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Fabrication and Investigation of Mechanical properties of Natural and Synthetic fibre reinforced Polymer Hybrid Composites

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Abstract

The Composite materials are replacing the traditional materials due to its advantages and also increase in demand for different materials as a result of rapid growth in industrial activities and advancement of civilization. Other side many researchers are focused on development of natural fibre reinforced composites due to more concern on reducing environmental pollution. In the present work the un saturated polyester based polymer Composites are fabricated separately with natural fibre like Sisal fibre and synthetic fibre as Glass fibre and also Hybrid composites are fabricated by combining both Sisal (natural fibre) and Glass fibre (Synthetic fibre). These Composites are tested to Investigate Mechanical properties like tensile strength, flexural strength, compressive strength and Impact strength and compared. The tensile, flexural and compressive strength of fabricated composites were tested by using universal testing machine whereas Impact strength of the composite is analyzed by using Izod impact tester. From this experimental investigations, it is observed that both hybrid composites and composites fabricated separately with natural fibre reinforcement and synthetic fibre reinforcement are showing better mechanical properties. Finally, it is concluded that the mechanical properties of Hybrid composites are better than the natural fibre reinforced composites and slightly lower than synthetic fibre reinforced composites.

Keywords: Natural fibre, Synthetic fibre, Polymer Hybrid composites, Mechanical properties.

1. INTRODUCTION

The demand for new materials is increasing day by day due rapid development of industrial sector all over the world and demanding for new materials which exhibit high strength and low weight. Fibre reinforced polymer composites plays a major role as it has strong load bearing capacity with light weight. The term composite can be defined as the material which is composed with two or more different materials and the resultant material being superior to the properties of the individual materials. The polymer composites and hybrid composites are finding increase in usage for numerous industrial applications. This is because of their high corrosion resistance, light in weight, good mouldability, transparent, economical and excellent surface finish which make them highly suitable for the manufacture of water tanks, pipe lines, bottles, bags etc.[1]. Fibre reinforced hybrid composites [2] are used for wide variety of structural applications as in many chemical, manufacturing industries, aerospace and automotive industry due their high strength to weight and stiffness to weight ratio. Fibre reinforced composite materials (FRP) consist of fibres of high strength and modulus embedded in or bounded to a matrix with distinct interfaces between them [3]. Fibres are principal load carrying members and surrounding matrix keep them in desired location and orientation, act as load transfer medium between them and protects them from environmental damage due to elevated temperature and humidity [4]. The natural or synthetic fibres used in fibre reinforced polymer composites. Cotton, jute and sisal etc.. are few examples for natural fibres[5] and glass, nylon, carbon etc.. fibres are few examples for synthetic fibres[6]. As compared with synthetic fibres Natural fibres have received much attention from researchers all over the world due to their advantages like low cost, renewable, biodegradable, good strength, easily available etc, but the drawback is the strength of natural fibres are less than the synthetic fibres. The synthetic fibre have high strength as compared with natural fibres, but it is costly, nonrenewable and doesn't decompose easily as compared with natural fibre. To get the advantages of both natural and synthetic fibers they are combined and hybrid composites are produced. John [7] et al has studied mechanical properties of polymer composites made with glass fibre reinforcement. They observed that the glass fibre reinforced polymer composites have shown better mechanical properties. Khanam et al has studied sisal/silk (natural fibre) reinforced polymer composites by varying the length of fibre used in composite. They reported that 2cm long fibres incorporated in polymer composites are having good mechanical properties like higher tensile, flexural, and compressive strength than 1 cm and 3cm long fibres. Khan et al has studied mechanical properties of jute fibre(natural) reinforced polymer composites [8,9] and found good results.

2. PRESENT WORK

In the present work unsaturated polyester resin based polymer composite are fabricated separately with sisal fibre, glass fibre and also hybrid composites by combining both sisal fibre and glass fibre. These composites and hybrid composites are tested to investigate the mechanical properties and compared. In The present work composite materials are manufactured by using hand lay-up process. The mechanical properties such as tensile, compression, flexural and impact strength of these composites are presented in detail.

3. MATERIALS USED FOR MAKING COMPOSITES

Sisal (Agaves Veracruz) short fibre (2 Cm long), collected from local sources and chopped strand mat of short glass fibre (2 Cm long) are were used to fabricate composites for the present work. The unsaturated polyester resin purchased from Allied marketing co, Secunderabad, T.S, India, cobalt naphthenate as a catalyst and methyl ethyl ketene peroxide as accelerator which are obtained from M/S Bakelite Hylam, Hyderabad, T.S, India ere used.

4. FIBRE TREATMENT

Sisal fibre(natural fibre) was collected in a glass tray, to which 5% NaOH solution was added for fibre treatment. The sisal fibres were soaked in this solution for one hour. The fibres were then washed thoroughly with fresh water to remove the excess of NaOH sticking to the sisal fibre. Final washing of sisal fibre is carried out with distilled water and these fibres were dried in hot air. The fibres were chopped into short length of 2 cm after drying for preparing composites.

5. PREPARATION OF COMPOSITE

In the present work the polymer composites were prepared by using hand lay-up technique. The matrix of unsaturated polyester resin and monoester of styrene are mixed thoroughly in the ratio of 100:25 by weight respectively. Later the accelerator of methyl ethyl ketene peroxide 1% by weight and the catalyst of cobalt naphthenate of 1% by weight are added to the mixture and mixed. The releasing agent of silicon is sprayed to the mould and the matrix mixture prepared is poured in to the glass mould. Then the fibre is added to the unsaturated polyester resin matrix mixture which was poured in the glass mould. The excess resign was removed from the glass mould and the glass plate with weight was placed on the top of this casting. It is allowed to cure for 24 hours at room temperature. After 24 hours the casting is placed at a temperature of $80^{\circ}C$ for 4 hrs in a oven. After 4 hours the fibre reinforced polymer composites were released from mould and these moulds are cut to prepare test specimens for testing materials as per ASTM standards.

6. MECHANICAL PROPERTIES

In the present work the Composites and hybrid composites fabricated are tested to Investigate Mechanical properties like tensile strength, flexural strength, compressive strength and impact strength. Tensile test is conducted on universal testing machine which widely used to determine strength, ductility and toughness of the materials. The tensile test specimen for present work is prepared according to the ASTM D638 standard. The dimensions of specimen, gauge length and cross-head speeds are chosen according to the ASTM D638 standard. The testing process involves placing the test specimen in the (UTM) testing machine and applying tension to it until it gets fractures. The compressive test specimen for present work is prepared as per the ASTM D695 standard.

Fig 1. Universal testing machine

A compression test involves mounting the specimen (UTM) in a machine and subjecting it to the compression. The compression test process involves placing the test specimen in the testing machine and applying compressive load to it until it gets fractures. The compressive force applied is recorded as a function of displacement. During the application of compression, the elongation of the gauge section is recorded against the applied force. The flexural specimens for present work are prepared as per the ASTM D618 standard. A 3-point flexure test is the most common flexural test used for composite materials. Specimen deflection is measured by the crosshead position. Test results include flexural strength and displacement of test specimen. The testing process involves placing the test specimen in the (UTM) testing machine and applying force on it until it fractures and breaks. The impact test specimens are prepared for current work is according to the required dimension following the ASTM-D256 standard. During the testing process, the specimen is loaded in the Impact testing machine (Izod impact tester) and allows its pendulum until it fractures or breaks the test specimen. Using the impact test, the energy needed to break the test material can be measured easily and this test can be used to measure the toughness of the test material and the yield strength. The tensile, flexural and compressive strength of hybrid composites were tested by using (UTM) universal testing machine whereas Impact strength of the composite is measured by using Izod impact tester.

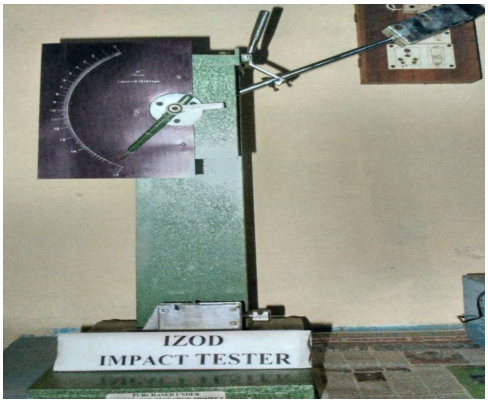

Fig 2. Izod Impact testing machine

7. RESULTS ND DISCUSSION

The tensile, compressive, flexural and impact strength of sisal, glass fibre reinforced composites and hybrid composite fabricated with sisal and glass fibre reinforcement are measured and test results are compared.

7.2 TENSILE STRENGTH

The fig. 3 shows the tensile strength of sisal, glass fibre reinforced composites and hybrid composite fabricated with sisal and glass fibre reinforcement. It is observed that the tensile strength of glass fibre reinforced composites are higher than the sisal fibre reinforced composites and sisal and glass fibre reinforced hybrid composite. This may be due

to high tesile strength of glass fibre as compared with sisal fibre. The Tensile strength of sisal and glass fibre reinforced hybrid composite is higher than the sisal fibre reinforced composites. The increase in tensile strength of hybrid composite is due to presence of Glass fibre. The tensile strength of sisal fibre reinforced composites is 22.8Mpa and glass fibre reinforced composites are 29.4Mpa and sisal and glass fibre reinforced hybrid composite is 26.9 Mpa.

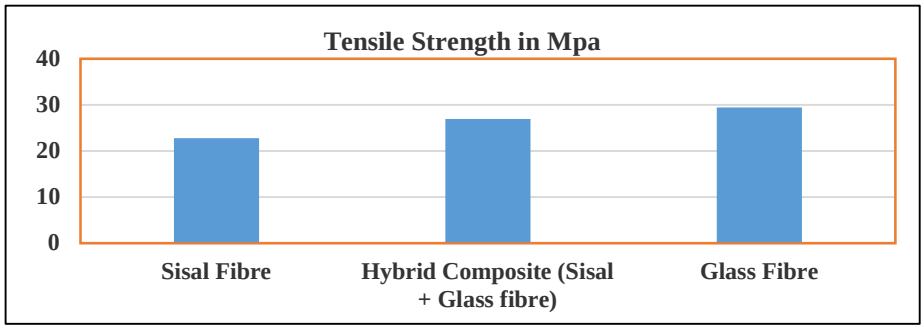

Fig 3. Tensile strength of Sisal/Glass fibre composites and hybrid composite.

7.3 COMPRESSIVE STRENGTH

The fig. 4 shows the compressive strength of sisal, glass fibre reinforced composites and hybrid composite fabricated with sisal and glass fibre reinforcement. It is observed that the compressive strength of glass fibre reinforced composites are higher than the sisal fibre reinforced composites and sisal and glass fibre reinforced hybrid composite. This may due to smaller diameter of the glass fibre as compared with sisal fibre diameter. The compressive strength of sisal and glass fibre reinforced hybrid composite is higher than the sisal fibre reinforced composites. The compressive strength of sisal fibre reinforced composites is 113.7 Mpa and glass fibre reinforced composites are 151.5Mpa and sisal and glass fibre reinforced hybrid composite is 136.8 Mpa.

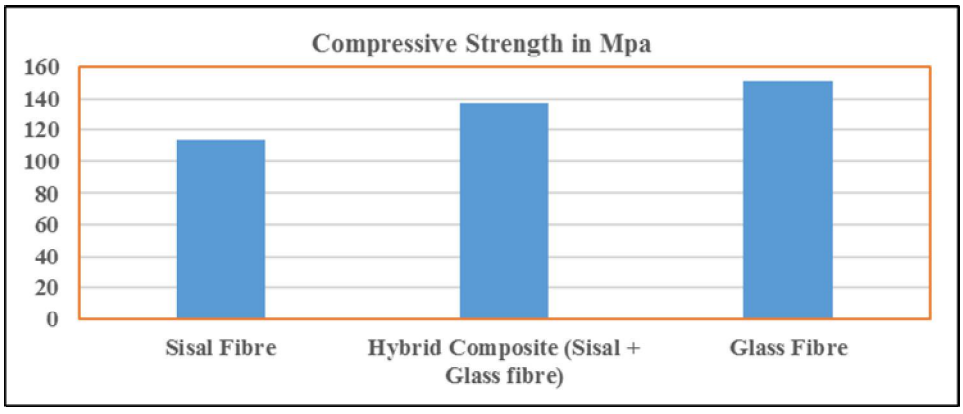

Fig 4. Compressive strength of Sisal/Glass fibre composites and hybrid composite.

7.4 FLEXURAL STRENGTH

The fig. 5 shows the flexural strength of sisal, glass fibre reinforced composites and hybrid composite fabricated with sisal and glass fibre reinforcement. It is observed that the flexural strength of glass fibre reinforced composites are higher than the sisal fibre reinforced composites. This may be due to high strength of glass fibre as compared with sisal fibre. The flexure strength of sisal and glass fibre reinforced hybrid composite is higher than the sisal fibre reinforced composites. The increase in flexure strength of hybrid composites is due to presence of Glass fibre. The flexural strength of sisal fibre reinforced composites is 87.3Mpa and glass fibre reinforced composites are 101.9Mpa and sisal and glass fibre reinforced hybrid composite is 96.7 Mpa.

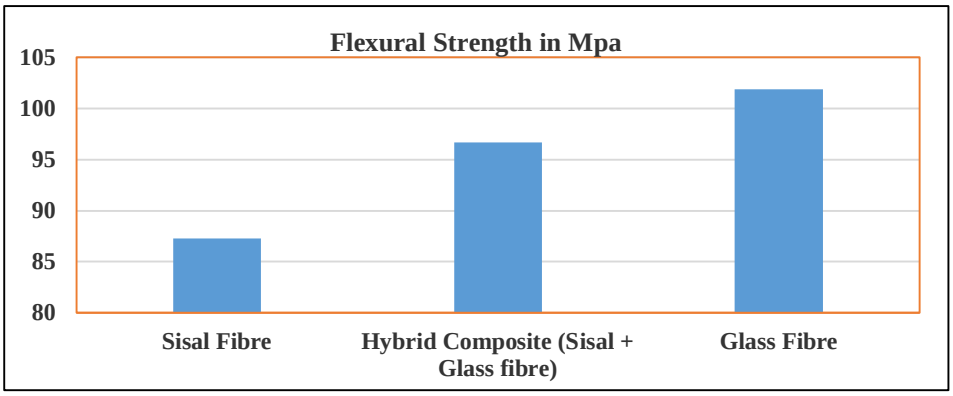

Fig 5. Flexural strength of Sisal/Glass fibre composites and Hybrid composite.

7.5 IMPACT STRENGTH

The fig. 6 shows the impact strength of sisal, glass fibre reinforced composites and hybrid composite fabricated with sisal and glass fibre reinforcement. It is observed that the impact strength of glass fibre reinforced composites are higher than the sisal fibre reinforced composites. The Impact strength of sisal and glass fibre reinforced hybrid composite is higher than the sisal fibre reinforced composites. The increase in Impact strength of hybrid composites is due to presence of Glass fibre. The impact strength of sisal fibre reinforced composites is 6.9KJ/M,^{2} glass fibre reinforced composites are 13.64KJ/M^2 and sisal and glass fibre reinforced hybrid composites are 11.3 KJ/M^2.

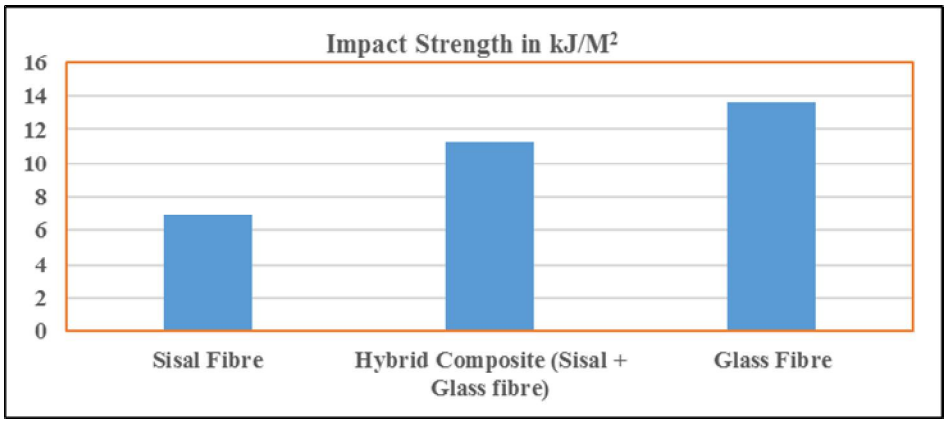

Fig 6. Impact strength of Sisal/Glass fibre composites and hybrid Composites.

8. CONCLUSIONS

The mechanical properties of sisal fibre, glass fibre reinforced composites and sisal and glass fibre reinforced hybrid composites made with unsaturated polyester resin have been studied and following conclusions are drawn.

1. It is observed that the tensile strength of glass fibre reinforced polymer composites is higher than the sisal fibre reinforced polymer composites and also sisal and glass fibre reinforced hybrid composites.
2. The compressive strength of glass fibre reinforced polymer composites is better than the sisal fibre reinforced polymer composites and also sisal and glass fibre reinforced hybrid composites.
3. The flexural strength of glass fibre reinforced polymer composites is better than the sisal fibre reinforced polymer composites and also sisal and glass fibre reinforced hybrid composites.
4. The impact strength of glass fibre reinforced polymer composites is better than the sisal fibre reinforced polymer composites and also sisal and glass fibre reinforced hybrid composites.
5. Tensile strength, Compressive strength, Flexural strength and Impact strength of sisal and glass fibre reinforced hybrid composites are better than the sisal fibre reinforced composites.

Finally, it is concluded that the mechanical properties of sisal and glass fibre reinforced hybrid composites are better than the sisal fibre reinforced polymer composites and slightly lower than the glass fibre reinforced composites.

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