Experiment on Acoustic and Vibration Damping Properties of Natural Fiber Reinforced Composites

D. Rajesh Kumar, R. Vishnuvardhan, R. Rahul

Abstract--- The process of natural fibrematerials in the structures has substantial quantity of attention recently. Presently, few reports present on sound and vibration damping frequency properties in natural fibres materials reinforced composites. In this chapter, the sound and vibration frequency properties of damping of natural material based composites aredistinguished. It was noticed that utilizing a natural (flax) fiber material reinforced composites has 33.8% improvement in vibration damping properties, when compared with glass fibre reinforced composites. Sound wave absorption coefficient of natural material (flax) reinforced composite has also improved 17.64% and 20% at higher and lower operating frequency levels respectively when related to glass fiber reinforced composites. These answer suggest that, natural fibermaterial based composites could be annext solution for environmentally friendly to observe the vibration and noise radiation problem.

Keywords--- Flax, Sound Absorption, Vibration Damping.

I. INTRODUCTION

Glass and carbonfibresmaterial, related with a resin are conventional fibre reinforced composite materials. These materials often have superior mechanical properties such has strength, stiffness and are light-weight related to their metallic counter portion.

These fibresused in many less weight constraints. As structures mean the light-weight and stiffness properties of normal materials make them efficient noise radiators compared to the material behaviour and structures.

This takes the advantage of over performancemetallic bonding structures and it also has good vibration damping properties and sound absorbing.

These natural materials fibres used for manufacturing composites. Replacing synthetic with natural materials will give positive result in the reduction of carbon emissions [4].

In this present study the acoustic response and properties of damping composite beams with natural materials with composed with are studied and compared.

By replacing synthetic materials with natural material in the fabrication of structures, it having excellent mechanical properties compared to others and are nearly equal to the properties of E-glass fiber [2]. In this recent study three different types of composite materials are used.

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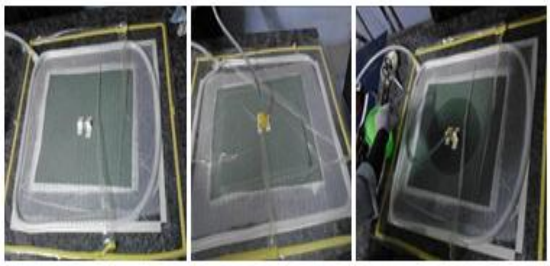
II. EXPERIMENTATION

A. Materials

The composite materials have been manufactured by (VARTM) process. Acetone (cleaning agent) was used to clean the mould surface it is used for fabrication of the composite fibre plate. Wax is applied in the surface layer for removal of composite plates. The ply is placed above the fibers and separate the medium is placed above the peel ply and the entire layup was packed and placed under vacuumarea. The resin was used in this fabrication process and Araldite LY 556. Since Araldite is a thermosetting resin it requires hardener for cutting. The Araldites is with hardener (1:10 ratio) and that is under the vacuum. After 12 h of keeping in vacuum it was removed and the part was left exposed to the atmosphere for venting the styrene gas produced from curing resin.The materials used for reinforcements along with their properties have listed in Table I. Fig.1 shows the steps followed in manufacturing the composite beams by VARTM technique.

a b c



d e f

Figure 1: Steps involved in VARTM a) placing fibers, b) Peel ply, c) connecting to vacuum pump, d) bagging, e) connecting tube for resin, f) resin infusion

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Table1: Properties of fiber materials utilised

Material	Density (g/cm^3)	Young's modulus (GPa)	Tensile strength (GPa)
E-Glass fiber	2.55	76	2000-3500
Flax fiber	1.54	50-70	345-1500

B. Vibration Damping Measurement

Specimens were cut into specified dimensions of 210 mm x 35 mm with a uniform thickness of 3mm.The specimens mouldedin the form of a cantilever beam structure are placedby using fixture [5]. An accelerometer sensor was placed at the specimen at the free end, which was supplied by Dytran whose sensitivity of 96.72 mV/g. The output signals are received (DAQ) card 9234.

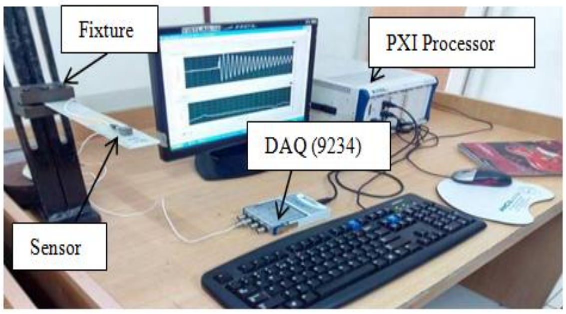

Figure 2: Experimental setup

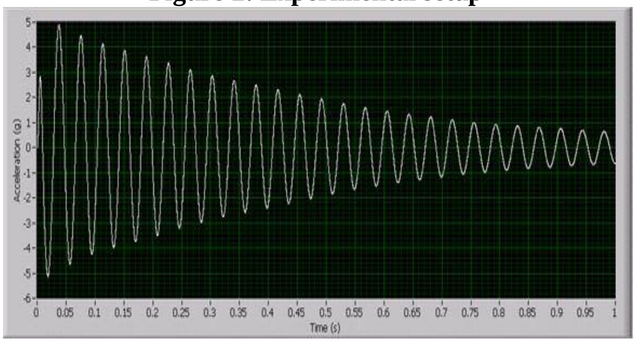

Figure 3: Waveform graph

Fig.3 shows the waveform graph from the LabVIEW software while the material was made to oscillate.

The damping factor ζ was calculated by taking the values of the successive peaks from the waveformand substituted in the Equation.1. The damping factor ζ listed in Table II.

$$ln\frac{x_1}{x_2} = \frac{2\pi\zeta}{\sqrt{1-\zeta^2}} \quad (1)$$

Where, x_1, x_2 - Successive peaks from the waveform graph.

Table 2: Vibration damping results

Specimen	Sample Name	Damping Factor (ζ)	Average Damping Factor (ζ)
Flax/Epoxy	FE 1	0.014296	0.013740
	FE 2	0.011550	
	FE 3	0.015375	
Glass/Flax/Epoxy (Hybrid)	GFE 1	0.009845	0.010074
	GFE 2	0.009998	
	GFE 3	0.010379	
Glass/Epoxy	GE 1	0.008724	0.009097
	GE 2	0.009566	
	GE 3	0.009000	

C. Sound Absorption Measurement

Impedance Tube Tester (ASTM E 1050) the sound absorption coefficient can be observed by measuring sound pressure in microphone.

Figure 4: Sample for sound absorption test

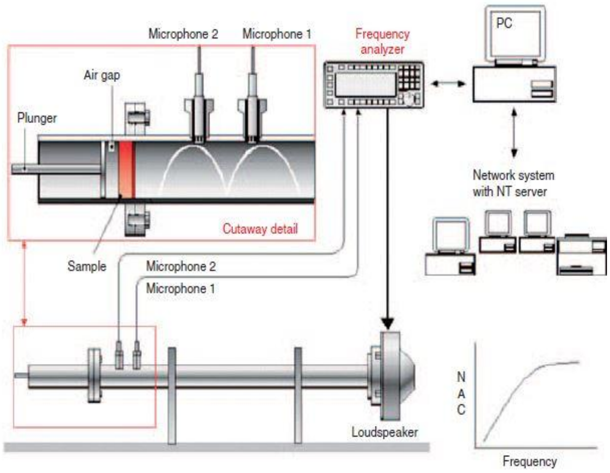

Figure 5: Impedance tube tester

The test sample of 100 mm diameter shown in Fig.4 mounted to one end, andan impedance tube was used with a sound source to another endas shown in Fig.5. The acoustical testsamples were tested in the frequency range of 100–2000 Hz.

Table3: Sound Absorption Coefficient of FRP Composites

Frequency (Hz)	Sound absorption coefficient (α) Flax	Glass	Hybrid
100	0.05	0.04	0.02
125	0.03	0.03	0.03
160	0.04	0.04	0.04
200	0.05	0.04	0.04
250	0.05	0.04	0.05
315	0.06	0.05	0.05
400	0.07	0.06	0.07
500	0.10	0.09	0.08
630	0.15	0.11	0.14
800	0.26	0.20	0.25
1000	0.42	0.38	0.38
1250	0.42	0.38	0.38
1600	0.31	0.29	0.28
2000	0.17	0.14	0.16

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III. RESULTS AND DISCUSSIONS

Analysis of Vibration Damping Factor

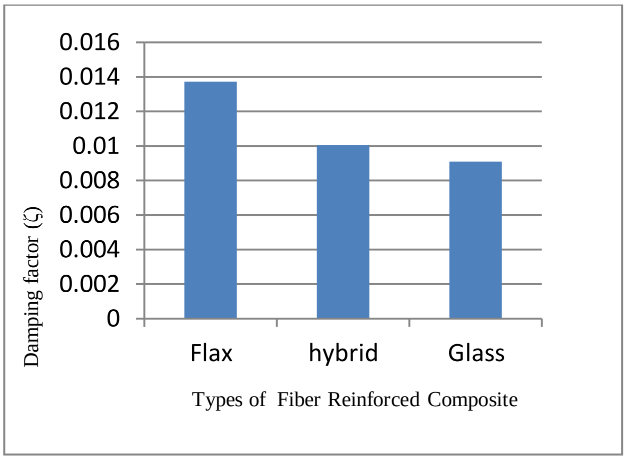

Figure 6:Comparison of damping factor for various fibre reinforcements

From Fig.6, it is inferred that the flax fiber reinforced composites have higher damping factorwhen compared to the traditional (Glass) fibre reinforced composites, which means that the utilisation of natural fibers have better results in vibration damping properties. Whereas the combination of glass fiber combined with the flax fiber also have some improvements.

Analysis of Sound Absorption

Sound absorption values in Table III show the absorption coefficient of the Flax/Epoxy, Glass/Epoxy, and Glass/Flax/Epoxy (Hybrid) fiber reinforced composites. From Fig.7, it is evident that, the sound absorption coefficient of Flax/Epoxy is greater than that of Glass/Epoxy and Hybrid in all frequency levels. The maximum sound absorption is observed at 1000 Hz for all the reinforcements.

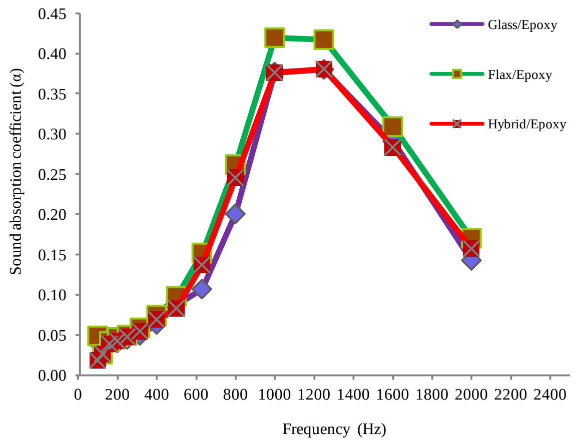

Figure 7:Absorption coefficient of the FRPs

From Fig.7 it is inferred that there is an improvement of sound absorption coefficient of flax/epoxy composite (17.64%) and also in Glass/flax/epoxy composite (12.5%) over Glass/epoxy composites.Flax/Epoxy with higher sound absorptioncoefficientdeveloped Fiber reinforced composites.

IV. CONCLUSIONS

By using natural (Flax) fiber based composite materials, vibrations can be damped efficiently. The experimental results shows that the natural materials have 33.8% improvement of vibration damping and17.64% of sound absorption properties, While the combined natural materials (Flax) and traditional material (glass) has an improvement of 26.7% of vibration damping and 12.5% of sound absorption properties were achieved . Thus, the proposed material can replace with the glass fibre reinforced plastic, where the sound and vibration damping properties plays momentous role.

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