IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified

Vol. 3, Issue 9, September 2016

Experimental Investigation on Tensile and Damping Properties of Flyash Reinforced Glass Fiber Epoxy Composites

S. Bharat Babu[1], Dr. B. Nagaraju[2], K. Naresh Kumar[3], J.V. Bhanu Tej[4]

P.G. Scholar, Department of Mechanical Engineering, ANITS College, Andhra Pradesh, India[1]

Professor, Department of Mechanical Engineering, ANITS College, Andhra Pradesh, India[2]

Assistant Professor, Department of Mechanical Engineering, ANITS College, Andhra Pradesh, India[3, 4]

Abstract: Glass Fiber Reinforced Epoxy (GFRE) composites are one of the most widely used in structural engineering components like Turbine blades, Airplane wings, and helicopter blades as well as in many others in aerospace, mechanical and civil industries. Most of these structural components are subjected to dynamic loadings where the damage results from resonant vibrations. In this project fly ash powder is mixed with epoxy resin and Flyash reinforced glass fiber epoxy composites are fabricated using hand lay-up process by varying the different weight percentages (0%, 5%, 10%, 15%, and 20%) of fly ash. The tensile strength of these specimens are found experimentally by Universal Testing Machine(UTM).The free vibration behavior of fly ash reinforced glass fiber epoxy composites is studied in fix-free boundary conditions using impact hammer technique. The objective of this project is to study the influence of flyash on glass fiber epoxy composites to know the behavior of tensile and damping properties. Experimental results shows that the tensile and damping properties are improved very much for 5% Flyash reinforced GFRE composites.

Keywords: Glass fiber, Epoxy resin, Flyash, Hand lay-up method, FFT analyzer.

I. INTRODUCTION

Composite materials at those that are formed by the combination of two or more materials to achieve properties those are superior to that of its constituents. Generally composite material is composed of reinforcement embedded in a matrix. When designed properly the new combined material exhibits better strength than would each individual material.

In recent years most of the manufacturing plants like aerospace, automotive industries are using glass fiber reinforced composites as they offer a high strength and modulus compared to other metallic materials.

The main advantage of these composite materials is their excellent surface finish, high strength to weight ratio, low density and fatigue damage tolerance. Hence, fiber reinforced composites are emerging as the substitution for other commercially available metals in preparing most of the components in automotive and aerospace industries where weight of the component is the critical factor.

Because of their higher impact strengths, high strength to weight ratios, glass fibers are widely used in many industrial applications. In order to improve the tensile properties of glass fiber reinforced components, a method a was proposed to mix the flyash powder whose particle size ranging from 53 to 78μm to epoxy resin[1].Since flyash possess a good damping properties, the addition of flyash also improves damping qualities in situations where components are subjected to dynamic loading.

II. LITERATURE REVIEW

This section presents the literature review of similar works done previously in the area of composite materials.

Manoj singla and vikas chawla [1] have done their project on mechanical properties of epoxy resin flyash composites. In their work, the specimens in the form of cube of size 10 mm×10 mm×10 mm are prepared by using glass fiber epoxy composites with fly ash as filler material by taking different weight percentages of glass fibers. The mechanical properties such as tensile strength, compressive strength, impact strength are determined experimentally. The fracture behavior of composite is studied with SEM. From SEM analysis, it has been found that flyash particles have been uniformly segregated.

Mohammed F.Aly et al [2] have done their research on experimental investigation on dynamic characteristics of laminated composite beams. In their work, they made some beams using hand layup process. Glass fiber is used as reinforcement in the form of bidirectional fabric and general purpose polyester resin is used as matrix for the composite material of beams. The experimental dynamic tests are carried out sing specimens with different fiber orientations. From the results, the influence of fiber orientations on flexural natural frequency is investigated. These experiments are used to validate the results obtained from finite element software ANSYS.

Maria Virginia Gelfuso, Daniel Thomazini, Julio Cesae silva de souza [3] has done their project on vibrational analysis of coconut fiber composites. In this project, the polymer with coconut fiber composites were made by injection processing and mechanically characterized by tensile and dynamic testing. Dynamic tests were performed to coconut fiber Polypropylene composites. The results showed that the young's modulus decreases with increase in coconut fiber content upto 15% of coconut fiber and again it increases at 20% of coconut fiber.

MR Doddamani and SM Kulakarni [3] have investigated on dynamic response of flyash reinforced functionally graded rubber composite sandwiches using taguchi approach. They presented the dynamic analysis of Jute-Epoxy sandwiches with flyash reinforced functionally gradient (FG) flexible, compound rubber core.

These samples were prepared using conventional casting techniques. They made a study on influence of flyash weight fraction, jute orientation and core to total thickness of sandwich on damping ratio and natural frequency. The design of experiments is based upon orthogonal array of Taguchi method. They developed a correlating equation from the results of Taguchi experimental design as a predictive equation for estimation of the properties of sandwiches .It is concluded that the predicted results are in correlation with the experimental observations.

N.Nayak, et al [5] have done experimental numerical study on vibration and buckling characteristics of Glass-epoxy hybrid composite plates. They made the hybrid composites using glass-carbon reinforced epoxy composites using hand lay-up process. They investigated the effect of lamination sequence on the nodal frequency of vibration and buckling strength of these hybrid panes.

The vibration study was carried out using B&K FFT analyzer, accelerometer &impact hammer excitation. Buckling tests were conducted using INSTRON 1195 to obtain the critical buckling load for various lamination sequences. The experimental results are compared with numerical predictions using FEM based software package ANSYS 13.0.A very good agreement was observed between experimental and ANSYS results.

III. MATERIALS USED FOR FABRICATION

In order to fabricate the Flyash reinforced glass fiber epoxy composites, the following materials are used.

A. E -Glass fiber (woven roving mat)

E-Glass has been used extensively in polymer matrix composites, commonly termed "fiberglass". These materials exhibit good mechanical properties.

Another type of glass fiber most commonly used in industrial applications is S-Glass. An E-glass fiber is a coarse fabric in which fibers are continuously woven roving in two perpendicular directions as shown in Fig1.The properties of E-Glass fiber is as shown in TABLE 1.

TABLE 1 Properties of E-Glass fiber

Density (g/cm^3)	Tensile strength (MPa)	Young's modulus (GPa)	Poisson's Ratio
2.6	2050	85	0.23

B. Epoxy resin

Epoxy resins are formed from a long chain molecular structure similar to vinyl ester with reactive fiber at either end. Epoxy resin is easily and quickly curved at any temperature from 5^0 to 15^0c depending on the choice of curing agent. In this work, Araldite ly 556 is used as epoxy resin.

Fig1 woven roving mat

C. Hardner

Hardner is used as a curing agent which is mixed with resin in appropriate proportions which helps to solidify the wet composite. Generally, the hardner and epoxy resin having ratio 1:2 is used in composite fabrication.

D. Flyash

Flyash is one of the naturally occurring product from the coal combustion process and it is used as partial replacement for Portland cement used in producing concrete. The size of flyash particles ranges from 0.5µm to 100µm.The major constituents of flyash are Silicon Dioxide (SiO_2), aluminium oxide (Al_2O_3), and calcium oxide (CaO)

IV. FABRICATION OF COMPOSITES

Hand lay-up technique

Hand lay-up technique is the simplest and oldest open molding method of composite fabrication process. In this work, flyash powder of different weight percentages (0%,5%,10%,15%,10%) are mixed with epoxy-hardner mixture and fiber reinforcements and flyash epoxy mixture are placed manually against the mold surface as shown in Fig2.The thickness is controlled by layers placed against the mold. After the preparation of specimens, the

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 3, Issue 9, September 2016

workpieces are cured for 24 to 36 hrs so that work pieces will get hard. After this, the specimens were cut according to ASTM standards using cutting machine. The designations of work pieces are shown in TABLE 2.

Fig 2 Fabrication by hand lay-up method

TABLE 2 Designation of work pieces

Designation	Composition
B1	50%Glass fiber+50%Epoxy
B2	50%glass fiber+45%epoxy+5%flyash
B3	50%glass fiber+40%epoxy+10%flyash
B4	50%glass fiber+35%epoxy+15%flyash
B5	50%glass fiber+30%epoxy+20%flyash

V. EXPERIMENTAL WORK

A. Tensile properties of flyash reinforced glass fiber epoxy composites

In order to know the tensile properties of fly ash reinforced composites in different weight percentages of flyash, the specimens are cut according to ASTM D 638 standards as shown in Fig3.These specimens are loaded in computerized Universal Testing Machine(UTM) of TUE-C600 as shown in Fig4.The tensile strength and Young's modulus values are tabulated in TABLE 3.The specimens before & after the tensile test are reported in Fig 5 &6 respectively.

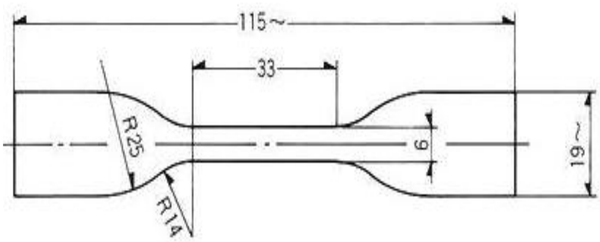

Fig 3 ASTM standard for tensile testing

Fig 4 Universal Testing Machine (UTM)

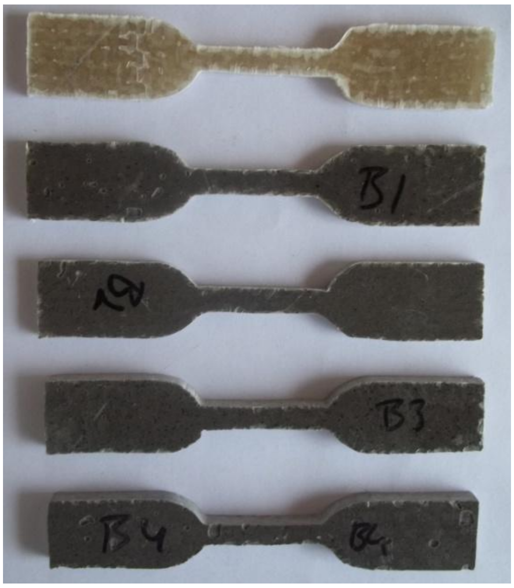

Fig 5 Specimens before testing

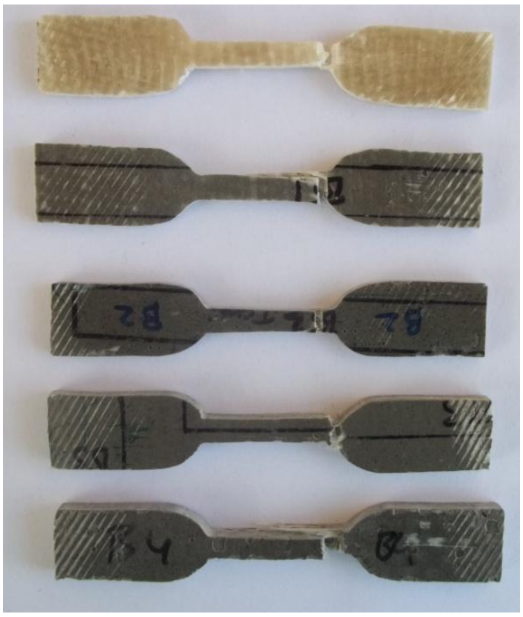

Fig 6 Specimens after testing

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 3, Issue 9, September 2016

B. Dynamic properties of Flyash reinforced Glass Fiber Epoxy Composites:

Natural frequencies and damping ratio of flyash reinforced glass fiber epoxy composites are determined using Impact Hammer test. The samples are cut from the laminates in the form of beam of dimensions 190mm×20mm×5mm. The specimens are clamped in the bench vice in the form of cantilever beam of span 140mm.The equipment used for vibration testing are shown in Fig 7 & 8 respectively

1 Impact hammer(Model number 2302-5)
2 Accelerometer(B&K type 4507)
3 FFT analyzer(Model CoCo-80)

The connections of FFTanalyzer,accelerometer,Impact hammer and cables to the system were done as specifications. The accelerometer is placed near the free end of the beam to record the vibration signals. The experiment is conducted as cantilever beam in fix-free boundary conditions.

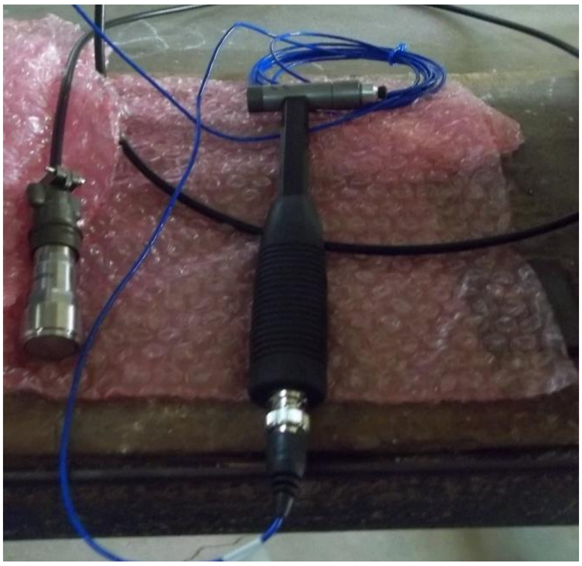

Fig 7 Impact hammer and accelerometer

Fig 8 FFT analyzer

The free vibration anaysis is initiated by exciting the beam with Impact hammer.As a result,the beam starts vibarting with natural frequency. Impact testing for remaining specimens is conducted by repeating the above procedure and corresponding frequencies curves are saved in FFT analyzer. The resulting frequency response functions are transmitted from FFT analyzer to a computer for modal parameter extractions using EDM (Engineering Data Management) software.

The frequency response curve obtained for B1 Specimen is shown in Fig 9.The natural frequencies obatined for different mode shapes are shown TABLE 4

Fig 9 Impact hammer test procedure

Damping Measurement:

Damping ratio is calculated by half wave bandwidth technique by calculating Q fator.Q factor is calculated by taking reference bandwidth of 3db below the peak value as shown in Fig 10

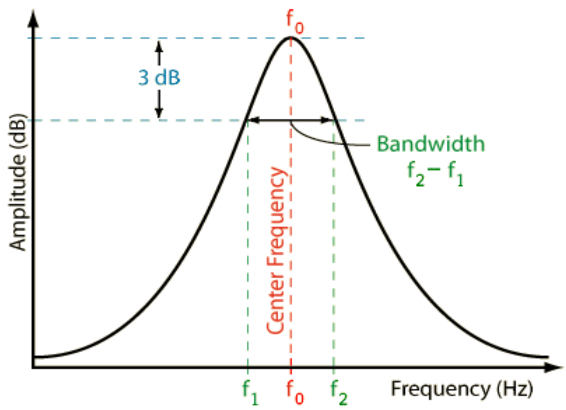

Fig 10 Half wave bandwidth technique

Q factor is given by

$$Q = \frac{fn}{f1 - f2}$$

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 3, Issue 9, September 2016

Now damping ratio zeta(ζ) is given by

$$\zeta = \frac{1}{2Q}$$

VI. RESULTS AND DISCUSSION

The experimental results obtained for tensile & damping test were reported in TABLE 3,4 & 5

TABLE 3 TENSILE STRENGTH OF COMPOSITES

Type of composite	**Tensile strength (N/mm^2)**	**Young's Modulus (MPa)**
B1	355	2343
B2	451	3712.5
B3	403	2112
B4	412	2719.47
B5	449	2963.69

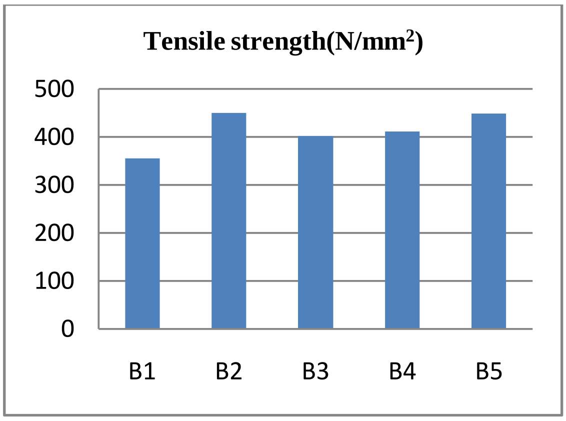

Fig 11 Variation of tensile strengh of different flyash percentages

It is infered from the Fig 11 that tensile strength was found to be more for 5% Fly ash reinforced glass fiber epoxy composites.

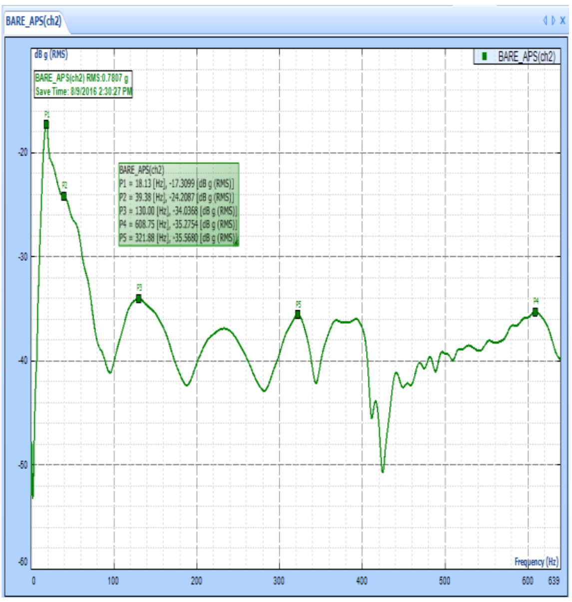

Fig 12 Frequency Vs dB curve for B1 specimen

TABLE 4 Natural frequencies of Flyash reinforced glass fiber composites

Type of composite	Natural frequencies(Hz)		
	Mode1	Mode2	Mode3
B1	18.13	39.38	130
B2	36.15	73.84	149.67
B3	21.25	51.63	141.26
B4	31.25	62.25	148.38
B5	18.13	40.38	138

TABLE 5 Damping ratos for Flyash reinforced glass fiber composites

Composite type	Damping Ratio
B1	0.551
B2	0.579
B3	0.524
B4	0.544
B5	0.589

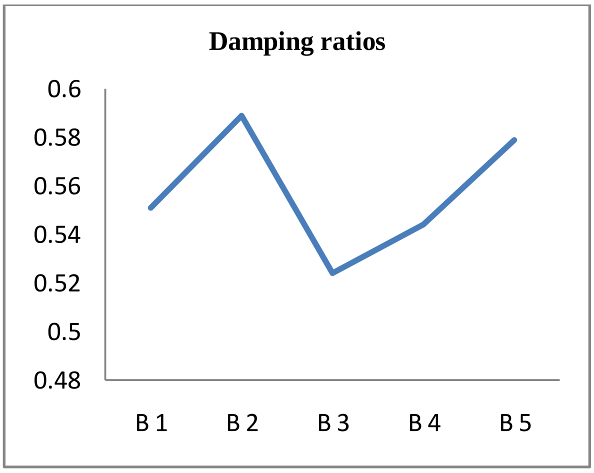

Fig 13 Variation of Damping ratios for different Flyash percentages

It was observed from the Fig 12 that maximum damping ratio is obatined for 5% Flyash reinforced glassfiber epoxy composites.

VII. CONCLUSION

Experimental investigation on Tensile and Damping properties of Fly ash reinforced Glass fiber epoxy composites with different weight percentages (0%,5%,10%,15%,20%) are done in this work.

The results concluded that

1. The maximum tensile strength is found to be more for a composite having 5% Flyash reinforced GFRE composites.
2. The natural frequencies and damping ratios are more for composite having 5% Flyash reinforced GFRE composites.

It is due to agglomeration of Flyash particles which can increase the stress concentration in the structure of polymer matrix which results in decrease of damping properties.

REFERENCES

[1] Manoj singla and vikas chawla of RIEIT, Railmajra district, Nawanshahr "Mechanical properties of epoxy resin flyash composites", Journal of minerals and materials characterization and engineering,Vol.9,No.3,PP 199-210,2010

[2] Mohammed F.Aly, IGM Goda and Glala A. Hassan ,"Experimental investigation on dynamic characteristics of laminated composite beams", International journal of mechanical and Mechatronics,IJMME-IJENS,Vol:10 No:3

[3] Maria Virginia Gelfuso, Daniel Thomazini, Julio Cesae silva de souza of Itajuba Federal University, Brazil, "Vibrational analysis of coconut fiber composites", Materials research,2014;17(2):367-372

[4] M.R.Doddamani, S.M.Kulakarni of National institute of technology, Surathkal-575025 "Dynamic response of flyash reinforced functionally graded rubber composite sandwiches using taguchi approach", International journal of engineering, science and technology, Vol 3,No.1,2011,PP 166-182

[5] N.Nayak, S.Meher and S.K.Sahu of Department of civil engineering, NIT Rourkela, India, "Vibration and buckling characteristics of Glass-epoxy hybrid composite plates", Proc.of International conference on Advances in civil engineering, AETACE

[6] P.Ganesa and S.Thirumavalan of department of mechanical engineering, Bharath University, Chennai "Free vibration behavior of glass fiber reinforced polymer composite", Middle east journal of scientific research 20(6):734-737,2014

[7] Sharayu U. Ratnaparkhi, S.S.Sarnobat, "Vibration analysis of composite plate", International journal of modern engineering research(IJMER) Vol.3,Issue1,Jan-Feb 2013,PP 377-380

[8] S.Pichi Reddy, P.V.Chandra sekhar rao, A.Chennakesava Reddy,G.Parameswari "Tensile and flexural strength of glass fiber epoxy composites", International conference on Advanced materials and manufacturing technology(AMMT) December 18-20,2014

[9] Ganesa B,Keerthi kumara.J, "Effect of cerium oxide as filler material on E glass fiber/epoxy reinforced polymer composites", International journal of development research vol.6,Issue04,PP 7425-7428,April 2016