Characterization And Performance Studies On Natural Fibre Reinforced Polymer Composites With Nano Alumina Fillers

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Abstract- *Composite Materials are replacing traditional materials, because of their superior properties, such as high strength-to-weight ratio, high mechanical strength and minimum thermal expansion etc. Polymer Nano-composites usually exhibit superior mechanical performance and improved barrier properties at very low loading levels compared to conventional filled composites. Jute, a natural fibre which is abundantly available in India, is used as reinforcement in composites, because it is cheap, renewable and easy to process.*

Unsaturated polyester resin (UPR) is a unique thermosetting polymer, characterized by good mechanical properties, resistance to corrosion and chemical attack, low viscosity, fast cure time and low cost. The study deals with the preparation of jute reinforced polymer matrix composites with polyester resin as matrix and micro-alumina as fillers using compression moulding technique according to ASTM standards.

Keywords- Composite materials, unsaturated polyester resin, jute fibre and nano alumina fillers

I. INTRODUCTION

Progress in the field of materials science and technology has given birth to fascinating and wonderful materials called composites, which are one of the most advanced and adaptable engineering materials. Composite materials are formed by combining two or more dissimilar materials that have quite different properties. Composite materials are replacing traditional materials, because of their superior properties, such as high strength-to-weight ratio, high mechanical strength and minimum thermal expansion etc. The development of new materials is on the anvil and the number is growing day by day.

Natural fibre reinforced polymer composites became more attractive due to their high specific strength, lightweight, biodegradability and environment friendliness. Natural fibre mixed with synthetic fibre-reinforced polymer composites are finding increased applications. Composites have gained tremendous industrial importance during the past few decades and are now considered as engineering materials win an ever increasing bonding applications ranging from household articles of everyday use to supersonic aircrafts and satellites.

II. NATURE OF STUDY

A Composite material (a.k.a composition material or composite) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. So far the most commonly used materials for mechanical applications, have a problem with balancing mechanical stability and their cost factors. The use of a composite material can overcome these problems with its high degree of reliability, design flexibility and production, as well as its resistance to corrosion, the composite material has become a unique material in various products and Equipment. To obtain research grade materials of jute unidirectional fiber, polyester resin and Alumina particles. To Fabricate the PMC specimen according to ASTM/ISO Standard for different compositions. To study the mechanical properties like Bending strength, Shear Strength and Hardness strength for different compositions of PMC. To conduct Hydrolytic and Oxidative Degradation test for different compositions of PMC.

A K Saha conducted studies on jute reinforced polymer composites by dynamic mechanical analysis. Chemically pre-treated jute fiber reinforced polymer composites were prepared and tested using dynamic mechanical analyser with wide range of temperatures. Test results have shown that chemically treated fiber composites had higher stiffness and storage modulus than untreated fiber.[1]

Ajith Gopinath conducted experimental investigations on mechanical properties of jute fibre reinforced composites with polyester and epoxy resin matrices. The author prepared composites with jute fibres of length 5 to 6 mm along with polyester and epoxy resins. The composites were synthesized at 18:82 fibre- resin weight % and mechanical properties were studied. He has concluded that epoxy composites have better strength than polyester composites. [2]

M K Gupta studied effects of sisal fibre loading on mechanical properties of jute Fibre Reinforced Polymer composites. The hybrid sisal/jute fibre FRP were prepared with different weight fractions along with epoxy resin as matrix. The author has concluded that after studying mechanical properties and SEM images of prepared composites, the results show that properties of hybrid composites increase with increase in fibre loading of up to 30% weight fraction. [3]

III. PREPARATION

A layer of mould releasing agent was first applied to the moulds. Jute mat was cut according to required dimensions and the amount of jute mat was varied for each trial (10, 20 and 30% by weight). The resin mixture for each specimen was weighed using the digital weighing balance. 1.5% by weight of each Hardener (MEKP) and catalyst (Cobalt naphthenate) were added to the weighed resin mixture.First, a layer of resin mixture was poured into the mould and spread evenly. Then, jute mat layers were added one at a time and were soaked in resin completely. After completion of layer by layer process pressure was applied by using compression mould and left for curing at room temperature. Now different tests like tensile test according to ASTM D 3039 standards was done, Compression test according to ASTM D 3410 standards was done, Rockwell test according to ASTM D 785 standard and water absorption test.

Fig 1- Computer interfaced universal testing machine

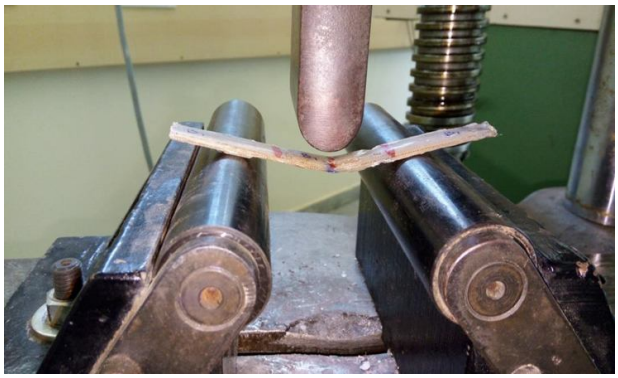

Fig 2- Bending test at failure

IV. RESULTS AND DISCUSSION

Tensile Test

Tensile test was carried out on the prepared test specimen using **universal testing machine** and the following Fig.3 were obtained from the computer depicting the tensile properties of the specimen. For each concentration, 3 specimens were prepared and to calculate strength, average of 3 was taken as in fig 3. The maximum tensile strength was shown by the specimen B6 (J-30% and A- 4%) and as the fibre and Nano-material weight was increased, tensile strength also showed an increasing trend except for specimen B3 (J-20% and A-2%).

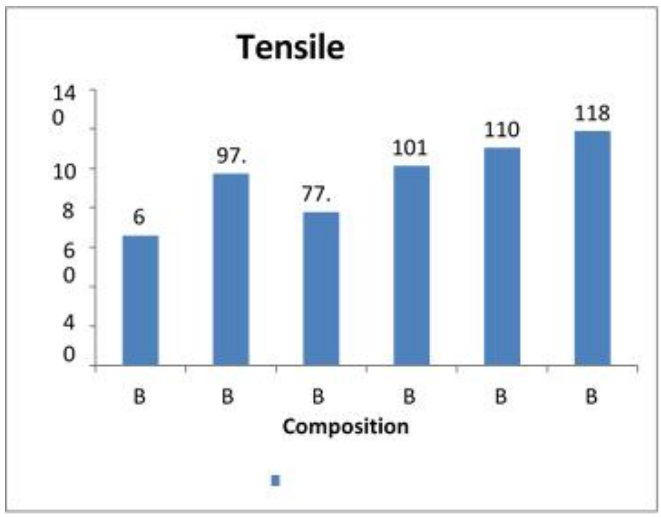

Fig 3- Graph for tensile test

Compression Test

Compression test was carried out on the prepared test specimen using universal testing machine and the following Fig.s were obtained from the computer depicting the compression properties of the specimen. Tabs using fibre glass was added to the specimen to avoid buckling and hence to

obtain accurate values. For each concentration, 3 specimens were prepared and to calculate strength, average of 3 was taken as in fig 4. The maximum compression strength was shown by the specimen B2 (J-10% and A-4%) and as the fibre weight was increased, compression strength got decreased. But for the same concentration of fibre, when Nano-alumina concentration was increased from 2% to 4%, there was an increase in compression strength.

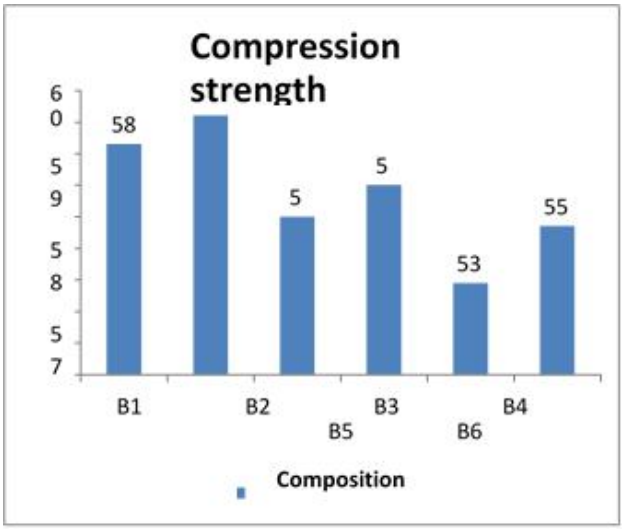

Fig 4-Graph for compression test

Bending Test

Bending test was carried out on the prepared test specimen using universal testing machine and the following Fig.5 were obtained from the computer depicting the bending properties of the specimen. The test carried out was 3-point bending test with distance between the supports 38.4 mm (12 * thickness). For each concentration, 3 specimens were prepared and to calculate strength, average of 3 was taken as in fig 5

The maximum bending strength was shown by specimen B3 (J-20% and A- 2%). Increase in fibre and Nano-alumina concentration increased bending strength till specimen B3, then it showed a decreasing trend. But for the same concentration of fibre, when Nano-alumina concentration was increased from 2% to 4%, there was an increase in bending strength, except for specimen B4 (J-20% and A-4%).

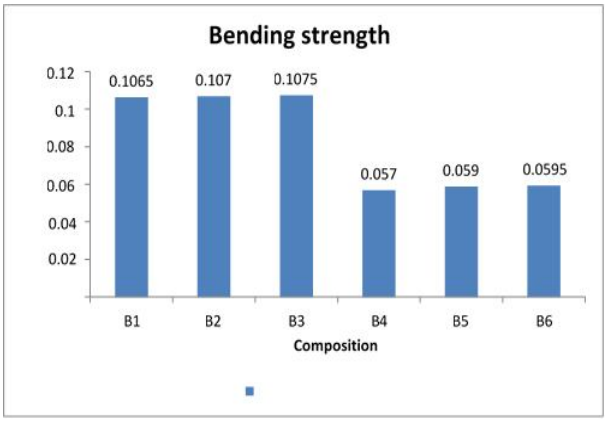

Fig 5- Graph of Bending test

Rockwell Hardness Test

The specimens with thickness of 6.4 mm were tested for hardness using the Rockwell hardness testing machine. The test was carried out with reference to M scale and a ball indenter by applying minor load of 10 kgf and major load of 100 kgf and for each composition, 3 to 4 were trials were conducted and average of the obtained values was considered for results.

The maximum hardness was shown by specimen B6 (J-30% and A-4%) (RH- M 98) and it was found that as the fibre and Nano-material weight was increased, hardness also showed an increasing trend.

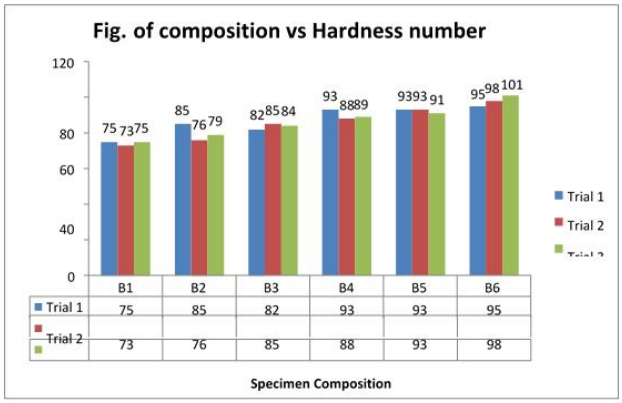

Fig 6- Composition vs Hardness number

Water Absorption Test

Water absorption is used to determine the amount of water absorbed under specified conditions. The test was carried out at room temperature and 3 dried specimens from each composition were subjected to water absorption test and averages of 3 were taken as in fig 7. The maximum water absorption percentage was for specimen B5 (J-30% and 4%). Increase in weight of fibre showed increase in water

absorption percentage. But for the same concentration of fibre, when Nano-alumina concentration was increased from 2% to 4%, there was a decrease in water absorption.

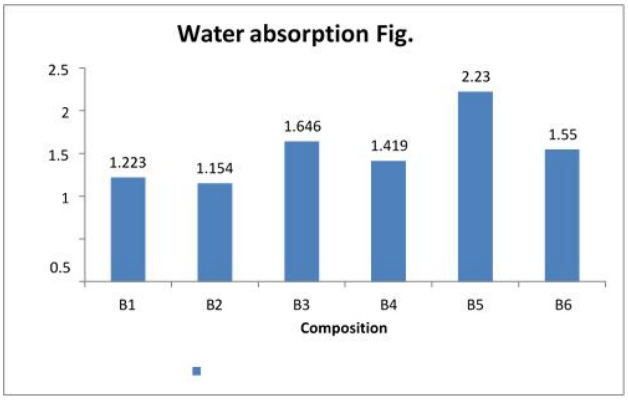

Fig 7- Water absorption figure

V. CONCLUSION

This project has provided us an opportunity to use our knowledge. By doing this project, we gained a lot of practical and software knowledge. Finally, we feel this project is a good solution in the present situation and we feel proud that the work has been completed within the time successfully.

- Jute Nano composite has been fabricated successfully by reinforcing natural fibre jute into a polyester resin matrix filled with Nano-alumina.
- The maximum tensile strength was shown by the specimen B6 (J-30% and A- 4%) and as the fibre and Nano-material weight was increased, tensile strength also showed an increasing trend except for specimen B3 (J-20% and A-2%).
- The maximum compression strength was shown by the specimen B2 (J-10% and A-4%) and as the fibre weight was increased, compression strength got decreased. But for the same concentration of fibre, when Nano-alumina concentration was increased from 2% to 4%, there was an increase in compression strength.
- The maximum bending strength was shown by specimen B3 (J-20% and A- 2%). Increase in fibre and Nano-alumina concentration increased bending strength till specimen B3, then it showed a decreasing trend. But for the same concentration of fibre, when Nano-alumina concentration was increased from 2% to 4%, there was an increase in bending strength, except for specimen B4 (J-20% and A-4%).
- The maximum hardness was shown by specimen B6 (J-30% and A-4%) (RH- M 98) and it was found that as the fibre and Nano-material weight was increased, hardness also showed an increasing trend.
- The maximum water absorption percentage was for specimen B5 (J-30% and 4%). Increase in weight of fibre showed increase in water absorption percentage. But for the same concentration of fibre, when Nano-alumina concentration was increased from 2% to 4%, there was a decrease in water absorption.

VI. SCOPE FOR FUTURE WORK

- Determination of other properties such as impact, thermal, fatigue and tribological behaviour.
- Carrying out advanced studies such as SEM, XRD and FT-IR to know the mechanisms of fracture and internal structure of composites.
- Usage of different natural fibres along with different orientations, different Nano-material fillers, comparison of properties with conventional and Nano-fillers.
- On the prepared composites, various machining characteristics such as drilling, reaming etc. can be carried out and machining properties can be studied.
- Using various analysis softwares, analysis can be done and the results obtained can be compared with experimentation results.

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