

MECHANICAL PROPERTIES OF SISAL, GLASS FIBRES, SUGARCANE BAGASSE FIBRE REINFORCED BY POLYPROPYLENE COMPOSITE

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Abstract: During past few years the use natural fibres has drawn more attention than that of synthetic fibres. The present paper deals with the mechanical properties of sisal fibre, glass fibre, sugarcane bagasse as reinforcement by developing the naturally biodegradable and ecofriendly composites. The composites consist of various mixtures like polypropylene reinforcement with sisal fibre, glass fibre, sugarcane bagasse by using injection molding. The composites are prepared by varying weight fractions of the fibres such as 15%, 20%, 25% of natural fibre with high amount polypropylene. The developed hybrid composite is tested for the mechanical properties like tensile, flexural and impact strength.

Keywords: Natural fibres, glass fibre, hybrid composite, polypropylene.

1. Introduction

In the engineering materials, the technology development of natural fibres has more advanced. These natural fibres have huge amount of resources of lignocellulose materials. From the last few years, the natural fibres usage is more all over the world whether it is sisal, sugarcane or man-made fibres (i.e., glass fibre) in the composites. composites with lingo-cellulosic fibre and the synthetic thermoplastics had received more attention in every survey. Natural fibres like sisal fibre and sugarcane bagasse is used so that the cost can be reduced for the composite material ^[1]. The

natural fibre can be used to scientific literature and to many industrial applications.

As far as, the composites are light in weight which consumes less fuel. due to this the composites usage in industries and this has increased the high range applications such as automotive spare parts, aerospace and rail applications. The main purpose of the composite materials is to reduce the weight, to increase the speed of vehicles and these composites neither expand nor contract due to change in temperature in any field of its usage ^[2]. Therefore, the usage of composites is preferable instead of aluminum and its alloys. The polymer matrix composites are nothing about the hybrid composites which is used for various sectors and these are fabricated by using thermosetting matrices.

Generally, the natural fibre is based upon thermoplastic composites exhibits lower strength when it is compared to the thermoset composites in performance. However, these thermoset composites have flexibility to design and it can be recycled since we are using natural fibres which is ecofriendly ^[3]. These natural fibres are not only ecofriendly but also it doesn't cause any harm to humans while producing the composites. Whereas the glass fibres can cause skin irritation to human's special care should be taken while using the glass fibre. Glass fibre is most used fibre for reinforcement for composite material and while coming for practical every injection moldings are available for glass reinforcement. Injection molding can produce in bulk or mass production

of glass fibre reinforced plastics ^[4]. Different composites of polypropylene reinforced with hybrid mixture are had prepared as per ASTM standard and their mechanical properties are investigated.

2. Experimental Procedure

2.1 Materials:

Polypropylene granules, and natural fibres like sisal fibre, sugarcane bagasse, glass fibre.

2.1.1 Sisal Fibre:

Sisal is a hard fibre which can be extracted from the leaves of agave sisalana and these plants grows only at dry areas, and it has life span of seven years. During the life span it grows more than two hundred leaves of length 2meters. In each leaf, nearly thousand fibres can be extracted. fibres can be extracted mechanically by decorticating the leaves, and these decorticated fibres are left to dry. So, that the fibre is free from moisture content to get better fibre.

2.1.2 Sugarcane Bagasse:

The wastage left after the extraction of juice from sugarcane is nothing about the bagasse. While coming to industrial extraction the wet bagasse of three tons are left for every ten tons of sugarcane extracted. Sugarcane extraction is nothing about the crushing of sugarcane, though the crushing is done the bagasse left will contain 45% of moisture which can be used as fuel. To get an appropriate bagasse, it is left to dry to avoid moisture content. Bagasse are used for manufacturing purpose like papers, disposal plates etc.

2.1.3 Glass Fibre:

Glass fibre is synthetic fibre, it is manufactured by using the pultrusion process. To manufacture the glass fibre different minerals are used such as kaolin clay, silica sand, limestone, fluorspar etc., are melted into liquid and brushed to get fine fibres. These glass fibres have high strength but it is less in weight.

2.1.4 Polypropylene:

Polypropylene is provided by the Indian petrochemicals limited, and it has the melting temperature of 175°C-180°C and the melted polypropylene flows at rate of 11g/10_{min}. Polypropylene of 1110MA grade is used for

injection molding. Since there are only three grades for injection molding they are 1030MG, 1250MG/MA and 1110MA.

2.2 Methodology Of Composite Fabrication:

An oven is taken for drying the raw materials of extracted fibres. The oven is temperature controlled one which can control the temperature of range 0-300°C. all the required materials which contains moisture is kept for drying purpose under 90°C about 1hour 30minutes before going for injection molding. The composites mixture of fibres is prepared in different proportion of fibres (in 15%, 20%, 25% as shown in table: 01) by change in weight ratio among the natural fibres and the pp i.e., polypropylene pellets are mixed properly to get a homogeneous mixture. After the proper mixture fibres, these are place in injection molding i.e., 2-ton hydraulic injection molding is provided by velagapudi Ramakrishna Siddhartha engineering college at kanur Vijayawada. The applied temperature to fabricate composites is about 220°C of 1000kgf/cm², with different weight fraction is developed for investigating of mechanical properties.

s.no	Sisal fibre	Sugarcane bagasse	Glass fibre	polypropylene
01.	05%	05%	05%	85%
02.	10%	05%	05%	80%
03.	05%	10%	10%	75%

Table.1 Fibre combinations of different weight fractions

2.3 Characterization Of Properties:

2.3.1 Tensile Properties:

An electronic tensometer of 2-ton capacity, with METM 2000 ER-1 model is provided by V. R. Siddhartha engineering college for investigating of tensile properties of the specimen. The specimen looks like a dog bone shaped, whereas the tensile test specimen is fabricated by following ASTM- D638M-89 for calculating the tensile properties. At the crosshead speed of 1mm/min the samples are tested and the strain was measured by using

extensometer. The sample specimen after the testing of tensile test is shown in fig: 01.



Figure 1. sample after tensile test.

2.3.2 flexural properties:

Flexural testing is nothing about the bending test, three-point bending test was performed by following the ASTM- D79M-86 for specimen molding. The specimen is about 100mm long, 12.5mm width, and 3mm thickness. The rollers used for three-point bending test, with 1mm/min of crosshead speed the strain rate is calculated. The flexural strength and flexural modulus can be calculated by following the below equations.

$$\text{Flexural strength} = \frac{3LP_{\max}}{2Bt^2} \quad \text{Eq. (1)}$$

$$\text{Flexural modulus} = \frac{ML^3}{4Bt^3} \quad \text{Eq. (2)}$$

Where, L= length of support span, B=width of specimen, t= thickness of specimen, $P_{\max}$ = maximum load and M=slope of initial load.



Figure 2. sample for flexural test.

2.3.3 Impact properties:

The impact test can be calculated by using charpy Izod impact test, the test sample is prepared by following the ASTM -D-256-97 standards. at the middle of the specimen a v-notch available because the specimen is molded at an angle of 45° from center and the depth under the notch is 10.16 ± 0.05 mm of the specimen. Different combinations of specimens were tested for energy joules of 1J.

$$\text{Impact strength (I}_s\text{)} = \frac{I_E}{T} \text{ J/m} \quad \text{Eq. (3)}$$

Where IE = impact energy in joules

T= Thickness of sample in mm



Figure 3. Sample after impact test.

3. Results And Discussion

3.1 Tensile strength:

The ultimate tensile strength of hybrid fibre reinforced with polypropylene pellets for obtaining composite material at different compositions of fibres as shown in fig:04. At 20% of composition mixture of fibres, the tensile strength is found to be increased. therefore, the calculated tensile strength for polypropylene is 24.5Mpa.

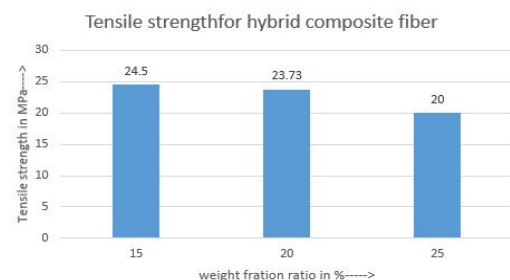


Figure 4. graphical representation for tensile property.

3.2 flexural strength:

Flexural strength of the hybrid fibre (i.e., sisal fibre, sugarcane bagasse, glass fibre) reinforced with polypropylene composite materials at different composition mixture. By observing the fig:05 for 20% of weight fraction the flexural strength is increased and for 15% and 25% the flexural strength is same. The flexural strength of polypropylene is 120Mpa.

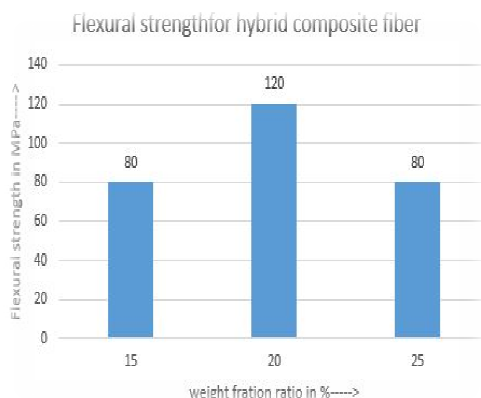
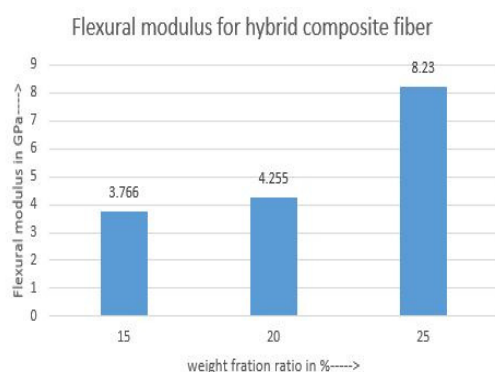


Figure 5. Graphical representation for flexural strength.

The flexural modulus will increase if the fibres are loaded. Because more fibre concentrated with polypropylene demands the higher stress for the same deformation due to the increase in obstruction, the modulus values will be increased with the increased with increase in fibre content in the specimen or samples.



- The authors would like propose that the 20% of hybrid composites (i.e., 10% SF, 05% SCB, 05%

Figure 6. graphical representation for flexural modulus.

3.3 Impact strength:

Impact strength is defined as the ability of material which resist, when the load is applied suddenly on it. By observing the fig:07 it is noticed that fibres play a major role for strengthen of composite materials since these fibres interacts with the crack formation in the matrix. It is observed that for 20% of weight fraction the impact strength increases and then it decreased due to fibre composition in polypropylene composites.

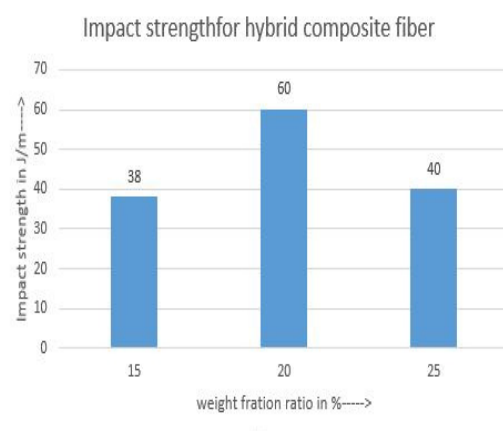


Figure 7. Graphical representation for impact Strength.

4. Conclusion

The effect of hybrid combinations of natural fibre reinforcement with the polypropylene pellets are investigated by varying the weight fraction of fibres and the mechanical properties are calculated. From this experimental study the following conclusion is drawn.

- By observing the three tests, it is cleared that the 20% of weight fraction results high impact, and flexural strength. Since the sisal fibre gives more stiffness among the all-natural fibres used for this study. So clearly due to increase in fibre composition the strength of composites increases.
- Flexural modulus of composites had increased with increase in fibre content in specimens (i.e., fibre loading). For 25% of weight fraction the higher flexural modulus is observed. GF) reinforced with the polypropylene pellets which has optimum set of mechanical properties.

- From the above observation, the authors concluded that these mixtures can be useful for wide variety of applications such as packaging, aerospace, carpets, loud speakers, and automotive spare parts etc. for better mechanical properties, high fibre loading can be done.

References

- [1]Ravi Kumar N, Ranga Rao CH, Raghava Rao B, Srinivas K Mechanical Properties of VakkaFibre Reinforced Polypropylene Composites Volume 3, Special Issue 3, March 2014.
- [2]TemesgenBerhanu, Pradeep Kumar, Inderdeep Singh Mechanical Behaviour of Jute Fibre Reinforced Polypropylene Composites (AIMTDR 2014).
- [3]Narra Ravi Kumar PinjalaTejomurthi B. Raghava Rao investigation on mechanical properties of short vakkafibre glass reinforced hybrid thermoplastic composites Vol. 1 Issue 7, September – 2012.
- [4]. N. M. BARKOULA, S.K. GARKHAIL T. PEIJS Effect of Compounding and Injection Molding on the Mechanical Properties of Flax Fibre Polypropylene Composites 2 June 2009.
- [5] S.Suresh & Raghu M, Non Vibration and Safe Electromagnetic Regenerative Suspension Lift Design (MAGLIF) International Innovative Research Journal of Engineering and Technology Vol. 1, No. 2, 2015.
- [6]Salma Siddika, Fayeka Mansura, and Mahbub Hasan Physico-Mechanical Properties of Jute-Coir Fibre Reinforced Hybrid Polypropylene Composites Vol:7, No:1, 2013.
- [7]K Sudhakar, Ch Srinivas Investigation of Mechanical Properties of Rice Straw Fibre Polypropylene Composites ISSN: 2248-9622, Vol. 4, Issue 1 (Version 2), January 2014, pp.182-187.
- [8]SubbiahJeevaGa, SubinKumar.Mb, yabezRaj.D Fabrication and Testing of Fibre Reinforced Composite Material Vol. 4, Special Issue 6, May 2015.

