International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 3 Issue 4, April-2014, pp: (465-470), Impact Factor: 1.252, Available online at: www.erpublications.com.

Mechanical Properties Characterization of Natural (Coir Based) Fiber Polymer Composite by Numerical Methods

Dr. Dinesh Shringi[1] ,Gaurav Solanki[2], Piyush Sharma[3]

[1]Associate Professor in Mechanical Engineering department, M.B.M. engineering college in JNV University, Jodhpur
[2]Pursuing master's degree program in Mechanical Engg., M.B.M. engineering college in JNV University, Jodhpur
[3]Pursuing Doctoral program in Mechanical Engg., M.B.M. engineering college in JNV University, Jodhpur

Abstract: Composite materials have successfully substituted the traditional materials in several light weight and high strength applications. The recognition of the potential weight savings that can be achieved by using the advanced composites, which in turn means reduced cost and greater efficiency, was responsible for this growth in the technology of reinforcements, matrices and fabrication of composites. Composite materials are emerging chiefly in response to unprecedented demands from technology due to rapidly advancing activities in aircrafts, aerospace and automotive industries. Common fiber reinforced composites are composed of fibers and a matrix. Fibers are the reinforcement and the main source of strength while matrix glues all the fibers together in shape and transfers stresses between the reinforcing fibers. Natural fibers have recently attracted the attention of scientists and technologists because of the advantages that these fibers provide over conventional reinforcement materials, and the development of bio fiber composites has been a subject of interest for the past few years. During the last few years, a series of works have been done to replace the conventional synthetic fiber with natural fiber composites For instant, hemp, sisal, jute, cotton, flax and broom are the most commonly fibers used to reinforce polymers like polyolefin , polystyrene , and epoxy resins .The mechanical responses in Fiber Reinforced composite (FRC) play a critical role in their performance, accurate thermal behavior measurements of FRC are essential.

INTRODUCTION

Composites are combinations of two materials in which one of the materials called the reinforcing phase is in the form of fiber sheets or particles and are embedded in the other material called the matrix phase. The advantage of composite materials over conventional materials stem largely from their higher specific strength, stiffness and fatigue characteristics ,which enables structural designs to be more versatile. Natural fibers have recently attracted the attention of scientists and technologists because of the advantages that these fibers provide over conventional reinforcement materials, and the development of bio fiber composites has been a subject of interest for the past few years. These bio fibers have low-cost with low density and high specific properties. These are biodegradable and nonabrasive, unlike other reinforcing fibers.the key issues in development of bio reinforced composites are

- Thermal stability of the fibers,
- Surface adhesion characteristics of the fibers, and
- Dispersion of the fibers in the case of thermoplastic composites.

MECHANICAL PROPERTIES OF COMPOSITES

Tensile Strength and Modulus

For the mechanical property to be describing the material we use simple mechanical formula to arrive at useful result for their suitability in application purpose. So one of the properties is deformation where the material obeys Hook's law, which can be said that the deformation is proportional to the applied force. For us to really specify the property we have to define the quantity stress and strain and this can be illustrated by the stretching experiment figure 1 where a bar of length $L_0$and cross-sectional area A is stretched by a distance ΔL by an applied force F.

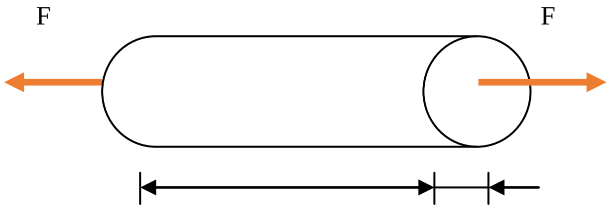


Figure 1: Illustration of Tensile Unidirectional Loading

Modulus of Elasticity

Since we say the material obeys Hook's law the stress and strain are related by the equation:

Stress = constant * Strain

Where the constant of the equation is known as the modulus of elasticity represented by:

$$E = \frac{\sigma}{\varepsilon}$$

FLEXURAL STRENGTH

Three Point Bending Test

This testing is an important part of the characterization of any material, as test results provide relevant information on how the material will behave in real terms [33]. This test conducted by using three point bending test. It is specifically for composite materials, which are often used in aerospace and automotive industries, also for energy applications, where it is important to understand how much you have to bend the material and maintain its strength. The objectives of flexural test are to determine the maximum stress.

Mechanical Characteristics of Fiber Composites

The mechanical properties of composites are of great importance. Since these properties affects the behavior of the components hence prediction of these values and their effect on geometry is to be known before design.

Mechanical Testing Results:

Mechanical properties like tensile strength (TS), Flexural strength (FS) are obtained by standard tests. Tensile and flexural properties developed by using UTM (Universal Testing machine). The tensile properties of fiber-resin composites is obtained as per the ASTM standard test method D 303976 for Tensile Strength [35]. The result obtained in various literatures is given below:

Mechanical Property	Coconut Fiber
Density	1.2 g/cm^3
Elongation	30 %
Tensile Stregth	175-250 MPa
Youngs Modulus	3.7-4.3 G Pa

Table 3.1: Properties of Coir Fiber [3,4]

Mechanical Property	Epoxy resins
Density	1.1 g/cm^3
Tensile Stregth	150 – 750 MPa
Youngs Modulus	3.7-50 G Pa

Table 3.2: Properties of Epoxy resin [3,4]

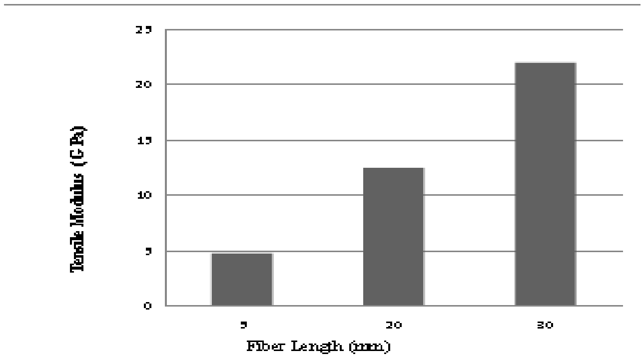


Fig 3.5: Tensile modulus of Composite (34)

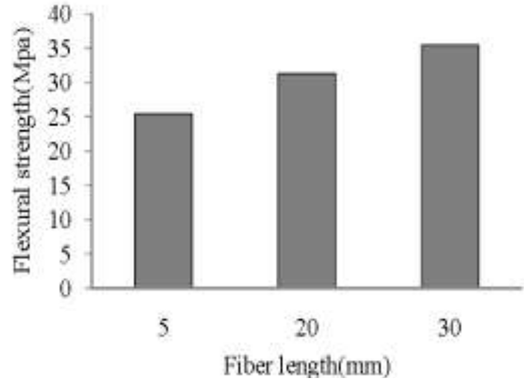


Fig 3.6: Flexural strength of Composite(34)

MODELING OF COMPOSITE

FEM Analysis of Composites:

The finite element simulation was done by finite element analysis package ANSYS .
ANSYS software solves for the combined effects of multiple forces, accurately modeling combined behaviors resulting from "metaphysics interaction"[40].

Procedure in modeling ANSYS

There are major and sub important steps in ANSYS model,

1. Preprocessing
2. Solution stage
3. Post processing.

Requirement specification: Firstly it is required to give preference for what type analysis you want to do, here we are analyzing for beam so given here structural part as Shown in fig.

Preprocessor: Now next step is preprocessor, where the preprocessor menu basically used to inputs the entire requirement thing for analysis such as- element type, real constraints, material properties, modeling, meshing, and loads. Element menu contains – defined element type and degree of freedom defined where we have to give the element structure type such as BEAM, SOLID, SHELL, and the degree of freedom, After the completion of this stage now meshing menu is introduced to mesh the problemThe step to follow the mesh is given as-

1. Meshing Attributes
2. Meshing
3. Mesh tool
4. Mesh the volume
5. Then apply meshing

The next step is to define the boundary condition by the help of define load menu, here in this analysis we defined the different boundary condition for different problems.First of all we define the type of analysis in particular physics whether Static modal etc.Then the load types are applied on object with respective boundary conditions.

Solution stage:
Now in this menu solution stage we have to introduce the analysis type means static analysis, harmonic analysis, modal analysis etc. After that the next step is to solve the analysis or problems by the help of solve menu.

Post processing: This menu is helpful to find the output of the problems. Such as:

1. Result summery
2. Plot results
3. List results

RESULTS

This chapter presents the mechanical properties of the Natural fiber reinforced epoxy composites prepared for this present investigation. Details of processing of these composites and the tests conducted on them have been described in the previous chapter. The results of various characterization tests are reported here. This includes evaluation of strength, flexural strength, has been studied and discussed. The interpretation of the results and the comparison among various composite samples are also presented.

Mechanical Characteristics of Composites

The characterization of the composites reveals that the fiber length is having significant effect on the mechanical properties of composites. The properties of the composites with different fiber lengths under this investigation are presented in Tables below.

Tensile Properties of Component

S.No.	Fiber Length mm	Tensile Modulus - 10% VF	Tensile Modulus - 30% VF	Tensile Modulus - 50% VF	Tensile Modulus - 70% VF
1	5	2.75	4.15	4.54	4.1
2	7.5	4.67	6.75	7.15	6.28
3	10	5.64	8.65	9.65	9.54
4	12.5	6.32	11.6	12	10.65
5	15	8.97	13.8	15.7	14.38
6	17.5	10.56	14.2	18	16.65
7	20	11.75	15.4	22	20.18

Table: Tensile Modulus for various Volume Fraction of Composite

Bending Modulus of Fiber Reinforced Composite

S.No.	Fiber Volume Fraction	Flexural Strength -10 mm	Flexural Strength -20 mm	Flexural Strength -30 mm
1	10	18.45	22.45	24.67
2	20	23.59	25.65	29.76
3	30	26.34	28.57	35.68
4	40	30.39	34.64	42.87

Table : Bending strength for Variable Length in (MPa)

International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 3 Issue 4, April-2014, pp: (465-470), Impact Factor: 1.252, Available online at: www.erpublications.com.

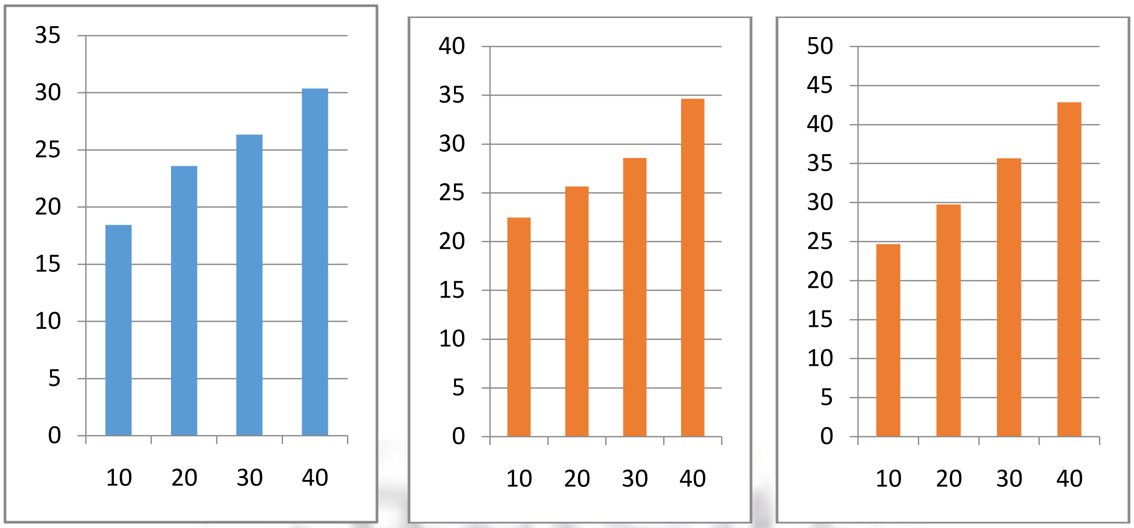
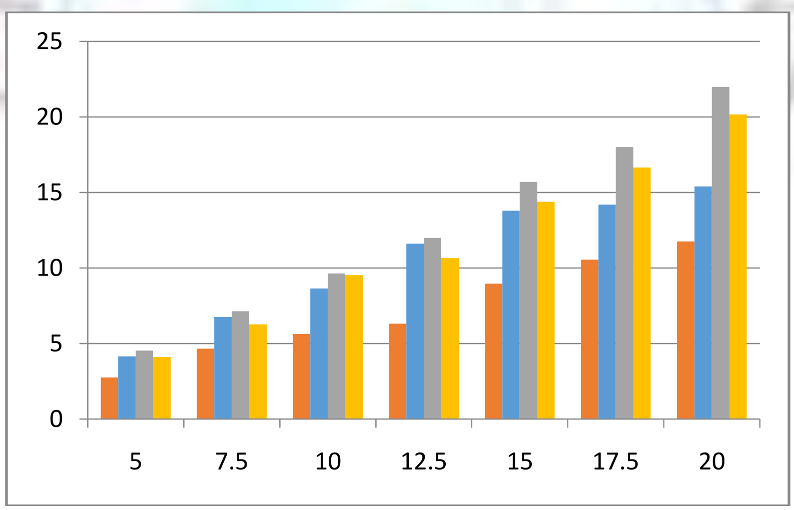


Fig: Bending strength for 10, 20 &30 mm Length

CONCLUSION

This experimental investigation of mechanical behavior of Coconut Fiber reinforced epoxy composites leads to the following conclusions: The fiber length has a positive impact on the strength of composites the higher the length the better the tensile strength.



The Effect of Fiber length on Tensile strength for Different Volume Fraction. The fiber volume effect has been trend of increase values. It has been noticed that, flexural strength, is also greatly influenced by the fiber lengths.

References

[1]. **"History of Composites",**http://nptel.iitm.ac.in/courses/101104010/lecture1/1_3.htm
[2]. Chauhan,A., Priyanka Chauhan,P., Kaith,B. "Natural Fiber Reinforced Composite: A Concise Review Article"Chemical Engineering & Process Technology,Volume 3(2),2011.
[3]. Krishnamoorti R, Vaia R "Polymer Composites: Synthesis Characterization and Modeling". American Chemical Society Symposium Series 804, Washington DC. (2002).

[4]. Stephen C. Myers1, "Renewable Polymers and Advanced Materials", Ohio BioProducts Innovation Center Columbus, OH,(2005).
[5]. Nguong, C.W, Lee, S.N.B., and Sujan,D." A Review on Natural Fibre Reinforced Polymer Composites" World Academy of Science, Engineering and Technology, Vol 73,(2013).
[6]. Miller, S.A.,Lepech,M.D., and Billington,S.L.,"Mechanical and Environmental Characterization of Biobased Composites",Stanford University,Report 179 (2013).
[7]. Joshi S.V., Drzal, L.T., Mohanty, A.K., Arora, S."Are natural fiber composites environmentally superior to glass fiber reinforced composites?",Composites: Part A 35 371–376, (2004).
[8]. A.K.Mohanty, Manjushri Mishra, L.T.Darzel,"Natural Fibers Bio Polymers and Bio composites", CRCPress (2006)
[9]. Malkapuram, R., Kumar, V. and Negi, Y.S."Recent Development in Natural Fiber Reinforced Polypropylene Composites",Journal of Reinforced Plastics and Composites, 28; 1169(2009).
[10]. Westman,M.P.,Laddha,S.G.,Fifield,L.S., Kafentzis,T.A.,Simmons,K.L.,"Natural Fiber Composites: A Review",Pacific northwest national laboratory,USA.(2010)
[11]. Rowell, R.M., Han, J.S. & Rowell, J.S. Characterization and Factors Effecting Fiber Properties. Natural Polymers and Agro fibers composite (2010).
[12]. Verma, D., Gope, P.C., Maheshwari, M.K., Sharma, R.K.,"Coir Fibre Reinforcement and Application in Polymer Composites",Journalof Material & Environment Science Vol 4 (2) 263-276, (2013).
[13]. Narendra, R. & Yigi, Y. Biofibers from Agricultural Byproducts for Industrial Applications. Trends in Biotechnology Vol. 23, (2005).
[14]. "Mechanical Property Evolution of coconut Fiber". A thesis by Waifielate,A.A., Abiola, B.O.,Deptt of ME,Blekinge Institute of Technology,SWEDEN,(2008).
[15]. Muthuvel,M.,Ranganath,G.,Janarthanan,K.,K. Srinivasan,K. " Characterization Study Of Jute And Glass Fiber Reinforced Hybrid Composite Material" International Journal of Engineering Research & Technology , Vol. 2 Issue 4, (2013).
[16]. Harisha,S., Michael,D.P, Bensely,A., Lal,A.D., Rajadurai,A."Mechanical property evaluation of natural fiber coir composite", Material Characterization, 60, 44-49,(2009).
[17]. Hill, C., Hughes, M.," Natural Fiber Reinforced Composites Opportunities and Challenges", Journal ofBiobased Materials and Bioenergy Vol. 4, 148–158, (2010).
[18]. Ku, H., Wang, H., Pattarachaiyakoop,N. and Trada,M.,"A review on the tensile properties of natural fiber reinforced polymer composites", Engineered Fiber Composites (2012).
[19]. Ramesh M., Palanikumar,K., Reddy,K.H ,"Mechanical property evaluation of sisal–jute–glass fiber reinforced polyester composites", Composites: Part B 48 1–9(2013).
[20]. Wambua,P., Ivens,J., Verpoest,I.,"Natural fibers: can they replace glass in fiber reinforced plastics", Composites Science and Technology 63 1259–1264(2003).
[21]. Singha,A.S., Thakur,V.K. "Mechanical properties of natural fiber reinforced polymer composites".Bulletin of Material Science, Vol. 31, No. 5, pp. 791–799, (2008).
[22]. Ferreira, J.A.M, Capela1,C., and Costa,J.D," A Study of the Mechanical Properties of Natural FiberReinforced Composites", Fibers and Polymers, Vol.11, No.8, 1181-1186,(2010).
[23]. Burguen,R.,Quagliata,M.J.,Mohanty,A.K., Mehta,G.,Drzal,L.T., Misrae,M., "Load-bearing natural fiber composite cellular beams and panels",Composites: Part A 35 645–656, (2004).
[24]. Malkapuram, R., Kumar, V. and Yuvraj, S .N., "Recent Development in Natural Fiber Reinforced Polypropylene Composites", Journal of Reinforced Plastics and Composites, , Vol. 28, pp. 1169-1189.(2008)
[25]. Sahari,J., Sapuan,S.M. "Natural fiber reinforced biodegradable polymer composites".