HARDNESS AND MORPHOLOGICAL STUDY OF FLY ASH-BAGASSE COMPOSITES

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ABSTRACT

During recent decades, by considering the environmental awareness and growing ecological concerns, bio-fiber-reinforced plastic composites playing an important role. The composites have many advantages over traditional glass fiber or inorganic mineral-filled materials, including lower cost, lighter weight, environmental friendliness, and recyclability.In the present investigation a Fly Ash (FA) – Bagasse fiber (BGF) composites with Epoxy Resin (ER) as parent material is developed. The BGF is used in two different size for the developed material. In two developed composites, BGF is varied as 13 µm-16 µm in diameter and 63 µm-95 µm in length, correspondingly in other two developed composites; BGF is varied from 1-5 mm in length. The microstructure of composite material is studied by using Scanning Electron Microscope (SEM). The SEM demonstrated that the FA and BGF are uniformly distributed over the matrix. It has been observed that the composites with FA-BGF shows higher hardness than only BGF composites and it is also found that the hardness of the composite material increases by increasing the size of the BGF from µm to mm.

***Keywords**: FA, BGF, SEM, Hardness.*

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1. INTRODUCTION

The term composite originally arose in engineering, where two or more materials are combined to rectify some short-coming of a particular useful component. Composite represents a material system consisting of several phases of which at least one is a solid phase with macroscopic perceivable boundaries and which makes it possible to obtain new properties or a combination of properties not attainable by any of its components separately or by their sum. The properties of composite materials depends upon the degree of inhomogeneity , density of constituents, method of fabrication, orientation of fibers in case of the fiber reinforced composites etc Gope et al (2011) developed a BGF -glass fiber reinforced composite material is with 15 wt%, 20 wt%, 25 wt% and 30 wt% of bagasse fiber with 5 wt% glass fiber mixed in resin. Scanning electron microscopy (SEM) shows that BGFs are well dispersed in the resin matrix. Addition of fiber increases the modulus of elasticity of the epoxy. Addition of BGFs decreases the hardness of the

developed composite. Manoj Singla et al (2010) determined experimentally by taking different weight percentage of glass fibers (E-300, mat form) with epoxy resin & comparison with fly ash reinforced composite. Fracture behaviour of composite can also be studied using SEM. SEM analysis is done to observe distribution of fly ash particles in matrix, resin fly ash interface, glass fibre matrix interface, glass fibre distribution etc, Acharya et al (2010) studied the effects of impingement angle and particle velocity on the solid particle erosion behavior of Bagasse Fiber Reinforced Polymer Composites (BFRPCs). The erosive wear is evaluated at different impingement angles from 30° to 90° at four different velocities of 48, 70, 82 and 109 m/s. The result shows brittle behavior with maximum erosion rate at 90° impingement angle. The morphology of the eroded surfaces was examined by using Scanning Electron Microscopy (SEM). Siddique et al (2008) carried out the effects of addition of natural san fibres on the fracture toughness and impact strength of high-volume fly ash concrete. The test results indicated that the replacement of cement with fly ash decreased the compressive strength and fracture toughness, and had no significant effect on the impact strength of plain (control) concrete. Addition of san fibres did not affect significantly the compressive strength, increased the fracture toughness and impact strength of high-volume fly ash concrete as the percentage of fibres increased. Mahendra et al (2007) showed in his investigation that an Al–4.5% Cu alloy was used as the matrix and fly ash as the filler material. Microstructure examination was done using a scanning electron microscope to obtain the distribution of fly ash in the aluminium matrix. The results showed an increase in hardness, tensile strength, compression strength, and impact strength with increasing the fly ash content. The density decreases with increasing fly ash content. Fly ash Cenospheres are hollow spheres, having size between 10–300 μm in diameter. Four compositions of Aluminium cenospheres composites having reinforcements of 0, 5, 10 and 15 % by weight been prepared by the Liquid Metal vortex method, It has been seen that the sample having a higher percentage of cenosphere (reinforcement) has shown a remarkable improvement in hardness and wear resistance. Improved mechanical properties of the composite could be obtained by addition of N-2(aminoethyl)-3-aminopropyltrimethoxysilane coupling agent. The mechanical properties greatly reduced, except for the flexural modulus. Alam et al (2006) attempted to find out sustainable use of fly ash generated from Barapukoria Power Plant. This is used as an admixture with Special Cement in 5%, 10% and 15% proportion. Laboratory test for different parameters such as compressive strength, workability, flexural strength, splitting tensile strength of such mixtures are carried out to find out optimum content. The results show almost no sacrifice for the strength of cement due to mixture of fly ash with a proportion of 10%.

There is some work reported on FA-BGF composite. However, no information is available on FA-BGF composite with ER as parent material In the present investigation a FA-BGF composite with ER as parent material is developed. The 2% FA with different fiber length is used and determined the mechanical properties such as hardness of the developed composite. And also the microstructure of composite material is investigated by SEM**.**

A research was therefore initiated with the objective of studying the feasibility of manufacturing composite boards from a mix of fibrous bagasse with FA particles by means of a flat press process and to show bagasse content, and pressure effect on selected board properties, i.e. bending strength, impact strength, modulus of elasticity, hardness etc.

Nomenclature

COMPOSITION	**SPECIFICATION**
C_0	NEAT EPOXY
C_1	10wt. % OF BGF (μm FIBER)
C_2	10wt. % OF BGF (1-5mm FIBER)
C_3	10wt. % OF BGF(μm FIBER) + 2wt. % OF FA
C_4	10wt. % OF BGF(1-5 mm FIBER) + 2wt. % OF FA
CY 230	Epoxy Resin
HY 951	Hardener
BGF	Bagasse Fiber

FA	Fly Ash
FCFA	F Class Fly Ash
SEM	Scanning Electron Microscope
Wt. /Wt.	Weight to weight

2. DEVELOPMENT OF COMPOSITE

The matrix system consists of ER (CY230) and corresponding hardener (HY951) supplied by M/s CIBATUL Limited, India. Two types of fillers namely BGF and FA have been used. BGF is supplied from sugar mill, kotdwara and FA is supplied from Century Paper and Pulp Industry Limited, Lal Kuan (India). BGF composition is shown in table 2.1. FCFA consists of high percentage of silica (52 Wt. %), alumina (26.20 Wt. %), and various compositions as shown in Table 2.2

TABLE.2.1 AVERAGE BAGASSE COMPOSITION

ITEMS	PERENTAGE
1. Moisture	49.0
2. Soluble solids	2.3
3. Fibre	48.7
4. Cellulose	41.8
5. Hemicellulose	28
6. Lignin	21.8

TABLE 2.2 COMPOSITION OF FLYASH

Composition	Percentage
Silica	52.50
Alumina	26.20
Fe_2O_3	6.50
Titanium	1.28
CaO	1.12
Potassium Oxide	0.96
Mg and MgO	0.29
Na_2O	0.29
Sulphates	0.34
Phosphates	0.05
Unburnt Coal	9.16

Epoxy resin (CY230), hardener (HY951), bagasse fibre and flyash with different weight percentage were used. Weight percentage (wt%) of BGF (10% wt) of different fiber length, flyash (2% wt) and epoxy resin were mixed by mechanical stirring at 3000 rpm according to above nomenclature. The curing curve of epoxy CY230 is shown in Fig. 2.1. Based on the curing

curve, the solution obtained by mixing of bagasse fibre and flyash in resin is kept in the furnace at a temperature of 90 ± 10 °C for two hours. At each interval of 30 minutes the solution is taken out from the electric furnace and remixed by mechanical stirrer at same speed. After two hours the whole solution is taken out and allowed to cool to a temperature of

45°C. When a temperature of 45°C has been attained the hardener HY951 (8 weight per cent) is mixed immediately. Due to addition of hardener high viscous solution is obtained which is remixed mechanically at high speed by the mechanical stirrer. The viscous solution so obtained is poured into different moulds for sample preparation.

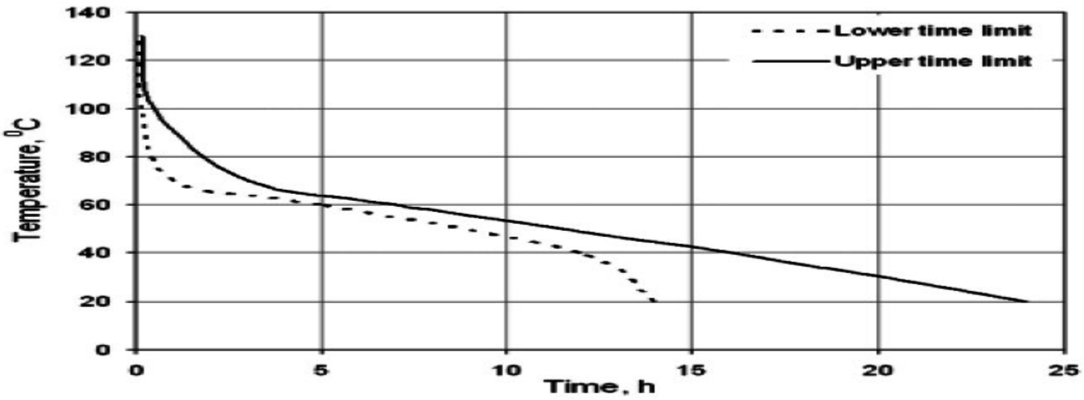

FIG2.1 Curing curve of CY 230 epoxy based composite

3. TESTING METHODS

The Rockwell hardness test is generally performed when quick and direct reading is desirable. The Rockwell hardness of the developed composite materials is carried on the P.S.I Hardness testing machine (rubber and polymer). The Rockwell hardness test of polymer composite is carried out on M scale. The ball indenter 1/4" (6.35 mm) diameter is selected as specified for polymer-polymer composites. The ball indenters are generally made of hardened tool steel or tungsten carbide. In Rockwell hardness test an indenter is first seated firmly in the material being tested by application of minor load 10 kilograms. The indicator is then set at zero and a major load of 100kgf is applied to the indentor and is allowed to continue for one second. After application, the major load is removed. The pointer indicates Rockwell hardness number on the red scale dial. At the various points on the specimen hardness is taken and average value is recorded.

The scanning electron micrograph study generally performed by Scanning Electron Microscope (SEM) which uses electron to form an image with high resolution or magnification. In the present investigation SEM studies has been done to see the dispersion of FA and SBR particles in resin. The images are obtained through microscope investigation with LEO435V6. To obtained the scanning electrons micrographs square samples are cut from the cast material and are silver coated to avoid the artifacts associated with sample charging and then placed inside a chamber in which an electron beam is fall on the material.

The accelerated voltage was 15 kV. Different images are taken at various magnification ranges.

4. RESULTS AND DISCUSSION:

4.1. Hardness

As known, hardness implies a resistance to indentation, permanent or plastic deformation of material. In a composite material, filler weight fraction significantly affects the hardness value of the composite material. Hardness values measured on the Rockwell M-Scale showing the effect of weight percentage of bagasse fibers on the hardness values of composite are presented in Table 4.1(a). It is found that the hardness increases with the increase in the fiber length .

Table 4.1(a): Rockwell Hardness values on M-Scale for various filled composite

S.No	C0	C1	C2	C3	C4
1.	60	55	61	80	84
2.	55	53	58	81	83
3.	58	54	56	79	86
4.	61	61	63	77	81
5.	55	56	56	76	82
6.	56	58	63	74	84
7.	60	50	54	80	80
8.	57	57	60	78	89
9.	55	52	62	76	86
10.	58	55	59	79	81
MEAN	57.5	55.1	59.3	78	83.6
SD	2.273	3.142	2.983	2.221	2.796
VARIANCE	5.166	9.877	8.900	4.888	7.822

4.2. Microstructure:

The microstructure of FA and BGF composite material was investigated by using Scanning Electron Microscope (SEM). The SEM analysis shows that FA particles and BGFs are uniformly dispersed in to the matrix. By using SEM it can be analyzed that there is any fracture or defect in the material or not. Figure 1-7 shows microstructure of different FA and BGFs reinforced composites material at various magnification ranges.

Figure 1 to 7 shows the SEM micrographs of different composite material investigated in the present work. In all the cases, good dispersion of FA - BGF in the resin matrix has been observed. Hence, from the micrographs it can be said that due to uniform dispersion of FA – BGF in the epoxy resin, a remarkably effect on the mechanical properties are obtained.

Figure 1 shows the SEM analysis of the neat epoxy resin and hardener composite without any reinforcing element.

Figure 2 shows the SEM micrographs of 10% BGF with 95µm length and diameter is varied from 14.35µm - 16µm fibers in the composite material. From fig it can be concluded that the bagasse fibers are uniformly mixed with the matrix material.

Figure 3 shows the SEM micrographs of 10% BGF with diameter 16.2µm – 16.37 µm with length of 1 – 5mm in the composite material.

Figure 4 shows the SEM micrographs of 10% BGF with vertical section of fiber of diameter 16.13µm – 16.25µm with length of 1 – 5mm in the composite material.

Figure 5 shows the SEM micrographs of 10% BGF + 2% FA with fiber of diameter 12.5 µm - 13.45 µm and length 83.5µm – 86µm. The spherical particles shown in the figs are the FA particles generally called as the cenospheres.

Figure 6 shows the SEM micrographs of 10% BGF + 2%FA with fiber length of 63.4µm and also the good interaction of FA particles with the matrix material.

Figure 7 shows the SEM micrographs of 10% BGF + 2% FA with fiber of length of 1 – 5 mm. The FA particles are uniformly dispersed into with the matrix material.

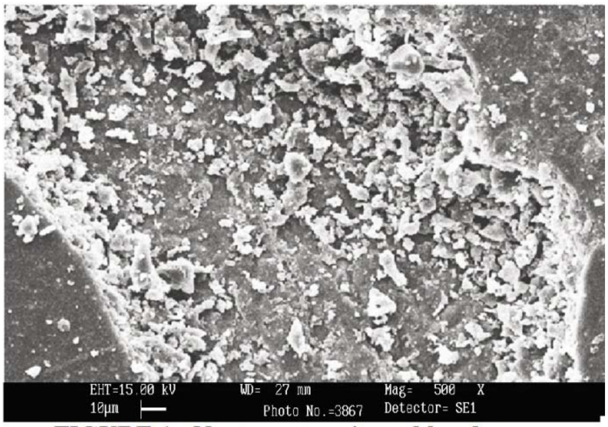

FIGURE 1 : Neat epoxy resin and hardener

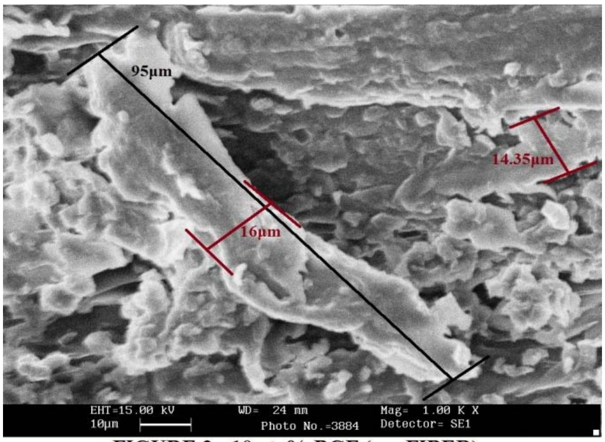

FIGURE 2 : 10wt. % BGF (µm FIBER)

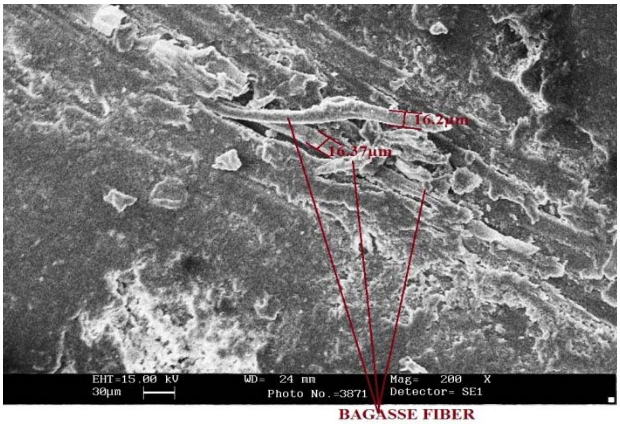

FIGURE 3 :10wt. % BGF(1-5mm FIBER)

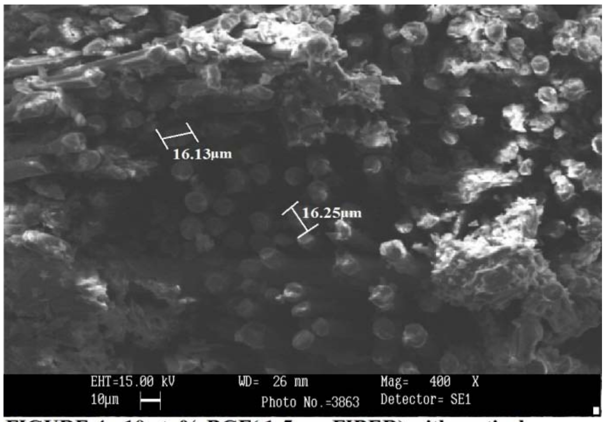

FIGURE 4 : 10wt. % BGF(1-5mm FIBER) with vertical section

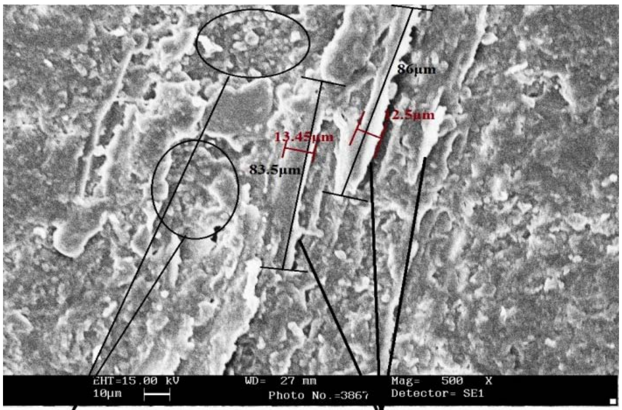

FIGURE 5 : 10wt. % OF BGF(µm FIBER) + 2wt. % OF FA

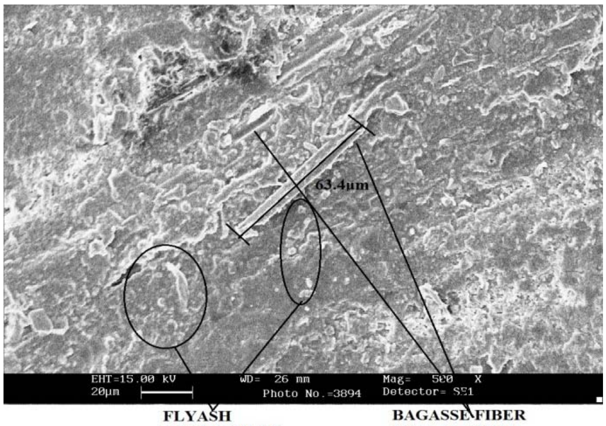

FIGURE 6 : 10wt. % OF BGF(µm FIBER) + 2wt. % OF FA

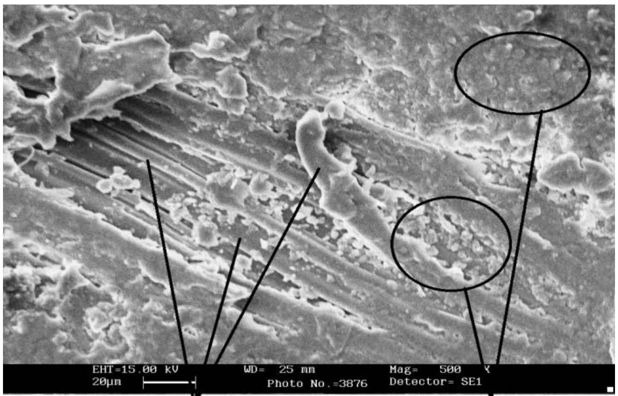

FIGURE 7 : 10wt. % BGF (2-5 mm FIBER) + 2wt. % FA

CONCLUSIONS

New composite materials have been developed by using FA and BGF and it can be concluded that the SEM analysis was used to determine the microstructure of the composite materials and also shows the uniform distribution of FA and BGF over the matrix. The hardness of the composite material increases by increasing the size of the fiber from µm to mm to the content of the matrix. The composites with FA – BGF show higher hardness than BGF composites.

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