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ANALYSIS OF DYNAMIC CHARACTERISTICS OF NATURAL (BANANA) FIBER,PHENOL FORMALDEHYDE AND ISOPHTHALIC RESIN COMPOSITES

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Abstract

Natural fiber reinforced polymer composites have emerged as a potential environmentally friendly and cost-effective alternative to synthetic fiber reinforced composites. The availability of natural fibers and the ease of manufacturing have tempted us to study their feasibility of their application as reinforcement and the extent to which they satisfy the required specifications in day to day applications. Present age car bumpers are made of thermoplastic olefins (TPOs), polycarbonates, polyesters, polypropylene, polyurethanes, polyamides which are non biodegradable and difficult to recycle. A try has been made to use banana fiber reinforced polymer composites in car bumpers. Since plenty of banana stem is available, so it is pertinent to use banana fiber as acomposite material along with a suitable matrix (cost effective) phenol formaldehyde and Isophthalic resin at various proportions (40-60%, 30-70%,50- 50%, 60-40%) by hand layup method. Peroxide treatment over banana fiber enhances the fiber property, Specimen was cut from the fabricated laminate according to ASTM standard for different experiments such as tensile test, damping test. The property of the material finds a significant use in present age car bumpers as it is biodegradable.

Keywords – *Natural fiber composites, Banana fiber, car bumpers, Phenol formaldehyde, isophthalic resin*

1 INTRODUCTION

A **Composite material** is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure.The new material may be preferred for many reasons common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials.

1.1 TYPES OF COMPOSITES

Metal Matrix Composites

MMC are composed of a metallic matrix (aluminium, magnesium, iron, cobalt, copper) and a dispersed ceramic (oxides, carbides) or metallic (lead, tungsten, molybdenum) phase.

Ceramic Matrix Composites

CMC are composed of a ceramic matrix and embedded fibers of other ceramic material (dispersed phase).

Polymer Matrix Composites

PMC are composed of a matrix from thermoset, Unsaturated Polyester(UP), Epoxy, thermoplastic, Polycarbonate(PC), Polyvinyl chloride, Nylon, Polystyrene and embedded glass, carbon, steel or Kevlarfibers (dispersed phase).

1.2 NATURAL COMPOSITE

Natural fibers in simple definition, are fibers that are not synthetic or manmade. They can be sourced from plants or animals. The use of natural fiber from both resources, renewable and non renewable such as oil palm, sisal, flax, and jute to produce composite materials, gained considerable attention in the last decades, so far. The plants, whichproduce cellulose fibers can be classified into bast fibers (jute, flax, ramie, hemp, and kenaf), seed fibers (cotton, coir, and kapok), leaf fibers (sisal, pineapple and abaca), grass and reed fibers (rice, corn, and wheat), and core fibers (hemp, kenaf, and jute) as well as all other kinds (wood and roots).

1.3BANANA FIBER

Banana fiber is extracted from the banana stem which is awaste material after harvesting the

banana.

WHY BANANA FIBER ?

Actually Banana is a gigantic herb, and a food fruit crop an ancient species cultivated all over the world. Next to Brazil India is the largest banana producer. The fruit bunches and leaves are main source of Income, besides the leaves are used as bio plates for serving food in homes and functions. Banana fruit contains of multi vitamin and proteins,other portions of Banana plant are dumped as waste, and the fruit bunches(the upper side 'U' type stem) is also cutted and wasted.

Farmers often face problems to clear it, Due to weather conditions such as floods, a heavy wind, the complete Banana trees falls down, and creates a heave loss and more over the price fluxuations for Banana fruits. Due to these factors Banana farmers are suffered to such kind of difficulties.

Banana trees can be extracted and converted as a fiber, through simple Machinery. This process will be done only after harvesting the Banana.

PROPERTIES OF BANANA FIBER

Sample no	Length(10^{-3})	Ultimate breaking strength (MN m^{-2})	SD Ultimate breaking strength (MN m^{-2})	%Breaking Strain	SD % Breaking Strain
1	10.00	1055.516	260.612	13.770	3.439
2	20.00	930.734	270.430	6.375	1.393
3	35.00	891.706	196.775	6.387	1.809
4	50.00	711.661	239.614	2.469	0.738
5	100.00	731.185	224.275	2.714	0.636

Mechanical Properties of Banana Fibers over different Lengths.(International Journal of Innovative Research in Science, Engineering and Technology Vol. 4, Special Issue 6, May 2015)

2 LITERATURE REVIEW

1,*"Free Vibration Characteristics of Banana/sisal natural fibersreinforced hybrid polymer composites"*

Author: N.Rajini et.al

Materials used: Banana and sisal fiber, unsaturated iso-phthalic, polyesterresin and MEKP

Manufacturing Process: Compression moulding methodResults: 50% of fiber usage increases fiber frequency

2*,"Experimental investigation of mechanical characteristics andvibration analysis of banana fiber reinforced composites"*

Author: Ravindra babu et.al

Materials used: Banana fiber, epoxy resin. Manufacturing Process: Compression moulding method

Results: 20-80% of proportions of banana fiber and epoxy gives goodstrength

3,"Vibration Characteristics of natural fiber reinforced polymercomposites"

Author: Rajesh Kumar et.al

Materials used: Banana fiber, phenol formaldehyde resinManufacturing Process: Hand lay up method

Results: Natural fibers are found to have good vibrational characteristics

4,"Free vibration and damping characteristics GFRP and BFRPlaminated composites at various boundary conditions"

Author: J.Alexander et.al

Materials used: Basalt woven fabric and unidirectional fabric, epoxy resin Manufacturing Process: Compression moulding method

Results: BFRP can be suggested for aerospace than EFRP 5,"Study of properties of banana fiber reinforced composites"

Author: S.Raja et.al

Materials used: Banana fiber, epoxy resin Manufacturing Process:

Compression moulding method

Results: Treated banana fiber seems to show good mechanicalcharacteristics than untreated banana fiber

6."A comparison of the mechanical properties of phenol formaldehyde composites reinforced with banana fibers and glassfibers"

Author: Z.Oomen et.al

Materials used: Banana fiber, Phenol formaldehyde resinManufacturing Process: Hand layup method

Results: Banana and glass fiber are found to have an increase in tensile,flexural and impact properties with increasing fiber loading.

3.EXTRACTION OF BANANA FIBER

The extraction of the natural fiber from the plant required certain care to avoid damage. In the present experiments, initially the banana plant sections were cut from the main stem of the plant and then rolled lightly to remove the excess moisture. Impurities in the rolled fibers such as pigments, broken fibers, coating of cellulose etc. were removed manually by means of comb, and then the fibers were cleaned and dried. This mechanical and manual extraction of banana fibers was tedious, time consuming, and caused damage to the fiber. The stepsinvolved in extraction of banana are

Step 1: Extraction of BF-The banana stem is extracted from the cultivated banana plant.

Step 2: Retting Process-Fiber is extracted from the banana stem using retting process withthe help of machine.

Step 3: Soaking of fiber-Fiber is washed and made free from dust and coarse particleswhich is present in between the fiber strands.

Step 4: Drying of banana fiber-The process of drying the banana fiber upto 12-24 hrs

3.1 MATERIAL SELECTION

Phenol Formaldehyde resin

- Phenol formaldehyde resins (PFs) are condensation polymers.
- Condensing phenol with formaldehyde in the presence of an acidicor alkaline catalyst.

Properties

- They possess excellent adhesive properties .
- Phenol- formaldehyde resins having high degree of polymerizationare hard, rigid, scratch resistant and infusible.
- They are resistant to non-oxidising acids, salts and many organicsolvents.
- They can withstand very high temperatures.
- They act as excellent electrical insulators also.

Isophthalic Resin

- Isophthalic polyester resin is the standard economic resin used bymany people.
- Isophthalic polyester resin is now becoming the preferred materialin industries such as marine where its superior water resistance is desirable.

Properties

- They are resistant to non-oxidising acids, salts and many organicsolvents.
- They can withstand very high temperatures
- They are biodegradable.
- They possess excellent adhesive properties

HARDENER

- The hardener used for phenol formaldehyde is Nitrous solution
- The hardener used for isophthalic is Ketone

TREATMENT UNDERGONE

Peroxide Treatment

In organic chemistry, peroxide is a specific functional group or a molecule with the functional group ROOR containing the divalent ion O–O. Organic peroxides tend to decompose easily to free radicals of the form RO then reacts with the hydrogen group of thematrix and cellulose fibers. For example, the peroxide initiated free radical reaction between PE matrix and cellulose fibers.

Improvements in banana fiber

- Improve the interface properties of fiber and matrix
- Peroxide radicals react with hydroxyl group of fiber and matrix
- As a result, good fiber matrix adhesion provides.
- It reduces moisture absorption tendency by the fiber and improvesthermal stability

3.2 FABRICATION

Hand lay-up process

- Wax coating is given to the base.
- Maylord sheet is kept over the base in order to prevent sticking ofmaterial
- Chopped fiber mat is kept over the maylord sheet.
- Layer of phenol formaldehyde resin is given above the choppedfiber.
- Again another chopped fiber layer is kept over the resin, again theresin is coated.

- This process is continued upto 3mm according to ASTM standard.
- After that a even weight of 50kg is spread over composites.
- Acetylene is used as a cleaning agent.
- Above process is repeated for isophthalic resin.

4 EXPERIMENTATION

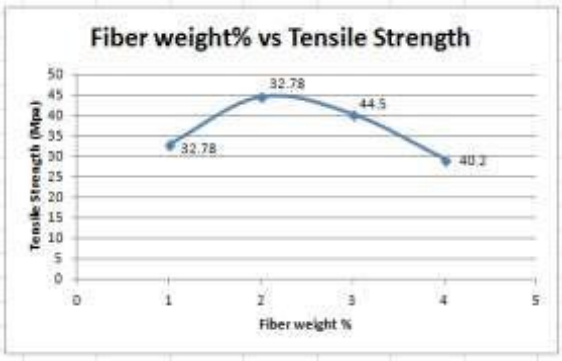
Tensile test

The tensile test is carried out using "**TRINIUS OLSEN H50KL**" in testing facility **NIT Trichy**. The moving speed of jaws is **1mm/sec** which is donoted find the exact point of tensile strength in material. Special jaws are mounted for carry out the tensile test.

Damping test

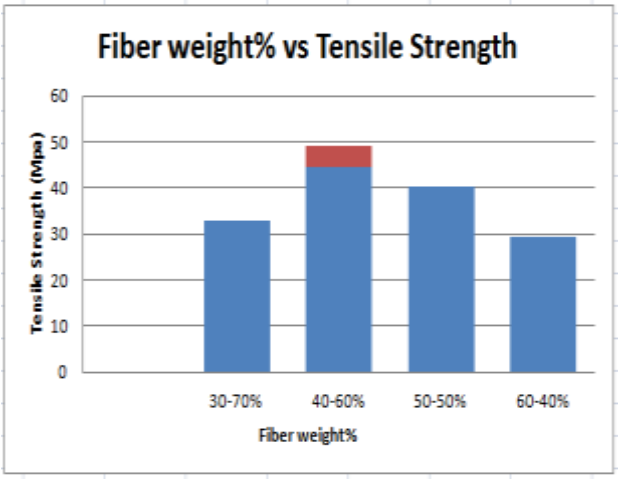
The damping test is carried out using "SLAM STICK" in testing facility NIT Trichy. The device is connected to computer, and its results are interpolated by using DAS Software in forms of curves, The accelerometer has some inbuilt memories to carry out common commands like START, STOP and DELAY.

4.1 RESULTS AND DISCUSSION

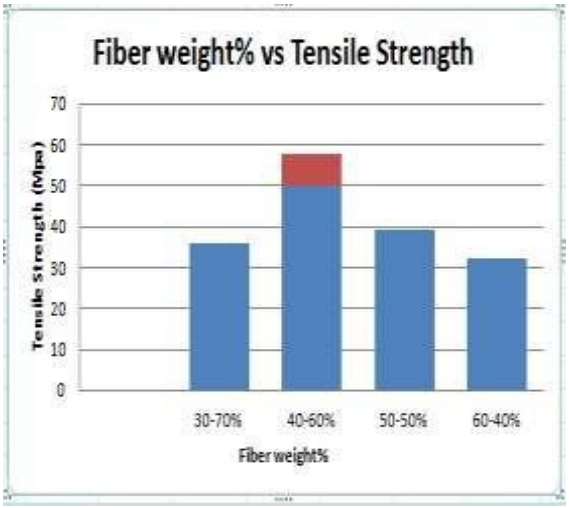


1(30-70%), 2(40-60%), 3(50-50%), 4(60-40%)
Tensile test results for Phenol Formaldehyde

1(30-70%), 2(40-60%), 3(50-50%), 4(60-40%)
Tensile test results for Isophthalic



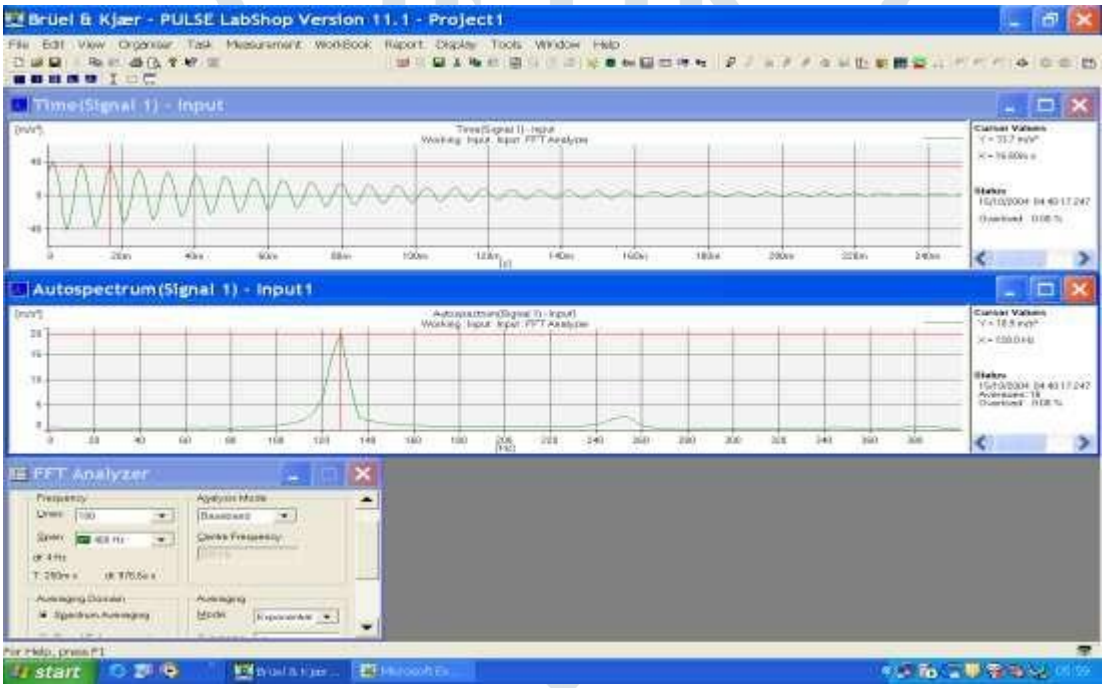
Treated tensile result for phenol formaldehyde



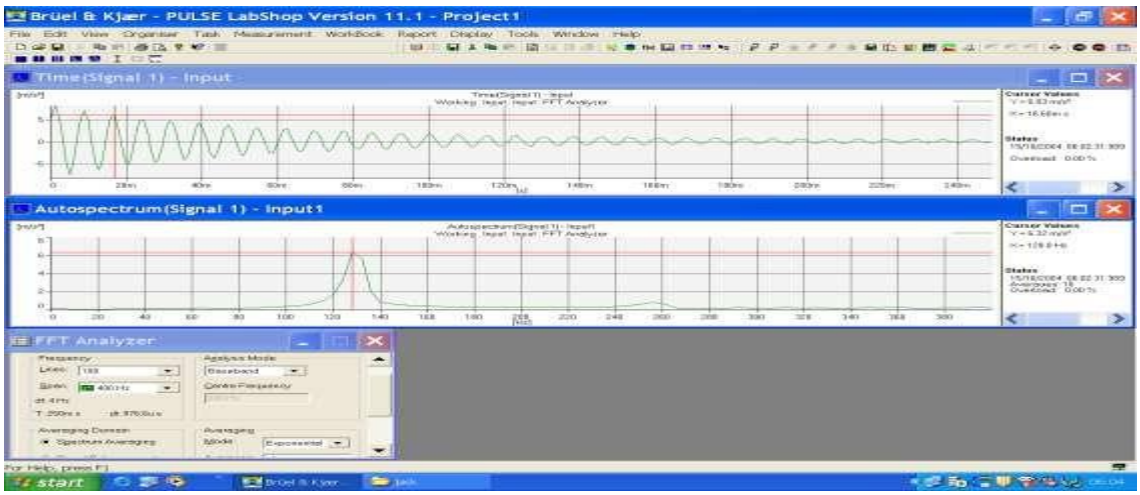
Treated tensile result for isophthalic

Damping test result

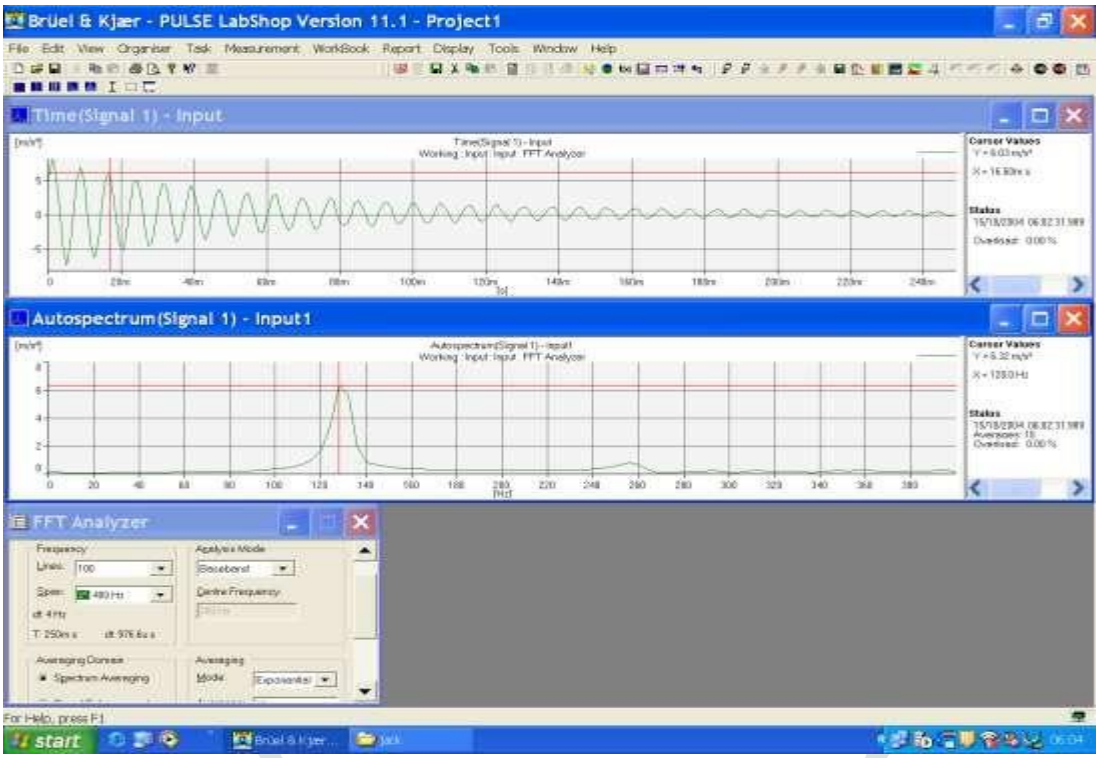
Damping test is only conducted for isophthalic resin since itshows good tensile value when compared to phenol formaldehyde



Damping result for isophthalic trail 1



Damping result for isophthalic trail 2



Damping result for isophthalic trail 3

Damping Factor Result

- To find Logarithmic Decrement value the below formula is used

  Logarithmic Decrement = In (X_1/X_2)

- To find the damping factor of material the following formula isused

  Logarithmic Decrement = $(2* \pi* \zeta) / (1- \zeta^2)^{1/2}$

Trails	**Damping factor (ζ)**
Trail 1	0.0143
Trail 2	0.0132
Trail 3	0.0137

Damping Factor Result

On considering the above damping factor values, the average ofthe three trials is taken as the damping factor of the material

Average value of damping factor = (0.0143+0.0132+0.0137) / 3

ζ = 0.0138

CONCLUSION

Thus it seems to be properties of isophthalic matrix composites shows good mechanical and dynamic properties when compared to test results ofphenol formaldehyde matrix composites, therefore banana fiber reinforced polymer composites with isophthalic matrix at 40-60% proportion is suggested for car bumpers where dynamic factors are very important.

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