January-February 2020
ISSN: 0193-4120 Page No. 7131 - 7139

Bio Caryota Chopped Fibre Reinforced Polyester Composites: Evaluation Vibration Analysis

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Abstract:

In nowadays the natural fiber reinforced composites use in automobiles, aerospace in terror parts and other application becomes raise due to less weight, low cost ,bio degradability and simple to manufacture. The natural fiber reinforced polymer composites necessary to know the vibration behavior to effectively use for the right engineering application. This work introduce the free vibration analysis of chopped caryota fiber reinforced polyester composites(CCFRPC) of cantilever beam. Also present the physical, chemical and mechanical characteristic of fiber was found by experimental methods. The vibration analysis is measured out in the beam having varying fiber lengths such as 10mm,25mm,50mm,100mm and 125mm.The 50mm fiber length of chopped fiber reinforced composites has optimum frequency than the other lenths of chopped fiber reinforced composites. Hence the 50mm length of chopped fiber reinforced composites suggested for automobile and industrial application.

Keywords: *Caryotafiber, Free vibration and Cantilever beam*

I. INTRODUCTION

Recent scenario the research is coming out in large quantum and is varied in nature in terms of its input, deliverable and utilization. It is important the quality of composite material can be used in automotive industry work flow of the improvement of natural fiber reinforced composites. V.S.Sreenivasan et al [1]identify the newely developed sansevieria cylindrical fibers,to determine the characteristic of fibers. Also studied the microstructural,XRD and FTIR analysis of fibers.Sathiskumar et al [2] found the physical , chemical and mechanical properties of sansevieriaehrenbergii fibers and also studied the thermal stability of the fibers using TGA and DTG analysis.Arthanarieswaran et al [3]. They have observed that the addition of glass fiber in the matrix along with the natural fibres increases the strength of composite material, also indicated that the performance of these materials are affected by inefficient fabrication in the composites, voids formed during the fabrication, etc.Nilza et al [4] have analyzed the characterization test such as ash content, carbon content. They have used Jamaican cellulose fibre, and indicated that this fiber can be used in interior work, also these composite may be used in structural application.Ratna Prasad and Mohan Rao [5] have tested the Jower, bomboo and sisal fibre reinforcements, and they have found that these fibres are available in large quantity, cheaper than other fiber used and renewable. Also they have asserted that the fiber arrangements and the volume fraction of fibres in the composites mainly affect the properties of this composite.Sathishkumar et al [6] They have

January-February 2020
ISSN: 0193-4120 Page No. 7131 - 7139

indicated that the fiber length plays an important role in deciding the property for these composites and also the extraction process for these composite is very easy and simple.Glass-Sisal /Jute fibre reinforced composite material effect is analyzed by Ramesh et al [7], they have indicated that sisal-GFRP produces better performance in tensile loading and Jute-GFRP produces best flexural loading and also indicated that the developed materials can be applied for medium weight products fabrication.

Planikumar et al. [8] have did experiments and found the mechanical properties for the woven alovera/sisal/kenaf reinforced composites. They have produced this composite material by hand layup process, the results from their experiments revealed alovera and kenaf reinforced hybrids shows better flexural strength whereas alovera, sisal and kenaf shows better impact strength. Elsayed et al. [9] have used old jute fibers punched by needles as reinforcement for fabricating for unsaturated polyester matrix composites. They have studied the tensile properties and the bending properties of the laminates and compare the results with the finite element analysis. The fracture of the matrix is studied by using scanning electron microscope. They have observed fiber pull out and fiber bridge mechanisms for the tensile and bending strength respectively.

Lukas et al. [10] have analyzed the state of the art knowledge on mechanical performance of natural fiber wood fiber reinforcement having polypropylene matrix and they made an effort for material development and market potentials. Peng et al [11] have made an effort to study the mechanical properties of pultruded composites using hemp and wool fibers. They have used different matrices such as polyurethane, polyester and vinyl ester. They have observed that the polyurethane produces comparatively better strength than the other type of matrices used

The nonwoven coir fibers effects on polyester matrix composites are studied by Jayapal and Natarajan [12]. They have conducted the experiments using different fiber percentage and the length of the fibers in polyester matrix. The results from their study indicate that the fiber content plays an important role in deciding the strength. Senthilkumar et al. [13] have fabricated the hybrid natural composites with treated and un treated condition, they have studied the vibration characteristics and found that the dynamic characteristic is more for the skin core and skin eccentric composites laminates.Bennet et al. [14] have analyzed the snake cross and coconut sheath fiber with treated and un treated reinforced polyester composites for varying stacking sequence, they have found that the mechanical properties and free vibration characteristic are quiet competitive for the treated fiber reinforced polyester composites.Mayandi et al[15] fabricated varying the fiber length and weight percentage of cissusquadrangularis fiber reinforced polyester composite laminate, they have reported tensile and flexural strength are 27MPa and 65MPa respectively this result optimum for the fiber length of 40mm and 40wt.% of fiber loading.Vijayakumar et al[16] Compression moulding process used to fabricate the caryota-bamboo-glass fiber hybrid composites with five layering pattern. The result reveals bamboo-glass fiber hybrid composites higher tensile strength than the other layering pattern of the composites, caryota-glass fiber hybrid composites higher flexural strength than the other layering pattern of the composites,and caryota-bamboo- glass fiber hybrid composites optimum impact strength than the other composite laminates.Also they have studied the fracturedspecimen internal cracks,fiber breakage and incomplete distribution of fiber and matrix are observed by using Scanning Electron Microscopy.Palanikumar et al [17] Compression molding process used to fabricate the unidirectional arrangement of fiber and varying

January-February 2020
ISSN: 0193-4120 Page No. 7131 - 7139

wt% of fiber reinforced with polyester composites.They have found 40wt% of fiber loading increase the mechanical and vibration properties than the other wt% of fiber loading of the composites.Also they have studied the morphological characteristics of the fractured specimen.

Nomenclature

CCFRPC Chopped Caryota Fiber Reinforced Polyester Composites

DAS Data Acquisition System

II. Materials and Methods

The matrix used for the composites preparation is polyester resin. The polyester resin is the one of the cheapest material used for composites preparation..It is purchased from covisanu private Ltd,Tamilnadu.For the composite fabrication 1wt% of cobalt naphthanate and 1wt% of methylethyl ketone peroxide is used as accelerator and catalyst.The caryota fiber used as a reinforcement for composite laminate preparation.The compression mold method usd to fabricate the composite laminates at various fiber length and uniform wt% of fiber.For the composite fabrication applied for the hydraulic pressure of 100Kgf/cm^2,temperature maintained at 70^{0}C and the relative humidity of 50% and kept for 20mins to get a required composites.The composite laminates are cut in to a prismatic sample of 200mm length,20mmwidth and 3mm thickness. The figure shows the different fiber length of uniform wt% of composite specimens[1-9]

Fig.1. Extraction of fiber from the flower steam

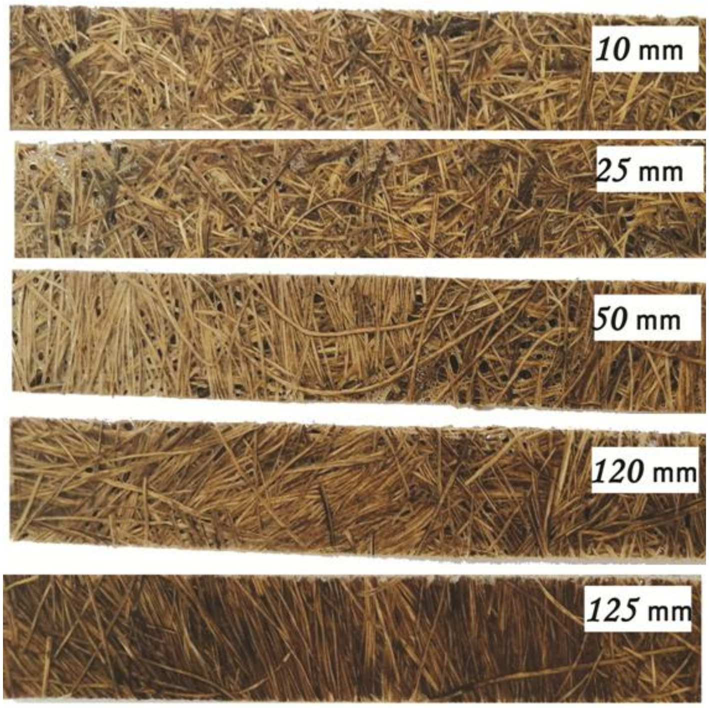

Fig. 2. Specimen for vibration analysis (10mm,25mm,50mm,100mm&125mm)

January-February 2020
ISSN: 0193-4120 Page No. 7131 - 7139

Fig. 3. Model testing equipment

The vibration testing experiment consists of tri axial accelerometer ,impulse hammer,Sensers,Data Acquisition System(DAS) and DEWE soft "7"software used for acquisition of data.The vibrating signal sense the data capturing to the Data Acquisition System(DAS) through the three different color cables.The output from the DAS the DEWE soft "7"software used to convert the frequency response time function.The data from the tri axial accelerometer can be displayed in numerical and graphical form in the computer system.The model analysis damping factor can be determined by the formula:

$$\zeta = \frac{\Delta\omega}{2\omega_n} \quad (1)$$

Where ζ = Damping factor

$\Delta\omega$ = Band width

ω_n = Natural frequency

In the experiment,the size of specimen used for modal analysis is 200mmx20mmx3mm is clamped using a "C"clamp in the cantilever beam set up.The tri axial accelerometer attached in the composite laminate with the help of wax.A light impact force is applied in the composite specimen using impulse hammer ,the vibrating signal is sensed by the tri axial accelerometer has been send to the DAS.The DAS feed the input signal to the computer system with the help of DEWE soft "7"software which convert the data innumerical and graphical form.

III. Result and discussion

3.1Physical,Chemical and Mechanical Properties of Caryota fiber

Kushner and hoofers method is use for find out cellulose content present in the caryotafibre. The caryota fiber the cellulose content is 69.64%. The caryota fiber the cellulose content increase caryota fiber has an importent influence on increase the mechanical characteristic of composite laminates. Klason lignin of APPITA Plls 78 method is used for determine the insoluble of the lignin content of the caryota fiber. The lignin content of the caryotafiber is 17.34%.The wax content measured by using Conrad with Soxhlet extraction. The density of the fiber is 1.32 gm /cc. The 20^0C temperature and 50% relative humidity can be measure the density tesing.

TEST Engineering & Management

January-February 2020
ISSN: 0193-4120 Page No. 7131 - 7139

Table 1.Physical ,Chemical and Mechanical Properties of Caryota fiber

Cellulose Content	69.64%
Lignin Content	17.34%
Wax Content	0.69 %
Moisture Content	8.42 %
Density	1.32 gm /cc
Ash Content (on dry basis)	3.74 %
Elongation	16.97%
Maximum tensile force	23.22N
Force at break	20.89N

3.2 Modal Analysis

The model characteristic obtained for natural frequency and damping of the chopped caryota fiber at varying length of composites at three nodes indicated in the Table 2.The result revealed the natural frequency and damping factor depends upon the wt% of fiber loading of the composite laminates.The vibration analysis indicates 40wt% 0f fiber loading of 50mm length of fiber reinforced composites optimum results than the other fiber length of the composites.Also the result indicates more than 45wt% of fiber loading of the composites natural frequency started sloping down from its higher values.The model analysis the 40wt% of the composites at 50mm length of fiber better interfacial bonding between the fiber and matrix ,which leads to increase the stiffness of the composites.The dynamic characteristic mainly depends on stiffness and moment of inertia and mass density of the composites[10-21].

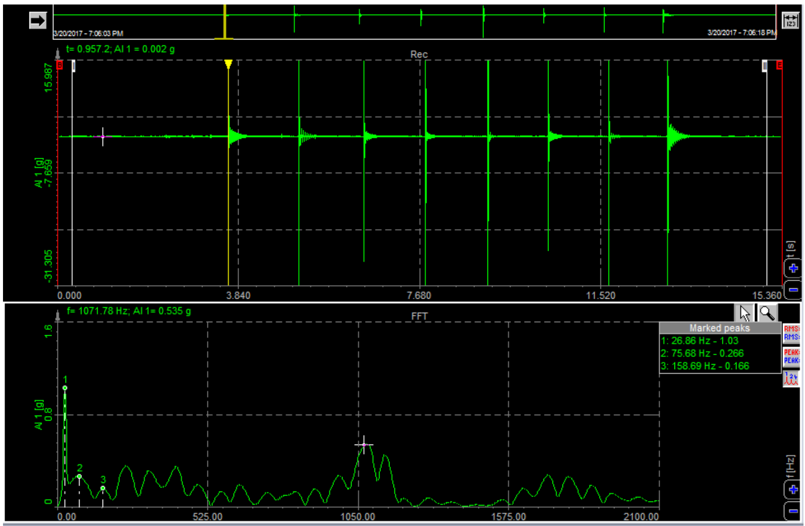

Fig. 4.Model analysis of 10mm length of fiber reinforced composites

January-February 2020
ISSN: 0193-4120 Page No. 7131 - 7139

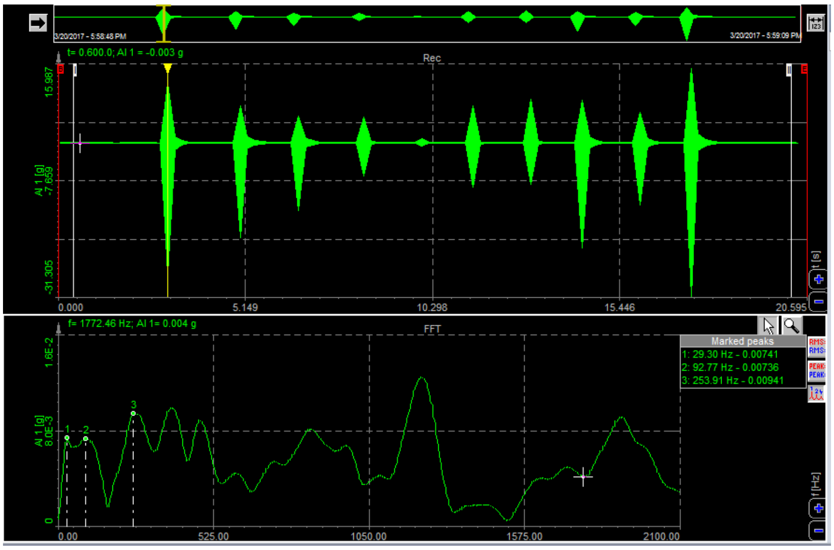

Fig. 5.Model analysis of 25mm length of fiber reinforced composites

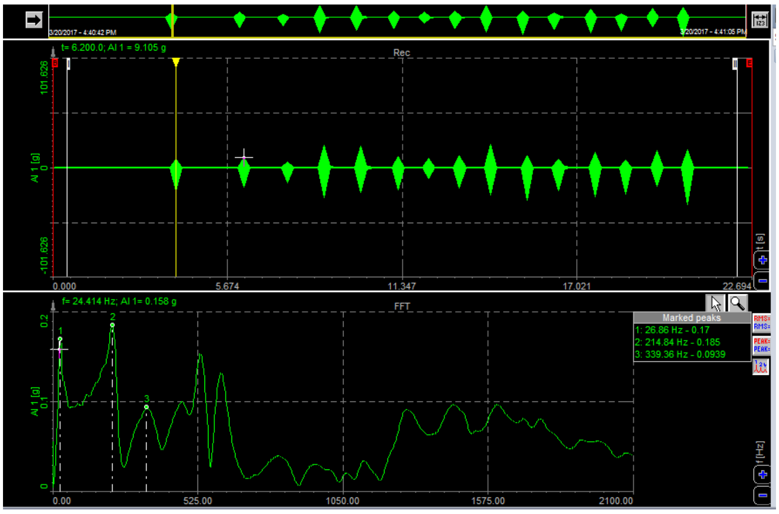

Fig. 6.Model analysis of 50mm length of fiber reinforced composites

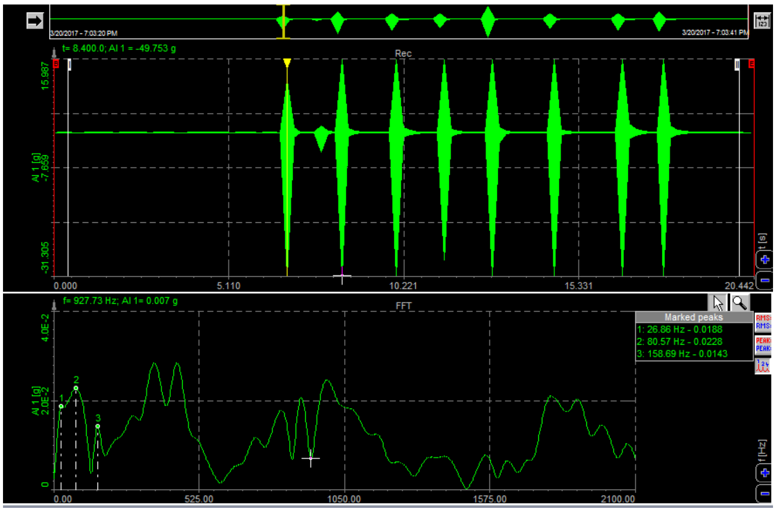

Fig. 7.Model analysis of 100 mm length of fiber reinforced composites

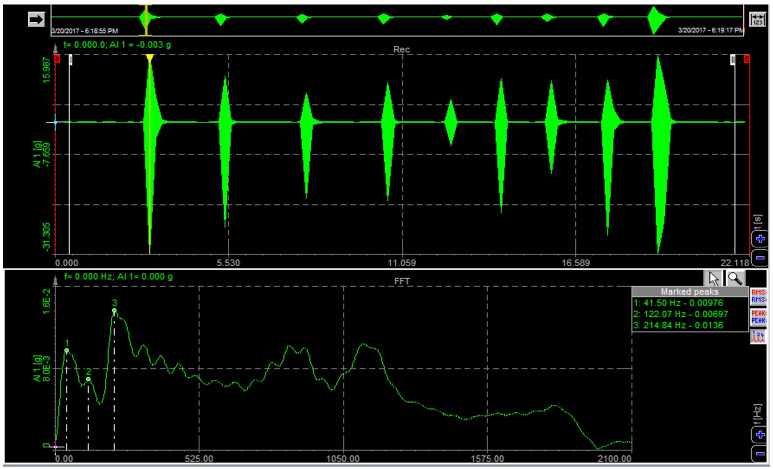

Fig. 8.Model analysis of 125 mm length of fiber reinforced composites

Fig.4-8Amplitude(g) Vs time(sec) and Amplitude(g) Vs frequency(Hz) curve generated for 40 wt% caryota fiber reinforced composites

Table 2.Model analysis of choppedcaryota fiber reinforced composites

Length of fiber in mm	**Natural Frequency(Hz)**			**Damping factor**		
	Node 1	**Node 2**	**Node 3**	**Node 1**	**Node 2**	**Node 3**
10	26.86	76.68	158.66	1.03	0.266	0.166
25	29.30	92.77	253.97	0.00741	0.00736	0.00941
50	26.86	214.8	339.36	0.075	0.0902	0.0652
100	41.50	122.07	214.84	0.00976	0.00697	0.0136
125	26.86	80.57	158.69	0.00188	0.0228	0.0143

3.3Morphology Analysis of fiber

Figure 9 shows the longitudinal directional view of single caryotafiber.Thecaryota fiber outer periphery has several irregularities surface for the sectional view of fibers,that provides good adhesion bonding between fiber and the polymer matrix.The manufacturing of composites laminates bridge between fiber and matrix leads to increase the characteristics of composites[22-26].

TEST Engineering & Management

January-February 2020
ISSN: 0193-4120 Page No. 7131 - 7139

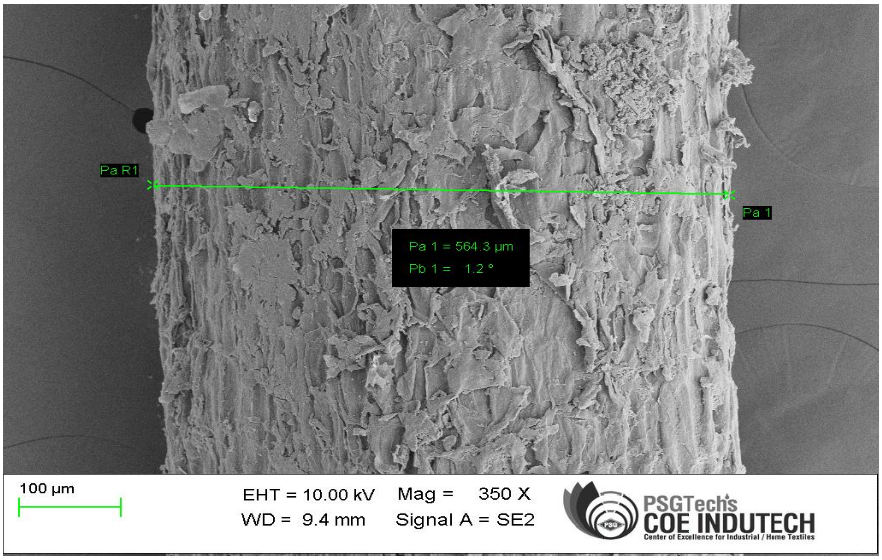

Fig. 9.Longitudinal sectional view of caryota fiber

IV. CONCLUSION

The newly developed caryota fiber was extracted manually from flower steam of fish tail palm tree and its properties were determined. The caryota fiber has more cellulose content which increase the mechanical properties of fiber.The physical and chemical properties observed the caryota fiber has high potential to use as reinforcement in the polyester matrix composites.The model analysis was carried out for composite specimen under cantilever beam set up free boundary condition. The chopped 50mm length caryota fiber has optimum frequency range of 26.86-339.36Hz than the other fiber length.The morphological analysis of longitudinal sectional view of caryota fiber analyzed by using EDAX.Hence the 50mm fiber length of caryota fiber reinforced composites suggested for automobile and industrial application.

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