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AN EXPERIMENTAL WORK ON EPOXY, BANANA FIBER&E GLASS FIBER COMPOSITES

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Abstract:-There are basic two phase of composite material, in which one is known as matrix material and another one is called reinforcing material. The reinforcing material is embedded over matrix material. The matrix material is continuous phase and reinforcing is discontinuous phase. The reinforcing phase is much harder than matrix phase. In composite material matrix phase removes the stresses between reinforcing phase and also protect from mechanical and environmental damage. The function of reinforcing material is to improve mechanical and thermal properties of composites.
Keyword:- Material Study , Composite Study , Mechanical Properties

1.Introduction

Synthetic fibers like glass fiber, nylon, carbon fiber etc. are considered to be potential filler material for various applications like wear resistant and structural components. Glass fiber reinforced polymer matrix composites are important engineering materials, mainly because of their low density in combination with excellent specific stiffness and strength. This synthetic fiber is found to be potential filler for improving strength capability of various polymers because of its high value of elastic modulus. But these synthetic fiber reinforced polymer composite have some disadvantages like they are corrosive and toxic in nature, higher cost and non-recyclable. It is remarkable to note that natural fibers such as sisal, jute, coconut coir, rice husk, banana etc. are richly available but are not optimally utilized. At present, the use of these fibers are in the production of mats, ropes, yarns and matting as well as in production of fancy articles like table mats, handbags, wall hanging and purses. Cotton, banana and pineapple are also used in making cloth in addition to being used in the paper industry. With growing environmental responsiveness and ecological concern, attention towards natural fiber reinforced composites have increased during the recent decades. The composites have many advantages, including low cost, light weight, nontoxic, biodegradable etc. Various natural fillers like pineapple, sisal and bamboo, coconut coir, jute etc. as the reinforcements in composites have been reported earlier. Apart from this, natural fibers possess very low strength and relative high moisture absorption which is much higher than synthetic fiber. This makes limited use of natural fibers in high strength applications.So, there has been a focus to fabricate a kind of light, porous material with better mechanical strength as well as light weight property.

2.Literature Survey

A great deal of work has been reported by many researchers on glass fiber based polymer composites. Z. Ahmad et al. studied that the effect of oil palm wood flour (OPWF) filler on impact strength of glass-fiber reinforced epoxy composite. In the present study, oil palm wood flour (OPWF) particles with less than 250 urn sizes have been used as filler materials in the woven-glass-fiber reinforced epoxy composite. In this study the impact strength, evaluated using V-notch Charpy method, showed reduction with increasing filler content up to 5 pph and then the strength increment in those composites containing more than 5 pph OPWF.it was found that the impact strength was found to decrease when the samples fractured at subzero temperatures and this happened because of the reduction of the matrix ductility at lower temperatures.Lauke et al. observed that Fracture resistance of unfilled and calcite-particle-filled Acrylonitrile-butadiene-styrene (ABS) composites reinforced by short glass fibers (SGF) under impact load.hereThe composites were studied with respect to the work of fracture (WOF), here the notched Charpy impact energy, determined by the Charpy V-notch impact test. A study on the fracture resistance of unfilled and calcite-filled SGF-reinforced ABS composites under impact load has been performed. The results showed that the interface energy is much higher than the matrix fracture work in the presence of SGF for SGF/ABS and SGF/calcite/ABS composites. S. Sprenger et al. in this study the tensile fatigue behaviour of a silica nanoparticle-modified glass fibre reinforced epoxy composite was investigated. In this study the nanoparticle- modified epoxy resins were used to fabricate glass fibre reinforced plastic (GFRP) composite laminates by resin infusion under flexible tooling (RIFT) technique. Tensile fatigue tests were performed on these composites, during which the matrix cracking and stiffness degradation was monitored.The experimental results showed that The fatigue life of the GFRP composite was increased by about three to four times due to the silica nanoparticles, becauseof Silica nanoparticle debonding and subsequent plastic void growth absorb energy and contribute towards the enhanced fatigue life for the nanoparticle-modified epoxy. Filho et al. this paper describes the influence provided by micro-ceramic particles on the flexural behaviour of glassfibre Composites. In this study a microstructural analysis was performed to evaluate the crack propagation mechanism of reinforced laminate composites under three bending testing.it was found that the use of ceramic particles distributed on the top beam side under bending behaviour contributes not only to the strength improvement, but also compensating the low compressive strength of glass-fibre composites.

G. Dharmalingam et al. The purpose of this work is to establish the tensile, flexural, and impact properties of banana-coir reinforced composite materials with a thermo set for treated and untreated fibers .it was concluded that The tensile and impact tests of treated banana-coir epoxy hybrid composites have higher tensile strength and impact strength than untreated composites. However, untreated fiber composites have greater flexural strength than the treated fiber composites. Sanjay K. Nayak et al.

studied Fabrication and Performance Evaluation on Banana/Glass Fiber-Reinforced Polypropylene Hybrid Composites. This study included Hybrid composites of Polypropylene (PP) reinforced with intimately mixed short banana and glass fibers were fabricated by compression molding with and without the presence maleic anhydride grafted polypropylene (MAPP) as a coupling agent. The result was reported that the BSGRP composites at banana to glass ratio of 15:15 shows improved performance. The maximum improvement in the properties is observed at 30 wt% of fiber loading, which is chosen as the critical fiber loading. Furthermore, the composites and hybrid composites with MAPP exhibited higher mechanical strength as compared with the composites without MAPP

Shashi Shankar et al. studied the effect of different parameters on mechanical behaviour of banana fiber reinforced epoxy composites. It was found that The Ultimate tensile strength value maximum at 15% (45.18Mpa) and decreasing starting from 15% to 20% (45.18Mpa to 38.30 Mpa) of the fiber. The flexural strength value slightly decreasing from 5% (92.12%Mpa) to 10% (87.31Mpa) and after that the value increased from 10% to 20% (87.31 Mpa to 321.38 Mpa) of the fiber. The alteration in the tensile strength depends on the kind of fiber that can be caused by other factors, such as the fiber length, and hydrophilicity as well as the difference in the chemical nature of the fiber. Shinji Ochi et al. describe the cultivation of kenaf and application to biodegradable composite materials included Mechanical properties of kenaf/PLA composites. Experimental results showed that The unidirectional fiber-reinforced composites showed tensile and flexural strengths of 223 MPa and 254 MPa, respectively. Moreover tensile and flexural strength and elastic moduli of the kenaf fiber-reinforced composites increased linearly up to a fiber content of 50%. M. Sain et al. was investigated the potential of wheat straw fibers prepared by mechanical and chemical processes as reinforcing additives for thermoplastics . It was concluded that Composites prepared with chemically processed wheat straw fibers showed comparatively lower strength properties compared to mechanically processed fibers.

Materials

This chapter describes the materials and methods used for the processing of the composites under this investigation. It presents the details of the characterization and various mechanical tests which the composite samples are subjected. The numerical methodology related to the determination of maximum stress generating in tested samples on finite element method is also presented in this chapter.

3.1 Raw materials

Raw materials used in this experimental work are listed below:

3.1.1 Matrix material: Epoxy

3.1.2 Filler material 1: Banana fiber

3.1.3 Filler material 2: E glass fiber

4.1 Mechanical tests

4.1.1 Tensile test

Tensile strength of composites materials are mainly decided by the fiber strength as well as fiber contents. So variation in composites strength with different fiber loading is obvious. The effect of fibre loading on the tensile strength and modulus are shown in Table 4.1

Table 4.1: Tensile strength and tensile modulus of samples

Designation	Composition	Tensile strength (MPa)	Young's modulus (MPa)
C_1	90wt% Epoxy + 10wt% Fiber	2.807	650.581
C_2	85wt% Epoxy + 15wt% Fiber	11.550	2385.414
C_3	80wt% Epoxy + 20wt% Fiber	18.991	2425.076
C_4	75wt% Epoxy + 25wt% Fiber	25.111	2144.789

Figure 1 A gradually increase in tensile strength can be observed with the increase in the fiber loading up to 25 wt% of banana/glass epoxy based hybrid composites. It is noted that the addition of fibers helps to increase the tensile strength of the banana/glass hybrid composites because tensile strength of banana as well as glass fiber is much higher than the epoxy and proper adhesion between the both types of fiber and the matrix gives continuously increment in tensile strength of composite as increases fiber wt%. Similar results have been obtained with banana/sisal/polyester composites.

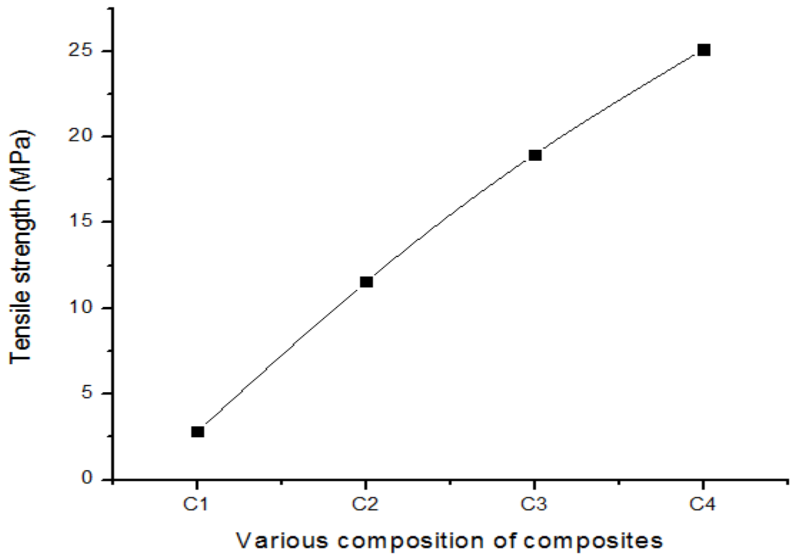

Figure 4.1: Tensile strength for different composition of composites

Figure 4.2 shows the variation in tensile modulus of samples C1, C2, C3 and C4. Maximum tensile modulus obtained for composite C3 (80wt% Epoxy + 20wt% Fiber) is 2425.076 MPa. Further addition of fibers reduces tensile modulus. Tensile modulus for sample C4 (75wt% Epoxy + 25wt% Fiber), is 2144.789 MPa. The increasing trend in tensile modulus up to 20 wt.%, is due to strong interfacial bonding among glass fiber, epoxy and banana fiber and then decreasing trend to 25wt. % is due to poor adhesion among glass fiber, epoxy and banana fiber. from fig it is noted that there is much difference in tensile modulus of samples C1 and C2 , it is because of increasing in fiber wt% from sample C_1 to C_2. But tensile modulus of samples C_2 , C_3 shows very less difference, and sample C_4 shows decreasing trend of tensile modulus. It can be observed that with increase in fiber loading tensile modulus increases but when the excess amount of fiber is added with respect to amount of binder say epoxy, accumulation of fiber is spotted in composite plate, which affects the tensile modulus of composite. Here accumulation of fibers occurred from sample C_3 to C_4. Due to fiber accumulation, tensile modulus of C_2 and C_3shows very less difference. Accumulation of fiber also serves the decreasing trend of tensile modulus in sample C_4 either increase in fiber loading.

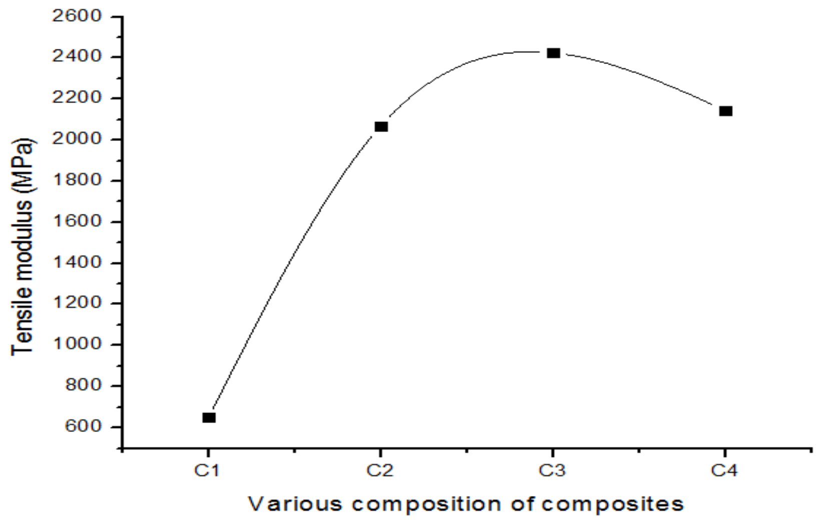

Figure 4.2: Tensile modulus for different composition of composites

Figure 4.3 shows the load-displacement curve for composite sample C1 (90wt% Epoxy + 10wt% Fiber). The slop of the initial half portion of the curve is more than the another half portion i.e. for the same elongation in first half portion take, more load as compared to another half portion. Breaking of the specimen of this composition occurs at peak load of 0.19402 kN.

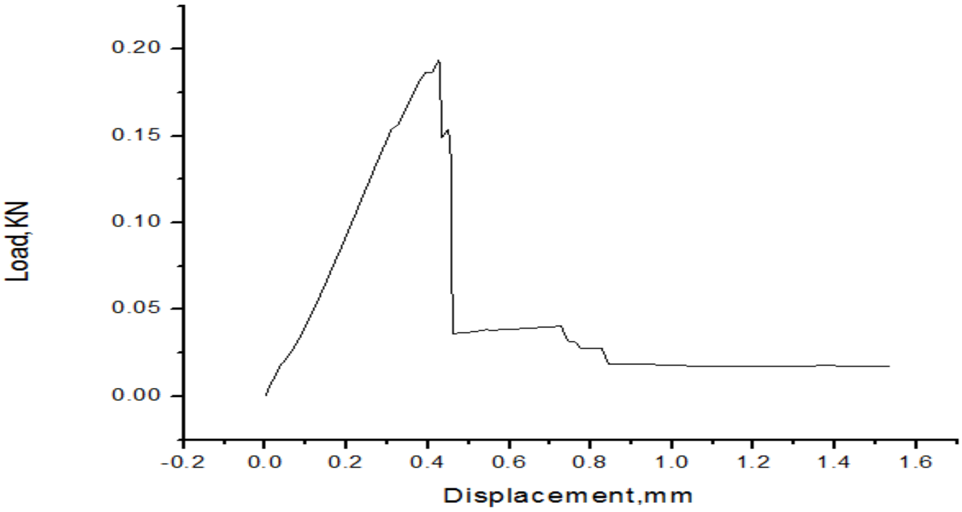

Figure 4.3: Load- displacement curve for (90wt% Epoxy + 10wt% Fiber) composite C1

Figure 4.4 is the load-displacement curve for composite sample C2 (85wt% Epoxy + 15wt% Fiber). 5 wt% additions of fibers results in increase in peak load i.e. to 0.93734 kN. The curve revels that displacement as well as strain for this composition (C2) is less than the composition (C1) i.e. resistance to straining has increased.

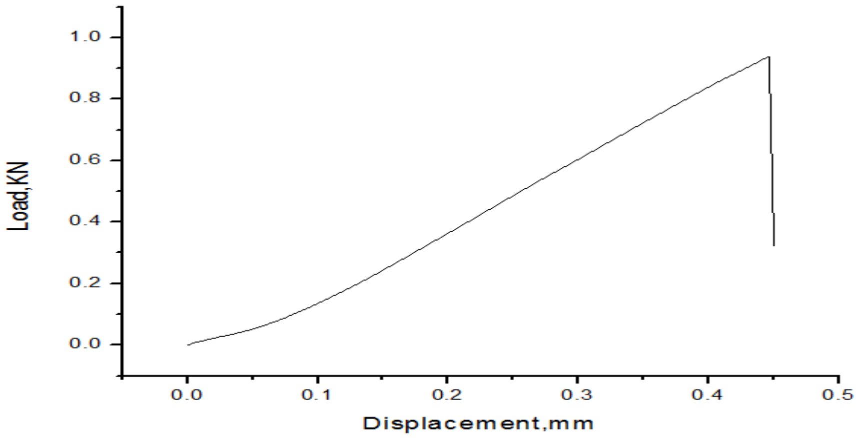

Figure 4.4: Load- displacement curve for (85wt% Epoxy + 15wt% Fiber) composite C2

Figure 4.5 shows the load-displacement curve for composite sample C3 (80wt% Epoxy + 20wt% Fiber). Composite with 20 wt.% total fiber break with maximum load of 1.42775 kN and maximum displacement is 0.74749 mm.

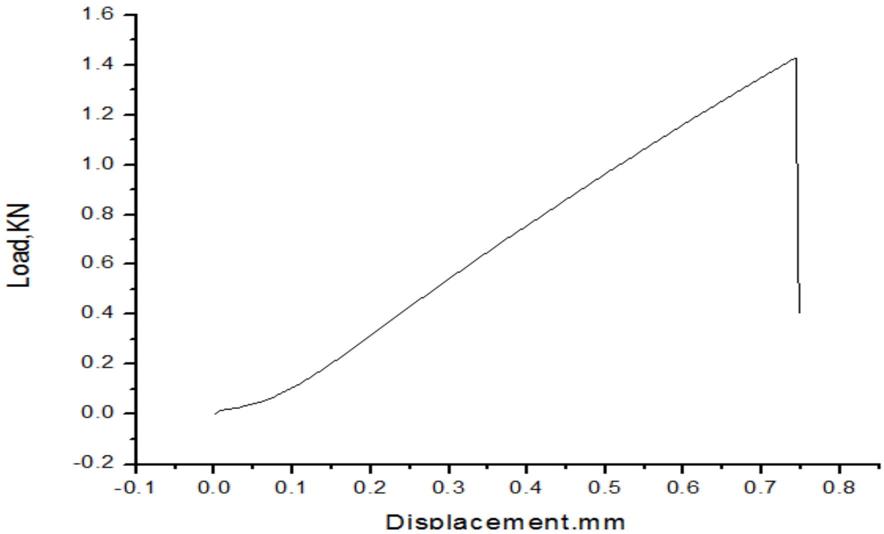

Figure 4.5: Load- displacement curve for (80wt% Epoxy + 20wt% Fiber) composite C3

Figure 4.6 shows the load-displacement curve for composite sample C4 (75wt% Epoxy + 25wt% Fiber). For this composition, peak load obtained is 2.10879 kN. Maximum displacement is 1.34062 mm which is less than that of composition C1, C2, and C3.

From all the load- displacement diagram it is observed that, maximum displacement decreases with increase in reinforcement in composites which shows that the brittleness of composite is increased with increase in reinforcement content.

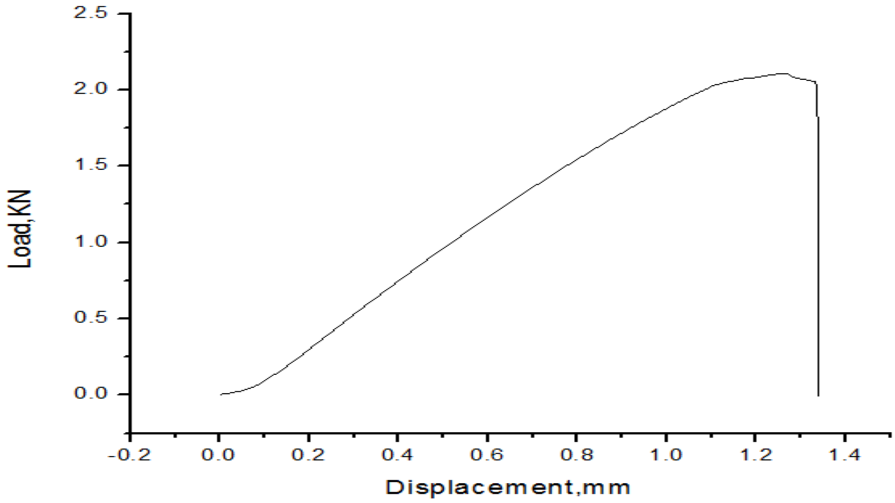

Figure 4.6: Load- displacement curve for (75wt% Epoxy + 25wt% Fiber) composite C_4

4.1.2 Flexural strength

The variations in flexural strength of the composites, as a function of the fiber loading content, measured using three point bending tests are tabulated in table 4.2**.** As far as the effect of fiber loading is concerned, composites with 25wt% fiber loading shows better flexural strength value as compared to 10,15,20 wt% fiber loading. The maximum flexural strength of 61.962 MPa is observed for composites with 25 wt% fiber loading.

Table 4.2: Flexural strength of various samples

Designation	Composition	Flexural strength (Mpa)
C_1	90wt% Epoxy +10wt% Fiber	25.11
C_2	85wt% Epoxy +15wt% Fiber	29.899
C_3	80wt% Epoxy +20wt% Fiber	44.393
C_4	75wt% Epoxy +25wt% Fiber	61.962

Figure 4.7 shows flexural strength of different combination of banana/glass hybrid fiber epoxy composites. The experimental results shows that, the flexural strength of 10% weight fibers epoxy composites is 25.11 MPa, which is increased to 29.899 MPa , 44.393 and 61.962 MPa by the reinforcing with 15%, 20% and 25% weight of fibers respectively. The reason behind increase in flexural strength is strong interfacial bonding between fibers and epoxy which act as mechanical interlocking between banana/glass fiber and epoxy. This creates a high friction coefficient. Investigations have shown that the similar results have been obtained by Thomas et al. [26] with banana/sisal/polyester composites.

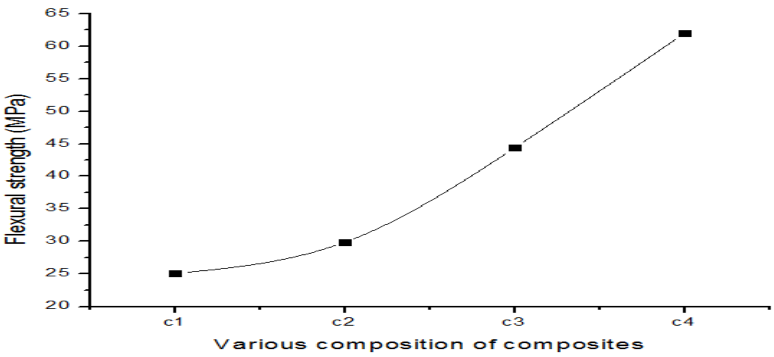

Figure 4.7: Flexural strength of composites

4.1.3 Hardness test

The measured hardness values of samples C1, C2, C3 and C4 are presented in table 4.3.

Table 4.3: Measured hardness of various samples

Designation	Composition	Hardness (Shore D)
C_1	90wt% Epoxy +10wt% Fiber	81.621
C_2	85wt% Epoxy +15wt% Fiber	83.455
C_3	80wt% Epoxy +20wt% Fiber	84.229
C_4	75wt% Epoxy + 25wt% Fiber	85.783

Figure 4.8 shows the variation of hardness for different combination of weight percentage of fiber in hybrid composites samples. From the investigation it was found that the hardness of composites samples increases with the increase in fiber loading of all composites samples. It is due to in all composites samples such as C1, C2, C3 and C4 with the increase in the fiber loading, porosity become less. It have been seen that due to increase in fiber loading randomization of fibers decreases which is the main reason of increasing hardness with higher weight percentage of fibers epoxy composites samples.

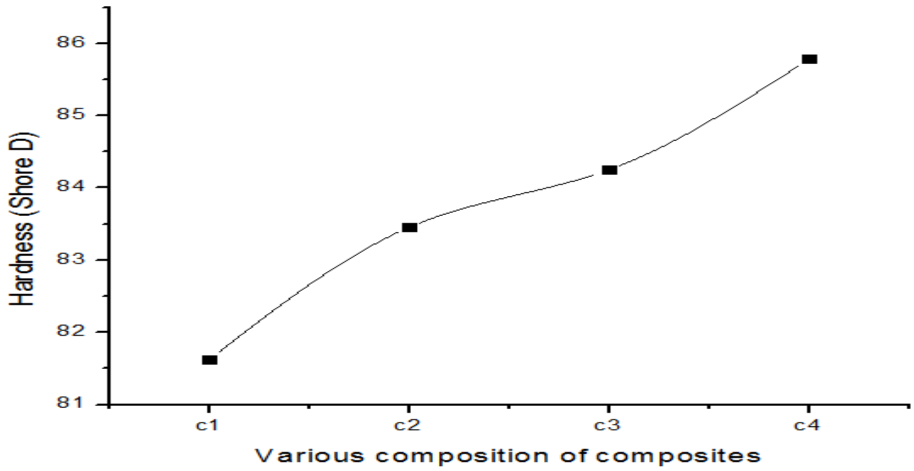

Figure 4.8: Hardness (Shore D) of various composites

The reasons behind the behavior of samples during hardness test are explained as follows: In hardness test, the reinforcement and matrix phase would be pressed together and touch each other more tightly by compressive load. Thus the interface can transfer pressure more effectively although the interfacial bond strength may be poor.

5. Conclusion

Following conclusion are made,

1. Successful fabrication of hybrid banana/glass fiber reinforced epoxy composites by simple hand lay- up technique.
2. Epoxy based banana/glass fiber reinforced hybrid composites can be utilized as structural material.
3. Epoxy based four hybrid composites (C1, C2, C3 and C4) have been fabricated with fiber loading increase from 10 wt% to 25 wt%, keeping constant contribution of each fiber in total percentage of fiber in each samples of composite.
4. The study shows that the tensile and flexural strength increases as the fiber loading in the composite increases. Both the strength analysis shows approximate same result with experimental one.
5. Finally optimum mechanical properties are obtained for composition C4 (75wt% Epoxy + 25wt% Fiber).
6. It has been noticed that the mechanical properties of the composites such as hardness, tensile strength and flexural strength are influenced by the fiber loading. A gradually increase in tensile and flexural strength can be observed with the increase in the fiber loading up to 25 wt% of composites.
7. It can be observed that the tensile modulus increases up to 20 wt% of total fiber then decreasing trend occur from 25 wt% of fibers which shows variation in the tensile modulus irrespective of fiber loading.
8. Hardness value increases continuously by increasing the fiberwt% in composites. Hardness is maximum with composition C4 (75wt% Epoxy + 25wt% Fiber) as compared to pure epoxy.

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