EFFECT OF NATURAL AND SYNTHETIC FIBERS ON MECHANICAL PROPERTIES OF EPOXY RESIN

Renuka Bulagoud[1],Prof T.T.Hawal[2],Prof M.S.Patil[3],

[1]P.G. Student , KLS GOGTE college, Belgaum, Karnataka (India)

[2]T.T. Hawal, Assistant Professor, KLS GOGTE Institute of Technology, Belgaum, Karnataka (India)

[3] Prof. M.S.Patil, Professor, KLS GOGTE Institute of Technology, Belgaum, Karnataka (India)

ABSTRACT

The mechanical properties of bisphenolA matrix composites reinforced with hybrid reinforcementlike rice husk and carbon nano fibers were evaluated. There are indications that the incorporation of both fibers into a single matrix which bisphenol A resin will stabilize mechanical properties and lowering manufacturing costs. In this research the tensile strength, flexural strengthand compression strength were studied for composite material reinforced withhybrid fiber .comparative study and effect of both fibers on mechanical properties of bisphenolA. An improvement of12%in mechanical properties was achieved by addition of natural fiber and 22% by CNF comparing with neat epoxy.Fracture surface analysis was done by using scanning electron microscope.

Keywords: Hybrid Composite, Fracture Surface, Electron Microscopy, Mechanical Properties.

I. INTRODUCTION

Composite materials are combination of two or more materials. These replace traditional materials by light weight and high strength.A composite material is combination of both matrix and reinforcement materials. Selection is based on application to achieve adequate mechanical properties. Most common fibers are manmade (Synthetic) fiber and natural Fibers can be used to reinforce the composite materials.

Synthetic fibers are the most widely used to reinforce plastics due to their low cost and good mechanical properties. However, these fibers have drawbacks as high density, non-renewable and non-biodegradable and high energy consumption .Natural fibers are bio-waste and these are easily available at a very low cost as compared to other fibers like carbon glass. They are ecofriendly, fully biodegradable, abundantly available, renewable, and cheap and have low density. Plant fibers are light compared to glass and carbon fibers. The biodegradability of plant fibers can contribute to a healthy ecosystem while their low cost and high performance fulfills the economic interest of industry [8]

The first and the most important problem is the fiber–matrix adhesion. The role of the matrix in a fiber reinforced composite is to transfer the load to the stiff fibersthrough interface. This process requires a good bond between the polymeric matrix and the fibers. Poor adhesion at the interface means that the full capabilities of the composite cannot be exploited and leaves it vulnerable to environmental attacks that may weaken it, thus reducing its life span. The aim is to improve the mechanical properties which can be done by physical and chemical treatment of natural fibers. In present work we have treated the rice husk with alkali treatment as it helps to improve the mechanical properties compared to other treatment like accetalization, silena etc.[9] Rice husk is natural fiber is available widely it bio waste mixed with bisphenol A matrix and carbon nano fibers are used as synthetic fiber. Hence in this work the mechanical properties of both natural and synthetic fibers separately and combined effect is studied. All so the study of crack propagation by fracture analysis using SEM is being done. [10]

II. MATERIALS AND METHODALOGY

2.1 Materials

The resin is used for present study is epoxy resin- Bisphenol A (80-90)%from Nepta resin and chemical ltd. It contains 3 parts catalyst(5-10)%, promoter 1%, and accelerator 5 %.The mixture of all these is used for manufacturing the composite by using aluminum sheet molds by hand layup method. The carbon nano fiber from NANOSHELL.MFG from Delhi with the diameter 500nm, Carbon content 95% minimum 99%Purity 96%, Density 0.065lb/in3, Bulk density 24.9lb/ft3, Fiber diameter: 0.283mils[1].And rice husk is collected from local rice mill factory as natural reinforcement. Average size of rice husk is 7mm Length, 1.5mm Width 0.7 mm thickness.

2.2 CHEMICAL TREATMENT OF RICE HUSK

2.2.1 ALKALI TREATMENT

Alkali treatment of cellulosic fibres with sodium hydroxide (NaOH) is one of such methods that have been employed in order to improve the fiber–matrix interface bonding[10]. This treatment removes wax, oils covering, some amount of lignin and the silicon content of the external surface of the RH fiber cell wall. [9]After chemical treatment change in rice husk is as shown on fig 2.2.

Fig no 2.2 after chemical treatment of rice husk

Steps involved in the treatment

1. 15% NaOH solution was prepared using sodium hydroxide pellets and distilled water.
2. Rice husk fibers were then dipped in the solution for 1hour.
3. After 1 hour fibers were washed with 1% acetic acid solution to neutralize the fibers.
4. Then it is washed with distilled water.
5. It was then kept in hot air oven for 3hours at 65-70°C.[10]

2.2 FABRICATION & PREPARATION OF COMPOSITE SPECIMENS

The Rice husks were collected locally from a rice mill from Belgaum Karnataka. Rice husk was washed several times with plain water to remove the dust and other foreign particles adherence to the fibers and was dried in sun light. Then these rice husk fibers were sieved with sieve shaker and a particular size rice husk fiber was chosen for the experiment. It was chemically treated to get good results. The CNF is supplied by NANOSHELLS LIM INDIA with required specification is used for fabrication of composites.

Usual hand lay-up technique was used for preparation of the samples. A aluminum sheet is used for preparation of mold of dimension (280x140x10) mm for casting the composite sheet as show in fig2.2.1 a. A silica mold release spray was applied at the inner surface of the mold for quick and easy release of the composite sheet. Different weight fractions of fibers were used and calculated from amount of epoxy resin and hardener(ratio of 100:1) by weight. (Weighing machine is as shown below) Later it was thoroughly mixed in a ceramic jar and laboratory mixer was used for uniform mixing with certain speed. Then calculated amount of rice husk and CNF is added to the mixture of epoxy resin and hardener and mixed properly. The composite mixture is then poured in to the mold.Care has been taken to avoid formation of air bubbles. The mold was allowed to cure at room temperature for 72 hrs. Care was also taken to consider this loss during manufacturing so that a constant thickness of sample can be maintained. This procedure was adopted for preparation weight fractions of fiber reinforced epoxy composite slabs. After 72 hrs, the samples were taken out from the mold and then cut in to required sizes as per ASTMstandardsfor Mechanical test. Cut sample are as shown in fig2.2.1b.

Fig no 2.2.1 mould used for fabrication of composites and cured cut samples.

Different combination of slabs/work pieces

1. Combination 1% of volume fraction of CNF mixed with 99% Epoxy Resin.
2. Combination of 10% of volume fraction of rice husk with 90% Epoxy Resin.
3. Hybrid composite with combination of 1% CNF, 10 % of Rice husks and 89% of Epoxy resin.

III. TEST METHOD

3.1 TENSILE TEST: The standard test method according to ASTM D3039-00 has been used. Dimensions of the test specimen used are (250x15x4) mm. The tensile test has been performed in universal testing machine in

GIT College Belgaum Karnataka. For each test, composite of four specimens were tested and average value of each set was taken for analysis. . The results obtained from the tests are presented as below table. Below formula is used for calculation tensile strength & Young's modulus.

$$\sigma = P/A \text{..........1}$$

$$E = \sigma L/\delta \text{.........2}$$

3.2 BENDING TEST

Three point bending test was carried out in an UTM machine in accordance with ASTM D790-02 used measure the flexural strength of the composites.. All the specimens (composites) were of rectangular shape having length is 150 mm, 12.7mm is width and thickness of 4mm. maintaining 100mm of span length.Three point bending method is used for calculating flexural strength. Below formula is used for calculation of flexural strength of composites

$$FS = \frac{3PL}{2bt2} \text{.............3}$$

$$G = 3PL3/4bt3y \text{......4}$$

3.3COMPRESSION TEST

The compression test was carried out in UTM machine in accordance with ASTM D695 to obtain the value of the compression strength of the composite materials. All specimens were rectangular shape having length 12.7mm width is 25mm, thickness is 12.7mm. The following formulas were used for calculation of compression strength and modulus.

$$\sigma = P/A \text{..........5}$$

$$E = \sigma L/\delta \text{.........6}$$

IV. RESULTS AND DISCUSSIONS

Table no 01: mechanical test results of composite material with different test

Composites With different reinforcement	Tensile strengths Mpa	Bending strengths Mpa	Compression Strengths in Mpa
Epoxy	14.5	25.12	66.12
Rice husk	22.12	59.41	25.6226
CNF	31.12	92.077	29.12
Ricehusk+CNF	32.25	98.15	34.174

4.1 TENSILE TEST

From below graph no 4.1 shows the comparison of tensile properties of the composite after addition of Rice husk with neat epoxy resin. Due to addition of natural fiber i.e. rice husk 8-10% of increase in tensile strength and modulus compare with neat epoxy resin.In nanocomposite, the reinforcement imparts a high portion of interface. If filler matrix interaction is poor, the particles are unable to carry any part of the external load. In that case, the strength of the composite cannot be higher than that of the neat polymer matrix. If the bonding between fillers and matrix is instead strong enough, the yield strength of a particulate composite can be higher than that of the matrix polymer. In the same way a high interfacial stiffness corresponds to a high composite modulus. Hence, the gradual increase in stiffness and tensile strength, as observed for the nanocomposites, revealing that the stresses are efficiently transferred via the interface. [8]CNF addition increases both tensile strength and modulus almost by 20% as compared to neat epoxy resin for 1% of CNF. Also as %CNF increases chance of formation of agglomerates due to poor desperation of CNF, it reduces the reinforcement effect. In case of the hybrid combination of both reinforcements, it gives both effects and due to this there is increase in tensile properties .Hybrid composite gives better tensile properties then other combination as in this combination the load is shared by both reinforcements.

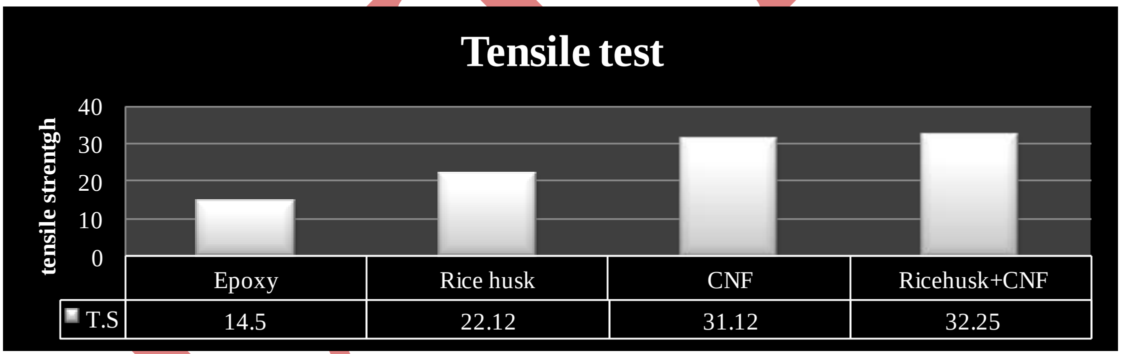

Fig no 4.1 tensile test results with different combination

4.2 BENDING TEST

Fig 4.2 shows the variation in flexural strength for neat epoxy and different reinforcement with volume fraction of fiber composites. The flexural strength results for different reinforcementreaction of fiber composite has also followed the same trend as for the tensile strength and have a maximum value for the combination of both fibers. [1]

Compared with neat epoxy resin after the addition of rice husk, there is an increase in the properties of bending strength, modulus.

While the addition of nano particles (CNF) to epoxy resin increases bending strength with a greater peak. Bending properties are slightly affecting the distribution of nano particle, but these are affecting the % CNF content more.

In hybrid composite bending properties are better compared with other combination.

4.3 COMPRESSION TEST

Due to the addition of different reinforcements the compression property is improved initially with less elongation buta little lack of compression strength. After the addition of fibers compression strength increases as shown in table. From obtained results compression strength of CNF and Rice husk is maximum as shown in fig 4.3.

From above graph initially with neat epoxy it has high compressive strength, but after adding rice husk its deformation reduces.Hence it is suitable for practical application. Initially it was more elastic in nature with less hardness due this deformation is more. Compression strength is high in combination of CNF_ RICE HUSK hybrid composite.

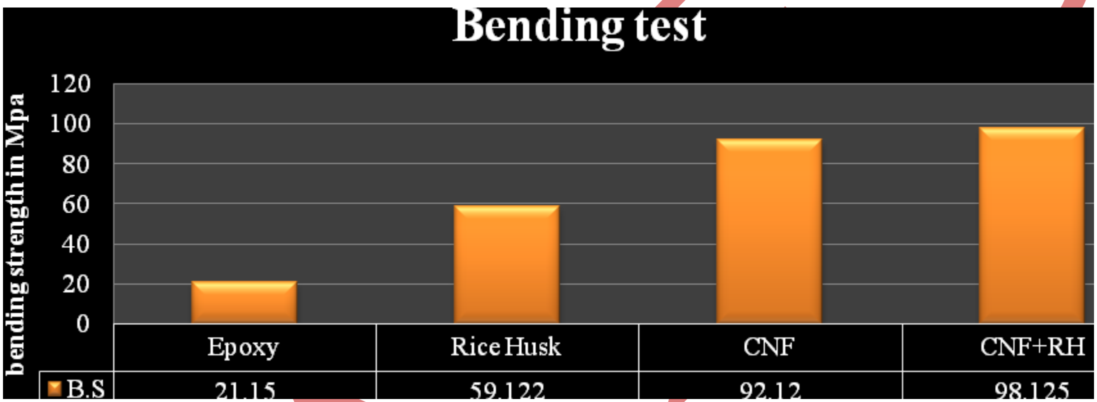

Fig no 4.2: Bending test results with different combination.

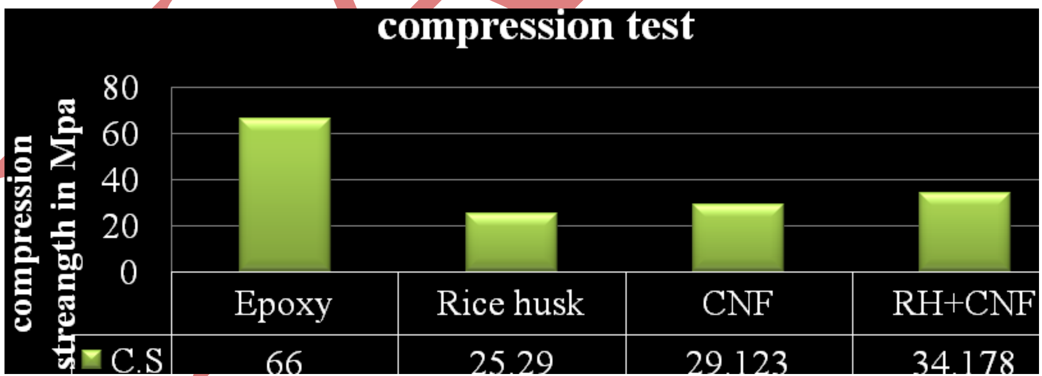

Fig no 4.3 Compression test results with different combination.

4.4 MICROSCOPIC STUDY

This is done by SEM results. Comparison neat epoxy (fig 4A) and CNF-EP (fig 4B) composite. From this we observed is that there is a brittle fracture by the addition of CNF. Due this increase in roughness this implies the path for the propagation of cracks because of CNF. From Fig C shows the enlarge fracture surface.

From Fig4D below fig shows that addition of more amount of CNF or mixing is not done properly. Hence the agglomerates are formed and due to this CNF are not distributed uniformly.

From below fig 4E shows fracture surface of rice husk epoxy resin composites and distribution of rice husk particles. Surface becomes brittle due to presence of silicon in rice husk. Crack propagation is more as compare to other then composites. White particle are rice husk as shown in fig 4E and 4F.

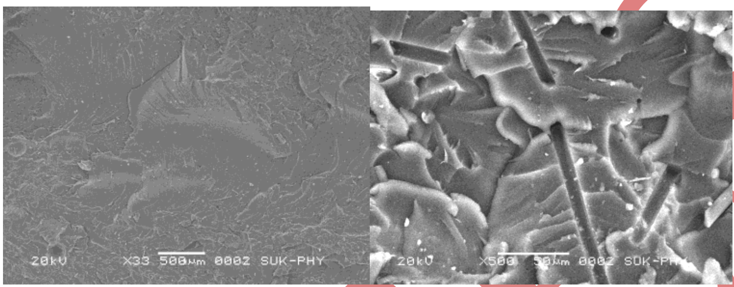

Fig No .04 Neat epoxy resin (left) 4A and 1% of CNF filled epoxy resin 4B (right) of tensile fracture surface.

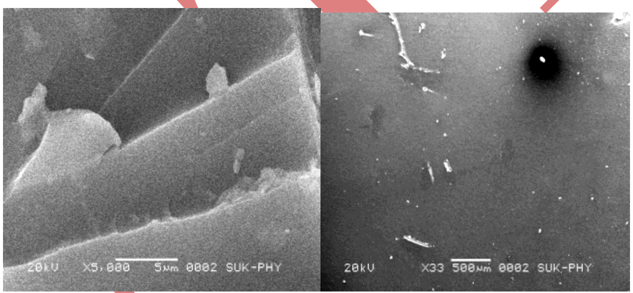

Fig No 04 High magnified crack propagation 4C (left) black agglomerates formed in CNF_EP combination 4D (right)

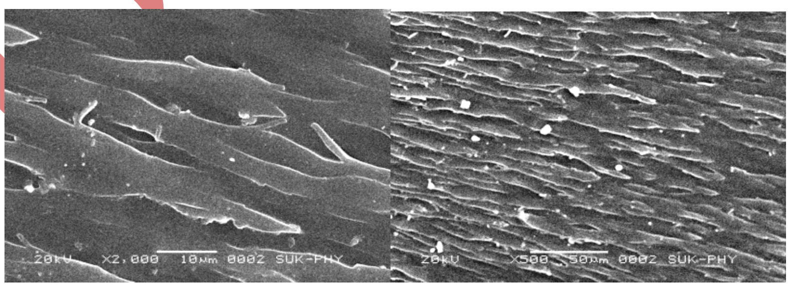

Fig no 04: Fracture surface for bending specimens with CNF_EP and rice husk resin initial cracks (left)E magnified image (right)F.

5. CONCLUSION

THE FOLLOWING CONCLUSIONS ARE DRAWN FROM THIS PRESENT STUDY.

5.1 CNF–EP composites

Mechanical tests were conducted on epoxy resin filled with carbon nanofiber (CNF).The optimal CNF content was 1.0wt. % as decided from literature survey.Which produces the highest improvement in mechanical strength as compared to the neat epoxy resin. The composite fabricated with epoxy filled1.0wt. % CNF produced 25.3% improvement in tensile properties, 45% in flexural strength and 40% in deformation in case of compressive properties.

5.2 RICE husk_ EP composite

The Rice-Husk which is an agricultural waste product of the rice mill and cannot be decomposed easily can be successfully utilized to produce natural fiber polymer composite by suitably bonding with epoxy resin. The addition of Rice-Husk fiber into neat epoxy significantly improved the mechanical properties of the material.10% weight fraction RH fiber gives the best result for 23% in tensile.35% in bend test results and also 20% in compressive strength increase in results as compare neat epoxy composite material. The RH fibers contain the silica which contributes in improving the hardness of the composite material.

The surface modification of fiber by chemical treatment improves the fiber matrix adhesion which further enhances the mechanical properties of the composite. The alkali treatment provides the highest improvement in strength in comparison treatment.

5.3 CNF-RICE HUSK – EP composite

In this combination surface area of the rice husk fibers, was significantly higher than the CNF surface area. Combined with the high aspect ratio of the rice husk fibers, made possible higher volume loadings of rice husk particles in the polymer compared with the maximum loading is attained with the nano fibers. Consequently, presence of combined effect both it exhibits the higher mechanical properties then other combination.

REFERENCES:

[1]Daniel R. Bortz, César Merino, Ignacio Martin-Gullon;Carbon nanofibers enhance the fracture toughness and fatigue performance of a structural epoxy system 71 (2011) 31–38.

[2]Wei-Jen Chena, Yi-Luen Li, Chin-Lung Chiang, Chen-FengKuan, Hsu-Chiang Kuan,Tzu-Ting Lin, Ming-Chuen Yip;Preparation and characterization of carbon nanofiber/epoxy resin nano-prepreg for nano composite.Journal of Physics and Chemistry of Solids 71 (2010) 431–435.

[3]Dispersion and alignment of carbon nanotubes in polymer matrix: A review;Xiao-LiXie, Yiu-Wing Mai,Xing-Ping Zhou;Materials Science and Engineering R 49 (2005) 89–112

[4]Improvement in mechanical properties of carbon fabric–epoxy composite using carbon nanofibers;Yuanxin Zhou, FarhanaPervin, ShaikJeelani, P.K. Mallick1 9 8 (2008)445–453

[5]Experimental study of mechanical and electrical properties of carbon nanofiber/ epoxy compositesSmrutisikhaBal; Scientist, Department of Metallurgical and Materials Engineering, N. I. T., Rourkela ;PIN: 769008, INDIA

[6]Mechanical proper ties of surf act ant-coating Carbon nanofiber/epoxy composite;ZHE YING, JIN-HONG DU, SHUO BAI, FENG LI,CHANG LIU, and HUI-MInternational Journal of Nanoscience, Vol. 1, Nos. 5 & 6 (2002) 1{6 ING CHENG;

[8]Nano materials, nano technologies and design by Michanel F.Ashby1stedition 2011,page no1 to 15

[9] Effect of chemical treatment on rice husk reinforced with polyethylene composites: Md.rezaur. Mdnazural slamzar.md Monimul.bioresoures volume 5(2),859-869.

[10]Effect of Chemical treatment on Flexure Properties of Natural Fiber-reinforced Polyester Composite: Mansour Rokbi, HocineOsmani, AbdellatifImad, NoureddineBenseddiqMansour Rokbi et al. / Procedia Engineering 10 (2011) 2092–2097.