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Analysis of Mechanical Properties of Coconut Fiber Reinforced Epoxy Polymer Composites by FEA analysis

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Abstract - *In recent years, composite material replaces conventional material like metal, wood etc due to its light weight, high strength to weight ratio and stiffness properties. Natural fibers like coir, bamboo fiber, banana plant fiber etc has low cost, easily availability and less harmful to human. In this work, coir fiber is used as a reinforced material. Composites were prepared with different weight ratio of coir fibers with epoxy resin. To find the effect of coir fibers on the mechanical properties of composite, tensile test, impact test and hardness test were conducted on the prepared specimens. ASTM D638-V and ASTM D256 standards were used to prepare the specimens for tensile and impact test respectively. Experimental result shows that the addition of coir fibers increases the strength of composite; the composite with 7.5% fiber content shows maximum tensile and impact strength.*

FEA analysis can be done to save time and compare the experimental data with FEA analysis data . Ansys software is used for FEA analysis . Finally check any difference in experimental data with FEA analysis

The experimental values are more than the FEA values. Decrease value in mechanical testing may result of the presence of inhomoginites such as, mixture of matrix and reinforced material thoroughly, air bubbles presence in the specimens

1.INTRODUCTION

The field of composite materials has progressed considerably over the last few decades. Properties like low density, high strength and stiffness, chemical and corrosion resistance, etc. make composite materials an attractive alternative to metals and alloys. The abundant availability of natural fibre gives attention on the development of natural fibre composites primarily to explore value-added application avenues. Reinforcement with natural fiber in composites has recently gained attention due to low cost, easy availability, low density, acceptable specific properties, ease of separation, enhanced energy recovery [2-5].

Natural fibers such as ramie, hemp, jute, sisal, bamboo, banana, oil palm fibers, etc. are used as reinforcements in place of glass fibers. Composite mechanical properties are improved with the increase in fiber weight fraction. But when the fiber weight fraction is too large, the composite fiber bundle strength and ultimate strength gets reduced. Also it depends on the way in which the fibers are aligned with matrix [4-6]. Coir fibers are used as reinforcement in this work, as it is non-toxic, low cost, high lignin content, low density, easy availability and less tool wear. The studies revealed that fiber weight fractions have significant effects on mechanical properties of composite such as strength, stiffness and toughness. Compared with pure plastic specimen, adding Coir fibre into plastic materials could increase tensile strength , Impact strength and hardness because fiber provide strength to reinforced composite[1] *FEA analysis can be done to save time and compare the experimental data with FEA analysis data . Ansys software is used for FEA analysis . Finally check any difference in experimental data with FEA analysis*

2. EXPERIMENTAL METHODS

2.1 FAE ANALYSIS

Compressive and Flexural analysis done by the help of ansys software . And the Results of Analysis Shown below. In ANSYS 14.0 software chose following input parameters for analysis purpose and also selects static structure and advanced composite tools.

1. Analysis type: ANSYS 14.5
2. Engineering data sources: Composite materials

These above mentioned engineering data and materials properties are required to analyze the prepared composite specimens so we can created one model and meshed it.

Finite element Analysis is a numerical method of a complex system into very small pieces called elements. The software uses equations that generate the behavior of these elements and solves them all.

3. Measurement Techniques

ASTM D638-V standard and ASTM D256, standard were followed for tensile and impact test respectively [5]. Three specimen of Coconut fibre composite were prepared with different wt% of fibre separately for both tensile and impact test. The mass values of the specimens were measured by a precision balance weighting machine

Finite element Analysis is a numerical method of a complex system into very small pieces called elements. The software uses equations that generate the behavior of these elements and solves them all. The parts were assumed to be transversely isotropic in nature. G2, Poisson's ratio was calculated using information and equations available in Materials for engineering [] some of the value used was based on the ratio of"typical" material property values provided by NX **Material**

ANSYS software is used for analysis

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Table 3.1 Glass Epoxy Material Properties

þ	Density (g/cc)	1900
E11	Young's modulus along fiber direction 1(Gpa)	80
E22	Young's modulus along matrix direction 2 (Gpa)	4
ν12	Poisson's ratio	0.35
ν13	Poisson's ratio	0.34
G12	Shear modulus in 1-2 plane (psi)	3.80E+05
G13	Shear modulus in 1-3 plane (psi)	3.80E+05
G23	Shear modulus in 2-3 plane (psi)	431720
X2t	Tensile failure stress in direction 1 (transverse to fiber direction) (Mpa)	490
X2c	Compressive failure stress in direction 1 (transverse to fiber direction) (Mpa)	244.76
S12	Shear strength in 1-2 plane (Mpa)	160.64
S13	Shear strength in 1-3 plane (Mpa)	155.43
S23	Shear strength in 2-3 plane (psi)	14000

Table 3.2.properties of epoxy material

Material Type	Isotropic Material
Mass Density	1.2 g/cc
Young Modules(E)	3000000mN/mm^2(kPa)
Poisson's Ratio (NU)	0.37
Yield Strength	27000mN/mm^2(kPa)
Thermal Expansion Coefficient (A)	6e-0051/C
Thermal Conductivity (K)	2250microW/mm-C
Specific Heat (CP)	938000000microJ/kg-K

Part Size (for tensile) : ASTM D638-V standard

Part Size (compressive) : ASTM D638-V standard

4. Result and Analysis

4.1. Compressive Test Results

Compressive analysis is done by using one end is fixed and other one is applying a compression as shown below .Taking three Specimen with 3% , 5 % , 7.5 % of coconut fibre in epoxy Resin

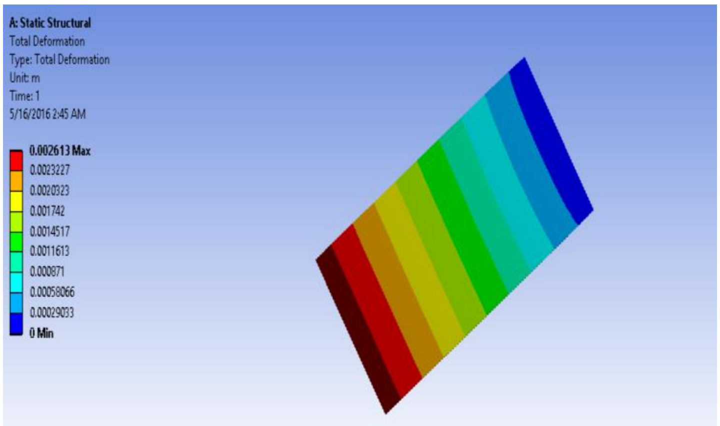

Fig 4.1 Total Deformation for 3% fibre

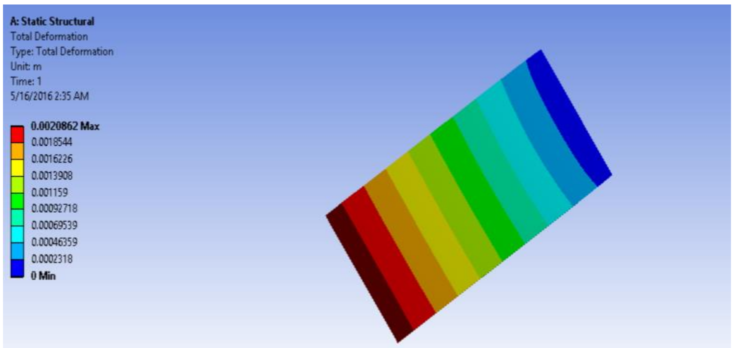

Fig 4.2 Total Deformation for 5% fibre

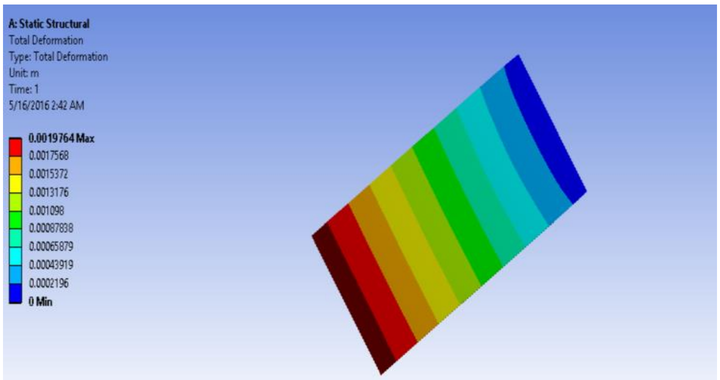

Fig 4.3 Total Deformation for 7.5% fibre

Above fig 4.1 ,4.2,4.3 shows the Total Deformation for 3%of Coir fiber under the 1100 N load. The Total deformation for 3% of Coir fiber, max is .0026 m. Fig 14 shows the Total Deformation for 5%of glass fiber under the 1400 N load. The Total deformation for 5% of coir fiber, max is .0020 m. Fig 15 shows the Total Deformation for 7.5 %of Coir fiber under the 1600 N load. The Total deformation for 7.5% of Coir fiber, max is 0.0019 m.
So it is concluded that as the fiber wt% increases its deformation decreases because fiber provide strength to

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the composite as we see 7.5% has lesser deformation which means that it has higher strength.

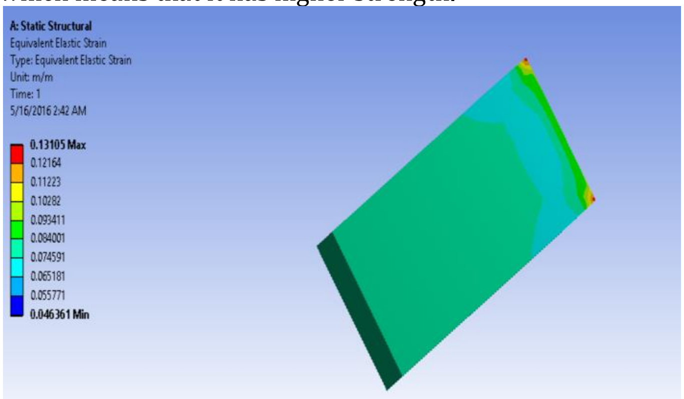

Fig 4.4 Elastic Strain for 3% fibre

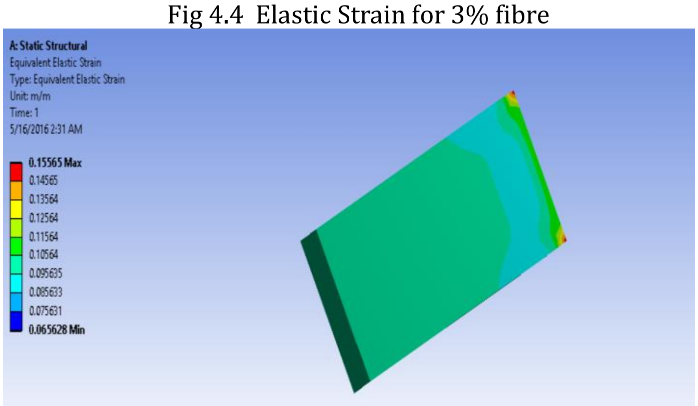

Fig 4.5 Elastic Strain for 5% fibre

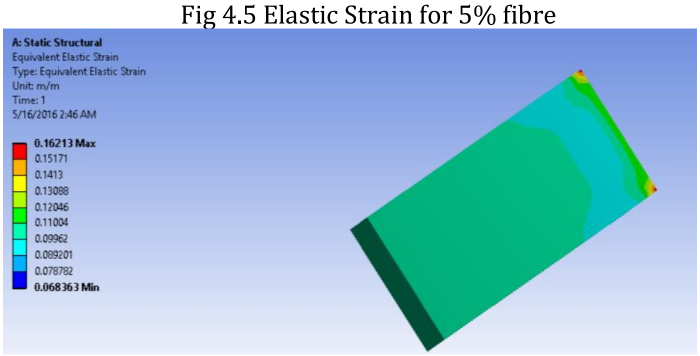

Fig 4.6 Elastic Strain for 7.5% fibre

Above fig 4.4, .5, 4.6 shows the Elastic strain for 3%of Coir fiber under the 1100 N load .The elastic strain for 3% coir fiber composite is maximum 0.13 and min 0.04 . Fig 17 shows the Elastic strain for 5%of Coir fiber under the 1400 N load .The elastic strain for 5% coir fiber composite is maximum 0.15 and min 0.065 . Fig 18 shows the Elastic strain for 7.5% of Coir fiber under the 1600 N load .The elastic strain for 7.5% coir fiber composite is maximum 0.16 and min 0.068 .

So from above data it is concluded that increase in fiber also affect the Elastic strain of a composite .Elastic strain increases as the fiber % increases and from above analysis 7.5% has maximum elastic strain.

4.2.2 . Flexural Test Result

Flexural Analysis is done by fixing to end and applying load perpendicular to the surface as shown in fig below

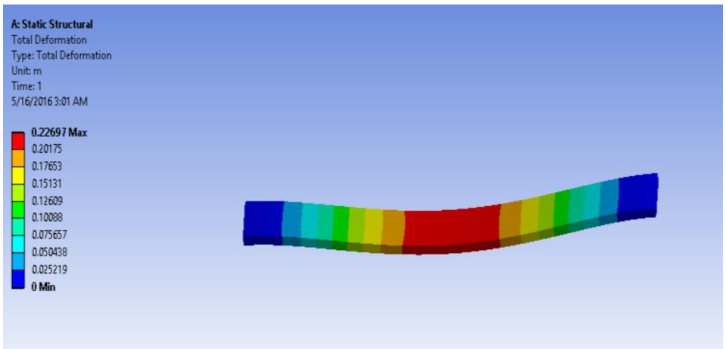

Fig 4.7 Total Deformation for 3% fibre

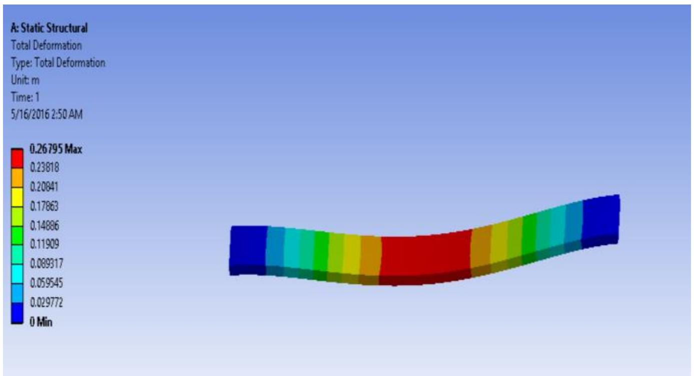

Fig 4.8 Total Deformation for 5% fibre

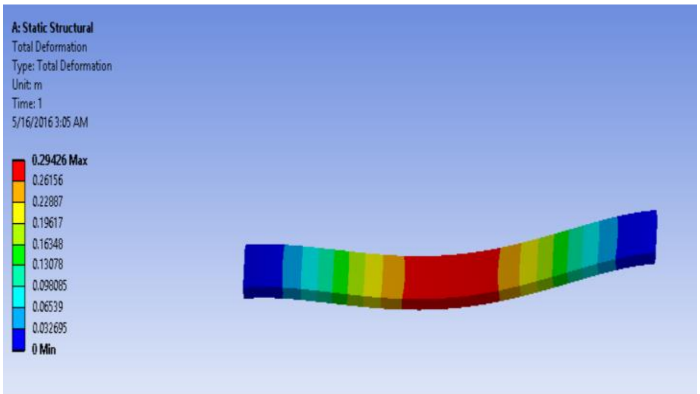

Fig 4.9 Total Deformation for 7.5% fibre

Above fig 23 shows the Total Deformation for 3%of Coir fiber under the 1100 N load. The Total deformation for 3% of Coir fiber, max is 0.22 m. Fig 24 shows the Total Deformation for 5%of glass fiber under the 1100 N load. The Total deformation for 5% of coir fiber, max is .26 m. Fig 25 shows the Total Deformation for 7.5 %of Coir fiber under the 1100 N load. The Total deformation for 7.5% of Coir fiber, max is 0.29 m.

From fig it can be concluded that the fiber % affect the flexural strength , fiber help the composite to resist against deformation.

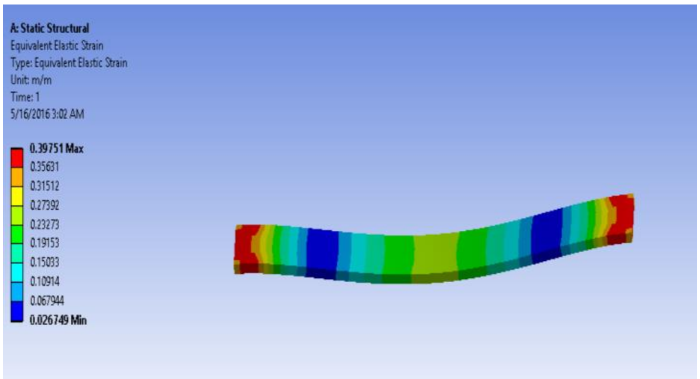

Fig 4.10 Elastic Strain for 3% fibre

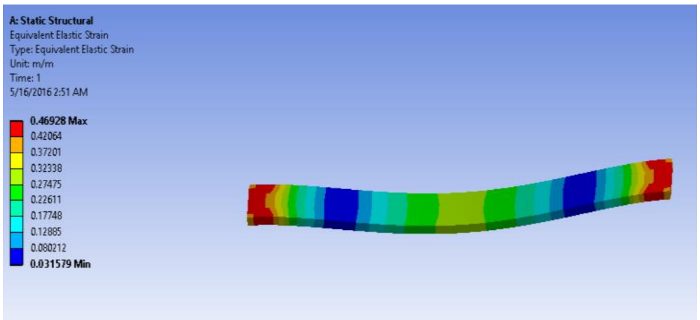

Fig 4.11 Elastic Strain for 5% fibre

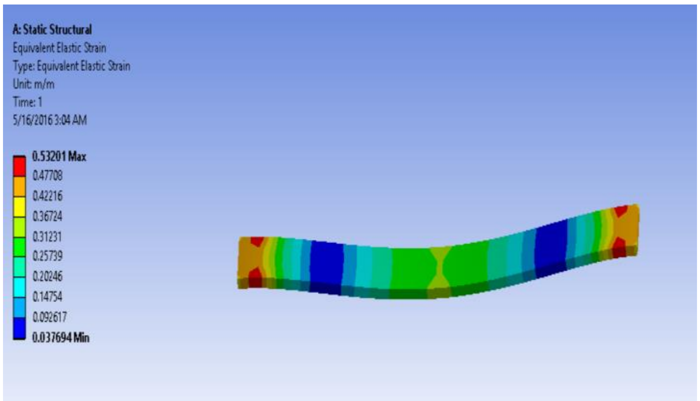

Fig 4.12 Elastic Strain for 7.5% fibre

Above fig 26 shows the Elastic strain for 3%of Coir fiber under the 1100 N load .The elastic strain for 3% coir fiber composite is maximum 0.39 and min 0.026 . Fig 27 shows the Elastic strain for 5%of Coir fiber under the 1100 N load .The elastic strain for 5% coir fiber composite is maximum 0.469 and min 0.0315 . Fig 28 shows the Elastic strain for 7.5% of Coir fiber under the 1100 N load .The elastic strain for 7.5% coir fiber composite is maximum 0.53 and min 0.037 .
So it can be said that fiber % help in increasing the elastic strain value. the composite having 7.5% fiber % has maximum elastic strain. Fiber increases the hardness of composite

5 CONCLUSIONS

Hardness of the specimen can be determined by the amount of fiber used ,As fiber% increases hardness of specimen also increases. From the FAE analysis it is also concluded that increase in fiber % help to decrease the deformation in specimen under load because fiber provide the strength to the specimen . FAE analysis also show that Von-misses Stress for both compressive and Flexural test also increases with increase in fiber % . because fiber provide hardness to the specimen . Since the matrix under stress transfers the load to the fibres ,fiber play a very important role in resisting against load ,so increase in fiber % also increases the stress occurred on specimen .

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