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DYNAMIC ANALYSIS OF GLASS FIBER REINFORCED UNSATURATED POLYESTER RESIN COMPOSITE

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Abstract : This study has been undertaken to investigate the determinants of stock returns in Karachi Stock Exchange (KSE) using two assets pricing models the classical Capital Asset Pricing Model and Arbitrage Pricing Theory model. To test the CAPM market return is used and macroeconomic variables are used to test the APT. The macroeconomic variables include inflation, oil prices, interest rate and exchange rate. For the very purpose monthly time series data has been arranged from Jan 2010 to Dec 2014. The analytical framework contains**.**

IndexTerms **- Glass fibers- unsaturated polyester- automobile application- different fiber loadings.**

I. INTRODUCTION

Composite materials produce combination properties of two or more materials that cannot be achieved by either fiber or matrix when they are acting alone. Fiber-reinforced composites were successfully used for many decades for all engineering applications. Application of polymer materials in many engineering application have enhanced the corrosion resistance and improved strength of many structures as witnessed in construction and building industries. Key of the factors that influence the properties of these composites are determined by fibre loading and orientation. Fibre loading enhances the strength of polymer composite and this property also determines the mechanical and corrosion wear behavior of any reinforced composites. Polymers are particularly attractive as matrix materials because they are easily process able and their density is comparatively low when compared to other materials. They exhibit excellent mechanical properties. High-temperature resins are used as composite materials are currently used in the manufacture of high-speed aircrafts, rockets and other related space and electronics. The reinforcements share the major load especially when a composite consists of fibre reinforcements dispersed in a weak matrix. Composite materials are one of the most significant inventions of the material sciences. Composite materials are used in furniture, packaging, assembly boards, paneling, fencing, kitchen to civil constructions, automobile and marine industries, military purposes and even space or aircraft manufacturing. So, composites are a versatile and valuable family of materials that can be used in many fields with high quality and low cost applications. Currently, synthetic fiber-reinforced thermoplastic composites are widely used because of their excellent mechanical properties and durability. Composite materials produce a combination property of two or more materials that cannot be achieved by either fiber or matrix when they are acting alone. Fiberreinforced composites were successfully used for many decades for all engineering applications. Glass fiber-reinforced polyester (GFRP) composites were most commonly used in the manufacture of composite materials due to their low cost, high tensile strength, high chemical resistance, and insulating 2 properties. The matrix comprised organic, polyester, thermo stable, vinylester, phenolic and epoxy resins. Suitable compositions and orientation of fibers made desired properties and functional characteristics of GFRP composites was equal to steel, had higher stiffness than aluminum and the specific gravity was onequarter of the steel. The various GF reinforcements like long longitudinal, woven mat, chopped fiber (distinct) and chopped mat in the composites have been produced to enhance the mechanical and tribological properties of the composites . Glass fiber reinforced unsaturated polyester resin (UPR) composite materials have become the alternatives of conventional structural materials, such as wood and steel in some applications, because of its good mechanical properties. Mechanical properties of fiber-reinforced UPR composites depend on the properties of the constituent materials, the nature of the interfacial bonds, the mechanisms of load transfer at the inter-phase and the adhesion strength between the fiber and the matrix Glass fiber reinforced (GFRP) Composite is the largest segment in the composite industry, worth several billions. Glass fiber is made from extremely fine fibers of glass. It is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes. The glass fibers are most extensively used as a raw material for composite materials. Glass fiber accounts for about 90% of the reinforcements used in composite consumption, globally. Most of the GFRP Composites are used in construction and transportation sectors. The demand for renewable energy in the form of wind turbines, demand for light-weight fuel efficient aircrafts & cars, and the demand for GFRP pipe, tank and other corrosion resistant equipment are major drivers increasing its demand in the coming years.

Materials

Property	Tensile strength (MPa)	Compressive strength (MPa)	Elastic modulus (GPa)	Density (g/cm3)
E-glass	3445	1080	73	2.58
Unsaturated polyester	90	55	3.23	1.35

Table 1.1 Properties of E glass fiber and unsaturated polyester resin (International Journal of Applied Science and Engineering 2017. 14, 3: 121-131 Mechanical Properties of Glass Fiber Reinforced Polyester Composites)

II LITERATURE REVIEW

Claudia Merlini et al

Claudia Merlini et al tested the Influence of fiber surface treatment and length on physico-chemical properties of short random banana fiber-reinforced castor oil polyurethane composites. The results of this study revealed that short random fiber composites with good tensile strength and dynamic mechanical properties can be successfully prepared using banana fibers as the reinforcement in a polyurethane matrix derived from castor oil. The treated banana fiber showed higher tensile strength and shear interfacial stress when compared to the untreated fiber, indicating a strong interaction between the treated fibers and the polyurethane matrix. F.C. Campbell In his text book named as "Structural Composite Materials", he clearly explained the Applications of composite include aerospace, transportation, construction, marine goods, sporting goods, and more recently infrastructure, with construction and transportation being the largest. In general, high-performance but more costly continuous-carbonfiber composites are used where high strength and stiffness along with light weight are required, and much lower-cost fiberglass composites are used in less demanding applications where weight is not as critical.

Autar K.Kaw

In his text named as "Mechanics Of Composite Materials " ,he explained the Basics of composites Materials.

TP Sathishkumar,et al

Glass fibers reinforced polymer composites have been prepared by various manufacturing technology and are widely used for various applications. Initially, ancient Egyptians made containers by glass fibers drawn from heat softened glass.Continues glass fibers were first manufactured in the 1930s for hightemperature electrical application. Nowadays, it has been used in electronics, aviation and automobile application etc. Glass fibers are having excellent properties like high strength, flexibility, stiffness and resistance to chemical harm. It may be in the form of roving's, chopped strand, yarns,fabrics and mats. Each type of glass fibers have unique properties and are used for various applications in the form of polymer composites. The mechanical, tribological, thermal, water absorption and vibrational properties of various glass fiber reinforced polymer composites were reported.

Alexandre Landesmann et al

This paper presents the results of an experimental investigation aiming at determining the mechanical properties of Glass Fiber Reinforced Polymer (GFRP) element produced by the Brazilian industry to classify it for structural applications.. The material samples used in this work were (i) prepared in accordance to ABNT-NBR15708:2011 recommendations, (ii) extracted from web and flange parts of different geometries of one standard H-shaped GFRP single profile, (iii) 2D fiber-reinforced fibrous and (iv) exhibited fibers' orientation on the longitudinal/pultrusion direction. A fairly extensive experimental program was carried out to cover both stiffness and strength structural characteristics of GFRP element, comprising the following mechanical failures modes: (i) direct tension and compression, (ii) two-point flexural bending, (iii) pin-bearing pushed-out and (iv) interlaminar shear deformation. Based on the obtained results, it was possible to conclude that the GFRP element analyzed displays structural classification compatible to E17 class mechanical requirement.

O. Adekomaya et al

The primary objective of this research work is to analyse the effect of fibre loading and orientation on the tensile and impact strength of the polymeric composite materials. Fibre reinforced composite materials have been reported to have attracted many applications in view of its low weight and superior strength when compared with the metal matrix composite. While researches have established the weight reduction of fibre reinforced polymer material, few works have reported the impact of orientation on the manufacturing of polymer composite. In this study, series of experimental works were done to demonstrate the manufacturing of glass-fibre reinforced epoxy resin with special attention on the influence of oriented reinforced composite material. The composites were manufactured using hand-lay technique with three different fibre loadings (10, 20, and 30 wt. %) and at two different fibre orientations (30o and 60o). Key of the finding drawn from this research form the basis of discussion and, composite with 60o fibre orientation showed better tensile strength when compared with the neat resin and other oriented (G10E30) fibre reinforced composite. Similar observations were also noticed on the impact strength of these composites which signify the improved mechanical properties of oriented reinforced composite materials.

M. S. EL-Wazerya et al

Glass fiber reinforced polyester composites have played a dominant role for a long-time in a variety of applications for their high specific strength, stiffness and modulus. In this research work, an E-glass fiber with random oriented reinforced polymer composite was developed by hand lay-up technique with varying fiber percentages (15%, 30%, 45%, and 60% by weight percentage).The influence of glass fiber percentage on the mechanical properties such as tensile strength,bending strength and impact strength was investigated. Hardness of composites was evaluated by using Brinell hardness tester. The results showed remarkable improvement in the mechanical properties of the fabricated composite with an increasing in the glass fiber contents. Tensile 18 strength varies from 28.25 MPa to 78.83 MPa, flexural strength varies from 44.65 MPa to 119.23 MPa and impact energy at room temperature varies from 3.50 Joules to 6.50 Joules, as a function of fiber weight fraction. The hardness value will greatly increase from 31.5 BHN to 47 BHN. The best mechanical properties obtained at 60 wt.% of glass fiber of fabricated composites.

A.H.M Fazle Elahi et al

Glass fiber reinforced unsaturated polyester (GFRP) based polymer composite was prepared using hand layup process. Four layers of GF were impregnated by polyester resin and pressed under load of 5kg for a day. Then the fabricated composite were heat treated from 60 degree Celsius to 150 degree for 1 hour and finally taken for mechanical test. Tensile strength, tensile modulus, elongation at break, impact strength, shear strength and hardness of the fabricated composite were measured. The experiment showed wonderful improvement in the mechanical properties of the fabricated composite resulted from the heat treatment. The maximum tensile strength of 200.6 MPa is found for 900C heat treated sample. Inverse relationship between heat and mechanical properties of the composite was observed above 1000C. Finally, the excellent elevated heat resistant capacity of GFRP composite shows the suitability of its application to heat exposure areas such kitchen furniture materials, marine, electric board etc.

III EXPERIMENTAL METHODOLOGY

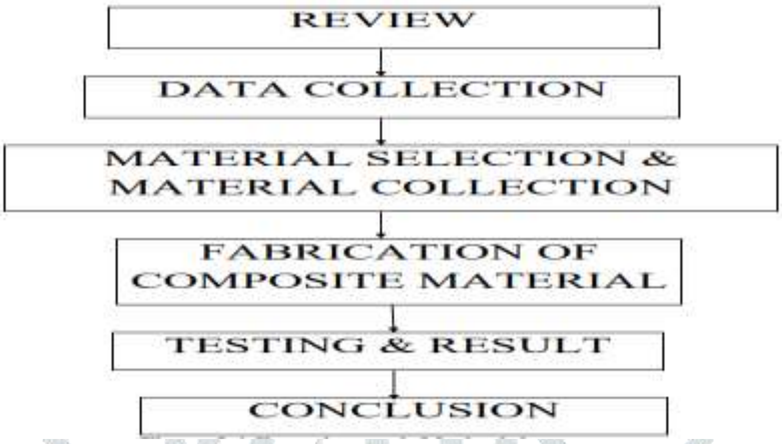


Fig no 1 Experimental Methodology

IV PREPARATION

Glass Fiber And Unsaturated Polyester Resin (GFPR) Proportions By volume.

We first choose E type glass fiber and fabricated the composite materials with different proportions. Which were tested for find out free vibration behaviour. Our composite materials listed below.

1, GF 10 % and PR 90 % by volume
2, GF 20 % and PR 80 % by volume
3, GF 30 % and PR 70 % by volume
4, GF 40 % and PR 60 % by volume
5, GF 50 % and PR 50 % by volume

Fig no 2 GF 10 % and PR 90 % by volume composite

Fig no 3 GF 20 % and PR 80 % by volume composite

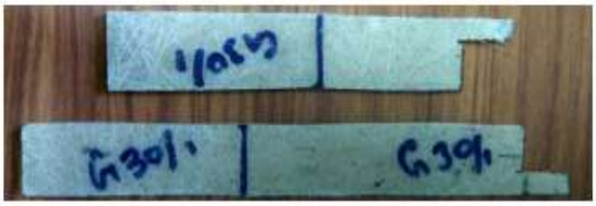


Fig no 4 GF 30 % and PR 70 % by volume composite

Fig no 5 GF 40 % and PR 60 % by volume composite

Fig no 6 GF 50 % and PR 50 % by volume composite

Fig no 7 Pure resin sheet

VIBRATION TESTING SETUP AND PROCEDURE

The connections of FFT analyzer, laptop, transducers, modal hammer, and cables to the system were done as per the guidance manual. The pulse lab shop version-9.0 software key was inserted to the port of laptop. The plate was excited in a selected point by means of a small impact hammer (Model 2302-5), preferably at the fixed end. The input signals captured by a force transducer, fixed on the hammer. The resulting vibrations of the plate in a select point are measured by an accelerometer. The accelerometer (B&K, Type 4507) was mounted on the plate to the free end by means of bees wax. The signal was then subsequently input to the second channel of the analyzer, where its frequency spectrum was also obtained. The response point was kept fixed at a particular point and the location of excitation was varied throughout the plate. Both input and output signals are investigated by means of spectrum-analyzer (Bruel & kjaer) and resulting frequency response functions are transmitted to a computer for modal parameter extraction. The output from the analyzer was displayed on the analyzer screen by using pulse software. Various forms of Frequency Response Functions (FRF) are directly measured. However, the present work represents only the natural frequencies and mode shape of plates. The spectrum analyzer provided facilities to record all the data displayed on the screen to a personal computer's hard disk or laptop and the necessary software. Normally in order to determine the natural frequencies of a system, recording the response spectrum for an excitation, where the excitation level is constant over the frequency band under consideration will suffice. However, it was observed, from the auto-spectrum of the excitation force, that it was not possible to maintain such uniform excitation in case of composite plates. So, test should be within linear range. The hammer excitation method is fast and simple method. A sharp impact pulse corresponds to a large frequency domain. Unfortunately, since the energy of the force pulse is limited, the method has poor signal to noise characteristics, but the noise can be minimized by using an adequate weighting function. Nevertheless, the composite plates showed very rapidly to have frequencies above 2000Hz, which are difficult to excite with enough energy by means of a hammer.

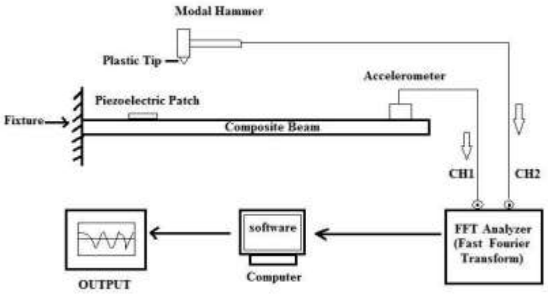


Fig no 8 Experimental Step Up Which Is Used For Calculating And Analysing Vibration

Fig no 9 Experimental Setup

V RESULTS & DISCUSSION

Vibration Behavior , GF 10 % And USPR 90 % By Volume

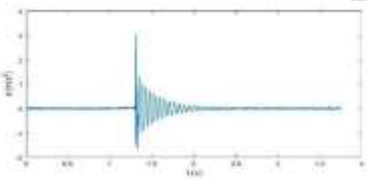


Fig 10 Vibration on X axis GF 10 % USPR 90 %

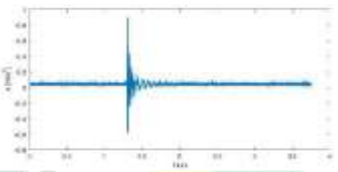


Fig 11 Vibration on Y axis GF 10 % USPR 90 %

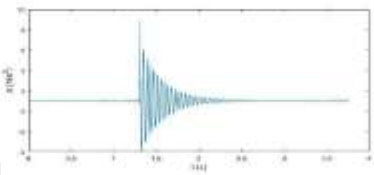


Fig 12 Vibration on Z axis GF 10 % USPR 90 %

Fig no 10,11,12 shows the vibration on the GF 10 % USPR 90 % composite material along three axis.

Vibration Behavior , GF 20 % And USPR 80 % By Volume

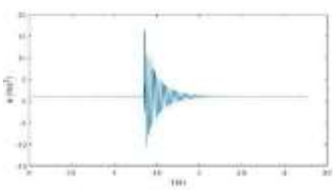


Fig 13 Vibration on X axis GF 20 % USPR 80 %

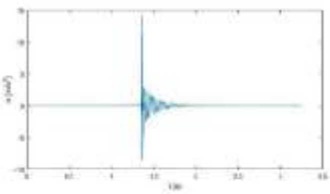


Fig 14 Vibration on Y axis GF 20 % USPR 80 %

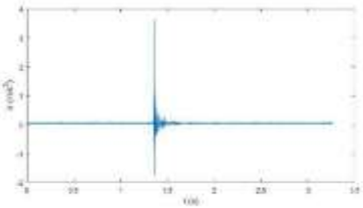


Fig 15 Vibration on Z axis GF 20 % USPR 80 %

Fig no 13,14,15 shows the vibration on the RBF 20 % USPR 80 % composite material along three axis.

Vibration Behavior , GF 30 % And USPR 70 % By Volume

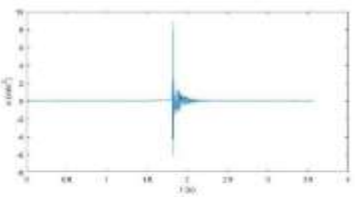


Fig 16 Vibration on X axis GF 30 % USPR 70 %

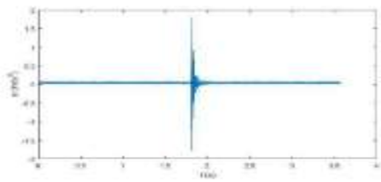


Fig 17 Vibration on Y axis GF 30 % USPR 70 %

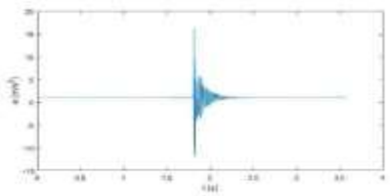


Fig 18 Vibration on Z axis GF 30 % USPR 70 %

Fig no 16,17,18 shows the vibration on the GF 30 % USPR 70 % composite material along three axis.

Vibration Behavior , GF 40 % And USPR 60 % By Volume

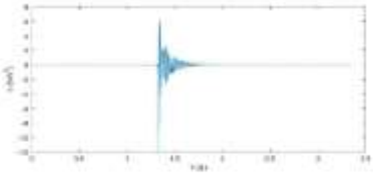


Fig 19 Vibration on X axis GF 40 % USPR 60 %

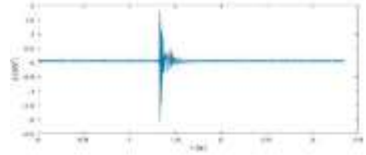


Fig 20 Vibration on Y axis GF 40 % USPR 60 %

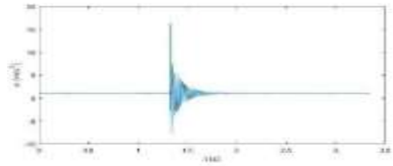


Fig 21 Vibration on Z axis GF 40 % USPR 60 %

Fig no 19,20,21 shows the vibration on the GF 40 % USPR 60 % composite material along three axis.

Vibration Behavior , GF 50 % And USPR 50 % By Volume

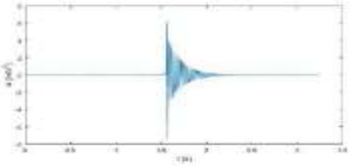


Fig 22,23,24 Vibration on X axis GF 50 % USPR 50%

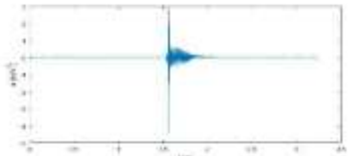


Fig 5.14 Vibration on Y axis GF 50 % USPR 50%

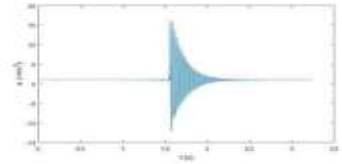


Fig 5.15 Vibration on Z axis GF 50 % USPR 50%

Fig no 22,23,24 shows the vibration on the GF 50 % USPR 50 % composite material along three axis.

Vibration Behavior Pure resin Sheet

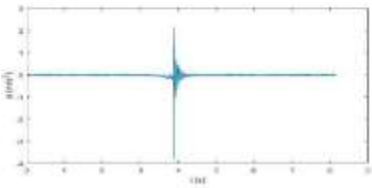


Fig 25 Vibration On Pure resin of X axis

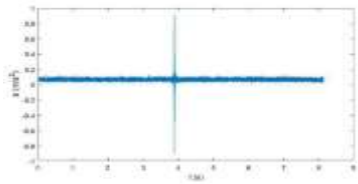


Fig 26 Vibration On Pure resin of Y axis

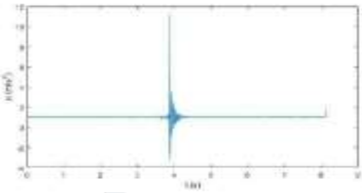
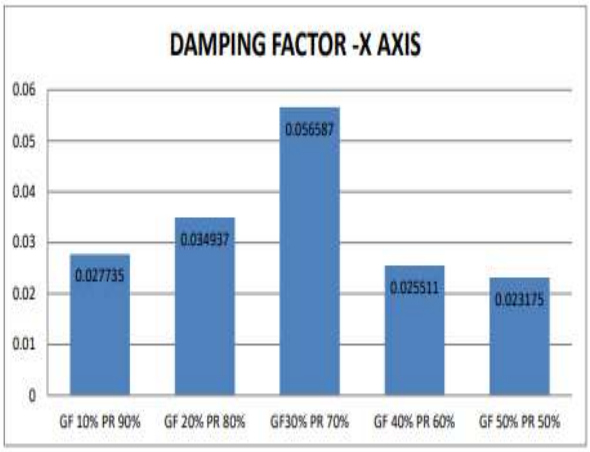
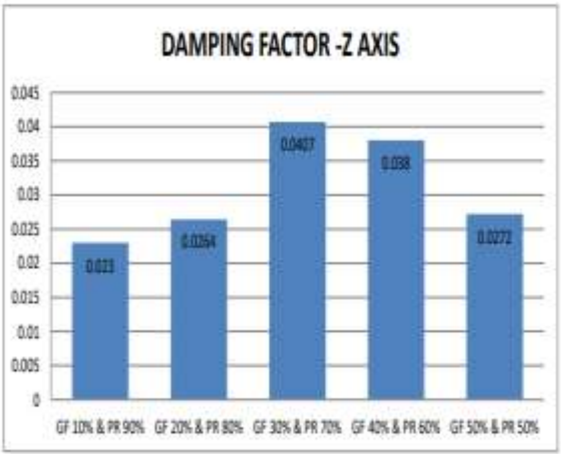


Fig 27 Vibration On Pure resin of Z axis

Fig no 25,26,27 shows the vibration on the pure USPR sheet along three axis.

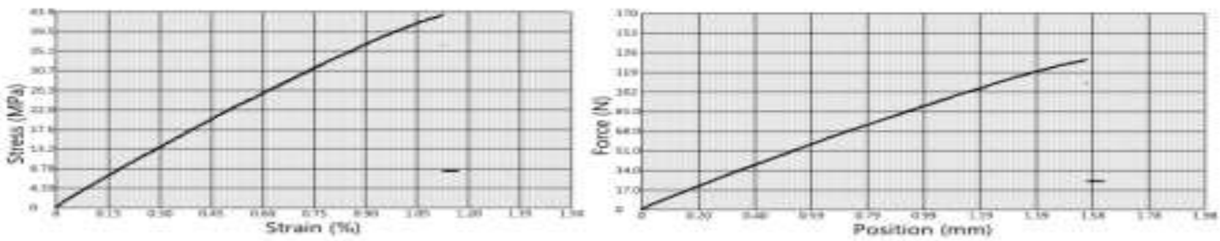


Graph no 1 Damping factor along X axis



Graph no 2 Damping factor along Z axis

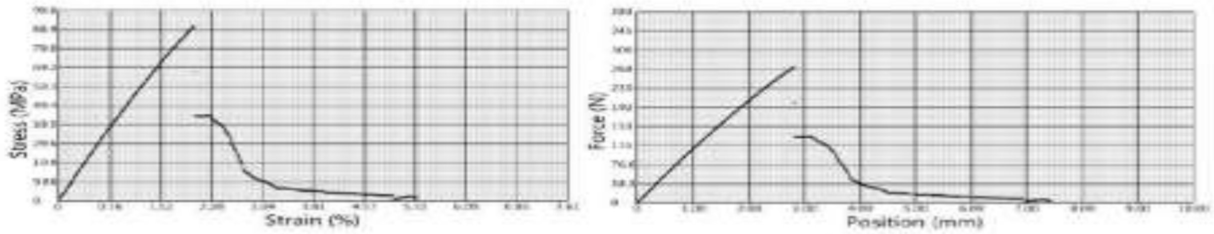
Tensile test on GF 30% -PR70% composite



Graph no 3 Tensile test on GF 30% -PR70% composite

Tensile properties of the composites are mostly affected by the materials, method, specimen condition and preparation and also by percentage of the reinforced. It was found from Graph no 3 the tensile strength increased from 44.3 MPa in the GF 30% -PR70% composite.

Bending strength test on GF 30% -PR70% composite



Graph no 4 bending strength on GF 30% -PR70% composite

Bending strength properties of the composites are mostly affected by the materials, method, specimen condition and preparation and also by percentage of the reinforced. It was found from Graph no 4 the bending strength increased from 90.3 MPa in the GF 30% -PR70% composite.

VI CONCLUSION

This experimental investigation of mechanical behavior of glass fiber reinforced polyester resin composites leads to the following conclusions: • This work shows that successful fabrication of glass fiber with random oriented reinforced polyester composites with different fiber contents is possible and very cost effective by simple hand lay-up technique. • It was found that the tensile strength varies from 43.3 MPa, flexural strength varies from 90.3 MPa and damping factor 0.056587 along X axis 0.0407 along Z axis at room temperature for GF 30% PR 70% composite. The mechanical, and dynamics properties of GFPR composites have been discussed. The important application of these composites has highlighted.

Electronics: GRP has been widely used for circuit board manufacture (PCB's), TVs, radios, computers, cell phones, electrical motor covers etc.

Home and furniture: Roof sheets, bathtub furniture, windows, sun shade, show racks, book racks, tea tables, spa tubs etc

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