Analysis of Tensile Characteristics of Composite Materials Reinforced with Banana Fiber Using Finite Element Analysis

V. S. Jagadale[1*],

[1*]Research Scholar, Dept. of Mechanical Engg., Koneru Lakshmaiah Education Foundation, Vaddeswaram (A.P.),522302, India. Email: vishjagadale@gmail.com

S. N. Padhi[2]

[2]Professor, Department of Mechanical Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram (A.P.), 522302, India.

I. ABSTRACT

Composite materials emerge mainly in response to technological demands as the aviation, aerospace and automotive sectors are rapidly advancing. Bio-fibre composite development has recently attracted the attention of scientists and technologists and has been a subject of interest in recent years. The main subject of this work is research into the tensile characteristics of banana fibre/epoxy resin composites at 30%, 40% and 50% volume fractions of banana fibre and fiber orientation 0^0, 45^0, 90^0. For analysis, the ANSYS 12.0 numbered package is used. In order to find the optimum number of cases the Taguchi l9 method is used. A total of 9 cases for tensile properties were studied. Compared to the other 30/70 and 50/50 the composition 40/60 was found to be usefully applied. For composition 40/60 and 0^0 fibers orientation, the maximum strength is 50.6 N/mm2.

Keywords: FEA, ANSYS, Volume fraction, Banana fibre, Simulation.

1. INTRODUCTION

Composites include strong materials (called reinforcement) embedded in lower materials (called matrix). Compounds consist of high load carriage. Strongest and strength support the structural load. Reinforcement The matrix or binding (organic or inorganic) maintains position, reinforcing orientation and the external load is transferred to the reinforcing. The components

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

of the composites retain significantly their individual, physical and chemical characteristics. In their industrial applications and basic research, their interest in fiber-reinforced polymer composites is rapidly growing. The fibers of bananas, sisal, bamboos and other lignocelluloses, which are cheap, renewable, fully or partially recyclable, are used more and more often as composite reinforcement agents. The reinforcement and filling in composites were examined in natural fibers such as jute, pineapple, abaca and coir. Taking the availability into account, bananas receive increasing attention. Composites with fiber strengthening polymers have many applications as a structural material class due to their manufacturing facilities, relatively low prices and better mechanical properties compared with polymer resins. These are considered as substitutions for metal materials in which the combination of metallic fibers with polymer matrix is an attractive material for the application of electronic packing.

The combination of reinforcement in resin matrix with high thermal conductivity and low thermal conductivity should dissipate the thermal flux of electronic packaging materials. New biobased composites are being produced in light of the increasing need for ecologically sound products and the need for lower prices of traditional fibers (e.g. steel, glass and aramid). Researchers continued to concentrate on composites of natural fibers (e.g. biocomposites). The composites contain enhanced resins made of carbon, synthetic and carbon fibre. Natural fibres, having various advantages, are a substance of low density producing relatively light, high-specific composites. Such fibers actually minimize reliance on both domestic and foreign oil and offer significant cost advantages, rapid production and a highly renewed fuel. Significant late developments have also been made regarding the use of natural fiber (e.g. mango, cellulose, jute, cotton, wheat, kenaf, coir, and bamboo, for example).

2. LITERATURE REVIEW:

Composite materials are essentially hybrid materials consisting of multiple materials, in a single structural material, to utilize their specific structural benefits. The composite material then has the characteristics of the two combined materials. The key is to examine a material macroscopically in which the components of the naked eye can be identified. Many researchers have improved the use of natural composites. Certain works are summarized below.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

To increase the moisture, sodium hydroxide is used for the treatment of untreated banana fibers. Untreated banana fiber and treated sodium hydroxide banana fiber are used as a material to strengthen both Epoxy Resin and Vinyl ester matrix. Cocoon shell powder in combination with the untreated and treated banana fibers is used as a reinforcement. The process of molding

banana fiber is used. The mould is made from aluminum and an interior part of the depositor for the production of the hybrid composite material. Banana fiber content is kept by 30% of the overall weight of the composites[1]. As the fibers increase while density decreases, the results demonstrated that the percentage absorption of humidity, void content, and compressive strength increased. However, 67.2 MPa, 653.07 MPa and 5.9% were the maximum values at 15 mm fiber length, showing that fiber size was essential in order to ensure the effective and maximum load transfer[3].

Natural fibers are cheaper, eco-friendly and biodegradable[4]. Numerous natural fibers have been studied for the use in plastics, such as flax, han, jute, sisal and bananas. Renewable and attractive marketing benefits natural fibres[5]. These agricultural waste may be used to produce fibre-reinforced polymers for commercial use. Production of polymer composites using natural fibres, such as coir, bananas and sisals, abundant in nature and calculated using different pattern structures (flexural module, bending rigidity, hardness number and water gap percent). The inclusion of volume fraction of the enhancement and coir indicators for a variety of structural and constructive applications influences the composite tensile, static as well as water absorption heavily [7, 10]. The coir is a material of refining. The Taguchi L9 method can be used [6, 12] for the selection of the correct test numbers. There was an increase in the bending strength of the reinforced composite with bamboo fibre[8]. It is proposed, in the case of glass fibres, that 30% weight of fiber is far better than 20% and 10% weight fraction of fiber refinement[9], in the case of strengthened banana fibres.

3. SIMULATION USING FEM

Finite element analysis is a computer-based analysis technique used to calculate structural strength and behavior. The FEM is the finite element of the structure. These elements are connected at certain points called nodes. The FEA is used to calculate the member's deflection, strains, heat, huddle behavior. The ANSYS 12.0 is used in our project FEA.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

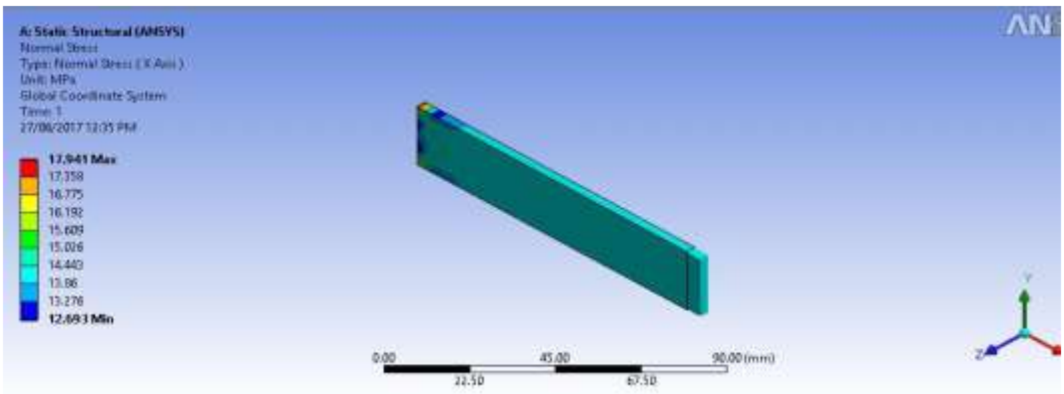
Finite Element Analyze is a simulation technique that evaluates the component, equipment and structural behavior, including the forces, pressures and temperatures used to carry out various load conditions. Thus a complex engineering problem can be resolved by means of finite element analysis with a non-standard form and geometry where a closed form solution is not possible.

3.1 Static analysis:

Statically analyzed structures and components that do not cause significant inertia and damping load effects are used to detect motions, stress, stress, strain and force. However, static analysis can include steady inert loads, like gravity, rotation and time change. The loading and responding conditions should vary slowly in static analyzes, that is the response to time and structure. For static analysis, load types include externally applied forces, times and pressures. Non nil displacement forces such as seriousness or spinning were imposed by the steady state. The structure itself will fail if the stress values achieved by this analysis cross the permissible values. To prevent such a failure, this analysis is necessary. The analysis were conducted successfully for the traction strength of banana fiber epoxy compounds.

Case 1:

Specimen size	:	20 x 3 x 200 mm
Composition	:	30/70& 30 ^{0}
Maximum Load	:	1271.06 N
Normal Stress	:	17.941 Mpa



ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

Fig 1: Tensile test using FEA (V_f 30% & 0°orientation)

Case 2:

Specimen size	:	20x3x200 mm
Composition	:	30/70&45 ^{0}
Maximum Load	:	491.96 N
Normal Stress	:	10.046 MPa

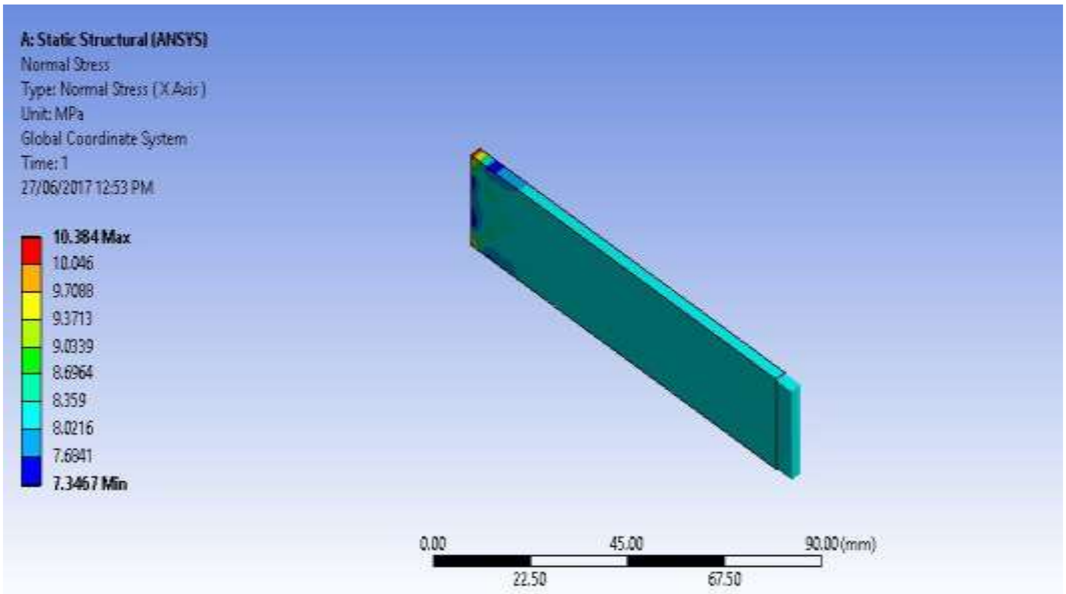


Fig 2: Tensile test using FEA (V_f 30% & 45^0)

Case 3:

Specimen size	:	20x3x200 mm
Composition	:	30/70 & 90
Maximum Load	:	521.36N
Normal Stress	:	8.1683Mpa

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

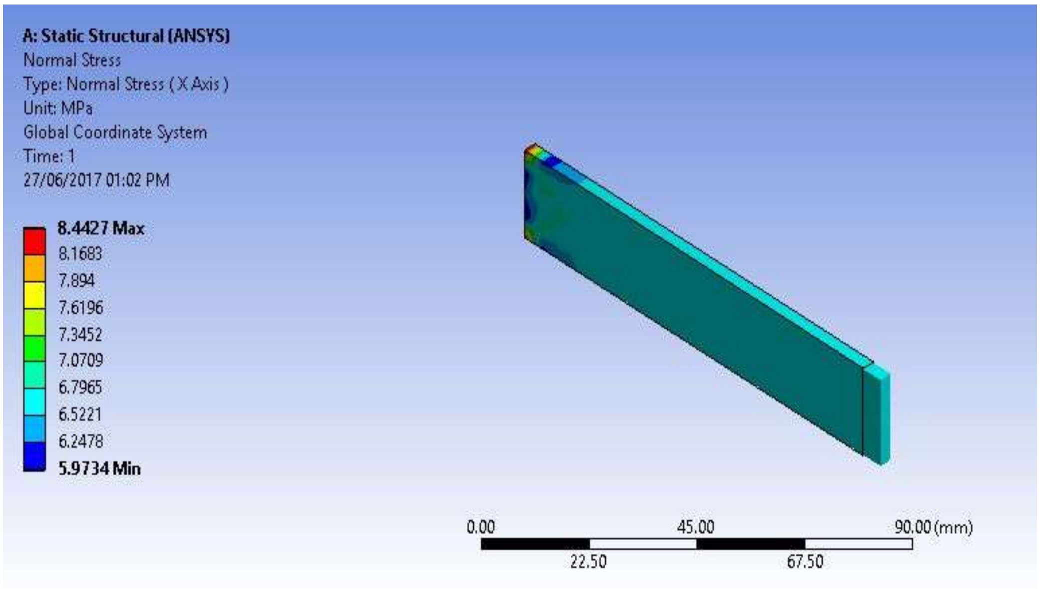
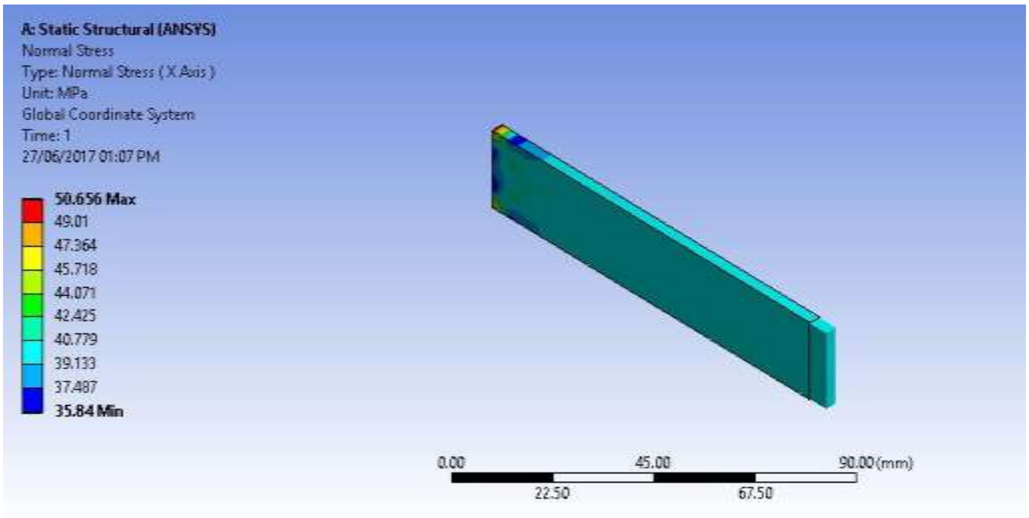


Fig 3: Tensile test using FEA (V_f 30% & 90^0)

Case 4

Specimen size	:	20x3x100 mm
Composition	:	40/60 & 0 ^{0}
Maximum Load	:	2817.5 N
Normal Stress	:	50.6 MPa



ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

Fig. 4: Tensile test using FEA (V_f 40% & 0 ^{0})

Case 5:

Specimen size	:	20x3x100 mm
Composition	:	40/60& 45^0
Maximum Load	:	40.74 N
Normal Stress	:	15.231 MPa

Fig. 5: Tensile test using FEA (V_f 40% & 45^0)

Case 6:

Specimen size	:	20x3x100 mm
Composition	:	40/60& 90^0
Maximum Load	:	385.14 N
Normal Stress	:	8.129 MPa

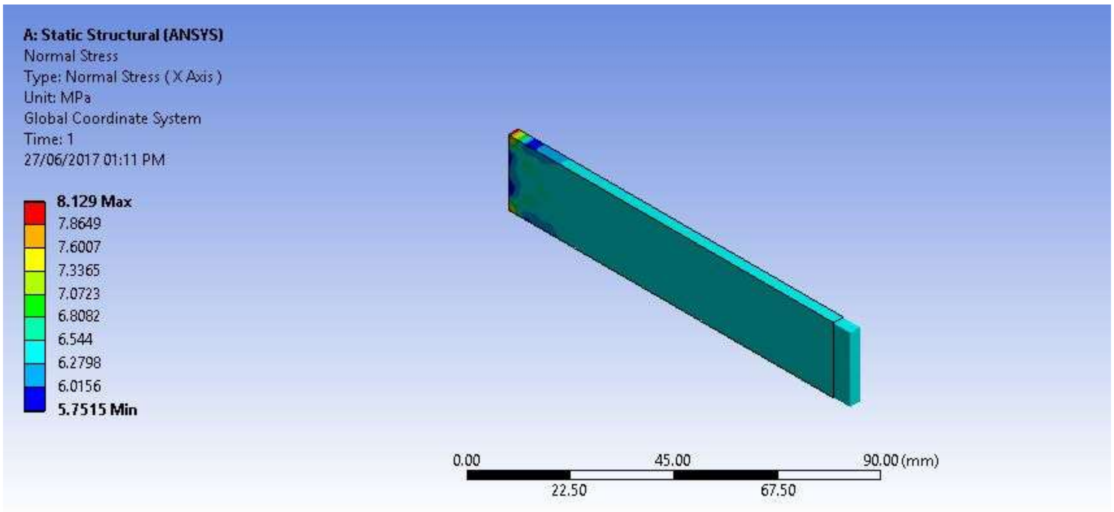


Fig 6: Tensile test using FEA (V_f 40% & 90^0)

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

Case 7:

Specimen size	:	20x3x100 mm
Composition	:	50/50 & 0^0
Maximum Load	:	1465.1 N
Normal Stress	:	21.107 MPa

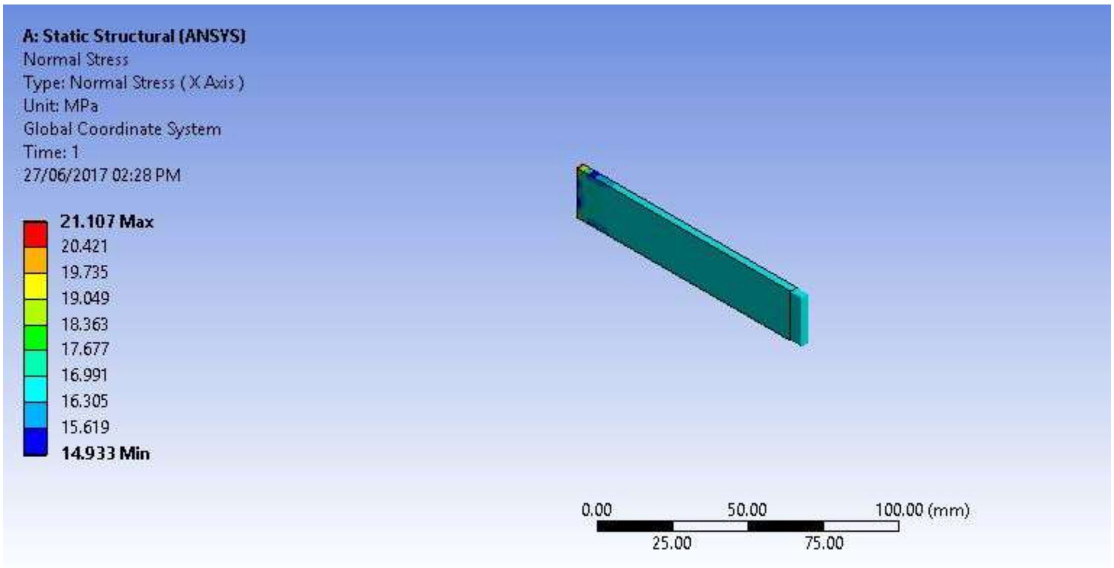


Fig. 7: Tensile test using FEA (V_f 50% & 0^0 mm)

Case 8:

Specimen size	:	20x3x100 mm
Composition	:	50/50& 45^0
Maximum Load	:	796.74 N
Normal Stress	:	14.775 MPa

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

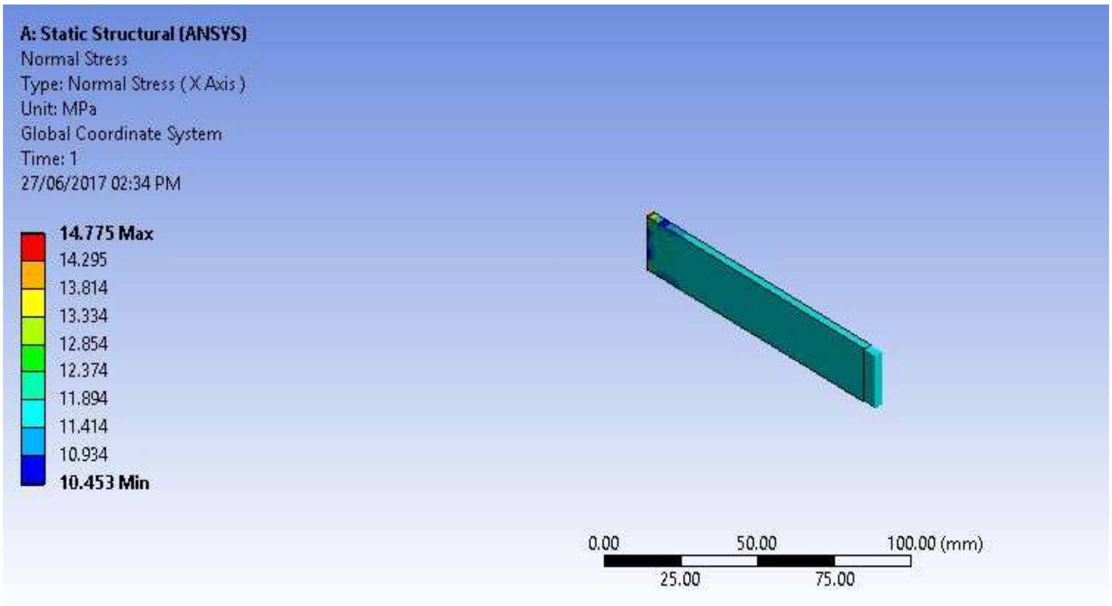


Fig. 8: Tensile test using FEA (V_f 50% & 45^0)

Case 9:

Specimen size	:	20x3x100 mm
Composition	:	50/50 & 45^0
Maximum Load	:	572.32 N
Normal Stress	:	11.187 MPa

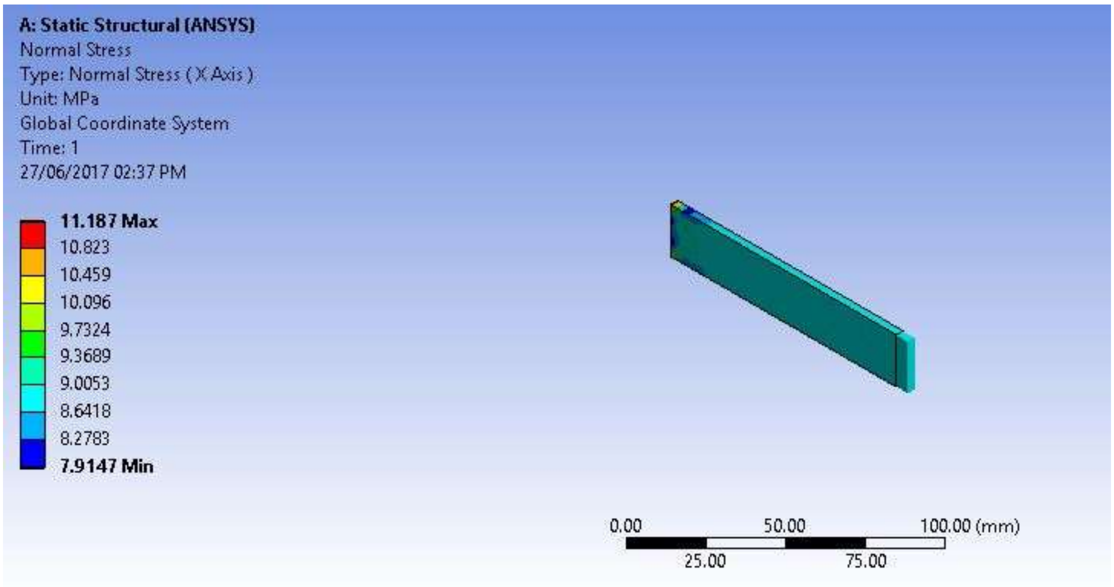


Fig 9: Tensile test using FEA (V_f 50/50% & 90^0)

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

4. RESULTS & DISCUSSION:

Following table shows tensile test results of various specimens with different volume fraction and fiber orientation by FEM

Table 1: Results of FEA

Sr. No.	Specimen composition	Fiber orientation	Tensile strength (N/mm^2)
1	A (30/70)	0^0	17.941
		45^0	10.046
		90^0	8.1683
2	B (40/60)	0^0	50.6
		45^0	15.231
		90^0	8.129
3	C (50/50)	0^0	21.107
		45^0	14.775
		90^0	11.187

A detailed numerical study was carried out on banana fibre / epoxy composite's mechanical behavior on the basis of various fiber fractions and fiber orientation. The results show that 40/60 is better than 30/70 and 50/50 tensile properties, as many authors have suggested.For composition 40/60 and 0^0 fibers orientation, the maximum strength is 50.6 N / mm^2.

5. CONCLUSION:

From the numerical analysis, the material can be said to be desirable or not. The cases examined in this report show that banana fibers can be used as an appropriate industrial material. The next study on composite epoxy banana is wide-ranging. Other aspects such as fiber length, fiber load, matrix, fibre orientation, load patterns of coir epoxy composite are also considerable for researchers. The availability of knowledge of the mechanical behavior dependence on these factors can be extended by varying these parameters and similarly analyzed for the results of experiments. Different variable parameters allow the same analysis to be done which saves

ISSN PRINT 2319 1775 Online 2320 7876

Research paper © 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 8, Issue 2, 2019

production and testing costs and time. The result was good tensile properties for a certain fraction in volume and fiber orientation.

REFERENCES

[1] Ever J. Barbero, "Finite element analysis of composite materials using ANSYS", Second edition. Boca Raton : CRC Press, 2014.

[2] Yongli Wu et.al "Three-dimensional finite element analysis of composites with coated spherical inclusions", Materials Science and Engineering: A, Volume 203, Issues 1–2, 15 November 1995, Pages 314-323.

[3] VishnuPrasad et.al, "Finite Element Analysis of Jute and Banana Fibre Reinforced Hybrid Polymer Matrix Composite and Optimization of Design Parameters Using ANOVA Technique", Procedia Engineering, Volume 97, 2014, Pages 1116-1125.

[4] J.H.Lim et.al, "An experimental and finite element analysis of the static deformation of natural fiber-reinforced composite beam", Polymer Testing, Volume 22, Issue 2, April 2003, Pages 169-177.

[5] Lee et.al, "Evaluation of interphase properties in a cellulose fiber-reinforced polypropylene composite by nano indentation and finite element analysis", Composites Part A: Applied Science and Manufacturing Volume 38, Issue 6, June 2007, Pages 1517-1524.

[6] A.Pegoretti et.al, "Finite element analysis of a glass fibre reinforced composite endodontic post", Biomaterials Volume 23, Issue 13, July 2002, Pages 2667-2682.

[7] D. Saravana Bavan et.al, "Finite Element Analysis of a Natural Fiber (Maize) Composite Beam", Journal of Engineering, Volume 2013 |Article ID 450381, 7 pages.

[8] T.Subramani et.al, "Finite Element Analysis of a Natural Fiber (Maize) Composite Beam", International Journalof Modern Engineering Research, Vol. 4, Iss. 6, June. 2014.

[9] Lohitesh Jaga Kumar et.al, "Experimental & Finite Element Analysis of Sisal Fibre Reinforced Composites", International Journal of Recent Trends in Engineering & Research, Volume 02, Issue 07; July – 2016.

[10] A.G Momin et.al, Finite Element Analysis of Fiber Reinforced Composite Material", International Journal of Latest Technology in Engineering, Management & Applied Science, Volume VII, Issue XI, November 2018.