Experimental studies on Mechanical properties and Characterization of Parthenium Short Fibre Reinforced Polymer Matrix Composites

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Abstract: ***The modern world can't be possible without any kind of improvement in the development of tailor made materials. Numerous researches are carried especially on synthesize of polymer based composite materials to attain the superior mechanical properties. Fibre Reinforced Plastics, Thermo & Thermoset Plastics are replaced with natural fibre reinforced composite. The research focus on enhancement of properties like high strength to weight ratio, non-toxic, dimensional stability, ease of availability, decomposable and affordability. Present researchers have extended their idea in new product design using natural fibres that is stronger as well as affordable which will be utilized to produce extreme applications in automotive fields. The current experimentation examines the mechanical performance of short fibre-parthenium strengthened epoxy composites. Parthenium fibres introduced as a reinforcement in polymer matrix. The mechanical properties of the composite are tested with ASTM D 638 standard. From the experimentation the test results are represented by plot the graph and observe the properties and their uses in different mechanical application.***

Keywords: ***Epoxy resin, Natural fibre reinforced Composite, Parthenium fibres.***

I. INTRODUCTION

The day by day increasing environmental awareness and community interest, led to thinking of the use of environmentally friendly materials1. Natural fibre is considered one of the environmentally friendly materials which have good properties compared to plastics. Government environmental policies have forced industries like automotive, packaging and construction to search for ecologically friendly materials. During 1980s the term polymer composite referred exclusively to the systems consisting of a polymer matrix in which inorganic fillers or reinforcing textile materials were incorporated2. Such a grouping was made at first due to economic reasons. In the 90s the term polymer composite material was extended to all systems with at least two components, one of which was organic. Nowadays, the use of composite is thriving3. Composites with natural fibre are one of the attractive replacements in solving the problem of environmental impact of industries. In the past few decades, research and engineering have been working on changing from monolithic materials to fibre-reinforced polymeric materials which is biodegradable and is ecologically safe.

India is a country with a wealth of producing approximately 14.5 million tons of natural fibres per annum4. The natural fibres are parthenium, bamboo, banana, coir, cotton, flax, hemp, jute, sugar cane bagasse and turmeric are used for preparing the composites. Current industry research acknowledged that the worldwide natural fibre reinforced polymer composites industry subdivision reached U$2.1 billion in 2010. The consumption of NFPcs has protracted substantially in the shopper merchandise as developing industry sectors throughout the last few years.

The mixture of different material in specific composition produces an excellent tailor made material called composites, where the individuality of the ingredients preserved. All the constituent materials performs together to deliver the required mechanical strength/stiffness to the prepared composite. Composites has more than two constituent material having dissimilar phases and bulk properties. The developed composite exhibits superior mechanical properties than the parent constituents[5].

II. LITERATURE REVIEW

Extensive research works have been experimented on natural fibre reinforced polymer matrix composites.

TP Sathish Kumar (2014) revealed that the composite materials are extensively used in the structural applications due to its enhanced load-bearing capabilities. Mostly, the mechanical properties of the natural fibre-reinforced hybrid composites are better than natural fibre composites. The research article summarizes the extraction and preparation methodology of the isophthalic polyester composites using the naturally available fibres like snake grass, banana and coir fibres. The flexural & tensile strength of the snake fibre reinforced composite materials have been assessed with the snake grass and/or banana, coir fibre reinforced hybrid composite materials. The experimental results of prepared composites were analysed by fracture mechanics. It was observed that, the fibre has pulled out from the deformed specimen while carrying out the elongation test. Hybrid composite exhibits enhanced flexural and tensile strength compared over snake grass fibre reinforced composite.

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K Velusamy (2018) characterized have created Calotropis Gigantea fiber fortified epoxy composites arranged by utilizing pressure forming system. The tests were completed by differing fiber length (10, 20, and 30 mm) and volume division (0, 5, 10, 15, 20, 25, and 30%). Moreover, the water retention conduct was broke down at various climatic temperatures of 10°C, 40°C, and 70°C. The composites fortified with 25% in volume of Calotropis Gigantea fiber indicated better tractable, flexural, and affect properties. The hardness esteem and water retention rate are higher for composites strengthened with 30% in volume of 30-mm Calotropis Gigantea strands. In addition, by expanding the shower temperature, the water assimilation rate related to this class of composite increments.

The broader literature research reveals, that the experimental study on mechanical properties of parthenium short fibre found be rare and this work attempts to fill the gap.

III. PROBLEM DESCRIPTION

Normal conventional parts are focussed to prepare in terms of lees weight, non-abrasive and non-biodegradable. It doesn't sustain more stress and forces. Manufacturing process is quite complicated to produce such quality of products[6]. Conventional parts are not so great in providing reinforcement in comparison with polymer matrix composites. There are numerous reasons that conventional parts are influenced by heat and fall short in corrosion resistance. Conventional parts are high end in terms of cost. Conventional parts are not so resilient enough like polymer matrix composites[7]. They also wear off easily. In addition to the above all, it gets less stiff.

IV. OBJECTIVES

- The focal intention is to develop the high strength to weight ratio polymer matrix composite material using parthenium plant stem as fiber material because it is an omnipresent species in India also conscientious for respiratory fault in human.
- To utilize the weed plant as reinforcement fiber in PMC, this is available in huge quantity in India. It will also spoil the fertility of agriculture land. Effective utilization of this weed plant will reduce the environmental impact also saves the fertility of agriculture land.
- The prepared composite material has to be mechanically tested and it will be proposed for automotive and industrial applications based on the experimentation.

V. EXPERIMENTAL PROCEDURE

Fig. 5.1 Parthenium polymer matrix composites

The parthenium plant has been extracted from the field. The redundant parts of the parthenium plants is been cut off. Then the fibres are peeled off from the stem and other exploitable portion of the plant. The extracted fibres are separated into three piles. Then the fibre is placed in a terrace of the building or somewhere open to and much close to sun light. So that the leaves can be dry out completely. The dried-out fibres are treated with certain chemicals before taken to re-enforcing. The first pile is treated with concentrated solutions. And the second pile is treated with dilute form of the same solutions. The third pile left remain untreated. The chemicals are -Acetic acid, NaOH, Acrylic acid, Benzyl chloride, Magnesium permanganate[8].

A pattern is made as per the requirement. Then the Epoxy resin is mixed up with the hardener in a ratio of 2:1. The pile which remains untreated with chemicals has been picked out. Then the fibres are arranged in a flat order in the pattern and the resin is poured over it and it forms the first layer[9]. Then the entire setup is left to harden for a while. The second layer is formed over the first layer by following the exact step as we did for the first layer. And third layer is formed over it. After a while the hardened and re-enforced fibre component is taken out of the pattern. The same procedure is followed for rest of the piles for greater re-enforcement. After that several tests are conducted on all fibre compounds such are hardness, impact and the comparison are made between them.

VI. EXPERIMENTATION TO REVEAL THE MECHANICAL PROPERTIES OF COMPOSITES

5.1 HARDNESS TEST

Rockwell hardness test is a preferable method to find the hardness of PMC as referred from previous literatures. Steel ball, diamond and steel cone are used as an indenter. Rockwell Hardness Number (RHN) is the number derived from the net increase in the depth of indentation as the load or an indenter is increased from a fixed minor load or preliminary load of 10kgf. In this experimentation ball indenter is used to find the hardness of the composite material.

Fig. 5.1 Rockwell hardness test

The test results shows that the concentrated specimen gives better results than others. Alkaline treatment improves the stiffness and strength of the specimen.

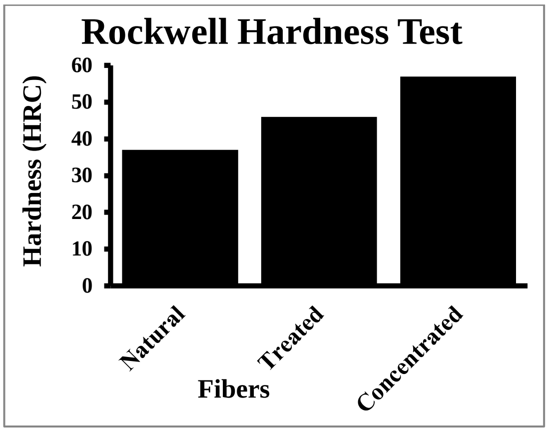

Fig. 5.2 Rockwell hardness test

Table No 5.1 Hardness Values

SPECIMEN	HARDNESS Value (HRC)
Untreated natural fibre	37
Diluted natural fibre	46
Concentrated natural fibre	57

5.2 IMPACT EXPERIMENTAION

5.2.1 Izod Impact Test

The Izod Impact Testing machine works on the principle of pendulum and flexural load. Here the impact load acts on the given specimen when a pendulum is dropping from a certain known height. In this test specimen is ruptured by a single blow. Following by the blow the readings are noted.

Fig. 5.3 Izod Test

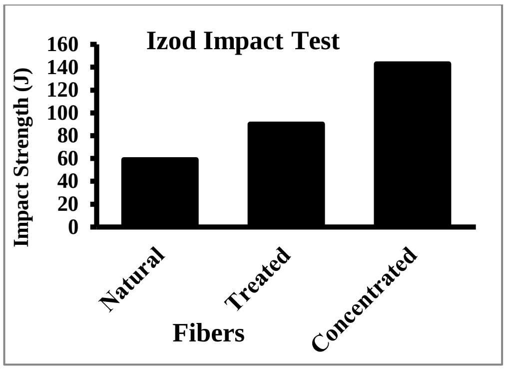

Fig. 5.4 Izod impact test

Table No 5.2 Results of Izod Impact Test

SPECIMEN	IMPACT STRENGTH (Joule)
Untreated natural fibre	59
Diluted natural fibre	90
Concentrated natural fibre	143

5.2.2. Charpy Impact Test

The V-notch impact test is also called as Charpy impact measurement. It is no different from the Izod Impact Test. Except for the fact that pendulum is placed at 90 degree during its release.

Fig. 5.5 Charpy impact test

Figure No. 5.4 and 5.6 shows similar results. The treated fiber based composite gives better performance as compared with non-treated fiber based specimens. Impact strength is having direct relation with the stiffness of the fibre content in the matrix.

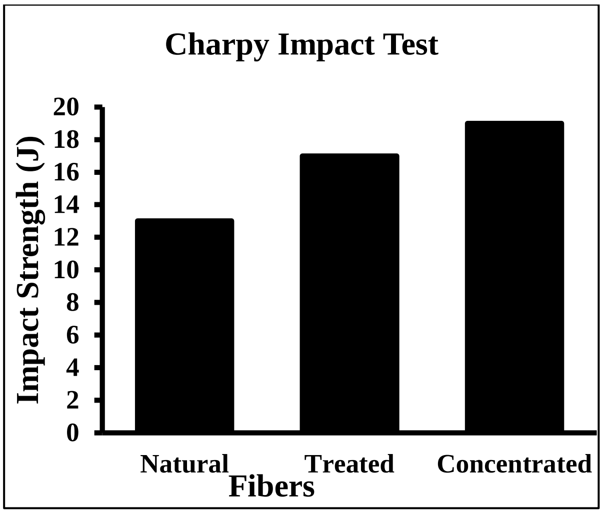

Fig. 5.6 Charpy impact test results

Table No 5.3 Result for Charpy test

SPECIMEN	IMPACT STRENGTH (J)
Untreated natural fibre	13
Diluted natural fibre	17
Concentrated natural fibre	19

5.3. Flexural Test

The three point flexural test is used to measure the flexural strength that is reasonably significant with tensile test. The specimen is rested between two knife supports and opposite probe produce flexural effect repeatedly until it breaks. The figure 5.7, shows in-house experimental setup.

Fig. 5.7 Flexural test

The treated fiber based composite gives low performance as compared with non-treated fiber based specimens. Increase in stiffness of the fiber results with maximizes the effect on flexural strength.

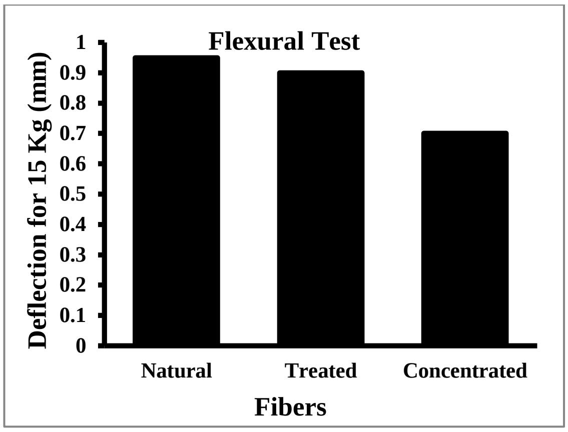

Fig. 5.8 Flexural test result graph

Table no 5.4 Result for Flexural test

SPECIMEN	LOAD (Kg)	DEFLECTION (mm)
Untreated natural fibre	15	0.95
Diluted natural fibre	15	0.9
Concentrated natural fibre	15	0.7

VII. STRUCTURAL ARRANGEMENT OF COMPOSITES

Microstructure analysis is widely used to evaluate the interfacial bonding and arrangement of fibre layers in the matrix materials. The arrangement of fiber is done manually in the matrix. The fibers are arranged in a distributed manner. First one layer of resin is applied then over the resin surface short fibers are spreads then next layer of resin is applied.

Fig. 6.1 Structure of composite specimen

VIII. SIGNIFICANCE OF THE PROPOSED MATERIAL

7.1 Benefits

- High strength to weight ratio.
- They have high durability and design flexibility.
- The finished product is biodegradable, non-abrasive and non toxic.
- Easily dispensable than normal conventional parts.

7.2 Limitations

- Cost of the resin and hardener is high.
- Fiber has to be extracted carefully because parthenium plant releases some gases and it will create respiratory problems to human beings.

IX. CONCLUSION

The Polymer composite has been successfully developed using resin and fibre. Mechanical properties of the developed PMC material were tested according to ASTM D 638 standards. From the results, it was observed that the concentrated PMC gives better result as compared with other specimens. Addition of the natural fibre in the polymer matrix composite exhibits superior mechanical properties is evident from the research. Fibre volume fraction is significantly influencing on mechanical properties in specific, increase of flexural strength. The developed material gives better tailor-made properties and it will be an alternative material for an automotive applications.

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