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Evaluation of Free Vibrational Properties of Glass Fiber - ISO Resin Bars

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Abstract: **Since the early years there has been an increase in the demand for stronger, stiffer and light weight materials for use in the aerospace, transportation and construction industries. Now a days the materials plays vital role in the manufacturing sections and automobiles. Composite materials used for structural purpose often have low densities resulting in high stiffness to weight and high strength to weight ratio Because of all the components are made of metals. They are facing a lot of problems because of corrosion, vibrations, strength and lifetime. The repair and replacement of entire structure is very difficult.**

Composite materials are rapidly being utilized in industries that have traditionally used metals. While the determination of mechanical properties this material is an important step, theoretical investigation of the variability of mechanical properties is very critical for varying composition of glass fiber andIso resinmaterial.The main criterion of this project is manufacturing in different combination of bars while maintain the same dimensions by varying the thickness of fiber glassand Iso resin material and test experimentally free vibrations, by using FFT analyzer with DAQ . The obtained values can be compare with ANSYS results and optimize the best combination.

Keywords*: *Glass fiber, Iso resin, free vibration, FFT analyzer, DAQ and ANSYS

I. INTRODUCTION

Composites are defined as combination of two or more different materials. A different number of fibers are available as reinforcement for composites. The Desired properties of most fibers are high strength, high stiffness, and relatively low density and these are strong, light weight material used for many products. ISO Resin 31.00 has a high quality, medium viscosity, medium reactive polyester resin based on Isopthalic acid and it shows good mechanical and thermal properties compared to other isopthalates and orthopthalates. This resin forms strong bond with glass fiber and shows good wet out characteristics and it is suitable for corrosion resistant applications. Resin is combined with glass fiber to form fiber reinforced plastic (FRP) which exhibits good properties of light weight, rigid, High strength-to-weight ratio and resistance to chemicals. Catalyst M.E.K.P. is used in this reinforcement. Methyl Ethyl Ketone Peroxide (MEKP) is added to Isopthalic resin the resulting chemical reaction cause heat and harden the resin.COBALT (Accelerator)is also added to the composition to accelerate the decomposition peroxide catalyst into highly reactive free radicals.

The present work describesan experimental study of free vibration of different compositions i.e. E-Glass fiber/ISO resincomposite plates by using FFT analyzer. By doing this experiment we have to increase the strength and lifetime of the component.

Literature review concentrate on vibration analysis of composite bars.Sharayu U.Ratnaparkhi[1] studied the vibrational analysis of composite plates. Natural frequencies of glass/epoxy composites was determining by using modal analysis technique in experimentation. These values can validate the results acquired from the FEA by using ANSYS. The experimental frequency of glass/epoxy composite is reasonable with ANSYS. The error percentage between experimentation and ANSYS is with in 15%.

Frequency Response of Composite Laminates at Various Boundary Conditions was studied by J.Alexander [2]. Natural frequencies of multilayered composite plates at different boundary conditions experimentally determined. He is mainly focused on two types of materials are basalt fiber reinforced epoxy and carbon fiber reinforced epoxy materials are considered. Finally the results are compared with ANSYS.Basalt/Epoxy composite shows improved resistance to vibration than Glass/Epoxy specimen.

Mechanical Properties and Free Vibration Response of Composite Laminates analyzed by M.Prabhakaran [3]free vibration and the effect of loading structure on tensile, impact and absorption properties of composites has been investigated. Increasing the specimen thickness then it will increase the natural frequency of the composite panel.

The mode shapes andnatural frequencies of a 12-layer and 16-layerGlass fiber/Epoxy Composite beams were experimentally determined by Parsuram Nayak [4]. The experimental result can be compared with ANSYS package, the percentage error between results is within 15%**.**

N.Nayak studied experimental and numericalvibration of Woven Carbon fiber/Epoxy Composite bars[5] and also effects of geometry, boundary conditions, and frequencies of vibrations of carbon fiber reinforced polymer panels. In this B & K FFT analyzer used,PULSE software is used to convert time into frequency.Experimental results can be compared withnumerical results using the FEM software. The natural frequencies of different boundary conditions were stated and the mode shapes of CFRP plates on different boundaries were plotted. When comparing the results the modal frequencies of CFRP are higher than that of GFRP.

The Effect of Woven Structures on the Vibration characteristics of Glass Fabric/Epoxy composite Plates was determined by Xu Lei [6]. The dynamic mechanical and vibration properties of the composite plates were studied. The result shows that woven structure had a strong influence on the fiber volume fraction.The result of the modulus E of DMA test of each sample is reliable with the natural frequency fand damping η in the vibration test.

II. METHODLOGY

A. FABRICATION

Fabrication of Glass Fiber/Iso Resin bars

The ISO resin acts as the matrix for the reinforcing of glass fibers. The percentage of glass fiber and resin are in different composition of six specimens are specimen1 will be 100% resin, specimen2 will be $(90I_r+10G_f)$%,specimen3 will be $(80I_r+20G_f)$%,specimen4 will be $(70I_r+30G_f)$% andspecimen5 will be $(60I_r+40G_f)$%. Glass Fiber is cutting with the length of 8mm; cutting should be done very carefully. A flat aluminum rigid channel was prepared and wax is kept on the surface of the channel. Laminating starts with the application of resin, cobalt (accelerator) and mekp (catalyst). In order to harden the resin catalyst were added. Do not add accelerator to peroxides when adding peroxides to resin solution, mix thoroughly to get the resulting product.This total matrix is mixed with glass fiber and stirred manually shown in fig1. After mixing the composite will be poured into aluminum channel as shown in fig2. After few minutes the specimens will be get harden and remove from the channel carefully. (I_r= Isoresin,G_f=Glassfiber)

Fig. 1 Mixture of glass fiber and resin

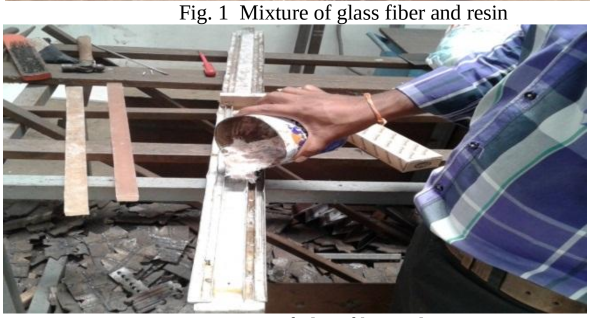

Fig. 2 Pouring of glass fiber and resin mixture

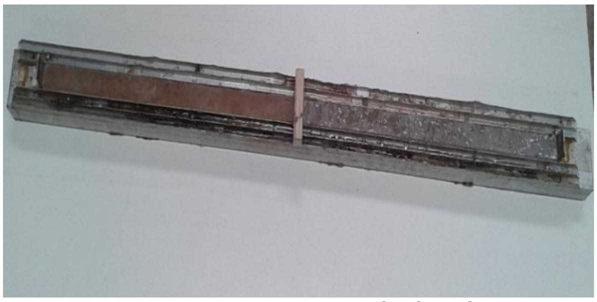

Fig. 3 Specimens curing process in the channel

Fig. 4 Final specimens after curing

III. EXPERIMENTATION

The connections of Data acquisition system, computer, and accelerometer, modal hammer and cables to the system are done. The subsequent vibrations of thespecimen in a particular point measure by an accelerometer. The E-glass/ISO resin composite plates clamped at one end on a table by using a C-clamp another end is free. The length of all specimens is 30cm, the width and thickness of plates also measured by screw gauge. Average Width and thickness of specimens are 2.6cm and 0.8cm.The KISTLER 8640A50 accelerometer is mounted on the free end with the help of bees wax and it is connected to the DAQ (Data Acquisition System) NI9234 which is connected to computer.

A. FREE VIBRATION TEST

For the free vibration response, the free end of the glass/Iso resin plate is hit for a fraction of second with an impact hammer as shown in fig6.

Free Vibration Testing for Glass Fiber/Iso Resin Bars

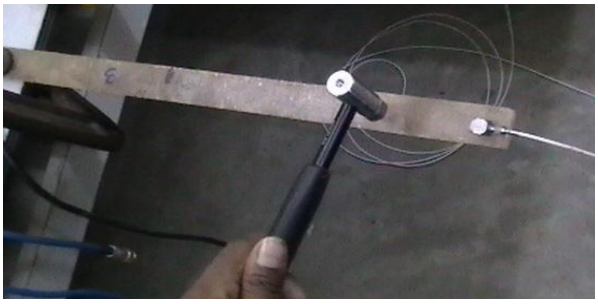

Fig. 5 Test for Glass Fiber/Iso Resin Bars

Fig. 6 FFT analyzer setup

The free vibration response is captured on the screen of LABVIEW and DEWEsoft. The test results for free vibration as obtained from LABVIEW and DEWEsoft. The FFT analyzer inbuilt to the computer, the time signal was input to the FFT analyzer. FFT analyzer converts time domain into frequency domain.

IV. RESULTS AND DISCUSSIONS

In the free vibration test, the natural frequency of specimen1is 40Hzand this specimen contains pure resin as shown in the above fig 7(a) but in the ansys the natural frequency is 37.42Hz shown in the fig7(b). The difference between the experimentation and ansys is 2.58%.

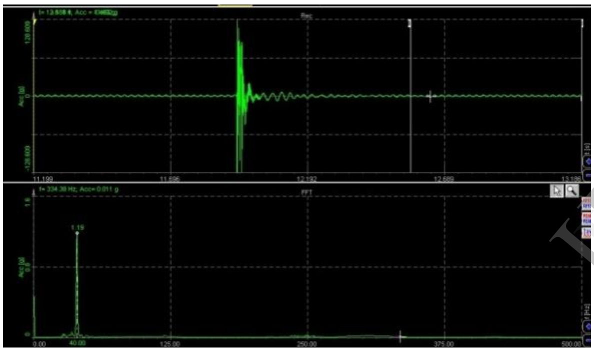

Fig. 7 (a) Free vibration experimentation test for the Specimen1

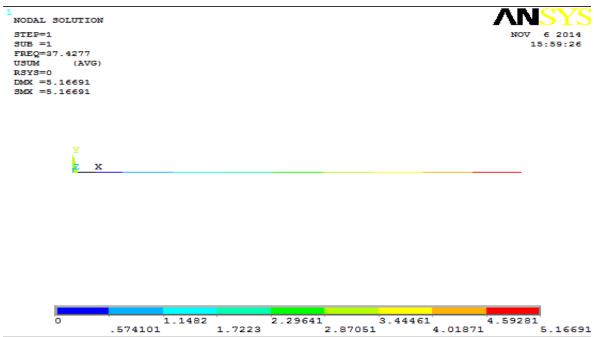

Fig. 7 (b) Free vibration ANSYS test for the Specimen1

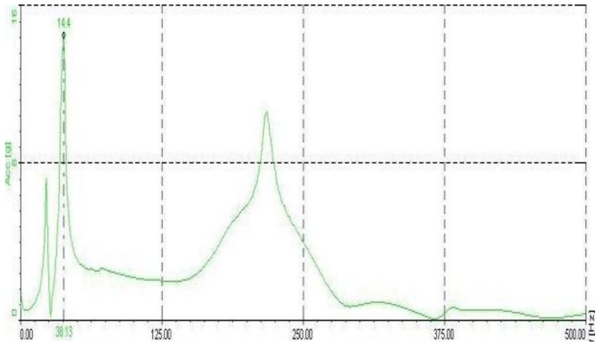

Fig. 8 (a)Free vibration experimentation test for the Specimen2

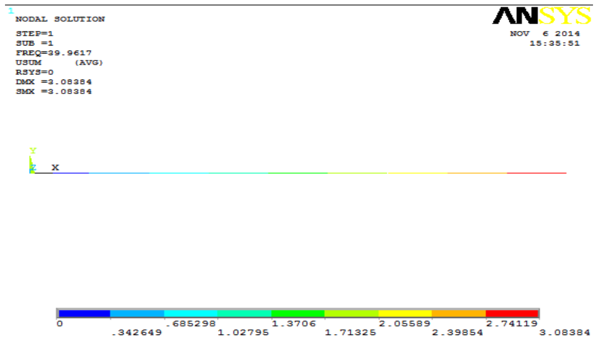

Fig. 8 (b)Freevibration ANSYS test forthe Specimen2

In the Free vibration test, the natural frequency of the specimen2 is 38.13 Hz and this is the composition of 90% resin and 10% fiber as shown in the fig8(a), but in the ansys the natural frequency is 39.96 Hz shown in the fig8(b). The difference between the experimentation and ansys is 1.83%.

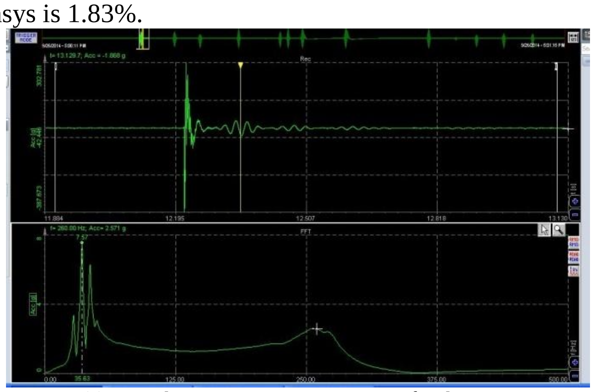

Fig. 9 (a)Free vibration experimentation test for the Specimen3

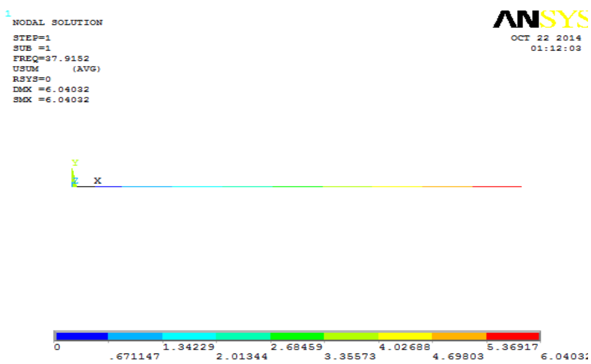

Fig. 9 (b)Free vibrationANSYS testfor the specimen3

In the Free vibration test, the natural frequency of the specimen3 is 35.63 Hz and this is the composition of 80% resin and 20% fiber as shown in the fig9 (a), but in the ansys the natural frequency is 37.91 Hz shown in the fig9 (b). The difference between the experimentation and ansys is 2.28%.In this specimen we get minimum naural frequency that is 35.63 compared to all specimens.

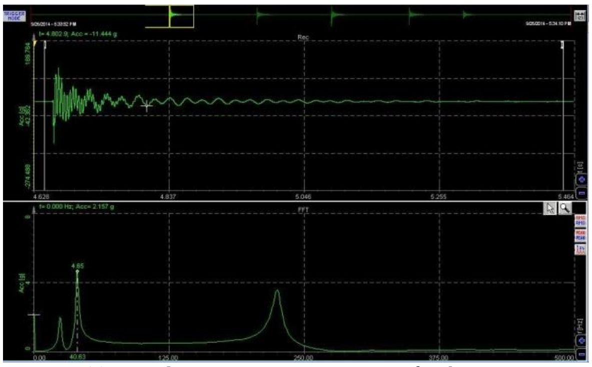

Fig. 10 (a)Free vibration experimentation test for the Specimen4

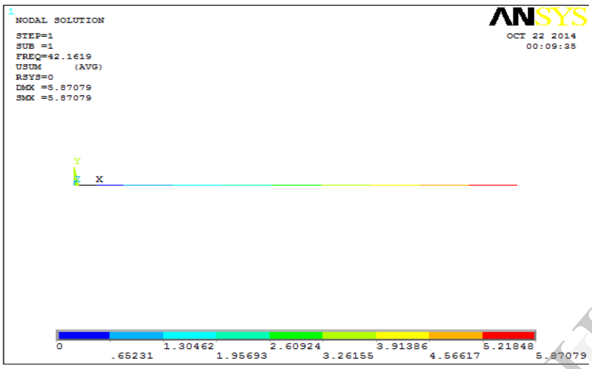

Fig. 10 (b) Free vibration ANSYS test for the specimen4

In the Free vibration test, the natural frequency of the specimen4 is 40.63Hz and this is the composition of 70% resin and 30% fiber as shown in the fig10 (a), but in the ansys the natural frequency is 42.06 Hz shown in the fig10 (b). The difference between the experimentation and ansys is 1.53%.

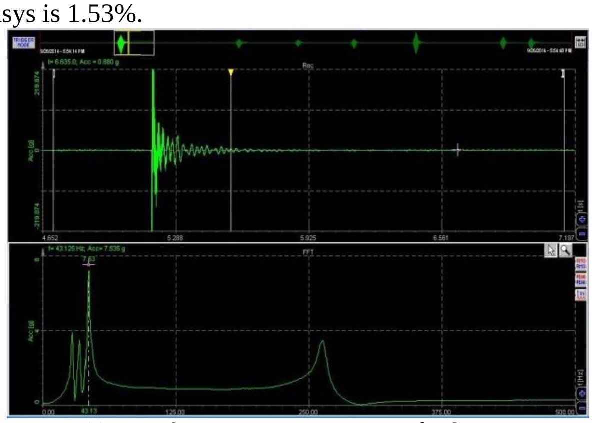

Fig. 11(a) Free vibration experimentation test for the specimen5

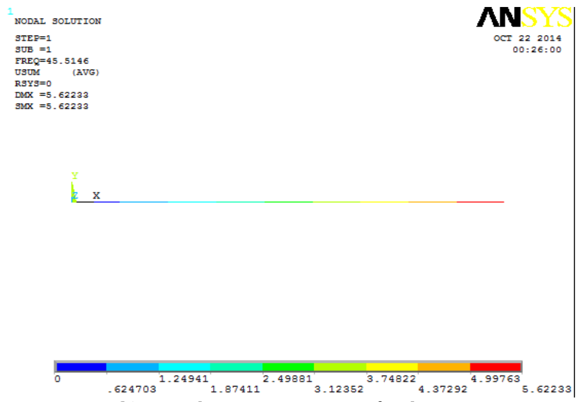

Fig. 11 (b)Free vibration ANSYS test for the specimen5

In the Free vibration test, the natural frequency of the specimen5 is 43.13Hz and this is the composition of 60% resin and 40% fiberas shown in the fig11 (a), but in the ansys the natural frequency is 45.51 Hz as shown in the fig11 (b). The difference between the experimentation and ansys is 2.38%.In this specimen we get maximum naural frequency that is 43.13 Hz in experimentation and 45.51 in ansys compared to all specimens. This shows more vibrations will occur in this combination, this is not optimum.

Free Vibration Experimentation Comparison with ANSYS

Specimens	Experimentation Results	Ansys Results	Difference (%)
S1	40	37.42	2.58
S2	38.13	39.96	1.83
S3	35.63	37.91	2.28
S4	40.63	42.16	1.53
S5	43.13	45.51	2.38

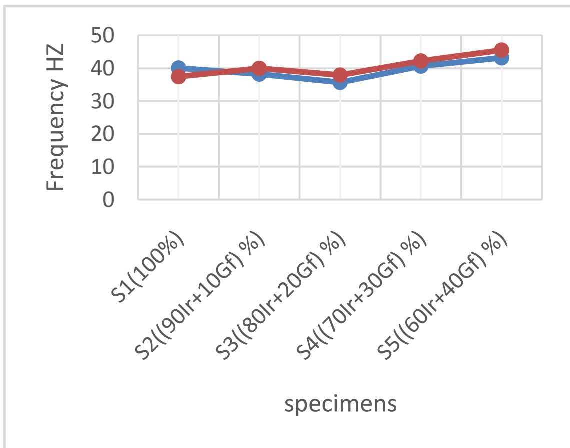

Fig. 12 Free vibration experimentation compared with ansys for natural frequency vs all specimens

CONCLUSION

In this project, manufacturing different combination of bars and also finding the natural frequencies of all the specimens in both experimentation and FEA. By increasing the percentage of glass fiber the frequency also increases up to certain level after it will decrease. The maximum natural frequency will occur in the specimen5

$(60I_r+40G_f)$.In real time applications always preferable low natural frequency. Finally we are concluding that the specimen3 $(80I_r+20G_f)$ will occur the minimum natural frequency. The specimen3 is the best composition of 80% resin and 20% fiber, by doing these we have to increase strength, lifetime and corrosion resistance. The percentage error between experimentation and FEA will be less than 3%.

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