STRENGTH CHARACTERISTICS OF HEMP FIBER POLYMER COMPOSITE

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ABSTRACT

The use of natural fibers like hemp, hemp, jute, bamboo, wood etc as reinforcement in composite materials has increased in recent years as a response to the increasing demand for developing biodegradable, sustainable, and recyclable materials. one of the natural fiber hemp which have properties similar to glass fibers. The hemp fibers are generally present in the stem of the plant due to which they are strong and rigid, which is a necessary requirement for the reinforcement of composite materials.

To find out the various mechanical properties of hemp fiber composites reinforced in unsaturated polyester resin. the length and weight of these fibers are changed and combined with polyster resin with help of a self made compression moulding set-upto produce the composite sheets. the length of fibers taken are as 10mm,15mm,20mm and 25mm.

Key Words*: hemp Fiber, Polyester Resin, mechanical properties Compression Moulding.*

I. INTRODUCTION

Composites made up of natural fibers have played a dominate role From a long period of time in various application due to their strengths and various properties. Studies have described in the literature [1–5], which have came across with various composites made from natural fibers like sisal, jute, bamboo, sun hemp, hemp, wheat straw etc. natural fiber obtained from different regions have different properties and these properties of fibers depends upon various factors of the region in which they are found.based upon the region, rainfall, temperature, humidity the percentage of cellulose content is different in every fiber and the cellulose contain will ultimately effect the mechanical properties of fiber.so the fiber must be selected according to the need of experiment.

Hemp

After sisal fiber, hemp is the most common used natural fiber in reinforcement with composites. Hemp is also naturally one of the ecological fibers and also oldest among other fibers. In hemp plant, fibers are present in the tissues of the stems which help to hold the plant erect. In doing so these fibers impart strength and stiffness to the tree. This high strength and stiffness of hemp fibers makes them a useful material to be used as reinforcement in composite materials.basic tensile strength of hemp fiber is estimated in between 200 to 300 Mpa(2).

Catling and Grayson{3} measured the diameters of hemp fiber bundles and found the average to be 30 mm with a range of 11.68–31.96 mm. The average hemp fiber length was found to be 8.46 mm with a range of 1–34 mm. Olsen and Plackett{4} found the average hemp fiber bundle diameter to be 25 mm and average hemp fiber bundle length was found to be 25 mm with a range of 5–55 mm..

II. MATERIALS AND METHOD DETAILS

HempFiber: -Hemp Fibers are purchased from AsthaFiber and Chemicals MI road Jaipur. Then fibers are cut into 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 temperature easily.

Catalyst: - Methyl ethyl ketoneperoxide are used as catalyst to fasten the chemical reaction 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 is the most common and the cheapest method for fabrication of composites under the pressure. And for this a set-up is made to reduce the overall cost. 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 for easy removal of the composite sheet from the set-up. The Teflon sheets are used on both part of die male and female part for better surface finish. Hempfiber 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.

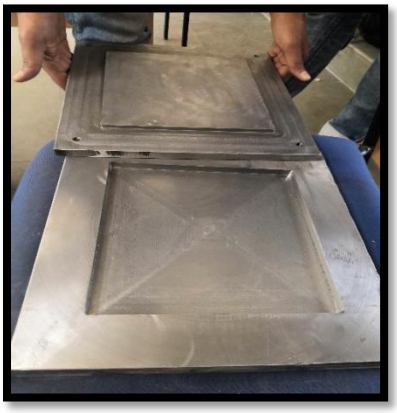

Figure 1. Mild Steel Mould

First the accelerator is added to the resin then the catalyst is added and finally the fiber is added into the mixture. The mixture is mixed properly and then poured into the mould. And the pressure required is applied through hydraulic bottle jack for .30 minutes. and to measure the pressure a pressure gauge was attached with the hydraulic jack and for measuring the temperature thermocouple is fixed on the frame as shown in figure 2.and after 30 minutes sheet is taken out from mould.

Figure 2. Self-Made compression moulding set-up

And left for some time for curing and then the specimens are 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 5mmvarious specimen are cut accordingly for tensile, flexural, and impact testing.

Mechanical Tests: - our main objective to perform this experiment is to determine the three important properties of composite materials which are tensile strength, flexural strength and impact strength. and for this following test are performed at room temperature as per ASTM standard.

Tensile Test: - The tensile strength is determined using ASTM D638 Standard testing machine. and the specimen cut from sheet in size of 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: - 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: -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 tests are done to determine effectiveness and behaviour of material when it is subjected to a controlled tension. or Tensile Strength is the maximum pulling force to the material to study the response of material with respect stress. Tensile strength can be find out using the equation.

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

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

Here $\boldsymbol{\sigma t}$is tensile strength of the fiber, Fc is force at the failure point, m is mass of the fiber and $\boldsymbol{\rho}$ is density of the fiber, **Af** is cross-section area of specimen, Length of fiber and weight of fiber is 10% of the resin weight. The hemp 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 10-25mm length hempfiber.

S.No	Length of fibers (mm)	Tensile Strength of composite. (MPa)
1	10	12.3
2	15	19.1
3	20	24.6
4	25	33.9

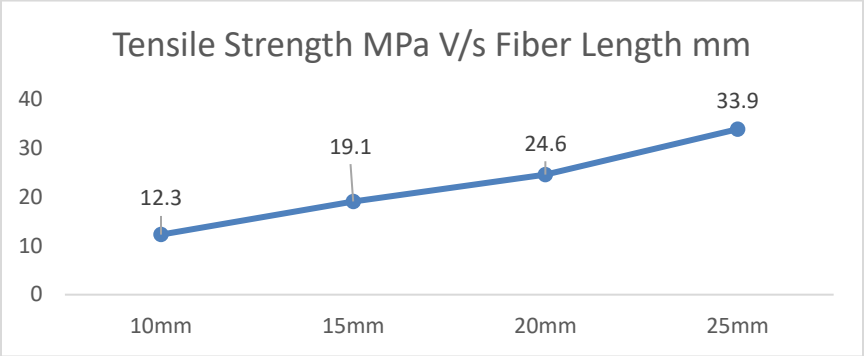

Figure 4. Tensile strength vs Fiber length

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 hemp polymer composite result were found be increasing with increase in length of fiber.

Table II. Flexural test result for the polyester composites reinforced with 10-25mm length hempfiber.

S.No	Length of fibers (mm)	Flexural Strength of composites (MPa)
1	10	26.8
2	15	37.8
3	20	44.1
4	25	47.2

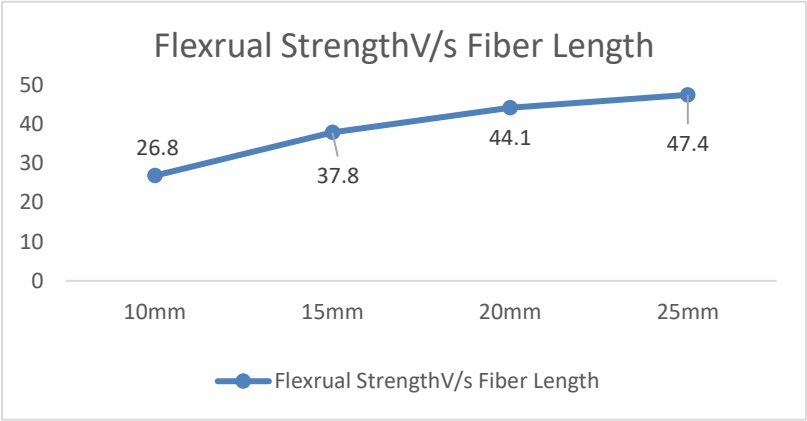

Figure 5. Graph between flexural strength and fiber length.

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 is 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 10-25mm length hemp fiber.

S.No	Fiber Length (mm)	Impact Strength (J/m^2)
1.	10	0.9
2.	15	1.8
3.	20	3.2

4.	25	4.9

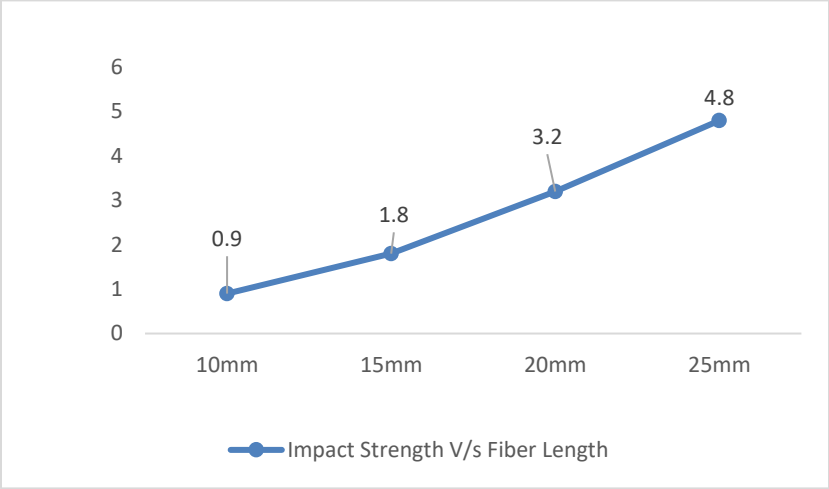

Figure 6. Graph between Impact strength and fiber length.

VI. CONCLUSION

Hemp fibers reinforced with unsaturated polyester resin composites are made and various mechanical properties are find out using different tests such as tensile strength ,flexural strength and impact strength. On the basis of these test results graph between length of fibers and mechanical properties are drawn. the composites have shown increasing mechanical properties as we increase the thread length.

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