ORIGINAL RESEARCH PAPER

Engineering

To Study the Mechanical properties of the composite material reinforced in natural fibre in different compositions

KEY WORDS: Polyester, Banana, Kapok and hand layup method,

Deepak Sharma Student in SSCET Badhani

Sangamdeep Singh Assistant Professor in SSCET Badhani

Dinesh Kumar Assistant Professor in SSCET Badhani

ABSTRACT

During recent years in constructive and automobile field these natural fibre durable thermoplastic composites are widely used. Natural fibres have more applications than synthetic fibres. Natural fibres are environmental as they are produced by farmers in the field and don't require any synthetic treatment. The composite material consists of more than two or more different forms of material. The natural fiber like banana, kapok, jute, bamboo, and silk plays an important role to enhance the properties of composite material. In the present work polyester is used with natural fiber i.e. banana and kapok. The composite material (Polyester & Banana fiber, Polyester & kapok fiber and polyester& kapok fibre& banana fibre) having weight percentage 90%&10% and 90%& 5%KF + 5%BF respectively. The fibers are treated with water solution and NaOH in order to increase the adhesion between the fibre and polyester. The sample of composite material are contrived by hand layup method. The mechanical properties such as tensile, flexural, shear and water absorption are calculated and analyzed. In this conclusion when both kapok and banana is added in equal ratio shows highest tensile strength. In case of flexural and shear the banana fibre shows highest strength. In case of water absorption the capacity of kapok fibre to absorb water is more than banana due to this the banana fibre shows high performance.

1. Introduction

Polyester hybrid composite reinforced by synthetic fibers have faced some environmental problems. Therefore, more attention has been paid to natural fibers such as sisal, jute, guard, coir, hildeguardia, silk, oil palm etc., as alternate fibers by many researchers. [1] Natural fibers have several advantages. They are economical, renewable; easily process able, light in weight, and ecological. They also posses high specific strength and do not donate to environmental pollution. [2]. The composite materials like plastics and ceramics have most powerful emerging material. Due to this the parts being constructed by natural fibers have improved environment sustainability. In the recent years kapok fiber has received increasing attention as an eco-friendly material for its intrinsic advantages [3]. Only limitation is the spinning of kapok fiber which reduces its applications which can be improved by mixing kapok fiber with other polymer matrix to produce different kinds of composite material. By treating the kapok fiber chemically or physically its physical and chemical interactions at the interface can be improved.[4]. Finally we found that banana fibers are well dispersed in the resin matrix using scanning electron microscopy. Yield strength decreases with addition of banana. Impact strength of epoxy material increases with addition of banana. Water absorption capacity increases with addition of fibre. Addition of silica decreases bending strength. [5] The fiber reinforced fiberglass was fabricated with 20, 40, 60, 80 gm kapok. The impact and water absorption were found to be increased and the tensile and flexural strength were slightly decrease [6] Sisal fiber laminates with three alternate layers of glass fibre gives better impact energy which increases to use in welding shielding, window door and automobile body panel. [7]

2. PROBLEM FORMULATION

After going through the above review literature it is seen that during few present years natural fibres in polymer matrix are generally used in structure and non structure field as a very useful resources. Agricultural waste like wheat, rice, husk, and their straw, hemp fibre and shells of various dry fruits are waste which can used to form fibre reinforced polymer composite which can be used in manufacturing field.. The final properties of the composites are studied by the properties of the fibre, properties of the resin and the ratio of fibre to resin in the final composite (fibre volume fraction). The arrangement and direction of the fibres also greatly affects the properties of the composite. .The behaviour of the composite depends greatly on the framework, involved in structure of natural fibre reinforced composite such as chemical treatment Amount of fibre used in matrix techniques involved in combination of fibres these frameworks are studied by different methods. Through chemical treatments the properties of the fibre surface gets improved and also it increases the fibre strength. It minimizes the water absorption of the composite and mechanical properties get better.

For better construction of materials to be used in different service conditions, two or more fibres are assorted together. Less work has been done on hybridized natural fibre reinforced composite as found from open literature. From all above study it is found that we need to manufacture and study the mechanical properties of hybridized kapok/banana fibre reinforced polyester composites by mixing the fibres with various fibres loading.

3. Experimentation procedure

3.1 Surface treatment of fabrics

The kapok fibre and banana fibre was taken in a glass tray. Two percent of NaOH was added into the tray and the fabric was allowed to soak in the solution for half an hour to remove the soluble greasy material. In order to enhanced the adhesion characteristics between the fabric/fibre and the matrix. The fibre was then washed thoroughly with water to remove the excess NaOH. Finally, the fibre was washed with distilled water and dried in an open atmosphere in 24 hours.

3.2 Composite fabrication

In composite fabrication a hand layup method is used in order to make the composite sheet. A glass mould of required dimensions was used for making the composite. The mould cavity was coated with a thin layer of aqueous solution of polyvinyl alcohol which acts as a good releasing agent. The uncured matrix mixture was poured into the mould up to a quarter of its volume. Over this the chopped fabrics were placed, to which another layer of matrix was poured. This was continued until the complete mould was filled and air bubbles were removed carefully with a roller.

Fig 1:Hand layup method

The top of the mould was covered with Teflon release film to prevent the cured composite from sticking to the top plate. Then the mould was closed for curing. The closed mould was kept under pressure for 24 h at room temperature. To ensure complete curing the composite samples were post cured at 80oCfor 1 h and test specimen of the required size were cut according to American chemical Society Standard Test Methods (ASTM) standard. The composite having different fabric content were prepared by varying the volume ratio of two fabrics, keeping the volume percent constant at 2% vol (hybrid composite).

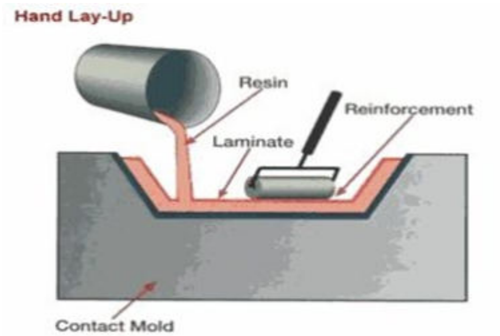

Fig 2:Fabrication of composite

3.3 Mechanical testing

3.3.1 Tensile testing

The tensile test is done by cutting the composite specimen as per ASTMD-638 standard. A universal testing machine (UTM) is used for testing with a maximum load rating. The tensile test is generally performed on flat specimens. The commonly used specimens for tensile test are dog-bone type. Composite specimens with different fibre combinations are tested, which are shown in figure. The specimen is held in the grip and load is applied and the corresponding deflections are noted. The load is applied until the specimen breaks and break load, ultimate tensile strength are noted. Tensile stress and strain are recorded and load v/s displacement graphs are generated.

Tensile strength=peak load/maximum displacement

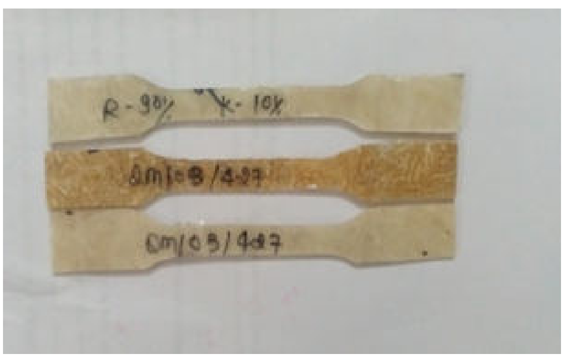

Fig 3:Specimen of tensile testing

3.4.2 Flexural test

The flexural test is done in a three point flexural setup as per ASTMD-790 standard. When a load is applied at the middle of the specimen, it bends and fractures. It is a 3-point bend test, which generally promotes failure by inter-laminar shear.

Formula;
Flexural strength=$3pl/2wT2$
P=peak load
L=Gauge length
W=width

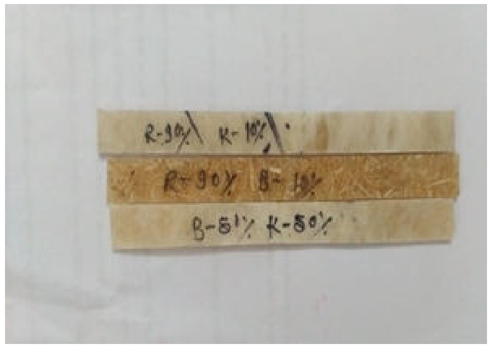

Fig 4:Specimen of flexural testing

3.4.3 Shear test

This test is based on the force which is required to measure the shearing force required to make holes or tears in the plastic. The shear test is useful in structural calculations for parts that may fall in shear. This is based on the force required to rip the plastic divided by the thickness. Test specimens shall be at least 3mm thick.

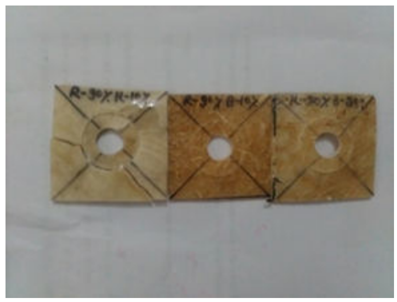

Fig 5: Specimen of shear testing

3.4.4 Water absorption

This test is based on laminates gain wait by absorption of water. This test is done for a period of 24 hours. The comparison of water absorption property for differents sample as shown in fig 7.

Fig 6 Specimen of Water absorption testing

4. Results and discussion

The composite samples 1, 2, 3, 4 and 5 of banana are tested for tensile properties, flexural shear and water absorption in UTM machine and obtain mechanical properties are shown in table 1.

Table 1: Mechanical properties of different samples of banana fibre

SAMPLE NO		Tensile strength (Mpa)	flexural strength (Mpa)	Shear strength (Mpa)	Water absorption (gms)
Banana B 10% R 90%	1	26.88	42.11	33.72	0.97
	2	25.42	46.99	33.43	0.96
	3	28.90	40.13	33.45	0.95
	4	22.59	43.42	32.04	0.96

	5	23.67	43.44	35.25	0.95
	Avg.	**25.49**	**43.22**	**33.58**	**0.97**

The composite samples 1, 2, 3, 4 and 5 of kapok are tested for tensile, flexural, shear and water absorption properties in UTM machine and obtain mechanical properties are shown in table 2.

Table 2: Mechanical properties of different samples of kapok fibre

SAMPLE NO		Tensile Strength (MPa)	Flexural Strength (Mpa)	Shear strength (MPa)	Water absorption (gms)
Kapok K 10% R 90%	1	30.01	35.02	22.95	3.04
	2	26.05	28.35	25.01	3.06
	3	28.12	44.43	28.3	3.03
	4	27.16	28.99	23.38	3.06
	5	22.13	28.75	26.77	3.05
	Avg.	**26.69**	**33.11**	**25.28**	**3.04**

The composite samples 1, 2, 3, 4 and 5 of banana and kapok(KF5%+BF5%) are tested for tensile properties , flexural shear and water absorption in UTM machine and obtain mechanical properties are shown in table 3

Table 3: Mechanical properties of different samples of kapok fibre and banana fibre (KF5%+BF5%)

SAMPLE NO		Tensile strength (Mpa)	Flexural strength (Mpa)	Shear strength (Mpa)	Water absorption (gms)
(B5%+K 5%) R 90%	1	28.92	40.61	24.94	2.24
	2	25.58	44.79	27.38	2.25
	3	23.77	34.62	27.67	2.24
	4	32.70	45.84	27.70	2.23
	5	28.35	41.56	27.78	2.22
	Avg.	**29.86**	**41.48**	**27.09**	**2.23**

The comparison of the kapok and the banana in different mechanical properties are shown in table 4.

Table 4: Comparison of mechanical properties of banana and kapok fibre

SAMPLE NO		Tensile strength (MPa)	Flexural strengt h (MPa)	Shear strength (MPa)	Water absorption (gms)
Banana 10%	1	25.49	43.22	33.58	0.97
Kapok10%	2	26.69	33.11	25.28	. 3.04
K5%+B5%	3	29.86	41.48	27.09	2.23

The graph is to be plotted between the kapok and banana fibre as shown in fig 8. In the graph it clearly shows that when kapok and banana fibre (5%KF+5%BF) are added in equal ratio shows highest tensile strength.

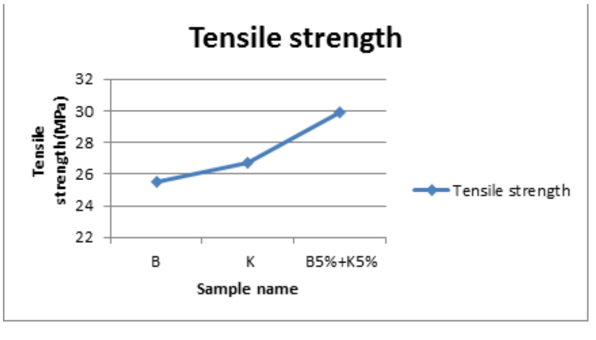

Fig 7: Tensile properties of banana and kapok fibre

The graph is to be plotted between the kapok, banana and both the fibre in equal ratio to measure the Flexural strength as shown in fig 9. In the graph it clearly shows that banana is better than all other fibre loading.

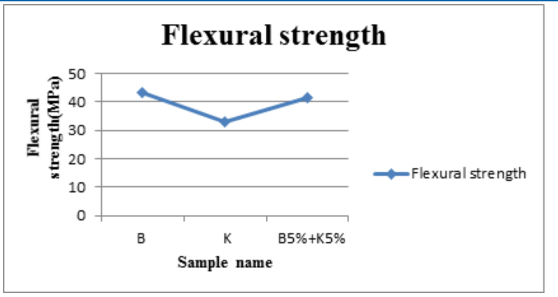

Fig 8: Flexural strength of Banana and kapok fibre

The graph is to be plotted between the kapok and banana fibre to measure the Shear strength as shown in fig 10. In the graph it clearly shows that banana fibre has highest shear strength than all other fibre loadings.

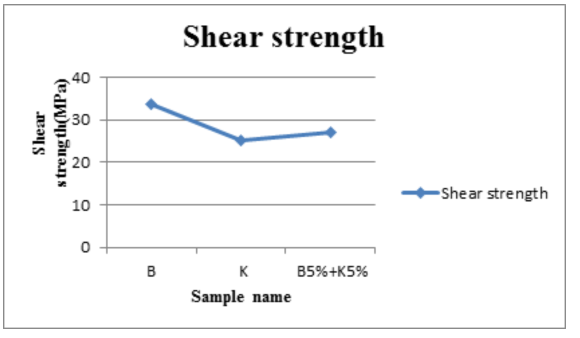

Fig 9: Shear strength of Banana and kapok fibre

The graph is to be plotted between the kapok and banana fibre to measure the water absorption as shown in fig 11. In the graph it clearly shows that kapok fibre has highest absorption capacity than all others.

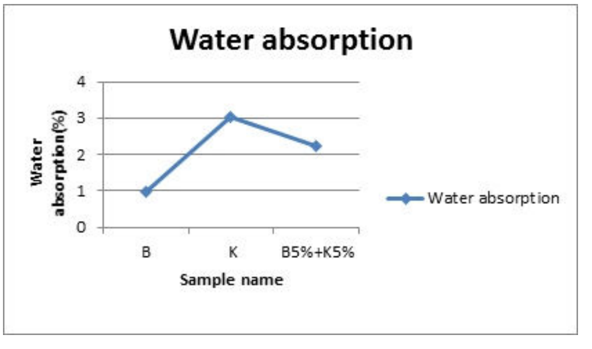

Fig 10: water absorption of Banana and kapok fibre

In fig 12 shows that the comparison between the kapok and banana fibre for measuring the mechanical properties like tensile, flexural shear strength and water absorption. The tensile strength is increasing in case of both the fibre are in equal ratio but the flexural and shear strength is increasing in the case of banana fibre. In case of water absorption the kapok fibre plays an important role as increase in water absorption in case of kapok fibre as compared to banana fibre and both the fibre in equal ratio.

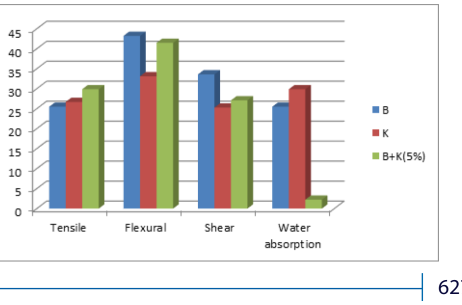

Fig 11: Comparison of mechanical properties of Banana and kapok fibre

5. CONCLUSION

In this work it is concluded that:

1 The highest tensile strength 29.86MPa shows when the both the fibres are added in equal ratio.
2 The flexural strength in banana fibre 43.22MPa is more than all other fibre loading.
3 In case of shear strength the highest shear strength 33.58MPa shows when the banana fibre is added to the matrix.
4 Water absorption capacity of kapok fibre is more than the banana fibre, due to banana fibre shows high performance as compared to kapok fibre.

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