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Mechanical Properties Of Sisal And Pineapple Fiber Hybrid Composites Reinforced With Epoxy Resin

Vikas Sahu[1], Keshav Singh Bisen[2], Murali Krishna[3]
[1&2]*PG Student, Mechanical Engineering Department, GGITS,JBP*
[3]*Associate Professor, Mechanical Engineering Department, GGITS,JBP*

ABSTRACT: *In this study, Work has been carried out to investigated tensile , bending and impact properties of hybrid composite of material constitutes sisal fiber and less discovered pineapple fiber. These composites are adhered using epoxy resin cosists HY951 resin and LY551 hardener suitably mixed in appropriate volume. Hybrid composites were prepared using sisal/pineapple fibers of 100/0, 70/30, 50/50, 30/70, and 0/100 Weight fraction ratios, while overall fiber weight fraction was fixed as 20gram. Here for preparing samples Hand lay up method is used , specimens are prepared , fibers are arrenged in unidirectional manner and tests are carried out , which shows tensile and bending strengths. The tensile & compressive test was applied on specimens of 300×50 & thickness varring from 4-6 mm in dimensions but in different proportions of sisal and pineapple by weight. The test result shows , the composite made by 50/50 fibers weight fraction of sisal & pineapple fiber has been shown best impact strenght 47.2 N/mm^2 as compare to other constitutes of sisal & pine fibers.this constitute have good tensile & bending strength & their density is also less than sisal fibers. These composites can be used in various purposes because of its unique features of recycleability, waste utilization, environment friendly, bio-degradibility, good strength and a good alternative to plastics.*

Keywords: *Composites, Bio-degradability, pine, sisal, resin, recyclability.*

I. INTRODUCTION

Now a day reinforced polymer composite become more popular for their variety of applications because of their high specific strength and light weight. Most of the materials are available in market which are made by the synthetic fiber .These fibers have serious drawbacks as high density, non-renewability, non-biodegradability, high energy consumption etc .Growing environmental awareness and societal concern, a high rate of depletion of petroleum resources, the concept of sustainability, and new environmental regulations have triggered the search for new products that are compatible with the environment. Due to that concern many of researchers are working on the field of natural fiber reinforced composite. The reason of attraction of that field over the traditionally using synthetic fiber is that, natural fibers having low density, high toughness, environment friendly, fully biodegradable , renewable, low cost. The biodegradability of plant fibers can contribute a healthy ecosystem while their low cost & high performance fulfils the economic interest of industries. India, endowed with an abundant availability of natural fibers such as jute, coir, sisal, pineapple, ramie, bamboo, banana etc., have focused on the development of natural fiber composites primarily to explore value-added application avenue.

One such fiber source known for a long time is pineapple leaves from which pineapple leaf fibers (PALF) may be extracted. Pineapple is the third most important tropical fruit in the world after banana and citrus. Due to development of fruit production industries like jam industries, production of pineapple fiber is increases. Earlier this pineapple fiber is residual waste in these industries, but now a days, due to its good appearance in color it is using in the textile industries .Sisal fiber is a promising reinforcement for use in composites on account of its low cost, low density, high specific strength and modulus, no health risk, easy availability in some countries and renewability. Sisal is a natural fiber is a yield, stiff fiber traditionally used in making twine and rope. It is a biodegradable and eco-friendly crop. Moreover, sisal is a strong, stable and versatile material and it has been recognized as an important source of fiber for composites. Sisal fiber made from the large spear shaped tropical leaves of the Agave Sisalana plant. In recent years, there has been an increasing interest in finding new applications for sisal-fiber reinforced composites that are traditionally used for making ropes, mats, carpets, fancy articles and others. Epoxy resin is a thermosetting resin , it is made of tightly linked adhesive polymer structure that are often used in surface coating. For the fiber reinforced polymer Epoxy resin is used as the matrix to efficiently hold the fiber in place.

In recent years researcher has shown their interest in the hybrid composite of natural & synthetic fibers. C. Grisha et al. (2012) investigate the tensile properties of hybrid composites made by reinforcing sisal, coconut spathe and ridge gourd as the new natural fibers into epoxy resin matrix. The composites fabricated consist of reinforcement in the hybrid combination like sisal-coconut spathe, sisal-ridge gourd and coconut spathe-ridge gourd with the weight fraction of fibers varying from 5% to 30%. The hybridization of the reinforcement in the composite shows greater tensile strength when compared to individual type of natural fibers reinforced. It is found that for the hybrid combination of ridge guard and sisal fibers there is 65% increase in the tensile strength. J Madhukiran et al (2013) investigated the mechanical properties like tensile & flexural strengths on the hybrid banana & pineapple fibers epoxy composite. Hybrid composites were prepared using banana/pineapple fibers in different weight ratio. The hybridization of these natural fibers has provided considerable improvement of flexural strength when compared to individual reinforcement. This work also demonstrates the potential of the hybrid natural fiber composite materials for use in a number of consumable goods.

To make further improvement in the field of natural fiber hybrid composites in this present investigation sisal & pineapple fiber hybrid composites of different fiber weight ratio has been prepared & evaluate the different mechanical properties of this hybrid composite.

II. LITERATURE REVIEW

Due to the world wide availability of sisal and pineapple fibers many researchers have begin to focus on these fibers. Some researchers are taking individual fibers for research & some had taken combinations of these fibers with other synthetic and natural fibers for the research work. N. Netrawali & S. Luo(1999) were prepared composite of pineapple fiber and PHBV resin of different fiber weight ratio wary from 20% to 30%. The tensile and flexural properties of these were tested & make a comparative study of these results with different types of wood specimens. Kuruvilla joseph et al.(1999) were make study of sisal reinforced polymer composites & they suggest, due to the low density & high specific properties sisal can be use in the automobile industries & sisal fiber composites can become good alternative material of wood in the building construction. JB Zhong et al.(2007) alkali treated sisal fibers were used for reinforcement & for the matrix phase urea-formaldehyde has been used for making composites. No. of specimen of different weight ratio of fiber has been prepared & different test impact, tensile & water absorption test has been performed over the specimens..V. Naga Prasad et al. (2011) were prepared sisal-glass fiber hybrid composites with the help of unsaturated polystyrene. The mechanical properties of like impact strength, compressive strength & tensile strength of sisal fiber, glass fiber & sisal-glass hybrid composite has been tested & made a comparative study between these properties of composites. The effect of chalk powder on compressive and impact strength of sisal/glass fiber hybrid composite has also been studied and it is observed. M. Boolan et al. (2012) were to investigate and compare the mechanical properties of raw jute and sisal fiber reinforced epoxy composites with sodium hydroxide treated jute and sisal fiber reinforced epoxy composites. The mechanical properties (tensile and flexural strength), water absorption and morphological changes were investigated for the composite samples. B Vinod & LJ Sukhdev (2013), were investigated the effect of orientation on the flexural strength of PALF reinforced bisphenol composite. Composites were made by using different fiber length . It was observed that the fiber length greatly influences the tensile properties of reinforced composites. A higher tensile strength of 36.36Mpa was obtained for the fiber length of 9mm compared to the fiber length of 3, 6 and 12mm. M.Sakthive & S.Ramesh (2013) were made a comparative study between banana, sisal & coir fiber. They prepared rectangular samples as per ASTM standard & then performed hardness test, impact charpy test & flexural test has been performed. From the testing results they suggest these fibers can be used in the automotive seat shell making.

III. MATERIALS AND EXPERIMENTAL METHODOLOGY

3.1 Materials

Two vegetable fibers were investigated: sisal and pineapple , For the matrix phase epoxy resin (Lapox HY 951) & Hardener (Lapox LY 556)is used for bonding the fibers .A mould of rectangular tube shape with 50 mm constant width and variable thickness is made in the college workshop. The sample piece obtained by this mould has constant 50 mm width & its thickness can be vary according to volume of fibers.

3.2 Sample Preparation

The testing samples are made by hand layup method. For sample preparation both sisal and pineapple fiber are cut into length of 28mm-30mm.these fiber are equally weighted into five groups i.e. sisal 100% with 0% pineapple ,sisal70% with pine30%, sisal50% with pine50%,sisal 30% with pine70% & 100 % pine apple fiber. Resin and hardener both mixed together in 4:5 respectively. Then mould is cleaned by brush and covered the mould by thin plastic film to avoid bonding between mould and sample pieces. After making the fiber

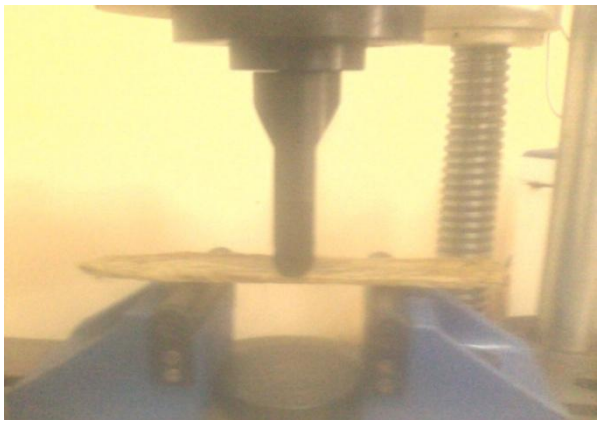
straight resin and hardener mixture applied over the fibers layer to make the bunch of fibers. Fibers bunch is transfer to the mould and press that bunch with 20 kg load. The castings were allowed to cure for 24hrs at room temperature. The composite is released from mould and these composites are ready for testing. Then after composites releasing these composites are relief for 3-4 days then these was tested on computerized UTM & impact testing machine.

3(a) Pineapple fiber

3(b) Sisal fiber

3(d) Sisal & pine samples

3(d) Composite weight taking



3(e) Bending test

3(f) Tensile test

3.3 Testing

3.3.1 Tensile test

Tensile test has been performed on tensile testing machine. Rectangular samples of size length 300 mm, width 50 mm & thickness 4-6 mm is used for tensile testing. The testing is done over 5 different types of sisal and pineapple fibers composite on the tensile testing machine. This tensile test is performed at load rate of 0.333KN per second. As shown in figure 100% sisal fiber weight composite shows maximum tensile strength while in case of pure pineapple samples the tensile strength is minimum. In the sisal and pineapple mix

composites the tensile strength is increases with the increase in sisal fiber composition in the testing samples. But due to increase in sisal fiber percentage the density of the testing samples is also increased.

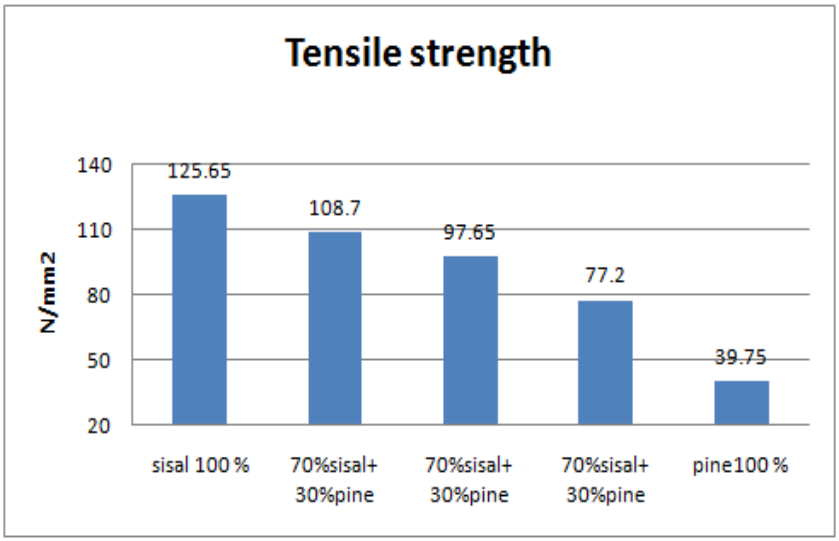


Fig.1 Tensile strength comparison graph

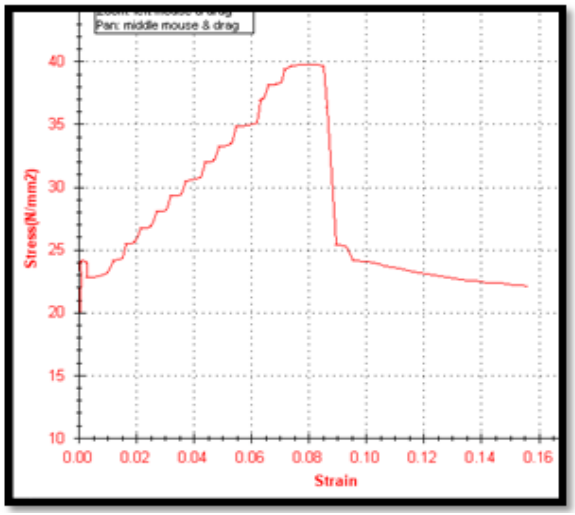


Fig2- Tensile test graph of Pure pine composite

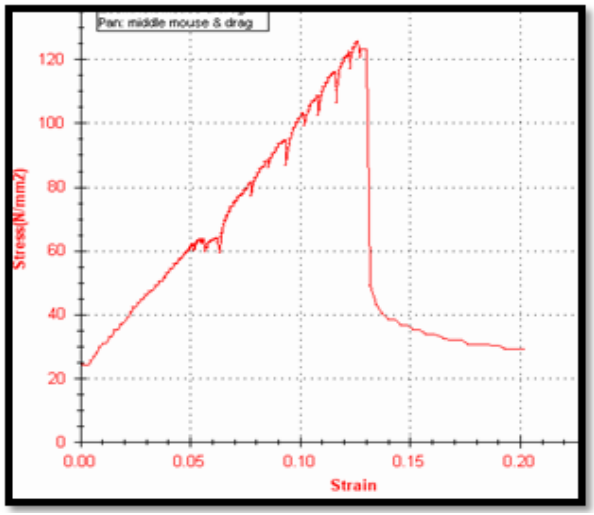


Fig 3-Tensile test graph of Pure sisal composite

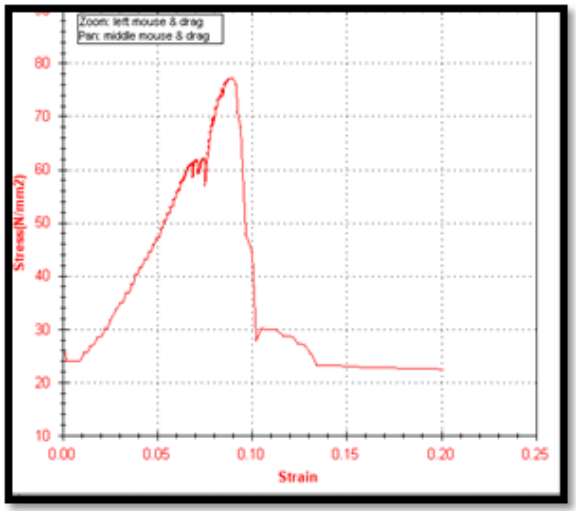


Fig 4- Tensile test graph of30% sisal+70% pine composite

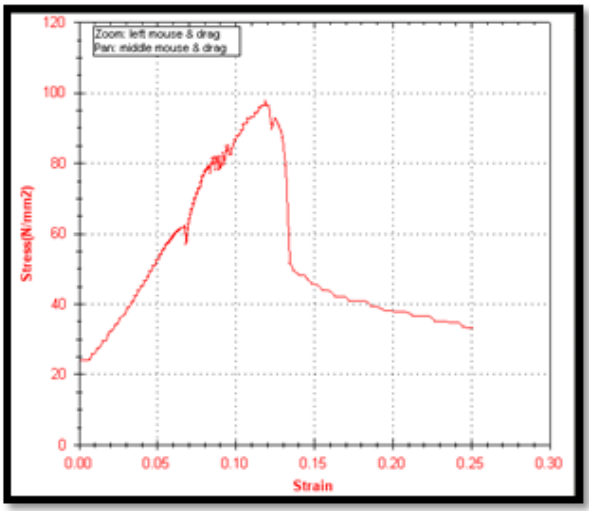


Fig 5- Tensile test graph of 50% sisal+50% pine composite

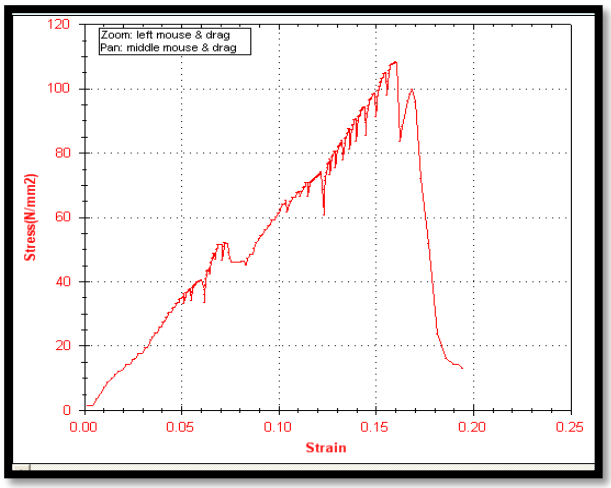


Fig 6- Tensile test graph of 70% sisal+30% pine composite

3.3.2 Bending test

Tensile test has been performed on computerized UTM .The long length rectangular flat composites have been tested. The composites had be hold over the two supports, the distance between supports had been maintain the twenty times of the width of the composites. Single point bending test is performed over the rectangular sample on the testing machine . A load rate of 0.333KN per second is applied for bending test. As the result it is observed that the sisal fiber composite has maximum bending strength with higher density and with the increase in the sisal fiber percentge the bending strength of fibers also increases.

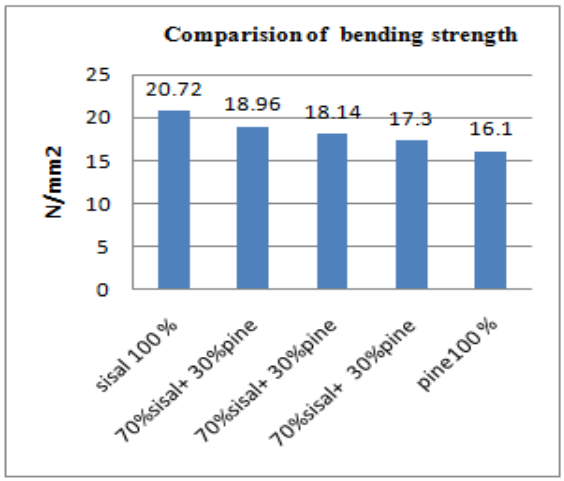


Fig. 7

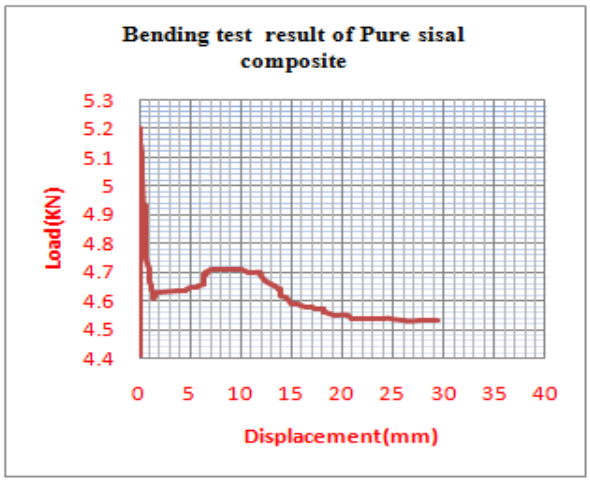


Fig. 8

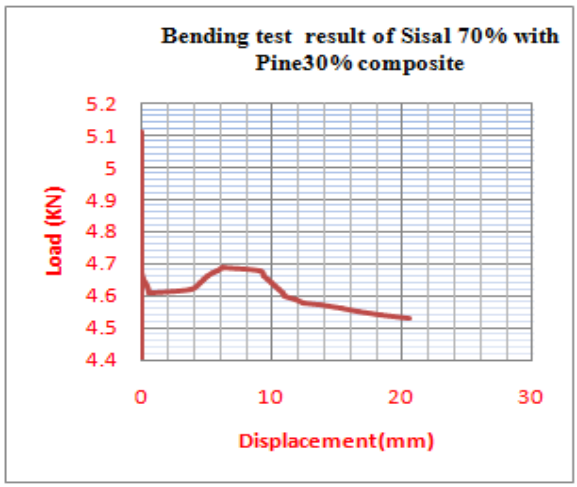


Fig. 9

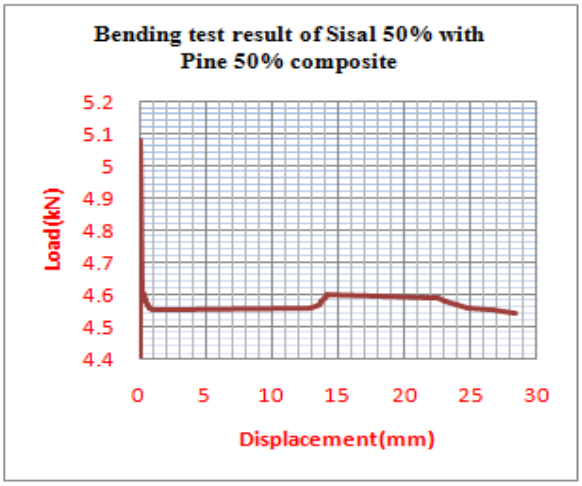


Fig. 10

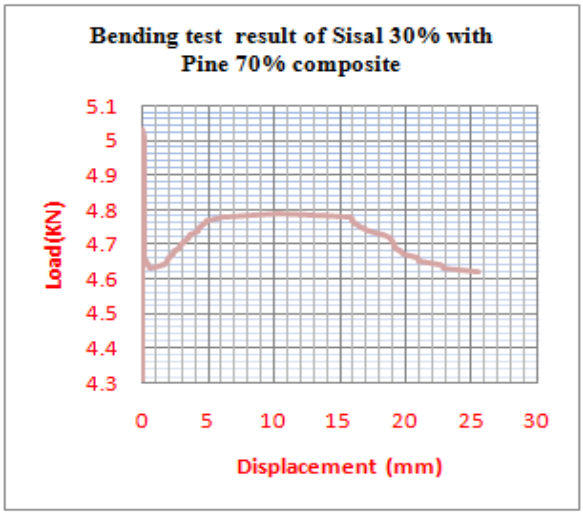


Fig. 11

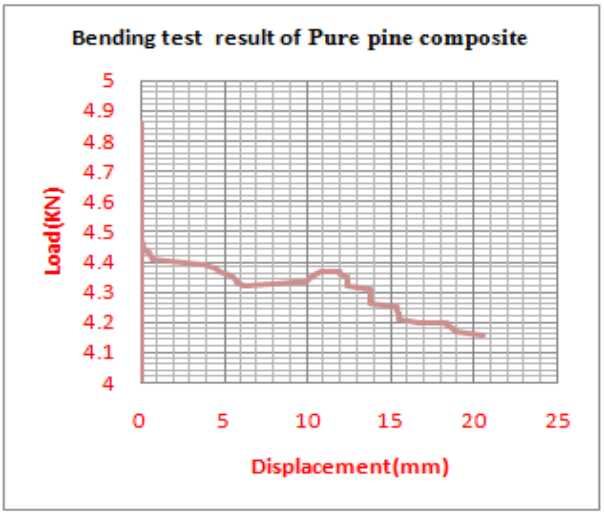


Fig. 12

3.3.3 Impact test

The impact test is performed over the samples of length 55 mm, width 10 mm & thickness is used 5.5 mm. Since fibers are arranged fibers longitudinally that's by Charpy test has been performed on the samples. Impact test had performed on manual impact machine. It has been observed that pure sisal composite is showing lower strength than the other composite & pure pine composite also showing also showing low strength as compare to sisal & pine mix composite. Sisal 50%+pine 50% mix composite is showing the maximum strength.

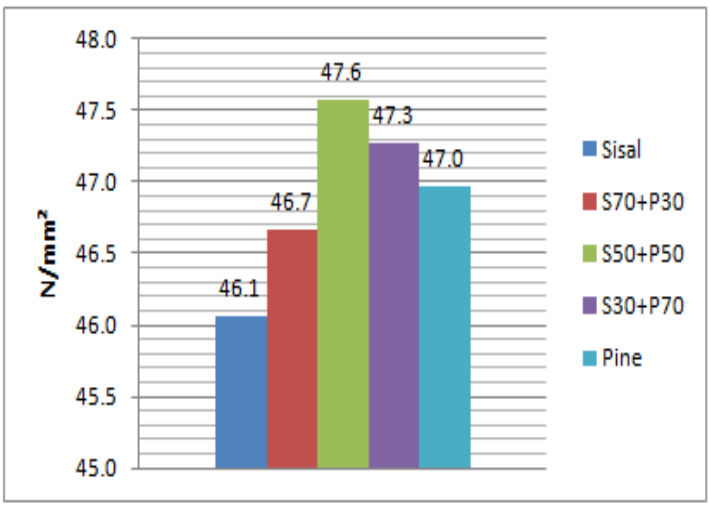


Fig. 13 Impact strength comparison graph

IV. Results and discussion

The mechanical properties like impact strength, bending strength & tensile strength has been tested on five different samples of sisal, pine & sisal-pine mix fiber composite. These results have been observed from the tensile, bending &impact testing.

S.No.	Reinforced Composites	Weight of composite (gm)	Length of composite (cm)	Width of composite (cm)	Thickness of composite (cm)	Density gm/cm³	Tensile strength (N/mm²)	Bending strength (N/mm²)	Impact strength (N/mm²)
1	Sisal 100 %	65	31.7	5	0.38	1.08	125.65	20.72	46.1
2	70%sisal + 30%pine	63	31	5	0.42	0.97	108.7	18.96	46.7
3	50%sisal + 50%pine	63	31.5	5	0.46	0.87	97.65	18.14	47.6
4	30%sisal + 70%pine	62	31	5	0.5	0.80	77.2	17.3	47.3
5	Pine100 %	60	30.5	5	0.55	0.72	39.75	16.1	47

Table 1: Properties of composite

The composite made by sisal fiber having higher tensile & bending strength is maximum, but its Density also high. The composite made by pineapple fiber having lower tensile & bending strength, but its density is low. The composite made by mixing sisal & pineapple fiber, having tensile & bending strength is higher than the pineapple fiber, but lower than the composite made by sisal fiber. In which the percentage of sisal fiber is increase so that the tensile & bending strength are also high.

But in case of impact testing the impact strength of sisal fiber is lower as compare to the composite of pure pine & sisal- pine mix composites. The impact testing results shows that the sisal-pine mix composite showing more better impact strength as compare to the pure sisal & pure pine mix composite. The composite in which sisal & pine mix 50-50 percent that composite shows the maximum impact strength.

V. CONCLUSION

Polymer matrix composite contains the sisal & pine fibers as the reinforcement phase was successfully fabricated by different proportions of weight of fibers .The material properties of fabricated sisal & pine fibers reinforced composites were observed. It is found that

1. In increase of the percentage of sisal fibers increases the tensile & bending strength of sisal-pine fibers composite, but it also increases the density of composite.
2. In increase of the percentage of pine fiber help to reduce the density of the composite & by the addition of pine fiber the impact strength of the composites also improved.
3. The hybrid composite made by sisal & pine by using different weight ratio are showing the good strength to weight ratio as compare to their individual constituents composite.
4. These different hybrid composites can become good replacement of traditionally using synthetic fibers.
5. Composite made by 50% sisal with 50% pine have maximum impact strength (47.6 N/mm^2) & it is also shows good tensile & bending strength.

These composites can be use in the fabrication of polymer sheets, pipes, furniture & to make pallet box for storing goods in the industrial applications.

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