e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 4, April 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

6381 907 438 6381 907 438 ijmrset@gmail.com www.ijmrset.com

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

Investigation of Vibration and Damping Characteristics of Sisal Based Natural Fiber Reinforced Polyester Composites

Abhijith Babu P[1], Abhinand P[2], Abhinav Anish C[3], Adeeb Danish AM[4], Dr.Sreeram D[5]

UG Student, Department of Mechanical Engineering, AWH Engineering College, Kozhikode, India[1]

UG Student, Department of Mechanical Engineering, AWH Engineering College, Kozhikode, India[2]

UG Student, Department of Mechanical Engineering, AWH Engineering College, Kozhikode, India[3]

UG Student, Department of Mechanical Engineering, AWH Engineering College, Kozhikode, India[4]

Associate Professor and Head of the Department, Department of Mechanical Engineering, AWH Engineering College, Kozhikode, India[5]

ABSTRACT: This experimental study evaluates the free vibration characteristics, natural frequency, and damping properties of short natural fiber (sisal) reinforced polyester composites. Composite specimens were fabricated with random fiber orientation using the hand lay-up method, considering different fiber lengths of 10mm and weight percentages of 5%, 10%, 15%, and 20%. Free vibration tests were conducted to determine the natural frequency and damping ratio of the composites and neat polyester resin for comparison. The results indicate that increasing the natural fiber content leads to an increase in natural frequency and a decrease in the damping factor of the composites. The composite with 20 wt.% fiber loading exhibited the highest natural frequency and lowest damping ratio compared to neat polyester. This study highlights the influence of fiber content on the vibration and damping characteristics of natural fiber-reinforced polyester composites, underscoring the potential for enhancing composite performance through controlled variation of fiber parameters.

KEYWORDS: Natural fiber, sisal, Polyester resin, Free vibration testing (FVT), Damping ratio, Natural frequency.

I. INTRODUCTION

A composite material is made by combining two or more materials, often ones that have very different properties. The two materials work together to give the composite unique properties. A composite is a structural material that consists of two or more combined constituents that are combined at a macroscopic level and are not soluble in each other. One constituent is called the reinforcing phase and one in which it is embedded is called the matrix. Two major types of composite materials are based on raw materials used. They are, 1) Synthetic composite, and 2) Natural composite, Synthetic composites are made from synthesized polymers or small molecules. Synthetic fibers do not depend either on an agricultural crop or animal farming. Synthetic fiber composite properties are stronger than natural composite but synthetic fibers burn more readily than natural and the cost of making materials would be more. Some of the synthetic composites are carbon/graphite, boron, Kevlar, and ceramic composite. Natural composites are made from fibers that are available naturally from plants and animals. It is also called green composite due to its environmentally friendly nature.

We must prefer natural composite instead of synthetic composite. The interest in natural fiber-reinforced polymer composite materials is rapidly growing both in terms of their industrial applications and fundamental research. They are renewable, cheap, completely or partially recyclable, and biodegradable. Plants, such as flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, bamboo, banana, etc Natural fiber-containing composites are more environmentally friendly and are used in transportation (automobiles, railway coaches, aerospace), military applications, building and construction industries (ceiling paneling, partition boards), packaging, consumer products, etc. Natural fibers are cheaper, biodegradable, and have no health hazards. Furthermore, natural fiber-reinforced fibers are seen to have good potential in the future as a substitute. Synthetic fibers are man-made fibers. Synthetic fibers are made from different

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

chemicals, hence each kind of synthetic fiber has its properties. Synthetic fibers are larger in length and are long-lasting. The only limitation of synthetic fibers is that they are poor absorbents of moisture and they catch fire easily.

Nowadays, natural fibers from renewable natural resources offer the potential to act as a reinforcing material for polymer composites as an alternative to the use of glass, carbon, and other man-made fibers. Among various fibers, sisal is the most promising reinforcement material due to its high content of cellulose and widely used natural fiber due to its advantages like easy availability, low density, low production cost, and also physical and mechanical properties

II. LITERATURE REVIEW

1) A Review on Mechanical Properties of Natural Fiber Reinforced Hybrid Polymer Composites, Authors-K.P.Ashik, Ramesh S.Sharma, The paper reviews the history and applications of natural fibers, focusing on hemp, jute, bamboo, and sisal as substitutes for glass fiber. Investigation indicates the potential to improve the properties of jute fiber-reinforced polyester composites. Developing a known stacking sequence hybrid offers potential for weight and cost reduction in the automotive industry, prompting further research into the mechanical and dynamic properties of jute/glass fiber reinforced epoxy hybrid composites, validated through FE simulation.

2) aeration and pro Properties of recycled HDPE/natural fiber composites, Authors Yong Lei, Qinglin Wu, Fei Yao, and Yanjun Xu, Composites comprising recycled high-density polyethylene (HDPE) and natural fibers (wood and bagasse) were produced via melt blending and compression molding. Maleated polyethylene (MAPE), carboxylated polyethylene (CAPE), and titanium-derived mixture (TDM) coupling agents were employed to enhance compatibility between bagasse fibers and RHDPE, yielding composites with mechanical properties comparable to those of virgin HDPE composites. In the RHDPE/pine system, MAPE acted as an effective coupling agent, while TDM served a lubricating role. Bagasse fibers, without coupling agents, altered the crystalline structure of RHDPE without affecting its overall crystallinity level.

3) Fully biodegradable natural fiber composites from renewable resources: All-plant fiber composites, Authors-Ming Qiu Zhang, Min Zhi Rong, Xun Lu, Benzylation treatment alters wood flour into thermoplastics by incorporating large benzyl groups onto cellulose, disrupting its crystalline structure. Control over reaction temperature, concentration of aqueous caustic solution, and choice of phase transfer catalyst regulates benzyl substitution, achieving a harmonious blend of thermal formability and mechanical performance in modified wood flour. Benzylation enables the transformation of plant fibers into thermoplastic materials, offering balanced processability, mechanical properties, and biodegradability for the manufacture of all plant fiber composites.

4) Natural Fiber Polymer Composites: A Review, Authors-D.Nabi Saheb, J.P.Jog, Natural fiber composites exhibit properties similar to conventional fiber composites but face challenges such as fiber incompatibility and inadequate moisture resistance. Polymer composites based on materials like PE, PP, PS, and PVC, which operate at temperatures around 200°C, encounter significant hurdles due to these issues. Enhancing the thermal stability of natural fibers is crucial for enabling their utilization with engineering polymers, aiming to combine the benefits of both materials. Researchers continue to focus on improving the thermal stability and performance of natural fibers to address these challenges.

5) Effect of fiber surface treatment on the fiber–matrix bond strength of natural fiber reinforced composites, Authors-Valadez-Gonzalez,J.M.Cervantes-Uc, R. Olayo, P.J. Herrera-Franco, Interfacial shear strength (IFSS) between natural fibers and a thermoplastic matrix has been enhanced through morphological and silane chemical modification of the fiber surface. An alkaline treatment was employed to improve both matrix-fiber wetting and chemical surface modification, enhancing physicochemical interactions at the fiber-matrix interphase. The alkaline treatment impacts the fiber in two ways. It increases surface roughness, leading to better mechanical interlocking between the fiber and matrix. It increases the amount of exposed cellulose on the fiber surface, thereby expanding the number of potential reaction sites for chemical bonding.

6) Properties and Modification Methods for Vegetable Fibers for Natural Fiber Composites, Authors-A.K.BLEDZKI, S.REIHMANE, J.GASSAN, Surface modification of natural fibers (NVF) is vital for high mechanical properties in NVF-polymer composites, often achieved through methods like plasma treatment or graft copolymerization. Coupling agents like silanes or stearic acid are vital for enhancing mechanical properties in NVF-polymer composites. They

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

boost Young's modulus and tensile strength by up to 50% and reduce moisture absorption by around 60%. Treating mercerized sisal fiber with amino silane 1100 enhances moisture resistance in sisal-epoxy composites. Conflicting theories on silane treatment effectiveness underscore the need for further research to optimize composite performance.

7) Chemical Treatments of Natural Fiber for Use in Natural Fiber-Reinforced Composites: A Review, Authors-Xue Li Lope G.Tabil, Satyanarayan Panigrahi, Chemical treatments such as alkali, silane, acetylation, benzoylation, acrylation, maleated coupling agents, isocyanates, permanganate, and others are extensively reviewed for their effectiveness in enhancing natural fiber-reinforced composites. These chemical modifications play a crucial role in increasing the interface adhesion between the fiber and matrix, thereby improving the overall mechanical properties of the composite material. While the efficacy of different treatments varies, most chemical modifications have demonstrated success in enhancing fiber strength, fitness, and adhesion between natural fibers and the matrix in composite materials.

III. METHODOLOGY

3.1 MATERIALS:

Fig 3.1 Polyester Resin


Fig 3.2 Sisal Plant


Fig 3.3 Sisal fiber

The materials used in this experiment for fabrication are SISAL/GLASS FIBER and POLYESTER resin. Polyesters, the least costly resins for FRP boat building with female molds, offer affordability but drawbacks like poor adhesion, water absorption, shrinkage, and VOC emissions. They're only compatible with fiberglass, suited for non-weight-sensitive, non-critical shape accuracy, and water-resistant applications with good ventilation.In polymer composites, natural fibers like sisal provide an environmentally beneficial substitute for synthetic fibers. Sisal is unique because of its high cellulose content, affordability, low density, and wide availability. It is a potential reinforcement material for a variety of applications due to its mechanical and physical characteristics.

Fiberglass, a type of fiber-reinforced plastic, combines glass fibers with a plastic matrix like epoxy or polyester resin. It is strong, lightweight, and adaptable. used it in cars, boats, bathtubs, swimming pools, and more. Though not as strong as carbon fiber, it's less brittle and more affordable, with a better bulk strength-to-weight ratio than many metals, and easily molded into complex shapes.

PROPERTIES	SISAL	GLASS
Density(g/cm^3)	1.33-1.45	2.55
Tensile strength	510-700	2400
Young's modulus (GPa)	9-38	70-90
Moisture Absorption %	11	3
Elongation at break (%)	2.2-2.9	-

Table 3.1 Physical and Mechanical Properties Of Sisal/Glass Fibers

PREPARATION OF COMPOSITES:

The hand lay-up process is used to prepare the sample. The hand lay-up technique is a simple and minimal method for composite processing. It involves spraying release gel on the mold surface, using thin plastic sheets, and placing reinforcement in the form of sisal fibers. Then, the thermosetting polymer is mixed with a hardener and spread uniformly. The

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

process is repeated for each layer of polymer and mat until the required layers are stacked. Release gel is then sprayed on the inner surface of the top mold plate, and the composite part is removed and further processed.

The time of curing depends on the type of polymer used for composite processing. For example, for epoxy-based systems, normal curing time at room temperature is 24-48 hours. This method is mainly suitable for thermosetting polymer-based composites. Capital and infrastructural requirements are less as compared to other methods. The production rate is less and a high volume fraction of reinforcement is difficult to achieve in the processed composites. The hand lay-up method finds application in many areas like aircraft components, automotive parts, boat hulls, disease boards, decks, etc. Generally, the materials used to develop composites through the hand lay-up method are given in Table 3.2 and also volume and mass calculations are given in Table 3.3.

Matrix	Polyester	Polyester
Reinforcement	Sisal fibre	Glass fiber

Table 3.2 Materials Used

3.2.1 Volume & Mass calculation

- Length of the composite materials:30cm
- Breath of the composite materials:30cm
- Thickness of the composite materials:3cm
- Total volume of the composite materials:30cm*30cm*.3cm=270 cm^3
- Sisal fibre: 5%, 10%, 15%, 20%.
- Polyester resin: 95%, 90%, 85%, 80%.

3.2.2 SAMPLE CALCULATION

- Sisal fiber (Sample 1)
- Volume of the sisal fiber=Total volume*% of the fiber/100
- Volume of the sisal fiber=270*5/100=13.5cm^3
- Density of the fibre:1.33 g/cm^3
- Mass=Density of the fiber*volume of the fiber
- Mass=1.33*13.5=17.955g
- Polyester resin (Sample 1)
- Volume of the resin=Total volume*% of the resin/100
- Volume of the resin=270*95/100=256.5cm^3
- Density of the resin:1.4 g/cm^3
- Mass=Density of the resin*volume of the resin
- Mass=1.4*256.5=359.1g

Sample	Sisal		Glass	
	Volume	Mass	Volume	Mass (g)
Sample:1	13.5cm^3	17.95g	71.25	34.45
Sample:2	27cm^3	35.91g	67.50	68.85
Sample:3	40.5cm^3	53.86g	63.75	103.27
Sample:4	54cm^3	71.82g	60.00	137.7

Table 3.3 Volumes And Mass Calculation Of Sisal And Glass Fiber

3.2.3 COMPOSITION OF SAMPLE

Sample	**SISAL/GLASS wt.%**	**POLYESTER wt.%**
Sample - 1	5	95
Sample - 2	10	90
Sample - 3	15	85
Sample - 4	20	80

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

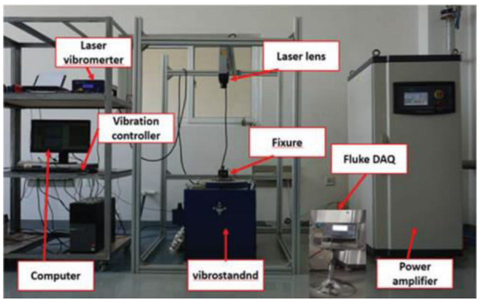
| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

3.3 FREE VIBRATION TESTING:

3.3.1 VIBRATION TEST OF COMPOSITE:

When there is no external force applied to the system and it is given slight displacement the body vibrates this vibration is called free vibration and the frequency of free vibration is called natural frequency. Fig. 3.4. and Fig. 3.5 shows the schematic diagram of the vibration system.



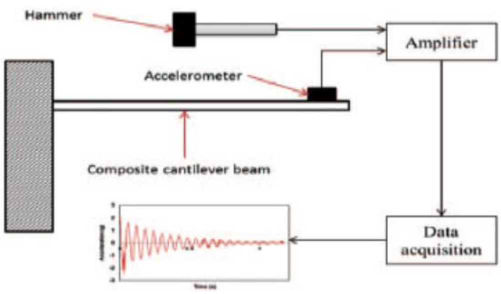


Fig. 3.4. Vibration test of composite setup

fig. 3.5 schematic diagram of the vibration system.

To perform the dynamic test, specimens were held as a cantilever beam. The free end of each sample was attached to the accelerometer, and the vibration was triggered using a rubber hammer. Figure 3.5 gives a schematic view of the vibration test systems.

The vibration acceleration time histories were recorded by the data acquisition program. The logarithmic decrement is used for calculating the damping ratio ζ of the cantilever beam from the recorded acceleration time histories based on the following equation

$$\zeta = \frac{1}{2\pi j} ln(\frac{x_i}{x_{i+j}})$$

Where x_i is of the i^{th} peak and x_{i+j} is the peak acceleration of the peak j cycles after i^{th}peak. The vibration frequency spectrum was obtained from the measured time-histories according to the fast Fourier transformation. The first main peak corresponds to the natural frequency of the composite. The average damping ratio and average frequency of each composite tested on two specimens were recorded.

IV.RESULT AND DISCUSSION

4.1 FREE VIBRATION ANALYSIS OF SISAL FIBER:

4.1.1 NATURAL FREQUENCY OF SISAL FIBER:

Free vibration and time histories of pure polyester and 5wt%, 10wt%, 15wt%, and 20wt% sisal fiber-reinforced polyester composite were carried out. The average damping ratios and natural frequencies of the composites are calculated according to the section. Shown fig.4.1(a), (b), (c), (d), (e) carried out the natural frequency of the polyester resin, Frequency vs. amplitude.Fig.4.2 (a), (b), (c), (d), (e) shown below carried out the Amplitude of pure polyester and 5wt%, 10wt%, 15wt%, 20wt% with respect to time.

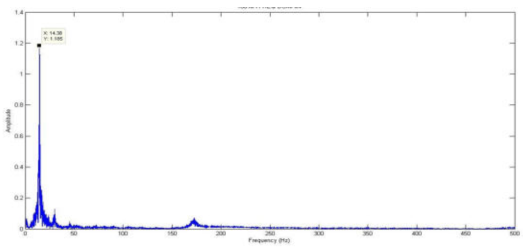


Fig 4.1 (a) Sample1, Freq (Hz) Vs Amp (g)

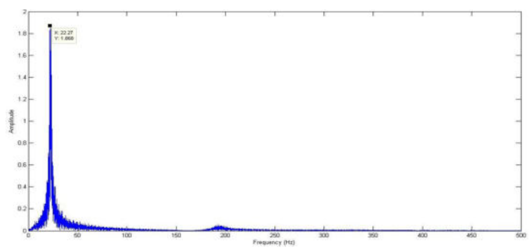


Fig 4.1(b) Sample2, Freq (Hz) Vs Amp (g)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

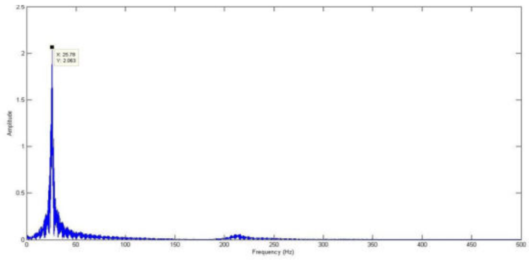


Fig 4.1(c) Sample3, Freq (Hz) Vs Amp (g)

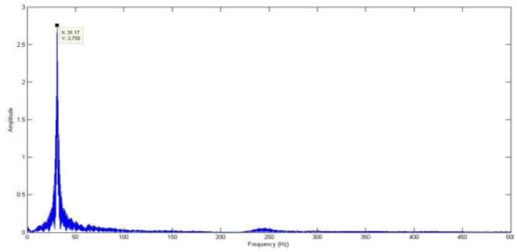


Fig 4.1(d) Sample4, Freq (Hz) Vs Amp (g)

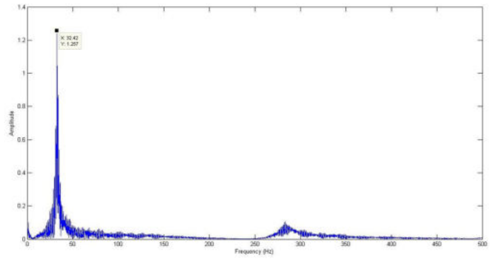


Fig 4.1(e) Sample5, Freq (Hz) Vs Amp (g)

Samples	polyester	5wt.%	10wt.%	15wt.%	20wt.%
1	14.38	22.27	22.85	31.17	32.42
2	14.30	23.13	25.78	31.88	43.75
3	14.61	22.81	22.81	32.11	42.81
Average	14.43	22.73	23.81	31.72	39.66

Table 4.1. Natural Frequency Of Sisal Fiber

4.1.1.1 NATURAL FREQUENCY GRAPH OF SISAL FIBER:

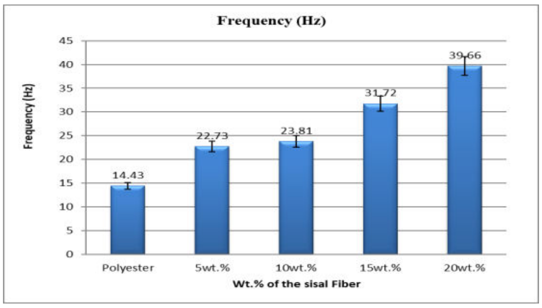


Fig.4.2 Natural Frequency values of various composite materials are shown. The value of the Natural Frequency of pure polyester resin is 14.43Hz and polyester resin with 5wt. %, 10wt. %, 15wt. % and 20wt. % of the sisal fiber values are 22.73Hz, 23.81Hz, 31.72Hz and 39.66Hz respectively. It is found that the maximum value of Natural Frequency of 39.66Hz is obtained with the addition of 20wt. % sisal fiber to the composite material.

4.1.2 DAMPING CURVE:

Free vibration test for pure polyester and 5wt%, 10wt%, 15wt%, and 20wt% sisal fiber-reinforced polyester composite was carried out and the obtained results are plotted as a graph which gives the damping ratio of the composite sample. Fig 4.3(a) represents the Time vs. acceleration graph for pure polyester. Similarly, Fig 4.3(b), (c), (d), and (e) represent the Time vs. acceleration graph for sample %, 10wt%, 15wt%, and 20wt% sisal fiber-reinforced polyester composite respectively.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

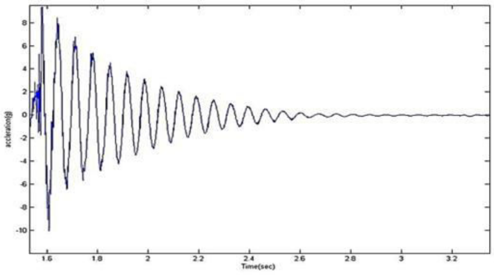


Fig.4.3 (a) Time history of Pure polyester

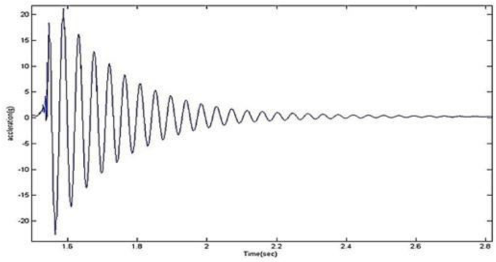


Fig. 4.3 (b) Time history of 5wt. %

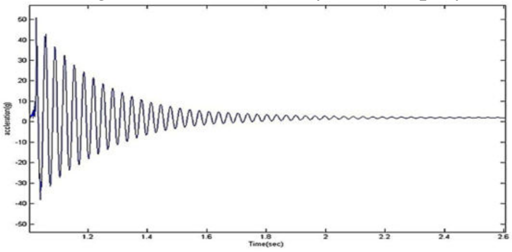


Fig.4.3 (c) Time history of 10wt. % of sisal fiber

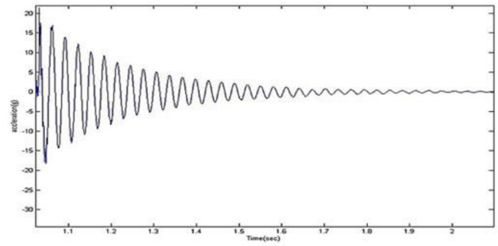


Fig.4.3 (d) Time history of 15wt. % of sisal fiber

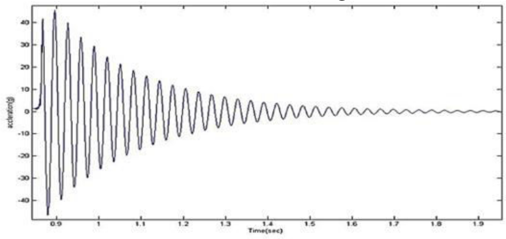


Fig.4.3 (e) Time history of 20 wt. % of sisal fiber

4.1.2.1 CALCULATION FOR DAMPING RATIO:

Find out the Damping ratio of the material using logarithmic decrement

Formula-1

$$ln\frac{x_0}{x_1} = \frac{2\pi\varepsilon}{\sqrt{1-\varepsilon^2}} \text{------------ (1)}$$

Where:

X_0 is i[th] peak

X_1 is the peak acceleration of the peak after i[th] peak.

PURE POLYESTER

$$x_0 = 4.799$$
$$x_1 = 3.792$$
$$x_2 = 3.323$$
$$x_3 = 2.697$$

These values are taken from the acceleration Vs time graph of pure polyester.

$$ln\frac{4.799}{3.792} = \frac{2\pi\varepsilon}{\sqrt{1-\varepsilon^2}}$$
$$\varepsilon = 0.0307$$

SAMPLES	POLYESTER	5WT.% OF FIBER	10WT.% OF FIBER	15WT.% OF FIBER	20WT.% OF FIBER
1	0.0375	0.0321	0.0367	0.0693	0.0346
2	0.0264	0.0366	0.0358	0.0232	0.0384
3	0.0283	0.0369	0.0358	0.0247	0.0555
AVERAGE	0.0307	0.0352	0.0361	0.0392	0.0428

Table 4.2 Damping Ratios Of Sisal Fiber

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

4.1.2.2 DAMPING RATIO GRAPH OF SISAL FIBER:

Fig.4.4. The damping Ratio values of various composite materials are shown. The value of the Damping Ratio of polyester resin is 0.0307 and polyester resin with 5wt. %, 10wt.%, 15wt.%, and 20wt.% of the sisal fiber values are 0.035, 0.0361, 0.039, and 0.0428 respectively. It is found that the maximum value of the damping ratio of 0.0428 is obtained with the addition of 20wt. % sisal fiber to the composite material.

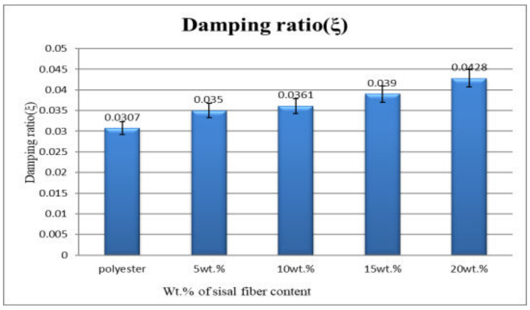


Fig 4.4 Damping ratio of sisal fiber

4.1.3 DECAY TIME OF SISAL FIBER

S.NO	SAMPLE	TIME(SEC)
1	Pure polyester	3
2	5wt.5 of fiber	2.6
3	10wt.5 of fiber	2.4
4	15wt.5 of fiber	2.1
5	20wt.5 of fiber	1.9

Table 4.3 Decay Time of Sisal Fiber

It is observed that the decay time decreases with the addition of sisal fiber, the minimum decay time is 20wt. % of sisal fiber composite materials

4.2 FREE VIBRATION ANALYSIS OF GLASS FIBER:

4.2.1 NATURAL FREQUENCY OF GLASS FIBER:

Free vibration and time histories of pure polyester and 5wt%, 10wt%, 15wt%, and 20wt% glass fiber-reinforced polyester composite were carried out. The average damping ratios and natural frequencies of the composites are calculated according to the section. Shown fig.4.9(a), (b), (c), (d), (e) carried out the natural frequency of the polyester resin, Frequency vs. amplitude. Fig.4.10 (a), (b), (c), (d), (e) shown in below carried out the Amplitude of pure polyester and 5wt%, 10wt%, 15wt%, 20wt% with respect to time

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

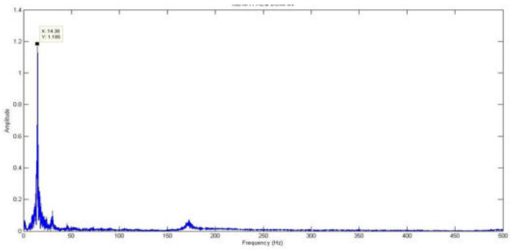


Fig 4.9 (a) Sample1, Freq (Hz) Vs Amp (g)

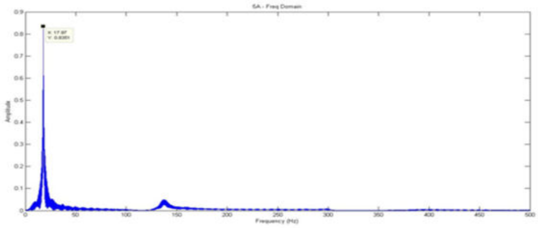


Fig 4.9 (b) Sample2, Freq (Hz) Vs Amp (g)

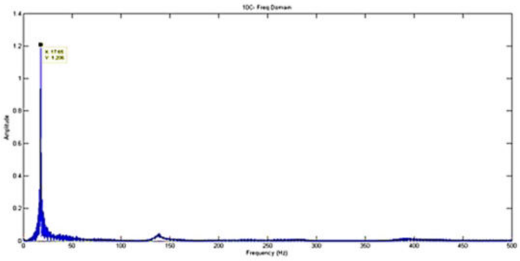


Fig 4.9 (c) Sample3, Freq (Hz) Vs Amp (g)

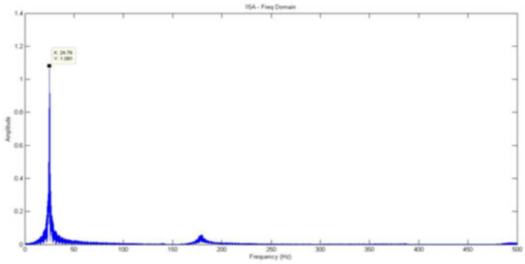


Fig 4.9 (d) Sample4, Freq (Hz) Vs Amp (g)

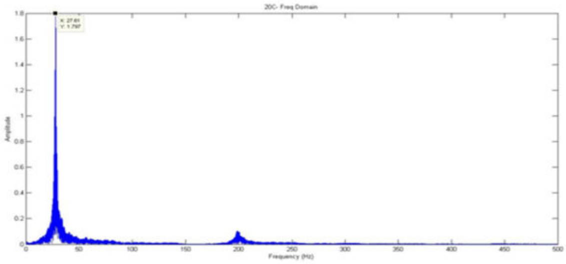


Fig 4.9 (e) Sample5, Freq (Hz) Vs Amp (g)

Samples	polyester	5wt. % of glass fiber	10wt.% of glass fiber	15wt.% of glass fiber	20wt.% of glass fiber
1	14.38	17.67	15.67	24.76	26.54
2	14.3	16.97	17.26	21.51	23.95
3	14.61	14.06	17.65	23.75	27.61
Average	14.43	16.23	16.86	23.34	26.033

Table 4.8 Natural Frequencies (Hz) Of Glass Fiber

4.2.1.1 NATURAL FREQUENCY GRAPH OF GLASS FIBER:

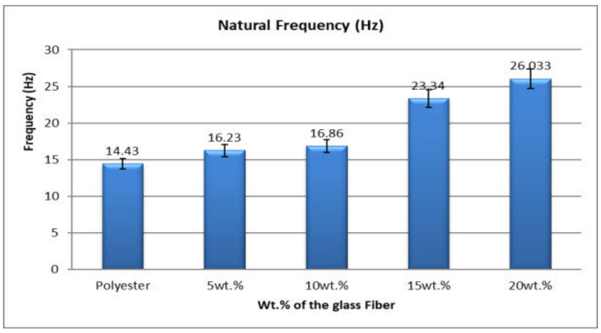


Fig 4.10 Natural frequency

Fig.4.10 Natural Frequency values of various composite materials are shown. The value of the natural Frequency of pure polyester resin is 14.43Hz and polyester resin with 5wt. %, 10wt. %, 15wt. % and 20wt. % of the glass fiber

International Journal Of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

values are 16.23Hz, 16.86Hz, 23.34Hz and 26.5 Hz respectively. It is found that the maximum value of Natural Frequency of 26.033Hz is obtained with the addition of 20wt. % glass fiber to the composite material.

4.2.2 DAMPING CURVE OF GLASS FIBER:

Free vibration test for pure polyester and 5wt%, 10wt%, 15wt%, and 20wt% glass fiber-reinforced polyester composite was carried out and the obtained results are plotted as a graph which gives the damping ratio of the composite sample.

Fig 4.11(a) represents the Time vs. acceleration graph for pure polyester. Similarly, Fig 4.12 (b), (c), (d), and (e) represent the Time vs. acceleration graph for sample %, 10wt%, 15wt%, and 20wt% glass fiber-reinforced polyester composite respectively.

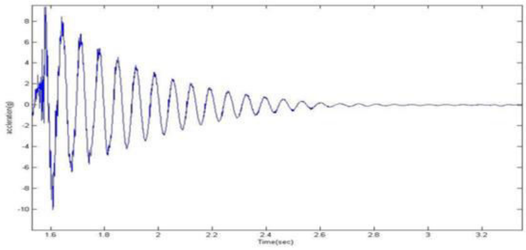


Fig. 4.11 (a) Time history of polyester

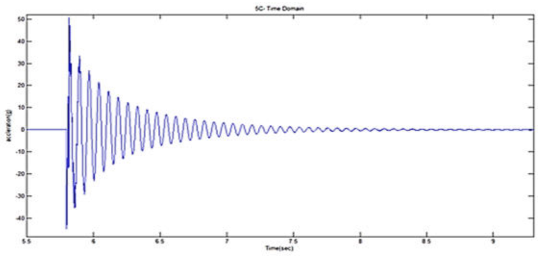


Fig. 4.11 (b) Time history of 5wt. % of fiber

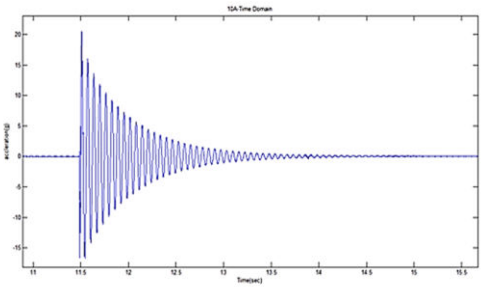


Fig. 4.11 (c) Time history of 10wt. % of fiber

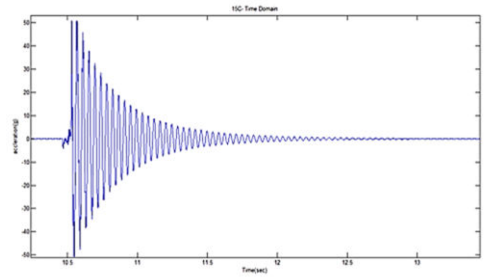


Fig. 4.11 (d) Time history of 15wt. % of fiber

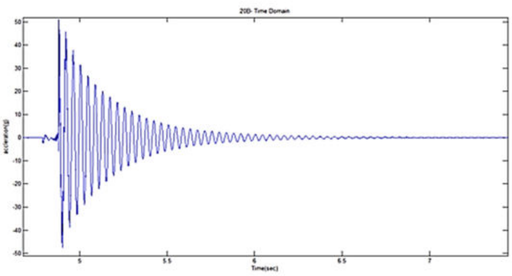


Fig. 4.11 (e) Time history of 20wt. % of fiber

Samples	Polyester	5wt.% of fiber	10wt.% of fiber	15wt.% of fiber	20wt.% of fiber
1	0.0375	0.017	0.01943	0.0248	0.0257
2	0.0264	0.0162	0.01562	0.0186	0.0171
3	0.0283	0.0201	0.01706	0.0134	0.0217
Average	0.0307	0.036	0.0367	0.041	0.0429

Table 4.9 Damping Ratios Of Glass Fiber Composite Materials

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

4.2.2.2 DAMPING RATIO GRAPH OF GLASS FIBER COMPOSITE MATERIALS.

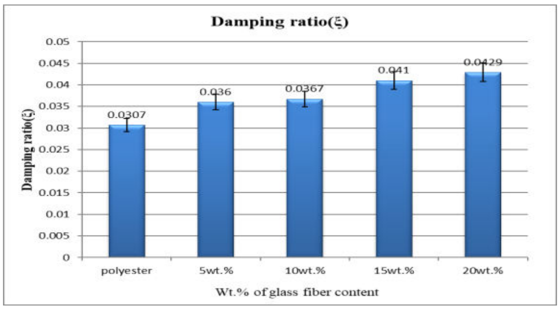


Fig 4.12 Damping ratio

Fig.4.12 The Damping Ratio values of various composite materials are shown. The value of the Damping Ratio of polyester resin is 0.0307 and polyester resin with 5wt. %, 10wt.%, 15wt.%, and 20wt.% of the sisal fiber values are 0.036, 0.0367, 0.041, and 0.0429 respectively. It is found that the maximum value of the damping ratio of 0.0429 is obtained with the addition of 20wt. % sisal fiber to the composite material.

4.2.3 DECAY TIME OF GLASS FIBER

Decay time, also known as reverberation time or reverb time, is an important parameter in the study of biocomposite materials, particularly when considering their acoustic and damping properties.

SL.No.	Sample	Time(sec)
1	Pure polyester	3
2	5wt.5 of fiber	3.9
3	10wt.5 of fiber	3.725
4	15wt.5 of fiber	2.669
5	20wt.5 of fiber	2.614

Table 4.10 Decay Time

Biocomposites' decay time, measured by reverberation chambers, is crucial for absorbing and dissipating energy through damping mechanisms. It is optimized using theoretical models and numerical simulations. Glass fiber addition decreases decay time, with a minimum of 20 wt.% in composite materials.

V. CONCLUSION

In this work, the vibration characteristics behavior of short sisal/glass fiber-reinforced polyester composites was investigated by free vibration testing. It is concluded that the addition of sisal fiber increases the natural frequency and damping ratio. These results encourage using sisal and glass fiber reinforced composite in vehicle parts where vibration absorption is of great concern. Also, the frequency has an adverse effect on the damping property of the composite.

In the experimental study, the sisal fiber is used as a reinforcing material with a polyester matrix, the composites have been fabricated and the physical characteristics of these materials are examined.

REFERENCES

1. Adrian M. Cunliffe, Nicola Jones, Paul T. Williams: Recycling of fibre-reinforced polymeric waste by pyrolysis: thermo-gravimetric and bench-scale investigations.
2. Aigbodion, Hassan, Ucatuanya: effect of orange peels ash on thermal properties of high-density polyethylene.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704205 |

3. Betiana A. Acha, Marı´a M. Reboredo, Norma E. Marcovich: Creep and dynamic mechanical behavior of PP–jute composites: Effect of the interfacial adhesion.
4. Bhanu K. Goriparthi, Suman, Nalluri Mohan Rao: Effect of fiber surface treatments on mechanical and abrasive wear performance of polylactide/jute composites.
5. Chandramika Bora, Pranjal Bharali, Silpi Baglari, Swapan K. Dolui, Bolin K. Konwar: Strong and conductive reduced graphene oxide/polyester resin composite films with improved mechanical strength, thermal stability and its antibacterial activity.
6. Heitorluizornaghi Jr, vinicios, ademir jose zattera: effect of the epoxy cyclohexyl polyhedral oligo metricises dioxane content on the dynamic fragility of an epoxy resin.
7. Jawaid, Abdul Khalil: effect of layering pattern on the dynamic mechanical properties and thermal degradation of oil palm- jute fibres reinforced epoxy hybrid composite.
8. Jawaid, Abdul Khalil, Azman Hassan, Rudi Dungani, Hadiyane: Effect of jute fiber loading on tensile and dynamic mechanical properties of oil palm epoxy composites.
9. Jawaid, Abdul Khalil, Omar S. Alattas: Woven hybrid biocomposites: Dynamic mechanical and thermal properties.
10. Karaduman, Sayeed, Ona, Rawal: Viscoelastic properties of surface modified jute fiber/polypropylene nonwoven composites.
11. Lindeke, Composite Materials, ENGR 2110
12. Libo Yan, Effect of alkali treatment on vibration characteristics and mechanical properties natural fiber reinforced composites
13. Maria L. Auad, Polymer viscoelasticity: Dynamic Mechanical Analysis (DMA).
14. Muralidhara, Sreenivasan: Thermal Degradation Kinetic Data of Polyester, Cotton and Polyester-Cotton Blended Textile Material.
15. Patel, K. S. Patel, R. N. Patel and K. D. Patel: Thermal and mechanical properties of modified polyester resin and jute composite.
16. Pandey, Dept. of Civil Eng., IISc Bangalore Composite materials [web-based course]
17. Smita Mohantya, Sushil K. Verma, Sanjay K. Nayak: Dynamic mechanical and thermal properties of MAPE treated jute/HDPE composites.
18. Yiping Qiu, Textile Structural Composites College of Textiles, Donghua University, Spring, 2006.

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com