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ANALYSIS OF PRODUCTION PERFORMANCE OF TAMILNADU NEWSPRINT AND PAPERS LTD – CASE STUDY

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Abstract: Every day, Tamilnadu Newsprint and Papers Ltd managers must make decisions about Production delivery without knowing what will happen in the future. Forecasts enable them to anticipate the future and plan, many forecasting methods are available to Tamilnadu Newsprint and Papers Ltd managers for planning, to estimate future demand or any other issues at hand. However, for any type of forecast to bring about later success, it must follow a step-by-step process comprising five major steps: 1) goal of the forecast and the identification of resources for conducting it; 2) time horizon; 3) selection of a forecasting technique; 4) conducting and completing the forecast; and 5) monitoring the accuracy of the forecast. Accordingly Linear Regression method is a widely used to predict this kind of demand. In this paper, we forecast the Production of Papers in TamilNadu Newsprint and Papers Ltd from the past 15 years of Production using the Linear Regression method
Keywords: Trend analysis; Linear Regression; Forecast Accuracy

1. INTRODUCTION

A time series is a sequence of evenly spaced observations taken at regular intervals over a period of time (such as daily, hourly, weekly, monthly, or yearly). An example of a time series is the Annual production to Tamilnadu Newsprint and Papers Ltd. Forecasts from time-series data assume that future values of the series can be predicted from past values. Analysis of a time series can identify the behavior of the series in terms of trend, seasonality, cycles, irregular variations, or random variations. A trend is a gradual, long-term, upward or downward movement in data. Seasonality refers to short-term, relatively frequent variations generally related to factors such as Shortage of raw material, high cost of production; Sales often experience quarterly and Yearly "seasonal" variations. Cycles are patterns in the data that occur every several years, often in relation to current economic conditions. Such cycles often exhibit wave like characteristics that mimic the business cycle. Irregular variations are "spikes" in the data caused by chance or unusual circumstances (examples: severe weather, labor strike, Water Problem, use of a new high-technology service); they do not reflect typical behavior and should be identified and removed from the data whenever possible. Random variations are residual variations that remain after all other behaviors have been accounted for. Graphing the data provides clues to a manager for selecting the right forecasting method.

Tamil Nadu Newsprint and papers (TNPL) Ltd. was established by the Government of Tamil Nadu in the Year 1976. The company produces Newsprint, Printing and Writing paper using bagasse, a sugarcane residue, as the primary raw material. Their manufacturing facility is located at Kagithapuram in Karur District of Tamil Nadu. Commencing production in 1984 at a modest 90,000 tonnes per annum, the company has made rapid strides and has emerged today as the largest paper mill in India at a single location with a total installed capacity of 400,000 tonnes per annum. TNPL's paper comes from three high end machines of Beloit Walmsley, Voith Paper with a total production capacity of 245,000 tonnes per annum and a third state-of-the-art paper machine with a production capacity of 155,000 tonnes per annum.

In this Paper forecast the next 15 years of production in Tamil Nadu Newsprint and papers (TNPL) Ltd using Linear Regression Method. The method is evaluated with different accuracy measures; variance (MSE and MAD), a numerical example shows the next 15 years of production.

2. TIME SERIES METHOD

2.1 Techniques for Trend

A trend is a gradual, long-term movement caused by changes in population, income, or culture. Assuming that there is a trend present in a data set, it can be analyzed by finding an equation that correlates to the trend in question. The trend may or may not be linear in its behavior. Plotting the data can give a Tamilnadu Newsprint and Papers Ltd manager insight into whether a trend is linear or nonlinear. Forecasting Techniques Based on Linear Regression. By minimizing the sum of the squared errors, which is called the least squares method, regression analysis can be used to create a representative line that has the form:

$$y = a + b * x \qquad (1)$$

where
y = the predicted (dependent) variable
x = the predictor (independent) variable
b = the slope (rise/run) of the data line
a = the value of y when x is equal to zero.

Consider the regression equation example y = 20 + 5x. The value of y when x = 0 is 20, and the slope of the line is 5. Therefore, the value of y will increase by five units for each one-unit increase in x. If x = 15, the forecast (y) will be 20 =5(15), or 95 units. This equation could be plotted on a graph by finding two points on the line. One of those points can be found in the way just mentioned; putting in a value for x. The other point on the graph would be a (i.e. y_x at x = 0). The coefficients of the line, a and b, can be found (using historical data) with the following equations:

$$b = \frac{n\left(\sum xy\right) - \left(\sum x\right)\left(\sum y\right)}{n\left(\sum x^2\right) - \left(\sum x\right)^2}$$

$$a = \frac{\sum y - b\sum x}{n}.$$

3. NUMERICAL EXAMPLE

Table 1 gives an example about the Production data in Tamilnadu Newsprint and Papers Ltd.

Table 1. Production data

YEAR	PRODUCTION INMETRIC TONNES (Y)	X	X^2	XY
1997-98	170618	-7	49	-1194326
1998-99	176075	-6	36	-1056450
1999-2000	178871	-5	25	-894355
2000-01	191106	-4	16	-764424
2001-02	184267	-3	9	-552801
2002-03	167878	-2	4	-335756
2003-04	182215	-1	1	-182215
2004-05	196241	0	0	0
2005-06	230079	1	1	230079
2006-07	231161	2	4	462322
2007-08	245471	3	9	736413
2008-09	254903	4	16	1019612
2009-10	245008	5	25	1225040
2010-11	265044	6	36	1590264
2011-12	343306	7	49	2403142

After calculating ∑x=0, ∑ y= 3262243, ∑xy=2686545, ∑x2=280, n=14 substitute into the Equations [2] for a and b, respectively

$$b = \frac{14(2686545) - 0(3262243)}{14(280) - 0} = 9594.804$$

$$a = \frac{3262243 - 9594.804\ (0)}{14} = 217482.9$$

Hence, the regression line is:

Y_x = 217482.9 + 9594.804) *8

Y =309775.8

Table 2 give the results of the Linear Regression method computed based on the above data.

Table 2. The Forecasting Production of Linear Regression Method

YEAR	PREDICTED PRODUCTION INMETRIC TONNES
2012-13	309775.832
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2018-19	367344.656
2019-20	376939.46
2020-21	386534.264
2021-22	396129.068
2022-23	405723.872
2023-24	415318.676
2024-25	424913.48
2025-26	434508.284
2026-27	444103.088

4. FORECAST ACCURACY

4.1 Mean Square Error(MSE)

In this section we present and discuss the different measures we use in the forthcoming analyses. Common measures for forecasting errors and its variability are MSE and also Mean Absolute Deviation (MAD). Silver et al (1998) recommend the use of MSE, because MSE is related to standard variation of forecast errors. However MSE is more sensitive to outliers and errors smaller than one due to the squared Function. Which mean that in an evaluation of different forecasting methods MSE and MAD sometimes presents a different result:

$$MSE = \frac{1}{T}\sum_{t=1}^{T}\left(X_t - \hat{X}_t\right)^2, \quad (2)$$

$$MAD = \frac{1}{T}\sum_{t=1}^{T}\left|X_t - \hat{X}_t\right|. \quad (3)$$

5. TEST RESULT

The data comes from Tamilnadu Newsprint and Papers Ltd; the data covers 15 Years. For an overlook the demand data are also shown in diagrams. Below the result of 15 years of forecast production is shown.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.887351052
R Square	0.78739189
Adjusted R Square	0.77103742
Standard Error	23138.64232
Observations	15

ANOVA

	df	SS	MS	F	Significance F
Regression	1	25776871561	25776871561	48.145	1.02391E-05
Residual	13	6960157989	535396768.4		
Total	14	32737029550			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	217482.87	5974.37	36.40	0.00	204576.02	230389.71	204576.02	230389.71
X Variable 1	9594.80	1382.80	6.94	0.00	6607.45	12582.16	6607.45	12582.16

RESIDUAL OUTPUT

Observation	Predicted Y	Residuals
1	150319.24	20298.76
2	159914.05	16160.95
3	169508.85	9362.15
4	179103.65	12002.35
5	188698.46	-4431.46
6	198293.26	-30415.26
7	207888.06	-25673.06
8	217482.87	-21241.87
9	227077.67	3001.33
10	236672.47	-5511.47
11	246267.28	-796.28
12	255862.08	-959.08
13	265456.88	-20448.88
14	275051.69	-10007.69
15	284646.49	58659.51

PROBABILITY OUTPUT

Percentile	Y
3.3	167878
10.0	170618
16.7	176075
23.3	178871
30.0	182215
36.7	184267
43.3	191106
50.0	196241
56.7	230079
63.3	231161
70.0	245008
76.7	245471
83.3	254903
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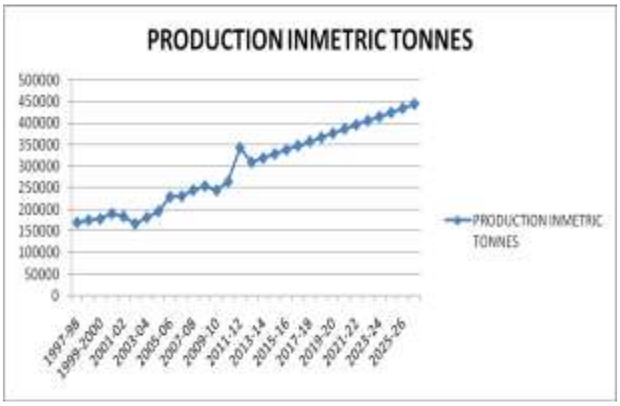

6. CONCLUSION

In this paper, we analyze a Linear Regression Method in forecasting approach to deal with the production data in Tamilnadu Newsprint and papers Ltd. Numerical experiments show that the next 15 years forecasting production in that company. For further studies, to predict the sales, net profit and working capital in TNPL.

7. REFERENCES

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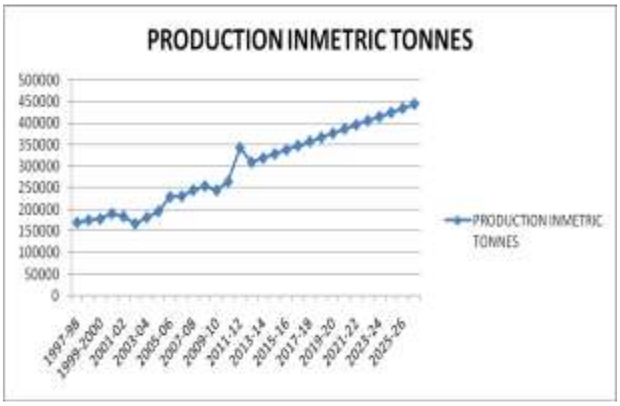

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M-Learning for children of 5-12 age groups in rural area of India

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Abstract*:* Internet has touched the urban and educated society in a big way. However the rural and less educated society is yet to enjoy the benefits. In India there are large number of non Internet Mobile users (NIMUs) -7.5 NIMUs for every internet users .It is hence essential that applications and products are designed with care and with usability in mind. Our own nation with a 1.2 billion population offers a business huge opportunity to develop socially relevant mobile applications for Rural India. Hence the primary objective of the paper is to reach to the NIMUs with mobile phone technologies and applications. The paper focus on implementing the M-learning application for NIMUs which display the animation of story and the voice will be played in the background .Beside the animation of story, the application has choices to display the story ,record the voice while reading the story ,videos of story and quizzes about the story , by keeping in mind the mental growth of child 5-12 age group.

Keywords- mobile learning, android , NIMUs, animation, Informal learning.

1. INTRODUCTION

According to the World Bank, "there are still precious few widespread examples of the use of [mobile] phones for education purposes inside or outside of classrooms in developing countries that have been well documented, and fewer still that have been evaluated with any sort of rigor" [17]. The cellphone has been argued to be an appropriate device for educational delivery in the so-called developing world [4, 9]. It is a low-power device that can be used in places without reliable electricity. Even though it is largely purchased for voice communications – which semi-literate users rely on for their social and economic needs – it is also able to run educational software that support visuals and voiceovers. Most of all, the cellphone is the fastest growing technology platform in the developing world. There are 2.2 billion mobile phones in developing regions like Africa and India, as compared to only 11 million desktops [6].

While cellphones can be deployed in schools in developing countries, the greatest opportunity is to facilitate informal learning in out-of-school environments so as to complement formal schooling. In underdeveloped regions, particularly rural areas, many schools are not only poorly equipped or lack highly-trained teachers. Worse, school attrition can be prevalent in underdeveloped regions. For instance, in rural India, about 43% of school-age children cannot attend school regularly because they have to work for the family in agricultural fields or households [3]. Mobile learning thus empowers poor children to balance their educational and income earning goals, by enabling them to learn anytime, anywhere, in places and times more convenient than school[1].

2. RELATED WORK

Koole [13] argues there is a tremendous scope for mobile learning and establishes a framework to assist practitioners in designing activities appropriate for mobile learning.Klopfer [12] adds that mobile learning games are not only engaging, but can also account for the user's context and environment to improve on the learning process. Mobile learning has been applied to the domains of nursing education [11], online communities [5, 6] and distance education [8,14].Similarly, Jarkievich et al. [9] and Scanlon et al. [15] explore the usage of mobile phones in outside classroom settings, whereas Bell et al. [3] study the social interactions around cellphone-based games in everyday settings. However, all of the above studies are based in developed world settings. A major contribution of this paper is instead to explore the scope of mobile learning in poorer developing regions of the India.

3. SYSTEM DESIGN

3.1) Mobile learning

Mobile learning may be defined as handheld technologies, together with wireless and mobile phone networks, to facilitate, support, enhance and extend the reach of teaching and learning. Mobile learning (M-Learning) is one new learning mode by which an individual can use the mobile communication terminals to assist them to learn. Mobile learning is formed in the background of knowledge exploding, it syncretises the characteristics of modern education thought, computer network technology, mobile communications technology and multimedia technology. Mobile learning may also be defined as highly situated, personal, collaborative and long term; in other words, truly learner-centred learning. M-Learning also provides instructors and education administrators with more flexible teaching and managing methods

3.2) Purpose

Our own nation with a 1.2 billion population offers a business huge opportunity to develop socially relevant mobile applications for Rural India . Hence, the primary objective of the proposed system would be to reach out to the non-Internet mobile users with mobile phone technologies and applications, with innovative research in Interaction Design addressing the various factors such as culture, language, user interfaces, modelling and software engineering, keeping diversity and scale in mind.

The work in understanding M-Learning would bring about a mass upheaval in contextually relevant, domain specific learning environment and is a step towards a well designed application or product development in this domain. Moreover, with the help of animations, it will help in better understanding and mental growth of child-5 Age group from distance villages and NGO's also.

3.3) Description of the proposed system:

The system consist of menus which will help the learner to learn about the options available.

Fig. 1 Option Screen

Following are the options available

3.3.1) Learn

The option “learn” is for story animation, The animation is Frame animation using the class “AnimationDrawable” in Android. The frames are displayed after some microsecond one by one.

Fig 2 Animation of story

3.3.2) Read and record
The learner can read the story and record the story,so that she can listen the story later on.

Fig. 3 Read and Record

3.3.3) Video
The learner can play the video which are available on mobile SD card.

Fig. 4 Playing Video

3.3.4) Quiz

After listening the story the learner can give the answer of quiz . The questions are related to the story,which will help the leaner to memorize the story.

Fig. 5 Quizzes

4. CONCLUSION

The application is implemented which help to learn about the story using animation for the children in rural area of India. The primary objective of the proposed system is provide the standalone mobile learning application which facilitates the animation of story ,displaying of story ,recording of voice ,videos of story and quizzes that test knowledge gained from the story. In future more stories can be added to enhance the learning experience.

5. ACKNOWLEDGEMENT

I would like to say thank to Supriya N., Palak Raina, Jyothsna V. for their help to complete the project.I also thankful to Mr Vilas M. for supporting me for completion of the project.

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M-Learning for children of 5-12 age groups in rural area of India

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Abstract*:* Internet has touched the urban and educated society in a big way. However the rural and less educated society is yet to enjoy the benefits. In India there are large number of non Internet Mobile users (NIMUs) -7.5 NIMUs for every internet users .It is hence essential that applications and products are designed with care and with usability in mind. Our own nation with a 1.2 billion population offers a business huge opportunity to develop socially relevant mobile applications for Rural India. Hence the primary objective of the paper is to reach to the NIMUs with mobile phone technologies and applications. The paper focus on implementing the M-learning application for NIMUs which display the animation of story and the voice will be played in the background .Beside the animation of story, the application has choices to display the story ,record the voice while reading the story ,videos of story and quizzes about the story , by keeping in mind the mental growth of child 5-12 age group.

Keywords- mobile learning, android , NIMUs, animation, Informal learning.

1. INTRODUCTION

According to the World Bank, "there are still precious few widespread examples of the use of [mobile] phones for education purposes inside or outside of classrooms in developing countries that have been well documented, and fewer still that have been evaluated with any sort of rigor" [17]. The cellphone has been argued to be an appropriate device for educational delivery in the so-called developing world [4, 9]. It is a low-power device that can be used in places without reliable electricity. Even though it is largely purchased for voice communications – which semi-literate users rely on for their social and economic needs – it is also able to run educational software that support visuals and voiceovers. Most of all, the cellphone is the fastest growing technology platform in the developing world. There are 2.2 billion mobile phones in developing regions like Africa and India, as compared to only 11 million desktops [6].

While cellphones can be deployed in schools in developing countries, the greatest opportunity is to facilitate informal learning in out-of-school environments so as to complement formal schooling. In underdeveloped regions, particularly rural areas, many schools are not only poorly equipped or lack highly-trained teachers. Worse, school attrition can be prevalent in underdeveloped regions. For instance, in rural India, about 43% of school-age children cannot attend school regularly because they have to work for the family in agricultural fields or households [3]. Mobile learning thus empowers poor children to balance their educational and income earning goals, by enabling them to learn anytime, anywhere, in places and times more convenient than school[1].

2. RELATED WORK

Koole [13] argues there is a tremendous scope for mobile learning and establishes a framework to assist practitioners in designing activities appropriate for mobile learning.Klopfer [12] adds that mobile learning games are not only engaging, but can also account for the user's context and environment to improve on the learning process. Mobile learning has been applied to the domains of nursing education [11], online communities [5, 6] and distance education [8,14].Similarly, Jarkievich et al. [9] and Scanlon et al. [15] explore the usage of mobile phones in outside classroom settings, whereas Bell et al. [3] study the social interactions around cellphone-based games in everyday settings. However, all of the above studies are based in developed world settings. A major contribution of this paper is instead to explore the scope of mobile learning in poorer developing regions of the India.

3. SYSTEM DESIGN

3.1) Mobile learning

Mobile learning may be defined as handheld technologies, together with wireless and mobile phone networks, to facilitate, support, enhance and extend the reach of teaching and learning. Mobile learning (M-Learning) is one new learning mode by which an individual can use the mobile communication terminals to assist them to learn. Mobile learning is formed in the background of knowledge exploding, it syncretises the characteristics of modern education thought, computer network technology, mobile communications technology and multimedia technology. Mobile learning may also be defined as highly situated, personal, collaborative and long term; in other words, truly learner-centred learning. M-Learning also provides instructors and education administrators with more flexible teaching and managing methods

3.2) Purpose

Our own nation with a 1.2 billion population offers a business huge opportunity to develop socially relevant mobile applications for Rural India . Hence, the primary objective of the proposed system would be to reach out to the non-Internet mobile users with mobile phone technologies and applications, with innovative research in Interaction Design addressing the various factors such as culture, language, user interfaces, modelling and software engineering, keeping diversity and scale in mind.

The work in understanding M-Learning would bring about a mass upheaval in contextually relevant, domain specific learning environment and is a step towards a well designed application or product development in this domain. Moreover, with the help of animations, it will help in better understanding and mental growth of child-5 Age group from distance villages and NGO's also.

3.3) Description of the proposed system:

The system consist of menus which will help the learner to learn about the options available.

Fig. 1 Option Screen

Following are the options available

3.3.1) Learn

The option “learn” is for story animation, The animation is Frame animation using the class “AnimationDrawable” in Android. The frames are displayed after some microsecond one by one.

Fig 2 Animation of story

3.3.2) Read and record

The learner can read the story and record the story,so that she can listen the story later on.

Fig. 3 Read and Record

3.3.3) Video

The learner can play the video which are available on mobile SD card.

Fig. 4 Playing Video

3.3.4) Quiz

After listening the story the learner can give the answer of quiz . The questions are related to the story,which will help the leaner to memorize the story.

Fig. 5 Quizzes

4. CONCLUSION

The application is implemented which help to learn about the story using animation for the children in rural area of India. The primary objective of the proposed system is provide the standalone mobile learning application which facilitates the animation of story ,displaying of story ,recording of voice ,videos of story and quizzes that test knowledge gained from the story. In future more stories can be added to enhance the learning experience.

5. ACKNOWLEDGEMENT

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Effect of Fiber Orientation on the Flexural Properties of PALF Reinforced Bisphenol Composites

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Abstract: Mankind has been aware of composite materials since several hundred years before Christ and applied innovation to improve the quality of life. Although it is not clear has to how man understood the fact that mud bricks made sturdier houses if lined with straw, he used them to make buildings that lasted. In recent years natural fibers appear to be the outstanding materials which are abundant and come as viable substitute for the expensive and nonrenewable synthetic fiber. Natural fibers like sisal, banana, jute, oil palm, kenaf and coir has been used as reinforcement in thermoset composite for applications in consumer goods, furniture, low cost housing and civil structures. Pineapple leaf fiber (PALF) is one of them that have also good potential as reinforcement in thermoset composite. The objective of the present work is to explore the potential of using PALF as reinforcement and investigate the effect of fiber orientation on the flexural properties of PALF reinforced Bisphenol composite. From this experimental study, it was observed that the fiber orientation greatly influences the flexural properties of reinforced composites. A higher flexural strength of 105.5754Mpa was obtained for inclined orientated fibers compared to that of Uni-directional & Bi-directional oriented fibers.

Keywords: *Pineapple leaf fiber, Bisphenol, anaerobic extraction, mechanical properties, flexural strength.*

1. INTRODUCTION

Recently, composite materials have successfully substituted the traditional materials in several light weight and high strength applications. The reasons why composites are selected for such applications are mainly their high strength-to-weight ratio, high tensile strength at elevated temperatures, high creep resistance and high toughness. By definition, composites are materials consisting of two or more chemically distinct constituents on a macro scale having a distinct interface separating them and having bulk behavior which is considerably different from those of any of the constituents[1].

Two types of fibers can be used for reinforcing in the composite materials:

1. Synthetic Fibers
2. Natural Fibers

Synthetic fibers are the most widely used to reinforce plastics due to their low cost and fairly good mechanical properties. However, these fibers have serious drawbacks as high density, non-renewability, non-biodegradability, high energy consumption etc.

Growing environmental awareness and societal concern, a high rate of depletion of petroleum resources, the concept of sustainability, and new environmental regulations have triggered the search for new products that are compatible with the environment. Sustainability, 'cradle to grave' design, industrial ecology, eco-friendly and bio-compatibility are the guiding principles of development of new generation materials. Lignocellulosic reinforced composites are the materials of the new paradigm. The use of biodegradable and environment friendly plant-based fibers in the composites reduces waste disposal problems, environment pollution and ecological concerns.

India, endowed with an abundant availability of natural fibers such as jute, coir, sisal, pineapple, ramie, bamboo, banana etc., has focused on the development of natural fiber composites primarily to explore value-added application avenues. Due to an occurrence of a wide variety of natural fibers in the country, Indian researchers have directed efforts for quite some time in developing innovative natural fiber composites for various applications. While the national research agencies in India have excellent scientific achievements to their credit for development of natural fiber composites, efforts on their commercialization have been limited so far. The natural fiber composites can be very cost-effective material especially for building & construction industry (panels, false ceilings, partition boards etc.), packaging, automobile & railway coach interiors and storage devices[2].

One such fiber source known for a long time is pineapple leaves from which pineapple leaf fibers (PALF) may be extracted. Pineapple (Ananas comosus) is the third most important tropical fruit in the world after banana and citrus. S.M.Sapuan et.al [3] reviewed the importance of pineapple leaf fiber by stating that PALF is the least studied natural fiber, especially for reinforcing composites. The article presented a survey of research works carried out on PALF and PALF-reinforced composites. Noor Sabah Sadeq [4] made experimental studies on Influence of Natural Fiber on the Mechanical Properties of Epoxy Composites. The study deals with the effects of natural fibers on some mechanical properties of the Epoxy composite. Jayamol George [5] made experimental studies on Short Pineapple-Leaf-Fiber-Reinforced Low-Density Polyethylene Composites. The influence of fiber length, fiber loading, and orientation on the mechanical properties has also been evaluated.

The objective of the present work is to investigate the effect of fiber orientation on flexural strength of the PALF reinforced polymer composite.

2. MATERIALS AND METHODOLOGY

PALF is one such fiber source known from a long time obtained from the leaves of pineapple plant (Ananascomosus) from the family of Bromeliaceae. The Food and Agriculture Organization (FAO) has reported that most of the world pineapple fruit production in 2001 amounting to about 13.7 million tons of fresh fruits are produced in Asia [6]. Pineapple leaves from the plantations are being wasted as they are cut after the fruits are harvested before being either composted or burnt. Additionally, burning of these beneficial agricultural wastes causes environmental pollution. Table 2.1

shows some of the physical and mechanical properties of pineapple leaf fiber.

Table 2.1 Properties of pineapple leaf fiber:

Property	Value
Density (g/cm3)	1.526
Softening Point (°C)	104
Tensile Strength (MPa)	170
Young's Modulus (MPa)	6260
Specific Modulus (MPa)	4070
Elongation at Break (%)	3
Moisture regain (%)	12

Bisphenol-A (BPA) is an organic compound which belongs to the group of diphenyl methane derivatives and Bisphenol. The chemical formula is $(CH_3)_2C(C_6H_4OH)_2$. BPA is used to make certain plastics and epoxy resins; it has been in commercial use since 1957. Table 2.2 shows some of the properties of Bisphenol resin.

Table 2.2 Properties of Bisphenol resin:

Tensile strength	30Mpa
Tensile modulus	3300 Mpa
Elongation at break	2%
Flexure strength	80Mpa
Flexure modulus	3100 Mpa
Melting point	156 - 159 ^{0}C
Specific gravity	1.19 - 1.20
Impact strength	2.0-2.2 kJ/m^2
Poisson's ratio	0.37

2.1 Extraction of fibers

PALF were extracted from the leaf of pineapple plant by biological method. The conventional extraction processes like retting leads to serious problems like methane and sulphide emission, water contamination and other environmental pollutions. Owing to the above factors, biological method is preferred to mechanical and chemical routes for extracting fibers of good quality from embedding matrix. It is in this context that National Institute of Interdisciplinary Science and Technology (NIIST), Trivandrum, Kerala devised a clean anaerobic process to yield superior quality fibers while shortening the processing time substantially. Here separation of fibers from their matrices is achieved by enzymatic cleaving of cementing compounds with in situ microbial growth and enzyme production. The organic residue generated by the process is converted to methane that can be recovered for fuel.

2.2 Chemical treatment

Alkali treatment or mercerization using sodium hydroxide (NaOH) is the most commonly used treatment for bleaching and cleaning the surface of natural fibers to produce high-quality fibers. Modifying natural fibers with alkali has greatly improved the mechanical properties of the resultant composites.

The following steps were carried out during chemical treatment:

- 5% NaOH solution was prepared using sodium hydroxide pellets and distilled water.
- Pineapple leaf fibers were then dipped in the solution for 1hour.
- After 1 hour fibers were washed with 1% HCl solution to neutralize the fibers.
- Then it is washed with distilled water.
- It was then kept in hot air oven for 3hours at 65-70°C.

2.3 Manufacturing of composite

A polypropylene (PP) mould having dimensions of 150 X 100 X 4 mm is used for composite fabrication. The mould was first cleaned with wax so that the laminate easily comes out of the die after hardening. Then around 15 to 20 ml of promoter and accelerator are added to Bisphenol and the color of the resin changes from pale yellow to dark yellow with the addition of these two agents. The laminates of three different fibers orientations mats of unidirectional, bidirectional and inclined are prepared using hand layup method. This method of manufacturing is a relatively simple method compared to other methods like vacuum bag molding, resin transfer molding, autoclave molding etc. Figure 2.1, 2.2 and 2.3 shows the uni-directional, bi-directional and inclined orinted PALF reinforced composites respectively.

Figure 2.1 Uni-directional oriented PALF reinforced composites

Figure 2.2. Bi-directional oriented PALF reinforced composites

Figure 2.3. Inclined oriented PALF reinforced composites

3. RESULTS AND DISCUSSION

The flexural properties of the unidirectional, bidirectional and inclined PALF reinforced composites was studied. There are two methods to determine the flexural properties of material: three-point loading system and four point loading system. In the present work three-point loading bending test was carried out on a test specimen as per ASTM D790 standard (125*14.5*4mm). The flexural test was conducted on JJ Lloyd universal testing machine with load cell of 1kN and using crosshead speed of 5 mm/min. The test was performed until the flexural failure occurred. Fig. 3.1 shows three-point bending test.

Figure 3.1–Test Specimen undergoing flexural test

The results of the flexural test are put forth in the form of stress-strain curves. Figures 3.2(a), 3.2(b) and 3.2(c) shows the stress-strain curve for unidirectional, bidirectional and inclined PALF composite respectively. The maximum load and maximum bending stress obtained from the experimental study is given in Table 3.2. Figure 3.3 shows the variation of maximum bending stress for different orientation of fibers in the composite.

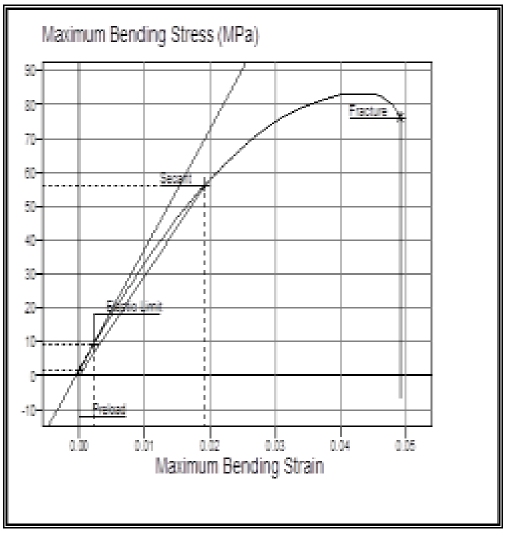

Figure 3.2(a) - Stress-strain curve of Uni- directional composite.

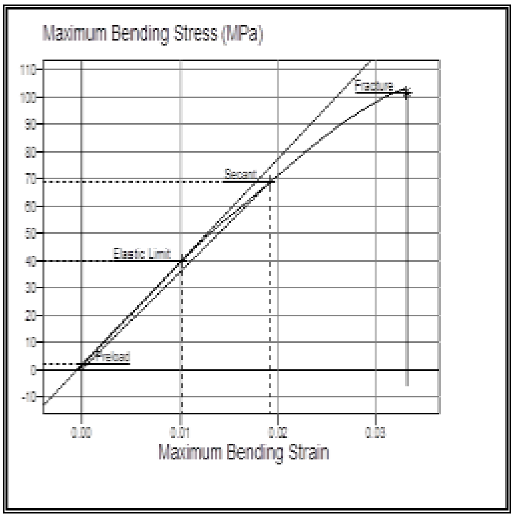

Figure 3.2(b) - stress strain curve if Bi- direction composite.

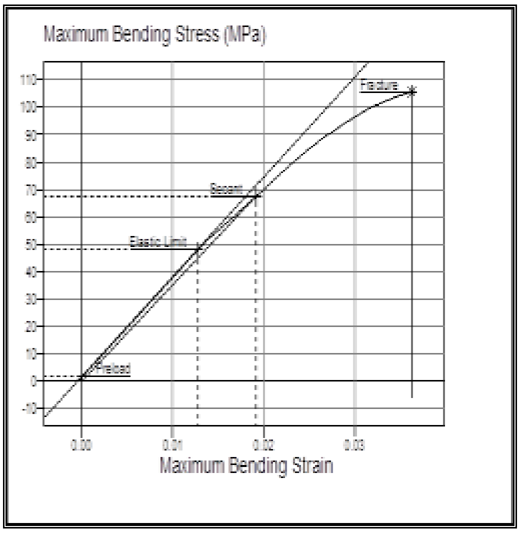

Figure 3.2(c) - Stress strain curve of inclined PALF composite.

Table 3.1 shows the maximum load and maximum binding stress for Uni-directional, Bi-directional and inclined fiber oriented reinforced polymer composite.

Table 3.1 Experimantal results:

Fiber Orientation	Maximum load(KN)	Maximum bending stress (MPa)
Uni-directional	**0.226514998**	**83.60543723**
Bi-directional	**0.278678076**	**102.8585419**
Inclined	**0.286039163**	**105.5754786**

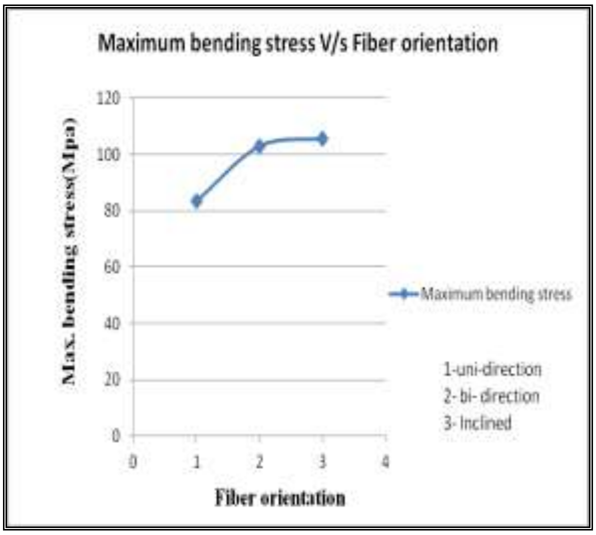

Figure 3.3 Variation of Maximum bending stress with fiber orientation.

The flexural strength of the matrix material Bisphenol alone is 80 Mpa (Table 2.2). From the table 3.1 it can be observed that the highest value of flexural strength of 105.57Mpa is obtained for inclined orientated fibers. In comparison with the flexural strength of matrix material, the reinforcement of fibres in inclined direction (45^0) increased the flexural strength of the composite by 24.22%. For Uni-directionally orientated fibers maximum bending stress marginally increased by 4.3% and for bi-directional orientated fibers it increased to 22.21% than the matrix material's value.

4. CONCLUSION

The results of the present study revealed that a useful composite with good properties could be successfully developed using treated PALF as reinforcing agent for the Bisphenol matrix. It can be seen that inclined oriented composites show better flexural strength (105.57 MPa) than Uni-directional and bi-directional oriented composites. Hence fiber orientation greatly influence the flexural strength of the PALF reinforced Bisphenol composite.

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Growing environmental awareness and societal concern, a high rate of depletion of petroleum resources, the concept of sustainability, and new environmental regulations have triggered the search for new products that are compatible with the environment. Sustainability, 'cradle to grave' design, industrial ecology, eco-friendly and bio-compatibility are the guiding principles of development of new generation materials. Lignocellulosic reinforced composites are the materials of the new paradigm. The use of biodegradable and environment friendly plant-based fibers in the composites reduces waste disposal problems, environment pollution and ecological concerns.

India, endowed with an abundant availability of natural fibers such as jute, coir, sisal, pineapple, ramie, bamboo, banana etc., has focused on the development of natural fiber composites primarily to explore value-added application avenues. Due to an occurrence of a wide variety of natural fibers in the country, Indian researchers have directed efforts for quite some time in developing innovative natural fiber composites for various applications. While the national research agencies in India have excellent scientific achievements to their credit for development of natural fiber composites, efforts on their commercialization have been limited so far. The natural fiber composites can be very cost-effective material especially for building & construction industry (panels, false ceilings, partition boards etc.), packaging, automobile & railway coach interiors and storage devices[2].

One such fiber source known for a long time is pineapple leaves from which pineapple leaf fibers (PALF) may be extracted. Pineapple (Ananas comosus) is the third most important tropical fruit in the world after banana and citrus. S.M.Sapuan et.al [3] reviewed the importance of pineapple leaf fiber by stating that PALF is the least studied natural fiber, especially for reinforcing composites. The article presented a survey of research works carried out on PALF and PALF-reinforced composites. Noor Sabah Sadeq [4] made experimental studies on Influence of Natural Fiber on the Mechanical Properties of Epoxy Composites. The study deals with the effects of natural fibers on some mechanical properties of the Epoxy composite. Jayamol George [5] made experimental studies on Short Pineapple-Leaf-Fiber-Reinforced Low-Density Polyethylene Composites. The influence of fiber length, fiber loading, and orientation on the mechanical properties has also been evaluated.

The objective of the present work is to investigate the effect of fiber orientation on flexural strength of the PALF reinforced polymer composite.

2. MATERIALS AND METHODOLOGY

PALF is one such fiber source known from a long time obtained from the leaves of pineapple plant (Ananascomosus) from the family of Bromeliaceae. The Food and Agriculture Organization (FAO) has reported that most of the world pineapple fruit production in 2001 amounting to about 13.7 million tons of fresh fruits are produced in Asia [6]. Pineapple leaves from the plantations are being wasted as they are cut after the fruits are harvested before being either composted or burnt. Additionally, burning of these beneficial agricultural wastes causes environmental pollution. Table 2.1

shows some of the physical and mechanical properties of pineapple leaf fiber.

Table 2.1 Properties of pineapple leaf fiber:

Property	Value
Density (g/cm3)	1.526
Softening Point (°C)	104
Tensile Strength (MPa)	170
Young's Modulus (MPa)	6260
Specific Modulus (MPa)	4070
Elongation at Break (%)	3
Moisture regain (%)	12

Bisphenol-A (BPA) is an organic compound which belongs to the group of diphenyl methane derivatives and Bisphenol. The chemical formula is $(CH_3)_2C(C_6H_4OH)_2$. BPA is used to make certain plastics and epoxy resins; it has been in commercial use since 1957. Table 2.2 shows some of the properties of Bisphenol resin.

Table 2.2 Properties of Bisphenol resin:

Tensile strength	30Mpa
Tensile modulus	3300 Mpa
Elongation at break	2%
Flexure strength	80Mpa
Flexure modulus	3100 Mpa
Melting point	156 - 159 ^{0}C
Specific gravity	1.19 - 1.20
Impact strength	2.0-2.2 kJ/m^2
Poisson's ratio	0.37

2.1 Extraction of fibers

PALF were extracted from the leaf of pineapple plant by biological method. The conventional extraction processes like retting leads to serious problems like methane and sulphide emission, water contamination and other environmental pollutions. Owing to the above factors, biological method is preferred to mechanical and chemical routes for extracting fibers of good quality from embedding matrix. It is in this context that National Institute of Interdisciplinary Science and Technology (NIIST), Trivandrum, Kerala devised a clean anaerobic process to yield superior quality fibers while shortening the processing time substantially. Here separation of fibers from their matrices is achieved by enzymatic cleaving of cementing compounds with in situ microbial growth and enzyme production. The organic residue generated by the process is converted to methane that can be recovered for fuel.

2.2 Chemical treatment

Alkali treatment or mercerization using sodium hydroxide (NaOH) is the most commonly used treatment for bleaching and cleaning the surface of natural fibers to produce high-quality fibers. Modifying natural fibers with alkali has greatly improved the mechanical properties of the resultant composites.

The following steps were carried out during chemical treatment:

- 5% NaOH solution was prepared using sodium hydroxide pellets and distilled water.
- Pineapple leaf fibers were then dipped in the solution for 1hour.
- After 1 hour fibers were washed with 1% HCl solution to neutralize the fibers.
- Then it is washed with distilled water.
- It was then kept in hot air oven for 3hours at 65-70°C.

2.3 Manufacturing of composite

A polypropylene (PP) mould having dimensions of 150 X 100 X 4 mm is used for composite fabrication. The mould was first cleaned with wax so that the laminate easily comes out of the die after hardening. Then around 15 to 20 ml of promoter and accelerator are added to Bisphenol and the color of the resin changes from pale yellow to dark yellow with the addition of these two agents. The laminates of three different fibers orientations mats of unidirectional, bidirectional and inclined are prepared using hand layup method. This method of manufacturing is a relatively simple method compared to other methods like vacuum bag molding, resin transfer molding, autoclave molding etc. Figure 2.1, 2.2 and 2.3 shows the uni-directional, bi-directional and inclined orinted PALF reinforced composites respectively.

Figure 2.1 Uni-directional oriented PALF reinforced composites

Figure 2.2. Bi-directional oriented PALF reinforced composites

Figure 2.3. Inclined oriented PALF reinforced composites

3. RESULTS AND DISCUSSION

The flexural properties of the unidirectional, bidirectional and inclined PALF reinforced composites was studied. There are two methods to determine the flexural properties of material: three-point loading system and four point loading system. In the present work three-point loading bending test was carried out on a test specimen as per ASTM D790 standard (125*14.5*4mm). The flexural test was conducted on JJ Lloyd universal testing machine with load cell of 1kN and using crosshead speed of 5 mm/min. The test was performed until the flexural failure occurred. Fig. 3.1 shows three-point bending test.

Figure 3.1–Test Specimen undergoing flexural test

The results of the flexural test are put forth in the form of stress-strain curves. Figures 3.2(a), 3.2(b) and 3.2(c) shows the stress-strain curve for unidirectional, bidirectional and inclined PALF composite respectively. The maximum load and maximum bending stress obtained from the experimental study is given in Table 3.2. Figure 3.3 shows the variation of maximum bending stress for different orientation of fibers in the composite.

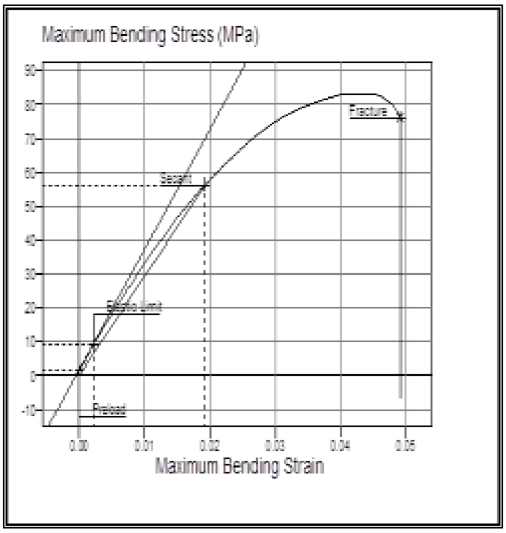

Figure 3.2(a) - Stress-strain curve of Uni- directional composite.

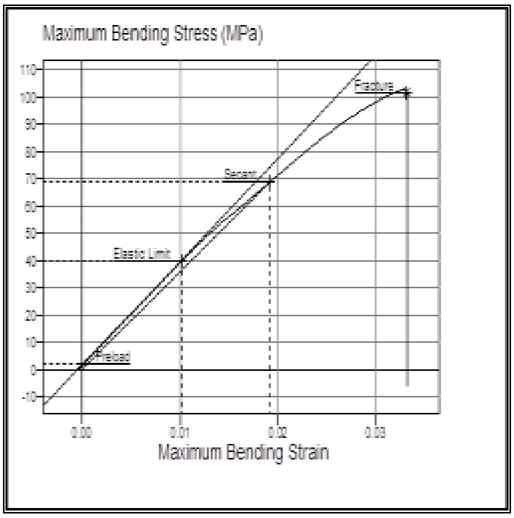

Figure 3.2(b) - stress strain curve if Bi- direction composite.

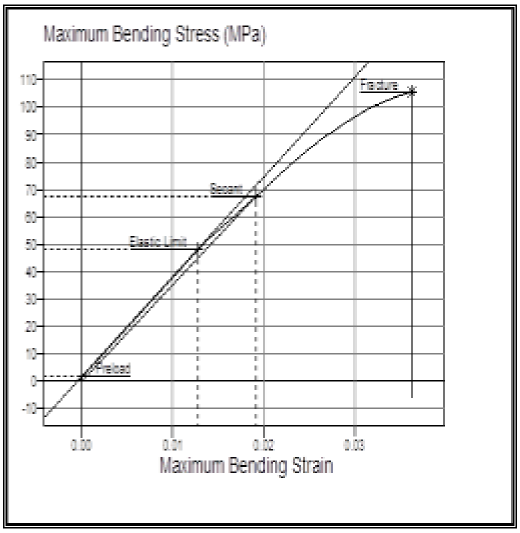

Figure 3.2(c) - Stress strain curve of inclined PALF composite.

Table 3.1 shows the maximum load and maximum binding stress for Uni-directional, Bi-directional and inclined fiber oriented reinforced polymer composite.

Table 3.1 Experimantal results:

Fiber Orientation	Maximum load(KN)	Maximum bending stress (MPa)
Uni-directional	0.226514998	83.60543723
Bi-directional	0.278678076	102.8585419
Inclined	0.286039163	105.5754786

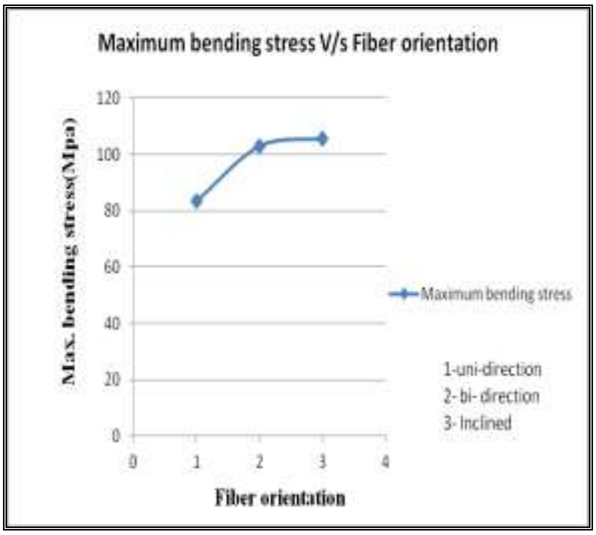

Figure 3.3 Variation of Maximum bending stress with fiber orientation.

The flexural strength of the matrix material Bisphenol alone is 80 Mpa (Table 2.2). From the table 3.1 it can be observed that the highest value of flexural strength of 105.57Mpa is obtained for inclined orientated fibers. In comparison with the flexural strength of matrix material, the reinforcement of fibres in inclined direction (45^0) increased the flexural strength of the composite by 24.22%. For Uni-directionally orientated fibers maximum bending stress marginally increased by 4.3% and for bi-directional orientated fibers it increased to 22.21% than the matrix material's value.

4. CONCLUSION

The results of the present study revealed that a useful composite with good properties could be successfully developed using treated PALF as reinforcing agent for the Bisphenol matrix. It can be seen that inclined oriented composites show better flexural strength (105.57 MPa) than Uni-directional and bi-directional oriented composites. Hence fiber orientation greatly influence the flexural strength of the PALF reinforced Bisphenol composite.

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EXPERIMENTAL STUDY OF DYNAMIC BEHAVIOUR OF HYBRID JUTE/SISAL FIBRE REINFORCED POLYESTER COMPOSITES

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Abstract: The present study deals with transverse vibration analysis of hybrid jute-sisal fabric reinforced polyester composites. The hybrid jute-sisal laminate are prepared by hand lay-up technique using untreated woven jute and sisal as reinforced materials and commercially available polyester resin as a matrix material. A cantilevered rectangular symmetric plate of hybrid jute-sisal fabric reinforced polyester composite having aspect ratio of 0.83 with 5 layers of cloth for hybrid jute-sisal laminate with fibre direction orientation at [+90°/+45°/0°/-45°/-90°] laminate is prepared. In the analysis, a frequency domain model is used along with Frequency Response Function (FRF) measurements obtained from the plate. These measurements are made using a Fast Fourier Technique (FFT) based spectrum analyzer. Natural frequency, damping factor and mode shapes are obtained from the laminates.

Keywords: *Transverse vibration; matrix material; mode shapes; Frequency Response Function; damping factor; Natural frequency*

1. INTRODUCTION

In recent years, the natural fibre reinforced composites have attracted substantial importance as a potential structural material. The attractive features of the natural fibres like jute, sisal, coir and banana have been their low cost, light weight, high specific modulus, renewability and biodegradability. Even though the basic concepts of composite materials were known from ancient times, the development of advanced composite materials such as boron epoxy, Kevlar epoxy, glass epoxy, carbon epoxy, etc., suitable for modern engineering applications has received attention only in recent past [1].Non-conventional fibres such as jute, sisal, coir, banana, palm fibres etc., are extracted from stem/leaf/fruit of plants. Among all these fibres, jute and sisal have an advantage over other fibres [2]. Jute is available both in fibre/strand and mat form, and sisal fibres are available in the fibre form. These fibres posses moderate strength and stiffness. Easy availability of these reinforced materials, availability of only a few mechanical properties of these fibers induced the interest and curiosity to take up this work.

The objective of the present work is to determine the damping factor and mode shapes for a cantilevered rectangular symmetric plate of hybrid jute-sisal fabric reinforced polyester composite with fibre orientation at [+90°/+45°/0°/-45°/-90°] using a Fast Fourier Technique (FFT) based spectrum analyzer.

2. EXPERIMENTATION

The hybrid jute-sisal laminate are prepared by hand lay-up technique using untreated woven jute and sisal as reinforced materials and commercially available polyester resin as a matrix material. A cantilevered rectangular symmetric plate of hybrid jute-sisal fabric reinforced polyester composite having dimensions 300x300x3.8 mm is as shown in Fig. 1.

Fig .1: Hybrid jute-sisal laminate

Block diagram of experimental set up and Experimental setup is as shown in Fig.2. & Fig. 3 respectively.

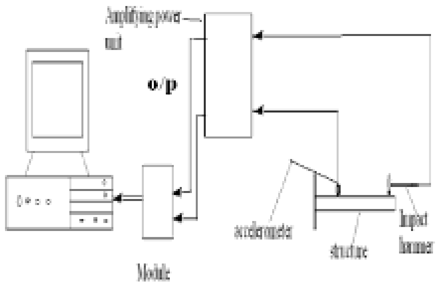


Fig. 2: Block diagram of experimental set up

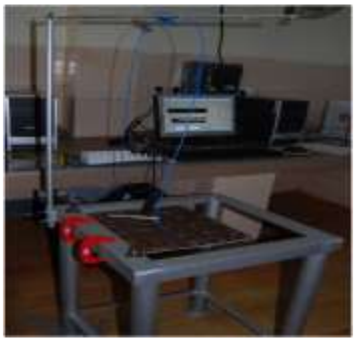


Fig. 3: Experimental set up

A grid of 7x6 (42 points) measurement points are marked over the surface of the laminate .The laminate is then clamped on test fixture and an impulse technique was used to excite the structure by impact hammer with force transducer built in to the tip to register the force input. The excitation signal is fed to the analyzer through amplifier unit. A piezoelectric accelerometer stuck on the desired measuring point of the specimen senses the resulting vibration response. The accelerometer signals were conditioned in the charge amplifier and fed to the analyzer. The analyzer in conjunction with Fast Fourier Transform (FFT) gives mathematical relation between time and Frequency Response Spectrum (FRS) and coherence functions are registered in the selected frequency range. At each grid point five measurements were made and their average was obtained. The output data of all 42 measurements was used as an input data for LABVIEW-2009 package to identify response frequencies. From the response frequencies natural frequencies, damping factor and mode shapes were obtained and animated [3].

Table 1 and Table 2 shows the modal properties of jute laminate and hybrid jute-sisal laminate and that are obtained using experimentation.

Table 1: Modal properties of jute laminate [7]

Dimension: 300x300x3.8 mm

Aspect ratio: 0.83

Mode No.	Frequency (f) (Hz)	Damping Factor (ξ) %
1	24.34	3.19
2	45.49	2.08
3	129.06	0.52
4	165.50	1.18

Table 2: Modal properties of hybrid jute-sisal laminate

Dimension: 300x300x3.8 mm

Aspect ratio: 0.83

Mode No.	Frequency (f) (Hz)	Damping Factor (ξ) %
1	24.008	3.546
2	47.803	3.681
3	129.447	2.165
4	147.595	2.086

3. RESULTS AND DISCUSSION

A cantilever test plates of hybrid jute-sisal fabric reinforced polyester composite having dimensions 300x300x3.8 mm were tested for input frequency of 250 Hz to obtain modal properties. The structural testing, analysis and reporting (LAB VIEW-2009) software which uses frequency response function (FRF) method to identify the modal parameters of a structure is used. . As explained, in this method, FRF measurements are made with an FFT analyzer and transferred to the lab view system for processing and curve fitting. Table 1 shows the modal frequency and the damping factor of Hybrid Jute-Sisal laminate. Fixed excitation is used here to obtain the response at various points on the specimen and results are also obtained at all points. Each peak from left to right shown in Fig.4 relates to corresponding mode shapes from 1 to 4 of hybrid jute-sisal laminate. The first four experimental mode shapes obtained for hybrid jute-sisal laminate plates are given in Fig.5.

The mode shapes give the information of dynamic behavior of laminate under various natural frequencies. The mode-1 is called as fundamental mode in bending, mode-2 is in twisting and the rest of the modes are under combination of bending and twisting [8]. The average damping factor obtained for fundamental frequency of hybrid jute-sisal laminate is 1.15 times greater than the jute laminate. However, the damping factors of hybrid jute-sisal reinforced polyester composites are higher than that of conventional composites and monolithic materials.

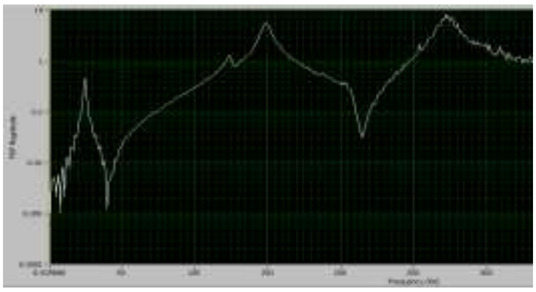
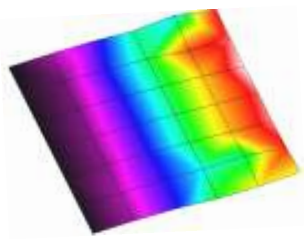
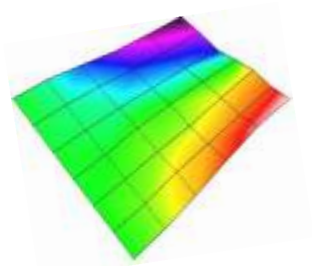


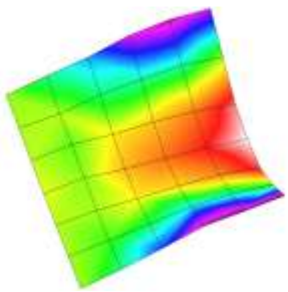
Fig.4: Magnitude – frequency response of hybrid jute-sisal laminate



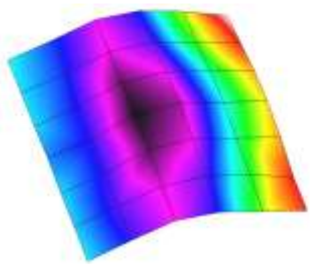
Mode : 1
Frequency : 24.008
Damping factor : 3.546



Mode : 2
Frequency : 47.803
Damping factor : 3.681



Mode : 3
Frequency : 129.447
Damping factor : 2.165



Mode : 4
Frequency : 147.595
Damping factor : 2.086

Fig. 5: Mode shapes of hybrid jute-sisal laminate

3.1Comparison Between the Experimental Results of Jute and Hybrid Reinforced Composite Laminate.

From table 1 and table 2 it can be observed that the average damping factor obtained for fundamental frequency of hybrid jute-sisal laminate (3.681%) is 1.15 times higher than that of jute laminate (3.19%).The variation in damping factor is due to difference in flexural stiffness of hybrid jute-sisal laminate and jute laminate and changes in the fibre angle that yields to different dynamic behavior of the composite laminate.

4. CONCLUSION

The main emphasis of the present work is on development, testing and characterization of hybrid jute-sisal fabric reinforced polyester composites to know their suitability and adaptability for various structural applications. Experimentally determined the natural frequency and mode shapes for hybrid jute-sisal laminate by using Fast Fourier Technique (FFT) analyzer.

a) The average damping factor obtained for fundamental frequency of hybrid jute-sisal laminate (3.681%) is 1.15 times higher than that of jute laminate (3.19%). The variation in damping factor may be due to difference in flexural stiffness of hybrid jute-sisal laminate and jute laminate and changes in the fibre angle yields to different dynamic behavior of the composite

b) Hybrid jute-sisal fabric reinforced polyester composites possess good damping factor as compared to conventional composites. Therefore, these composites can be used as vibration absorbing materials in certain applications such as automobile industries, for house construction roofing material and for indoor applications.

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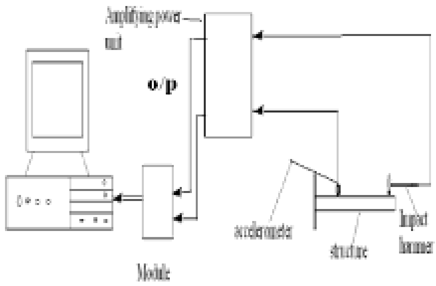
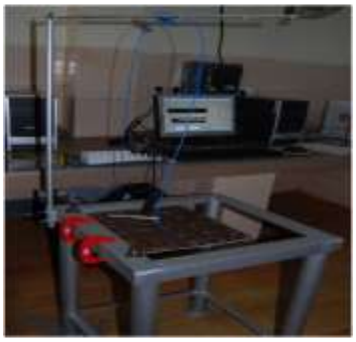


Fig. 2: Block diagram of experimental set up



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4	147.595	2.086

3. RESULTS AND DISCUSSION

A cantilever test plates of hybrid jute-sisal fabric reinforced polyester composite having dimensions 300x300x3.8 mm were tested for input frequency of 250 Hz to obtain modal properties. The structural testing, analysis and reporting (LAB VIEW-2009) software which uses frequency response function (FRF) method to identify the modal parameters of a structure is used. . As explained, in this method, FRF measurements are made with an FFT analyzer and transferred to the lab view system for processing and curve fitting. Table 1 shows the modal frequency and the damping factor of Hybrid Jute-Sisal laminate. Fixed excitation is used here to obtain the response at various points on the specimen and results are also obtained at all points. Each peak from left to right shown in Fig.4 relates to corresponding mode shapes from 1 to 4 of hybrid jute-sisal laminate. The first four experimental mode shapes obtained for hybrid jute-sisal laminate plates are given in Fig.5.

The mode shapes give the information of dynamic behavior of laminate under various natural frequencies. The mode-1 is called as fundamental mode in bending, mode-2 is in twisting and the rest of the modes are under combination of bending and twisting [8]. The average damping factor obtained for fundamental frequency of hybrid jute-sisal laminate is 1.15 times greater than the jute laminate. However, the damping factors of hybrid jute-sisal reinforced polyester composites are higher than that of conventional composites and monolithic materials.

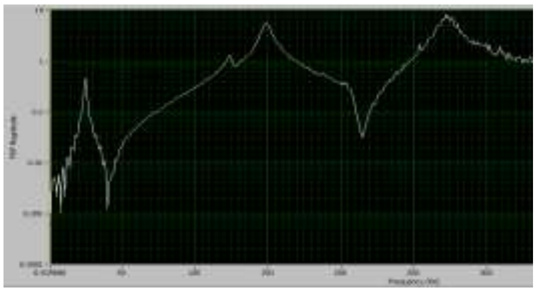

Fig.4: Magnitude – frequency response of hybrid jute-sisal laminate

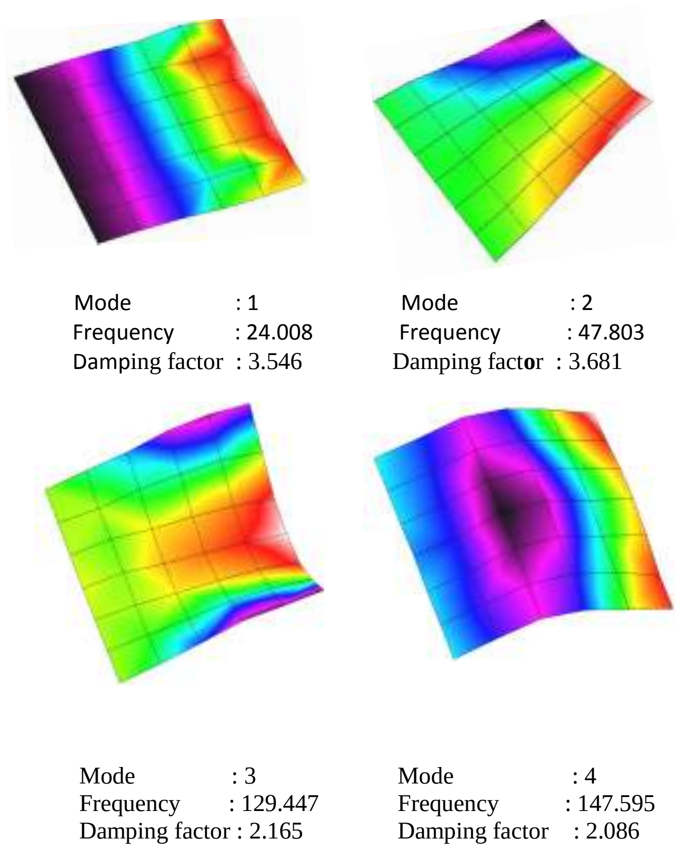

Fig. 5: Mode shapes of hybrid jute-sisal laminate

3.1Comparison Between the Experimental Results of Jute and Hybrid Reinforced Composite Laminate.

From table 1 and table 2 it can be observed that the average damping factor obtained for fundamental frequency of hybrid jute-sisal laminate (3.681%) is 1.15 times higher than that of jute laminate (3.19%).The variation in damping factor is due to difference in flexural stiffness of hybrid jute-sisal laminate and jute laminate and changes in the fibre angle that yields to different dynamic behavior of the composite laminate.

4. CONCLUSION

The main emphasis of the present work is on development, testing and characterization of hybrid jute-sisal fabric reinforced polyester composites to know their suitability and adaptability for various structural applications. Experimentally determined the natural frequency and mode shapes for hybrid jute-sisal laminate by using Fast Fourier Technique (FFT) analyzer.

a) The average damping factor obtained for fundamental frequency of hybrid jute-sisal laminate (3.681%) is 1.15 times higher than that of jute laminate (3.19%). The variation in damping factor may be due to difference in flexural stiffness of hybrid jute-sisal laminate and jute laminate and changes in the fibre angle yields to different dynamic behavior of the composite

b) Hybrid jute-sisal fabric reinforced polyester composites possess good damping factor as compared to conventional composites. Therefore, these composites can be used as vibration absorbing materials in certain applications such as automobile industries, for house construction roofing material and for indoor applications.

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