INVESTIGATION OF MECHANICAL BEHAVIOUR OF SISAL FIBER POLYMER COMPOSITE

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ABSTRACT

The polymer composite material is replacing the traditional materials as other materials are limited and composite having condescend properties such as high impact strength, high tensile strength, high flexural strength and nature created materials natural fiber which are biodegradable and eco-friendly and easily available. Natural fiber is by product of agricultural product and natural fibers have low density and light weight. The polymer composite is made by compression moulding process. The percentage of sisal fiber is 10% of resin weight and size of sisal fiber is varied from 5mm to 20mm. It was used with 80% of polyester resin (93P) and 2% of cobalt as accelerator and 8% of methyl ethyl ketone peroxide as catalyst for cured. The polymer composite is made with 8Mpa pressure at room temperature. The test specimen is cut from 200mmx200m sheet which is made by compression moulding machine. The investigation of mechanical properties using ASTM standard test for plastic materials. After study about the properties with respect to fiber length it concludes that mechanical properties are increases as size increases.

***Key Words**: Sisal Fiber, Polyester Resin, Compression Moulding, Mechanical Properties.*

I. INTRODUCTION

It is clear that when two or more materials are combined, the result is a composite. In the ancient time of polymer composites first time an Egyptians and Mesopotamians for the construction purpose.[1]. The Composite, the wonder material with low cost, light weight, high strength and abundantly available. Sisal fiber is by product of agricultural products and extracted from the plant of sisal using various methods like water retting, chemical retting etc. [2] Natural Fiber as reinforcement in polymer matrix provide biodegradable and eco-friendly and positive environmental benefits. The use of natural fiber with polymer has been an appreciable success for many researchers and engineers for the application of aerospace, automobile, electrical appliances, constructional line.

The properties of the composite depend upon the composition of individual components as resin and fiber have their different properties and it also depends on the method of formation and process parameters. Recent studies investigate that use of natural fiber is positive for environment as compare to the manmade fibers and polymer composite is observed that it is biodegradable using natural fiber such as flax [3-4], bamboo [5-6], sisal [7-8-9], hemp [10], jute [11-12], nettle [13] as reinforcement of biodegradable plastics. The Tensile strength of the polyester and sisal fiber is 20-25MPa and 360-370MPa respectively. The Flexural Strength of the polyester and sisal fiber is 30-35MPa and 650-700MPa.

The major drawback associate with the mixing of natural fiber is as reinforcement with the polymer composite are the bad wettability and water absorption which is overcome by chemical extraction treatment using alkaline treatment. This will be finished by using polyester resin with sisal fiber in a mould with compression moulding process at 80Mpa pressure and at room temperature of 30.2°C and they are left for curing for 15 minutes. Then the panel cut according to the ASTM standards for the testing of mechanical properties of composite. Once the testing is finished then analysed the mechanical properties as the specimen according to the fiber size.

II. MATERIALS AND METHOD DETAILS

Sisal Fiber: -Sisal Fiber is purchased from local source and for to extraction of fiber for better mechanical properties is purchased from Astha Fiber and Chemicals MI road Jaipur. Then fiber is copped in 5mm,10mm,15mm,20mm size and treated with 10% of NaOH for 1 day then it washed and dry for 3 hours in the sunlight.

Polyester Resin: - Resin is also purchased from Aastha Fiber and Chemicals and it is of Polyester 93P grade which cured at room temp easily.

Catalyst: - Methyl Ethyl Ketone Peroxide is used as catalyst for to initiate the process and help to cure the material.

Accelerator: - Cobalt Naphthalene is used as accelerator which accelerator the rate of chemical process and help to cure.

III. FABRICATION OF POLYMER COMPOSITE

Compression Moulding process [13] is the best and most common method for fabrication under the pressure for the fabrication of composite. The mild steel mould is used for the specimen of size 200mm X 200mm X 5mm.The Teflon sheet was placed in the mould for better surface finish and easily removing the sheets of composite. The Teflon sheet is used for both side female and male part of the mould for the surface finish. Sisal fiber after alkaline treatment is used for fabrication of polymer composite with polyester resin and catalyst and accelerator.

For the better reinforcement 10% fiber to the weight of the resin is used and accelerator is 2-3% of the resin weight and catalyst is 5-8% of the resin weight is used.

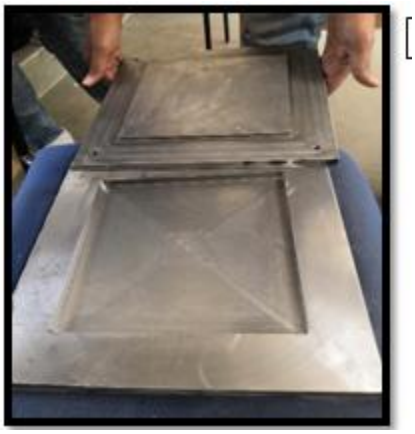

Figure 1. Mild Steel Mould

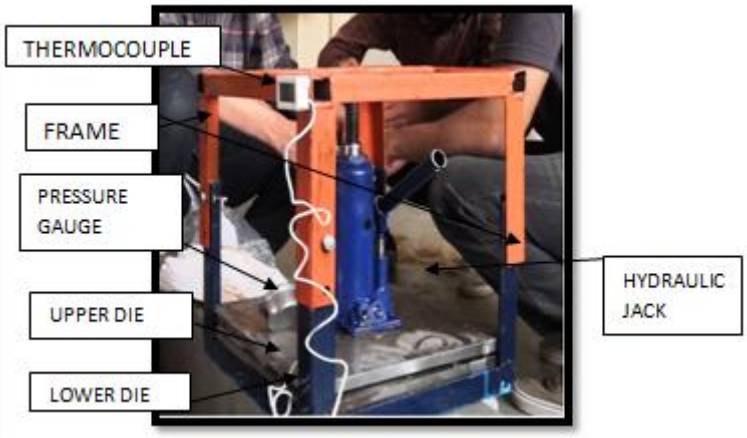

Figure 2. Compression Moulding Setup

First the accelerator is added to the resin then the catalyst then add the fiber into the mixture and stir the mixture properly then pour the mixture into the mould and apply the pressure through hydraulic bottle jack and measure the pressure using pressure gauge which was attached with the hydraulic jack and for to measure the temperature there is one thermocouple is fixed on the frame as shown in figure 2.Then the sheet is remove from the mould and cure the sheet about 30 minute then it is use for to cut according to the ASTM standards. Simultaneously same process is for other size fiber to fabricate the sheets.

IV. METHODOLOGY

Preparation of Specimen for various Mechanical testing as per ASTM Standards: - From the sheet as per mould size of 200mmX 200mm X 5mm and cutting the specimen for tensile, flexural, impact testing.

Mechanical Tests: - The main objective to determine the three important properties of composite materials are following test at room temperature.

Tensile Test [15]: - The tensile strength is determined using ASTM D638 Standard testing machine and the specimen is cut from sheet of size 150mm X 20mm X5mm and gauge length is 50mm.The test is conducted using computerised tensile testing machine and tensile strength was reported in MPa.

Flexural Test [16]: - This test is also conducted at room temp using ASTM D790 Standard through three-point computerised testing machine and the size of specimen cut from the sheet is 115mm X 15mm X5mm. The Flexural Strength is carried out and reported in MPa.

Impact Test [17]: -Izod Impact test is conducted using ASTM D256 Standard by swinging pendulum as similar in the case of metal using sudden applied of load to the specimen and the size of the specimen is 55mmX10mmX5mm.The Impact Strength is carried out and reported in J/m

Figure 3. Specimen for Testing

V. EXPERIMENTAL RESULTS AND DISCUSSIONS

Tensile Test: -Tensile Strength of any material is the exterme stretching force to the material that it can sustain before breaking the part. It is considered in force per unit area. Tensile strength can use determine using the below equation

$$\boldsymbol{\sigma t} = \frac{\mathbf{Fc}}{\mathbf{Af}} \qquad (1)$$

$$\boldsymbol{Af} = \frac{\boldsymbol{m}}{\boldsymbol{\rho L}} \qquad (2)$$

Here $\boldsymbol{\sigma t}$ is the tensile strength of the fiber, Fc is the force at the failure point, **m** is the mass of the fiber and **ρ** is the density of the fiber, **Af** is the cross-section area of the specimen, Length of the fiber were diferent and weight of fiber is 10% of the resin weight. The sisal polymer composite fiber result were found 10% higher than those found by [10] and similar to those found by [11].

Table I. Tensile test result for the polyester composites reinforced with 5-20mm length sisal fiber.

S.No.	Fiber Length (mm)	Tensile Strength (MPa)
1.	5	13.6
2.	10	22.5
3.	15	29.4
4.	20	34.5

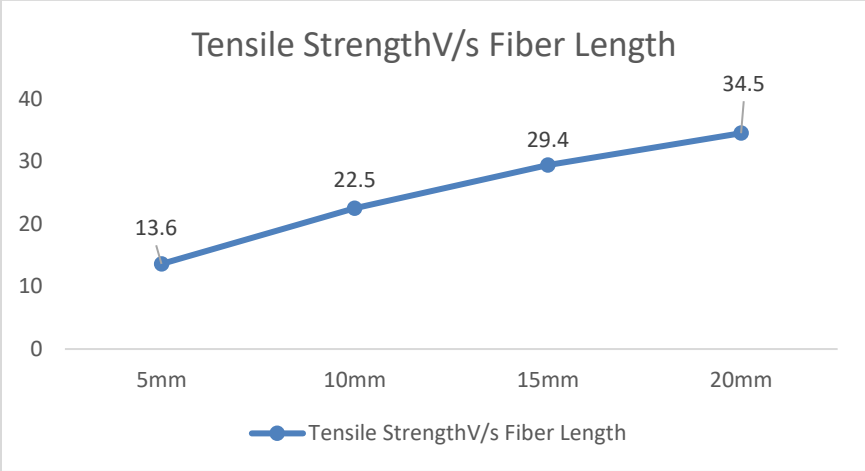

Figure 4. Graph between tensile strength and fiber length.

Flexural Test: -It is basically bending test to find out the maximum bending stress that can be applied to the material before it yields. It is also known as modulus of rigidity. The sisal polymer composite result were found 5% higher than those found by [11] and similar to those found by [12].

Table II. Flexural test result for the polyester composites reinforced with 5-20mm length sisal fiber.

S.No	Fiber Length (mm)	Flexural Strength (MPa)
1.	5	35.8
2.	10	41.2
3.	15	46.7
4.	20	52.1

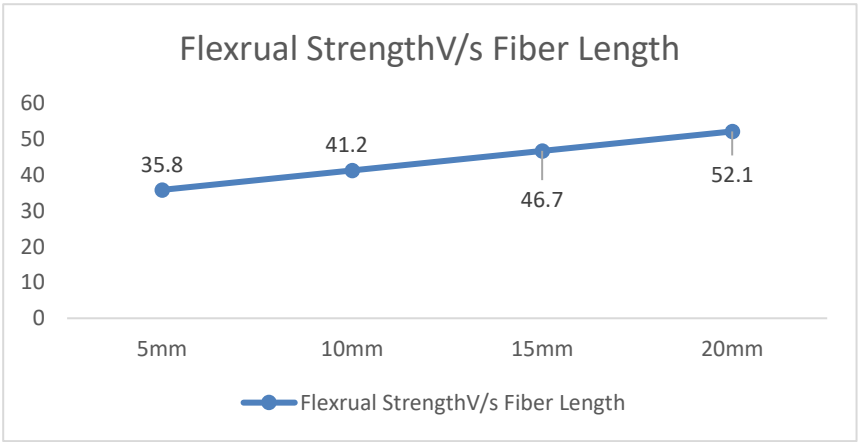

Figure 5. Graph between flexural strength and fiber length

Izod Impact Test: -It is for to determine the impact resistance of the materials. A pendulum with certain load is applied to the specimen releasing from the specific height as per standard. The swings of pendulum were applied impact or sudden load on the specimen and the impact strength is reported in the Joule.

Table III. Impact test result for the polyester composites reinforced with 5-20mm length sisal fiber

S.No	Fiber Length (mm)	Flexural Strength (J/m^2)
1.	5	2.1
2.	10	3.8
3.	15	5.4
4.	20	6.9

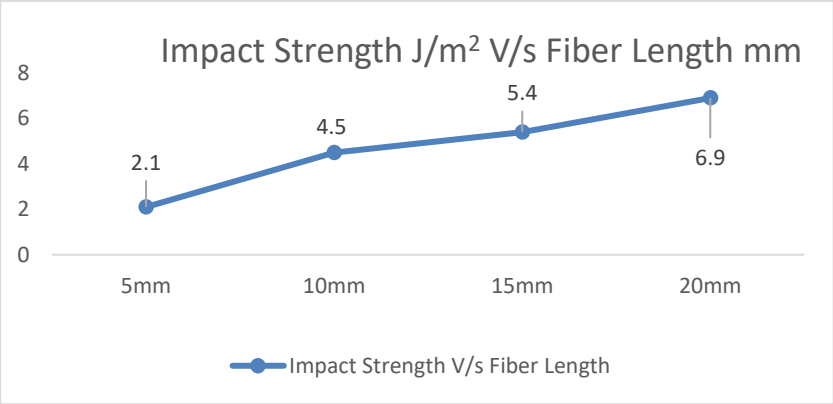

Figure 6. Graph between Impact strength and fiber length

VI. CONCLUSION

Sisal fiber reinforced polyester resin composite were investigate and conclude that all three tensile, flexural, impact strength is increases with fiber length increases for the short fiber size 5mm to 20mm. Interior of the automobile can be constructed using sisal fiber.

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