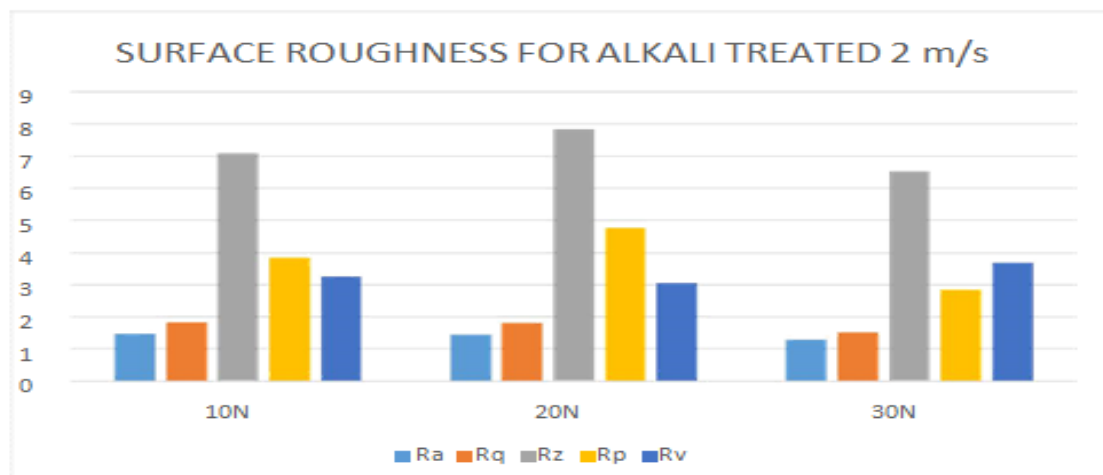


Fig. 4.9 Wear Test For Alkali Treated 2 m/s

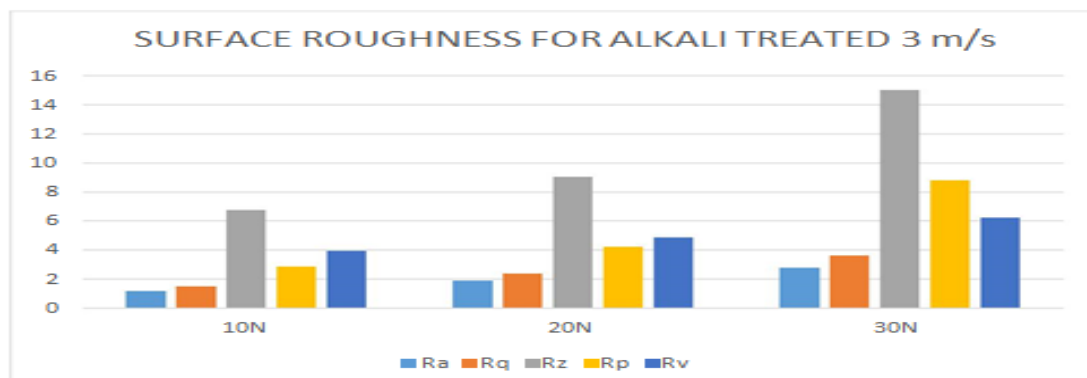


Fig. 4.10 Wear Test For Alkali treated 3 m/s

The wear studies are carried out for the distance of 1000m at a various velocity of 1m/s, 2m/s, 3m/s. Due to the alkali treatment the properties of the composites slightly better than the acid treatment composite. The wear rate of the alkali treated specimen is lower when compared to the wear of the acid treated specimen and the coefficient of friction is varied.

CONCLUSION

In this present work, coccinia grandis fiber with polyester resin and to make a polymer composites. The natural fiber has many advantages than the synthetic fibers and also it has a self-lubricating fiber due to the presence of the wax and moisture content present in it. Thus the mechanical properties like hardness, density, wear properties are studied and comparison of acid treated specimen to the alkali treated specimen. The 10% alkali NaOH treatment on the fiber changes the mechanical and chemical properties of the fiber. It gives additional strength to the fiber that influences the density, hardness and other property of the fiber. And also rate of wear is more for the first 1000 meters after it was decreasing, this phenomenon is common for sliding velocity of 1m/s, 2m/s, 3m/s and for 10N, 20N, 30N. It shows that the natural fibers are having the wear rate different from the metal. The surface roughness of the wear specimen also shows the gradual decrease and increase in the result.

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