Analysis of Mechanical Behaviour of Natural Filler and Fiber Based Composite Materials

R.Kishore, G.Karthick, M.D.Vijayakumar, V. Dhinakaran

Abstract*: This Research work is mainly concentrated on the development of the new trends of the particulate based polymer composites to explore the in-depth utilization of the natural resource's residue. For the past decade the natural fibers are been used as reinforcement for the polymer composite in research. Researchers are showing immense interest to adapt natural fibers in the place of glass fibers, mainly attracted by its weight to strength ratio; these fibers are available at very low price and having more natural advantages such as using green resources, renewable and biodegradable. In this Research, the residue such as egg shell, Red mud and coir fiber are selected as reinforcement for the fabrication, with the selected constituents' composites is fabricated using compression moulding and the mechanical behavior is analyzed for the same. This work mainly concentrates on the comparison of different lengths of coir fiber and different compositions of the filler materials with the matrix as polyester. The mechanical behavior such as Tensile strength, Flexural strength and Impact strength are compared between different runs of samples with varying fillers and fiber length.

***Index Terms*: Coir, composite, compression moulding, red mud, egg shell fillers**

I. INTRODUCTION

These are the materials also called as composition materials these are fabricated from two individual components which have different chemical and physical properties when combined make a new material which has a unique property. Many conventional materials like metal and synthetic fibers this natural fiber can be a great change indeed. The advantages of the natural fibers are greater availability, less density, high toughness, and a reasonable specific strength, the main functions of matrix is to transfer the stresses between the reinforcing fibers and to protect the fibers from environmental or mechanical damage whereas the presence of fibers/particles in a composite improves its mechanical properties, such as stiffness, strength etc. the main motive is to obtain the both material properties without compromising the weakness of the either fiber. Thus, a

composite material or structure possesses a unique combination of properties. Now-a-days, coir fiber composites have gained increasing interest due to their eco-friendly properties. Natural fibers are potential alternatives to artificial fibers. Many composites exhibit very high resistance to temperature corrosion and oxidation. These characters provide design opportunities which are not possible with conventional synthetic materials. There is a huge interest in fabricating new materials which improves optimal utilization of natural resources, and mainly of renewable resources. In addition, composite using natural fiber from coconut husk has been studied for potential aerospace applications.

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CLASSIFICATION OF NATURAL FIBRES

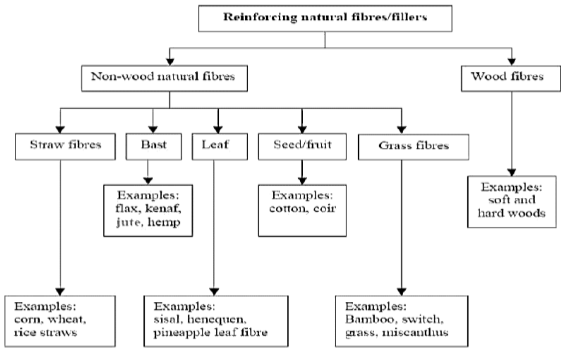

Figure 1 classification of natural fibers

Most used reinforcement in Composites are the synthetic fiber which doesn't give best solution to current problems, it required huge amount of energy to produce, and contains particulates. Numerous of researches have been reported on natural fiber reinforced composites, which have successfully proven their applicability in different kind of fields. The current trends in improved utilization of eco friendly bio products have created the way for more complicated applications for value-added products, providing huge potential for improving the rural economy in major coir-producing countries.

MATERIAL PROPERTIES

The additives such as Red mud, egg shell are very rarely used and analyzed for its mechanical properties, In the process of extraction alumina from bauxite using bayer process, red mud or bauxite residue is obtained from digestion of sodium hydroxide, it is an insoluble material. A very serious environmental problem is created due to the generation of Red mud it has become necessary to find out alternative uses of industrial wastes due to increased environmental threat and to develop value added products using them. This work is a step in that direction. Red mud was collected from Madras Aluminum Company (MALCO) at Salem, India and is sieved to obtain particle size in the range of 75-100 μm.

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The egg shell comprises calcified shell and shell membranes including inner and outer cell membranes. These membranes return albumen to prevent intervention of bacteria. Shell membrane is also essential for formation of shell. The shell comprises of sialic acid a carbohydrate component found in shell.

The resin system consists of unsaturated Ortho phthalic polyester (Specific gravity @29°C: 1.138, Viscosity: 475 cPs and Mass per unit area: 445.96 g/m2), MEKP catalyst and Cobalt Octo ate accelerator supplied by Sri Vinayaka Enterprises, Chennai, Tamil Nadu, India was used. Polyester resins are unsaturated resins formed by the reaction of dibasic organic acids and polyhydric alcohols. Polyester resin tends to have yellowish tint, and is suitable for most backyard Research's.

II. LITERATURE SURVEY

Wang.w et al. Investigated percolation theory instead of traditional diffusion process to understand the mechanism of moisture absorption of the composite material

Hull.D. et al. studied that composites are materials that have strong load carrying material known as reinforcement into weaker material known as matrix. Reinforcement provides good Strength and rigidity, The matrix or binder such as organic or inorganic materials maintains the position and orientation of the reinforcement. It proves constituents of the composites retain their individual, physical and chemical properties, together they produce multiple qualities which individual constituents cannot produce alone.

In composite materials the idea of using cellulose fibers as reinforcement agent is not new and recent one but man had used this idea for a long time, since the beginning of our civilization when straw and grass were used to reinforce mud to make bricks.

Singleton.A.C.N. et al. experimented the laminate based natural flax fibre by hand layup method and compression moulding method the fiber was manufactured and mechanical properties were analyzed and tracked. Improvements in strength and stiffness and high toughness was achieved by varying the fiber polymer volume

Angelo.G.Facca et al. investigated natural fiber reinforced thermoplastics were formed to micro mechanical models and they were tested for stiffness of natural fiber composites such as rice husk glass fibers and it was obtained that traditional synthetic fibers have more mechanical properties

III FABRICATION OF COMPIOSITES

For investigation the coir fiber is selected as the bas material (Reinforcement). The unsaturated vinyl ester resin i selected as the matrix or resin and Termite mound soil was used a filler material. The Compression Moulding process technique wa used for fabricating the coir based vinyl ester composite. Pol Vinyl Acetate (PVA) release agent was applied to the surfac before the fabrication. In the ratio of 1:0.015:0. 015 Termit mound soil filler, Cobalt Octoate accelerator and MEKP catalys have been added. The merged layers were placed in the resi matrix and pressed heavily before removal. After 1 hour, th composites were removed from the mould and cured at roon temperature for 24 hours.

Figure 2 Laying coir in plate

Figure 3 Pouring Resin

Figure 4 Fabricated plate

Figure 2 – 4 Process of Composite fabrication

III RESULTS AND DISCUSSION

EXPERIMENTAL RESULTS

The composite martial is made up of coir fiber filled with Egg Shell and Red mud using polyester resin as matrix material. The composite sheets with varying compositions of fiber and particulate content as shown in the table were fabricated. For each test, five specimens with identical dimensions as per ASTM standard were prepared and the average result was determined. The results of tensile, impact and flexural tests were tabulated as shown below.

TENSILE TESTING

Using the universal testing machine tensile strength of the composites was measured (Make: FIE Pvt Ltd, Yadrav& Model: UNITEK-94100) having cross-head Stroke of 1000mm and Clearance between columns is 650mm. Range of testing is 0KN to 100KN. Power supply is 1PH, 230V A.C and 50hz. As per the ASTM D638-08 standard. The specimens were cut from the fabricated composite in the approximate length, width and thickness of 160 mm, 20 mm and 3 mm respectively. Similar specimens were tested to obtain the average tensile strength value. The photographic image of the boiled egg shell added Coir-Vinyl ester composite specimens after tensile fracture is shown.

Table 1 Experimental results

Sample No.	Fiber length (mm)	Fiber content (wt %)	Filler content (wt %)		Tensile Strength (MPa)	Impact Strength (kJ/m²)	Flexural Strength (MPa)
			Egg Shell	Red mud			
1	10	30	5	5	32.6	37.6	43
2	10	20	10	10	37.2	37.9	45.7
3	10	10	15	15	31.7	33.1	42.8
4	30	30	5	5	37	**38.9**	48
5	30	20	10	10	**38.2**	38.6	**48.8**
6	30	10	15	15	355	37	48.2
7	50	30	5	5	32.8	36.9	45
8	50	20	10	10	35.1	34.6	43.9
9	50	10	15	15	31.6	33	43.8

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Figure3 Photographic image of tensile testing machine.

Figure 4 Photographic image of tensile test specimen after fracture.

FLEXURAL TESTING

Flexural test at three points has been conducted as per the ASTM D790-07 in the UNITEK machine Model: 94100 using a load cell of 0 kN to 100 KN. Maximum crosshead stroke=1000mm and Clearance between columns=650mm.Power supply=1 HP, 230V A.C and 50HZ. Similar specimens were tested to obtain the average flexural strength of composites The specimen was freely supported by a beam, and the load was applied in the middle of the specimen. The photographic image of the generated fractured lines during the flexural test. The rectangular test piece, of the size of 100 mm × 30 mm × 3 mm for the flexural test was cut from the prepared composites.

Figure5 Photographic image of flexural testing machine

Figure6 Photographic image of flexural test specimen After fracture

IMPACT TESTING

Impact strength testing was carried out using impact testing machine Make: ATS FAAR, Model: 16.1, and capacity of up to 25 J as per ASTM D256-06 standard. Specimens having approximate length, widths, and thickness 62.5, 6.25, and 3mm, respectively, were cut from the fabricated composite. The test specimen was supported as a vertical cantilever beam and broken by a single swing of a pendulum.

Figure 7 Photographic image of impact testing machine

Figure 8 Photographic image of impact test specimen after fracture

EFFECT OF FIBER AND PARTICULATE PARAMETERS ON

The tensile properties of the specimen were obtained in different fiber lengths.

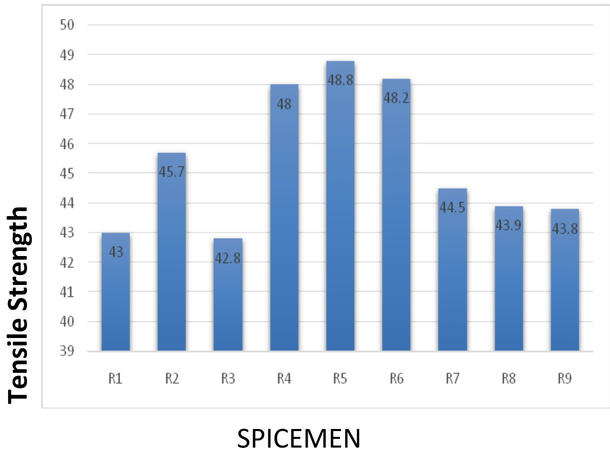

Figure9 Effect of fiber and particulate parameters on Tensile strength.

The minimum tensile strength value was obtained in the composition of 50 mm length fiber of 30% with 30 % of Particulate content (15 % of Egg Shell and 15 % of Red mud) by weight and very high tensile strength was obtained in 30 mm length fiber of 20 % with 20% of particulate content (10 % of Egg Shell and 10 % of Red mud) by weight.

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EFFECT OF FIBER AND PARTICULATE PARAMETERS ON

1. IMPACT STRENGTH

The figure shows the effect of fiber and particulate parameters on impact strength. The high impact properties were obtained in all the levels of fiber length. The minimum impact strength value was obtained in the composition of 50 mm length fiber of 10% with 30 % of Particulate content (15 % of Egg Shell and 15 % of Red mud) by weight and very high impact strength was obtained in30 mm length fiber of 30 % with 10 % of particulate content (5 % of Egg Shell and 5 % of Red mud) by weight.

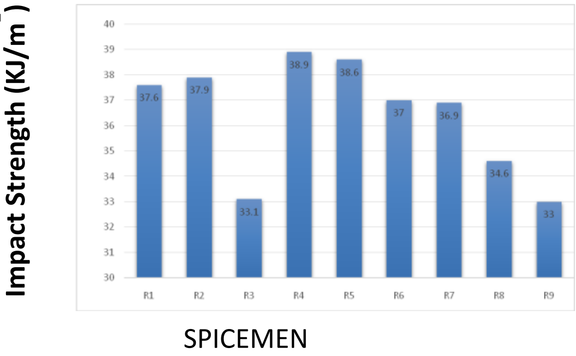

Figure10 Effect of fiber and particulate parameters on Impact strength

EFFECT OF FIBER AND PARTICULATE PARAMETERS ON

FLEXURAL STRENGTH

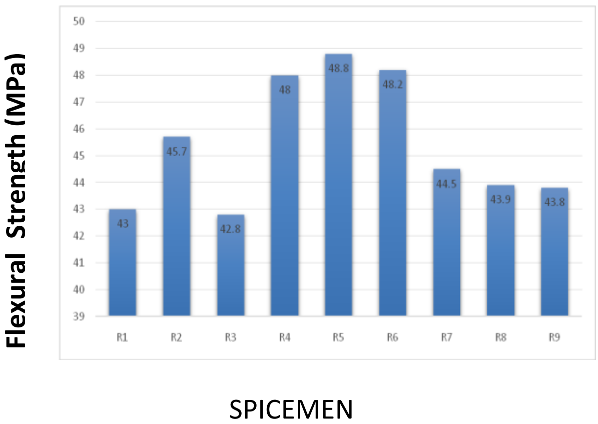

Figure 11 Effect of fiber and particulate parameters on flexural strength

The figure shows the effect of fiber and particulate parameters on flexural strength. Very high flexural properties were obtained in all the levels of fiber length. The minimum flexural strength value was obtained in the composition of10 mm length fiber of 10% with 30 % of Particulate content (15 % of Egg Shell and 15 % of Red mud) by weight and high impact strength was obtained in 30 mm length fiber of 20 % with 20 % of particulate content (10 % of Egg Shell and 10 % of Red mud) by weight.

IV CONCLUSION

It can be concluded that the composites fabricated with different parameters have varied properties and specifically when the major mechanical properties (Impact strength, Flexural strength, Tensile strength) are considered, the combination of filler and fiber length plays a major role in determining the property of the composite.

From the above result it is concluded that the impact strength and the flexural strength are clocked high in the combination of 30mm fiber length and 10% of filler weight and impact strength is clocked high in the combination of 30mm fiber length and 5% of filler weight. With these results it can be concluded as the 30mm length fiber is most efficient compared to the other filler lengths.

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