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Development of Glass/Banana Fibers Reinforced Epoxy Composite

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Abstract
Banana fiber reinforced epoxy composite have been prepared for the evaluation of tensile strength, flexural strength and impact strength .
Banana fibers obtained from the stem of banana plant (Musa sapientum) have been characterized for their diameter variability and their mechanical properties, with a stress on fracture morphology.
Natural fibers present important advantages such as low density, appropriate stiffness and mechanical properties and high disposability and renewability. Also,they are recyclable and biodegradable.
Banana fiber in combination with glass has proved to be excellent for making cost effective composite materials. The hybridization of FRP at 20% wt fraction of reinforcement results an increasing in the tensile strength of HFREC by an amount of 1.24% than GFREC and by 71.2% than BFREC. The hybridization of FRP at 30% wt fraction of reinforcement results an increasing in the tensile strength of HFREC by an amount of 2.5% than GFREC and by 63.4% than BFREC. The tensile strength has shown the highest value when a 10% of banana fiber and 20% of glass fiber is used and an interleaving arrangement of glass and banana fiber is followed.
The hybridization of FRP at 20% wt fraction of reinforcement results an increasing in the flexural strength of HFREC by an amount of 6.9 % than GFREC and by 27.3 % than BFREC.
The hybridization of FRP at 30% wt fraction of results an increasing in the flexural strength of HFREC by an amount of 6% than GFREC and by 23 % than BFREC.
The impact strength shows the highest value .When banana fibers and glass fibers are reinforced in a ratio of 1:2 .The impact strength of HFREC increases by an amount of 5.1% than GFREC and by 91% than BFREC.
Keywords: BFREC (Banana fiber reinforced epoxy composite),GFREC (Glass fiber reinforced epoxy composite), HFREC (Hybrid fiber reinforced epoxy composite), Hand lay up

I. Introduction

It is well known that over the past few decades, polymers have replaced many conventional materials in various applications, which is obviously due to the advantages of polymers over conventional materials (Georgopoulos, Tarantili, Avgerinos, Andreopoulos, & Koukios, 2005). Polymers can be modified by the use of fillers and reinforcing fibers to suit the high strength/high modulus requirements.

Fiber-reinforced polymers offer additional options over other conventional materials when specific properties are required and find applications in diverse fields, ranging from appliances to spacecraft (Nabi Saheb & Jog, 1999).

Natural fiber is a reinforcement which has recently attracted the attention of researchers because of its advantages over the other established materials.

In this context, banana fiber reinforced composites have recently gained importance. Banana fibers are mainly used for lightweight composites and green composites in agricultural industries. These composites can also be used for door panels, room partitions, wall cladding, food packaging, home appliances, automotive parts, building and construction, and electrical housing.

Banana fibers are a waste product of banana cultivation, are easily available, and may be reinforced in thermosets and thermoplastics.

In this paper some experimental investigations on banana fiber reinforced composites could offer some interesting results. This paper reports the fabrication of hybrid composites with different weight fraction of reinforcement and with different weight percentage of different fibres and then on these specimen different tests were conducted according to ASTM standard .With these tests mechanical properties of HFREC were evaluated .

II. Materials and methods

Matrix:

Epoxy resin of grade AW-106 and epoxy hardener HV 953 U was supplied by Araldite.

Composite Materials:

Glass fiber, banana fiber, Epoxy resin and Epoxy Hardener were the raw material for the composite . In this research a plain weave mat of E-glass fabrics of 0.3 mm thickness as synthetic reinforcement was used to manufacture the composite material. Banana fibers mat were used as natural reinforcement. Banana fiber and Glass fiber were supplied by Chander Parkash and Company Jaipur. The matrix material was Epoxy resin, which is thermosetting resin supplied by Araldite.

Composite manufacturing method

Many techniques available in industries for manufacturing of composites such as compression molding, vacuum molding, pultruding, and resin transfer molding are few examples. The hand layout process of manufacturing (Davim et al, 2004) is one of the simplest and easiest methods for manufacturing composites. A primary advantage of the hand layout technique is to fabricate very large, complex parts with reduced manufacturing times. Additional benefits are simple equipment and tooling that are relatively less expensive than other manufacturing processes. The prepared specimens are shown below in **Figure 1**

Fig.1 Composites Specimen

Testing of composites:

Tensile Testing: This test was carried out at Central Institute of Plastic engineering & Technology (CIPET), Murthal on Autograph machine.

A rectangular composite specimens were made as per the ASTM D638M to measure the tensile properties. The length, width and thickness of the specimen were 165,19 and 4 mm, respectively and the experiment was conducted at room temperature. Composite specimens were placed in the grips and were pulled at a speed of 5 mm/min until failure occurred. The strain gauge was used to measure the displacement.

Flexural testing: This test was carried out at Central Institute of Plastic engineering & Technology (CIPET), Murthal on Autograph machine .
In this the Composite specimens of dimensions 130×12×4 mm were manufactured and the flexural testing was carried on autograph machine as per ASTM D 790. Flexural testing commonly known as three point bending testing. In this testing the specimen were horizontally placed on two supports and load was applied at the centre. The deflection was measured by the gauge placed under the specimen, at the centre.

Impact testing: This test was carried out on Tinius Olsen machine as shown in figure2 below as per procedure mentioned in ASTM D 256.

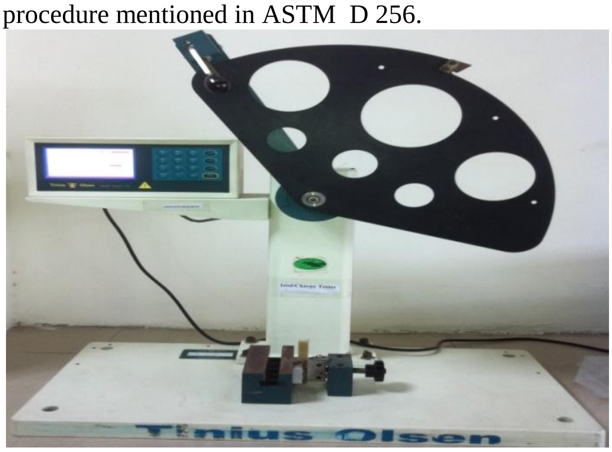

Fig.2 Tinius Olsen Machine

Composite specimens were placed in vertical position (Izod Test) and hammer was
released to make impact with specimen and CRT reader gives the reading of Impact strength.

Results and Discussions: The results of various tests are reported here which includes evaluation of tensile strength, flexural strength, and impact strength..

1. **Tensile Testing:** Experimental results of tensile testing of different composites with

different weight fraction of reinforcements are shown in **Table 1** and **Figure 3**.

Sr. no	**Total %age of reinforcement in composite (weight fraction)**		**%age of fibers in reinforcement** BANANA %age	GLASS %age	**Tensile strength (N/mm^2)**
1	20 %	GFREC	0	20	82.11
		HFREC	5	15	82.9
			10	**10**	**83.13**
			15	5	56.34
		BFREC	20	0	48.56
2.	30 %	GFREC	0	30	90.8
		HFREC	5	25	86.3
			10	**20**	**93.11**
			15	15	72.9
			20	10	68.15
			25	5	63.7
		BFREC	30	0	56.98

Table 1: Tensile Strength of BFREC, GFREC and HFREC at 20% and 30% wt. fraction of fiber.

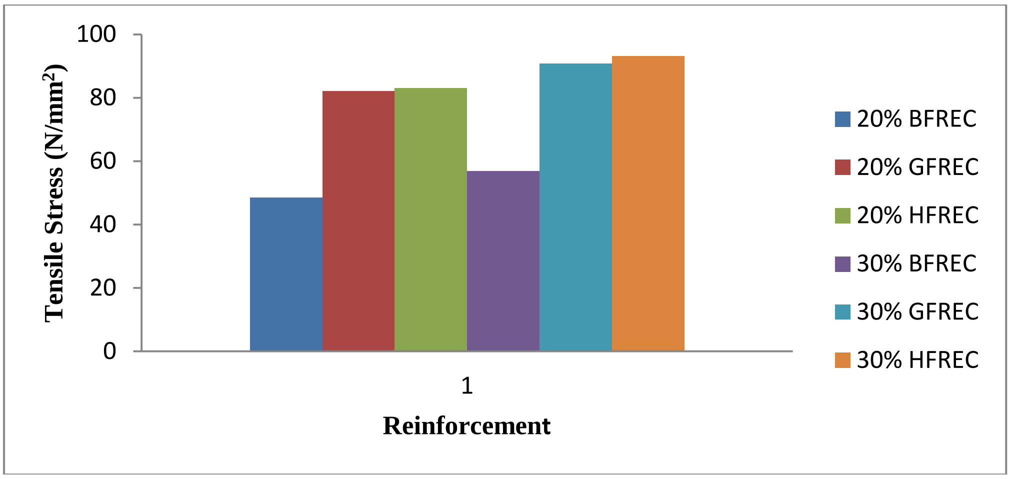

Fig. 3: Comparison of Tensile Strength of BFREC, GFREC and HFREC at 20% and 30% wt. fraction of reinforcement.

The results shows that 20% hybridization of fiber reinforced plastic results an increasing in the tensile strength of HFREC by an amount of 1.24% than GFREC and by 71.2% than BFREC and due to 30% hybridization of fiber reinforced plastic results an increasing in the tensile strength of HFREC by an amount of 2.5% than GFREC and by 63.4% than BFREC. The reason for increase in tensile strength in HYBRID FIBER REINFORCED EPOXY COMOSITE is that natural fibers have higher interfacial strength with the matrix than synthetic fibers [14] and synthetic fibers have high strength than natural fibers.

2. Flexural Testing: The experimental results of flexural tests of composites with different weight fraction of reinforcement are shown in Table2 and **Figure 4.**

The results shows that 20% hybridization of FRP results an increasing in the flexural strength of HFREC by an amount of 6.9 % than GFREC and by 27.3 % than BFREC when banana fibers and glass fibers are reinforced in a ratio of 1:2.

Sr. no	**Total %age of reinforcement in composite (weight fraction)**		**%age of fibers in reinforcement** BANANA %age	GLASS %age	**Flexural strength (N/mm^2)**
1	20%	GFREC	0	20	62.13
		HFREC	5	15	63.7
			10	**10**	**66.4**
			15	5	54.9
		BFREC	20	0	52.18
2	30%	GFREC	0	30	69.26
		HFREC	5	25	68.47
			10	**20**	**73.4**
			15	15	70.86
			20	10	64.7
			25	5	62.35
		BFREC	30	0	59.7

Table 2: Flexural Strength of BFREC, GFREC and HFREC at 20% and 30% wt. fraction of fiber.

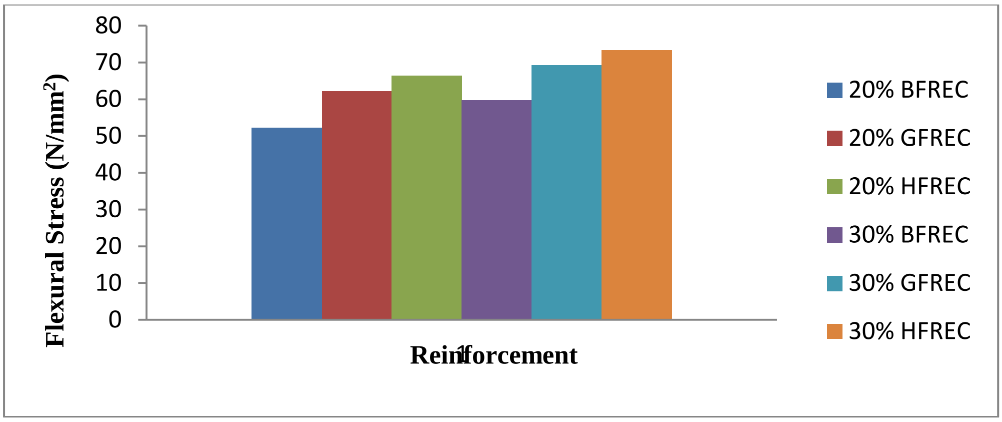

Fig.4: Comparison of Impact strength of FRP at 20% and 30% wt fraction of Reinforcement.

And due to 30% hybridization of FRP results an increasing in the flexural strength of HFREC by an amount of 6% than GFREC and by 23 % than BFREC. The glass fiber reinforced composites show better flexural strength than banana fiber reinforced composites because glass fiber can take more bending loads than banana fibers. However banana fibers reinforced along with glass fibers in epoxy matrix produces better results as compared to glass fiber reinforced composites the reason for increase in flexural strength may be the combined effect of the properties like high stiffness and capability to take high bending forces by both banana fibers and glass fibers.

3.Impact Testing: The experimental results of impact tests of composites with different weight fraction of reinforcement are shown in **Table 3** and **Figure 5.**
Table 3 represents the comparison of impact strength of BFREC, GFREC and HFREC at 20% weight percentage of reinforcement. Experimental results reveal that HFREC has high impact strength than BFREC and GFREC. The HFREC shows maximum impact strength when banana fiber and glass fiber reinforced in epoxy matrix at a ratio of 1:1. The reason for increase in impact strength of HFREC may be the high interfacial strength of banana fiber with epoxy matrix and the ability of glass fiber to withstand against impact loading that's why glass fiber reinforced composites are used in fabrication of the body of airplanes to bear high impact load exerted by air.

Sr. no	**Total %age of reinforcement in composite (weight fraction)**		**%age of fibers in reinforcement**		**Impact strength (J/m^2)**
			BANANA %age	GLASS %age	
1	20 %	GFREC	0	20	138.4
		HFREC	5	15	123.67
			10	**10**	**144.95**
			15	5	102.8
		BFREC	20	0	78.78
2.	30 %	GFREC	0	30	174.65
		HFREC	5	25	165.4
			10	**20**	**183.57**
			15	15	145.72
			20	10	121.8
			25	5	105.47
		BFREC	30	0	95.8

Table 3: Impact Strength of BFREC, GFREC and HFREC at 20% and 30% wt. fraction of reinforcement.

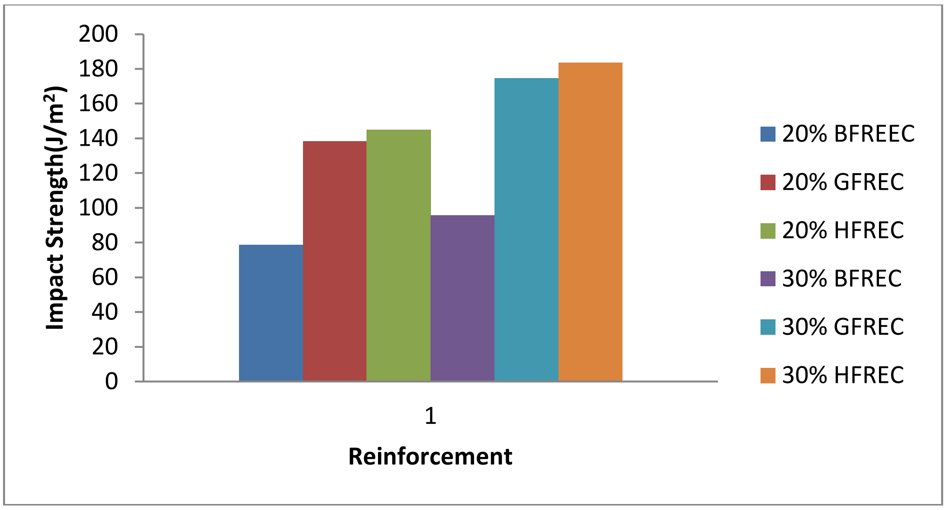

Fig.5: Comparison of Impact Strength of BFREC, GFREC and HFREC at 20% and 30% wt. fraction of reinforcement.

Experimental results show that impact strength of HFREC increase by an amount of 4.7% than GFREC and by 83% than BFREC. Table 3 represents the comparison of impact strength of BFREC, GFREC and HFREC at 30% weight percentage of reinforcement. When banana fibers and glass fibers are reinforced in a ratio of 1:2 than HFREC shows higher impact strength. Experimental results reveal that impact strength of HFREC increase by an amount of 5.1% than GFREC and by 91% than BFREC.

III. Conclusion

Results shows that 30% weight fraction of fiber had much better mechanical properties than 20%, and 10% weight fraction of fiber reinforcement in case of both Glass Fiber as well as Banana Fiber reinforcement. The experimental results show that GFREC had more Tensile Strength, Flexural Strength and Impact Resistance than BFREC. The Hybridization of Glass Fibers and Banana Fiber at varying wt. percentage of both fibers within the matrix had greater Tensile Strength, Flexural Strength and Impact strength than both GFREC and BFREC. It has been noticed that by adding a small wt. percentage of Banana Fiber in GFREC enhance its properties to a great extent. The Hybridization of Banana Fiber and Glass Fiber not only improve the mechanical properties of FRP composite but also reduce its cost and make it Eco Friendly composite.

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