MECHANICAL BEHAVIOUR OF JUTE-GLASS FIBER REINFORCED HYBRID COMPOSITES

A Project Report Submitted To Jawaharlal Nehru Technological University
In Partial Fulfillment of Requirements for the Award of the Degree of

BACHELOR OF TECHNOLOGY
IN
MECHANICAL ENGINEERING

Submitted by

KORIVI RANGA NANDA KISHORE (09501A0323)

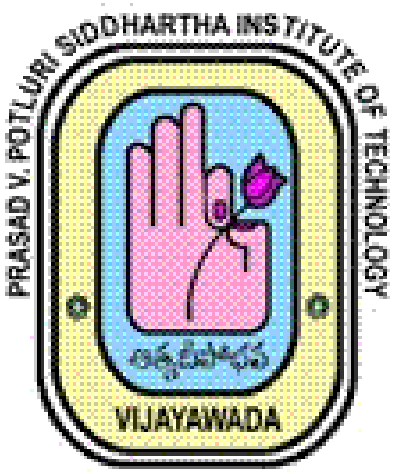
CHIPPALASESHI KOTESH (09501A0308) **KANNEGANTIGOWTHAM (09501A0320)**

CHUKKAPALLI VINAY KUMAR (09501A0305)

Under The Esteemed Guidance Of

P . RAVI KUMAR$_{\textbf{M.tech}}$

ASSISTANT PROFESSOR
DEPARTMENT OF MECHANICAL ENGINEERING
PVPSIT, KANURU



DEPARTMENT OF MECHANICAL ENGINEERING

PRASAD.V.POTLURI SIDDHARTHA INSTITUTE OF TECHNOLOGY
(Accredited by NBA, an ISO 9001-2000 CERTIFIED INSTITUTION)
Affiliated to JNTU, Kakinada, Approved by AICTE, New Delhi
Kanuru, Vijayawada-520007
2009-2013

PRASAD.V.POTLURI SIDDHARTHA INSTITUTE OF TECHNOLOGY

(Accredited by NBA, an ISO 9001-2000 CERTIFIED INSTITUTION)

DEPARTMENT OF MECHANICAL ENGINEERING

CERTIFICATE

This is to certify that the project work titled **"MECHANICAL BEHAVIOUR OF JUTE-GLASS FIBER REINFORCED HYBRID COMPOSITES"** is a bonafide work done by

KORIVI RANGA NANDA KISHORE (09501A0323)

CHIPPALASESHI KOTESH (09501A0308) **KANNEGANTIGOWTHAM (09501A0320)**

CHUKKAPALLI VINAY KUMAR (09501A0305)

Submitted in partial fulfillment of requirement for the award of degree of Bachelor of Technology in Mechanical Engineering during the year 2009 - 2013 by Jawaharlal Nehru Technological University.

P . RAVI KUMAR$_{\text{M.tech}}$
ASSISTANT PROFESSOR, Project Guide
Department Of Mechanical Engineering
PVPSIT, KANURU

Dr. K. SIVAJI BABU$_{\text{P.hD}}$
HEAD OF THE DEPARTMENT
Department Of Mechanical Engineering
PVPSIT, KANURU

ACKNOWLEDGEMENT

The satisfaction that accompanies the successful completion of any task would be incomplete without a mentioning the people, who made it possible and whose guidance and encouragement crown all the efforts with success.

We wish to place on record our profound gratitude to $Dr.P.Venkateswarlu_{P.hD}$, **Principal, PVPSIT, Kanuru, Vijayawada** for having given us the opportunity to complete this project successfully.

We reckon to a distant pleasure to endorse out indebtedness and deep sense of gratitude to $Dr.K.SIVAJI\ BABU_{P.hD}$, **Head Of Department Of Mechanical Engineering** for his encouragement in all endeavors.

We are greatly indebted to our project guide Sri. $P\ .RAVI\ KUMAR_{M.tech}$, **Assistant Professor, DEPARTMENT OF MECHANICAL ENGINEERING** for his patience and cheerful readiness to help us in our project. We thank him for the support, encouragement, suggestions and co-operation during the course of the project.

We are also very much grateful to all the staff and faculty of the Department Of Mechanical Engineering for their cooperation during the course of this project work. Finally, we would like express our sincere thanks to **Assistant Professor M. Mounika** for her helpful advices and constructive criticism during the course of this project work.

By

KORIVI RANGA NANDA KISHORE (09501A0323)

CHIPPALA SESHI KOTESH (09501A0308)

KANNEGANTI GOWTHAM (09501A0320)

CHUKKAPALLI VINAY KUMAR (09501A0305)

ABSTRACT

Fiber reinforced polymer composites have a wide variety of applications as a class of structural materials because of their advantages such as ease of fabrication, relatively low cost of production & superior strength as compared to neat polymer resins. The fiber which serves as a reinforcement in polymers may be either synthetic or natural. Although, synthetic fibers such as glass, carbon etc. possess high specific strength; their fields of applications are limited because of their higher costs of production.

Recently, there is an increasing interest in hybrid composites that are made by reinforcement of two or more different types of fibers in a single matrix, because these materials attain a range of properties that cannot be obtained with a particular kind of reinforcement. Further, material costs can be reduced by careful selection of reinforcing fibers. Currently, the trend is to produce hybrids of synthetic and natural fibers because this type of reinforcement in composites optimizes the production coast compared to those of synthetic fibers and also increases the structural properties of the composites compared to those of natural composites.

In this connection to this, an investigation has been carried out to make potential utilization of JUTE fiber as reinforcement with GLASS fiber in polyester polymer matrix which is very cheap and is easily available in India. The objective of the present research work is to study the effect of mechanical properties of jute and glass fiber composites individually by varying the volume fraction of fiber in the composites and compare them to the respective hybrids produced by varying the volume fraction of both fibers in the same matrix. The matrix used for current investigation is general purpose polyester resin. The specimens have been fabricated by hand-layup technique with different volume fraction of jute and glass fiber. Theoretically mechanical properties are predicted by rule of hybrid mixture model, using the resin and fiber properties together with their respective volume fraction and compared with the experimental results. Simulation is done using ANSYS software for tensile modulus to compare and conclude about the results obtained by the other methods.

CONTENTS

Chapter No:	Description	Page No
Chapter 1	**INTRODUCTION**	**1- 20**
	1.1 Introduction to Composites	2
	1.2 Types of Fibers	7
	1.3 Hybrid Composites	13
	1.4 Advantages of Composites	13
	1.5 Introduction to ANSYS	16
	1.6 Thesis Outline	19
Chapter 2	**LITERATURE SURVEY**	**21-23**
	2.1. Literature review	22
	2.2. The knowledge gap	22
	2.3. Objectives of the present research work	23
	2.4. Outline of research work	23
Chapter 3	**METHODS AND MEANS**	**24-41**
	3.1 Method for Theoretical Evaluation of Mechanical Properties for Composites	25
	3.2 Method for Evaluation of Actual Mechanical Properties for Composites	30
	3.3 Method for Evaluation of Tensile Modulus for Composites through Simulation	40
Chapter 4	**RESULTS AND DISCUSSION**	**42-68**
	4.1. Behavior of Composites under Flexural Loading	43
	4.2. Behavior of Composites under Impact Loading	49
	4.3. Behavior of Composites under Tensile Loading	54
	4.4. Behavior of Composites under In-Plane Shear Loading	66

Chapter 5	**CONCLUSIONS**	**69- 74**
	5.1 Conclusions Based on Behavior of Composites under Flexural Loading and Impact Loading	70
	5.2 Conclusions based on behavior of composites under tensile loading	71
	5.3 Conclusions based on behavior of composites under Shear loading	73
	5.4 Scope for Future Work	74
	REFERENCES	**75**

LIST OF TABLES

Table No.	Name	Page No.
1.1	Chemical Composition of Natural Fibers	10
1.2	Properties of Natural Fibers	12
3.1	List of Formulas for Theoretical Evaluation of Mechanical Behavior of Composites	30
3.2	Test sample dimensions with respect to type of test	34
3.3	Test sample composition in volume fraction	34
4.1	Loads and Corresponding Deflection obtained in Experimentation Process for Three-Point Bending Test	43
4.2	Stress, Strain and Young's Modulus obtained in Experimentation Process for Three-Point Bending Test	44
4.3	Energy Absorbed and Impact Strength obtained in Experimentation Process (Izod impact testing)	49
4.4	Young's modulus (E_1) and Poisson's ratio (ϑ_{12}) in direction obtained by rules of mixture	54
4.5	Young's modulus (E_2) and Poisson's ratio (ϑ_{21}) in transverse direction obtained by rules of mixture	55
4.6	Ultimate load in Newton's and elongation	56
4.7	Stress, Strain and Young's modulus in longitudinal direction obtained by experimentation	56
4.8	Young's modulus in longitudinal direction obtained by simulation	57
4.9	Shear Module's (G_{12}) calculated using rules of mixture	66

LIST OF FIGURES

Figure No.	Name	Page No.
1.1	Different types of Composites materials	7
1.2	Classification of Natural Fibers	11
3.1	Isostress and Isostrain Condition for Simple Unidirectional Composite	27
3.2.1	Simple parallel model of unidirectional composite	27
3.2.2	Simple series model of unidirectional composite	27
3.3	Definition shear relative to the X_1, X_2Cartesian axis	29
3.4	Raw jute	33
3.5	Glass Tape	33
3.6	Refined fibers ready to use	33
3.7	Tensile Test Samples	35
3.8	Flexural Test Samples	36
3.9	Impact Test samples	36
3.10	Tensile Testing Machines in Unloaded Condition	38
3.11	Tensile Testing Machine Performing Flexural Test	39
3.12	Izod Impact Testing Machine	39
3.13	Solid95 Element	40
3.14	Sample modeling of tensile samples in ANSYS	41
3.15	Sample Analysis of Tensile Sample	41
4.1	Variation of the Flexural Modulus in Different Samples Obtained By Experimentation (Three-Point-Bending Test)	45
4.2	Variation of the Flexural Modulus of Composite obtained by Experimentation (Three-Point Bending Test) in Hybrids with Respect to Pure Samples.	47

Figure No.	Name	Page No.
4.3	Variation of the Flexural Modulus by varying the jute content in the pure matrix of Composite Obtained by Experimentation (three-point bending test)	48
4.4	Variation of the Flexural Modulus by Varying the Glass Content in the Pure Matrix of Composite Obtained By Experimentation (Three-Point-Bending Test)	48
4.5	Variation of the Energy Absorbed in Joules by Different Samples obtained by Experimentation (Izod impact testing)	50
4.6	Variation of the Impact strength in $^{joules}/_{mm^2}$ by Different Samples Obtained experimentation (Izod impact testing)	50
4.7	Variation of the Impact Strength of Composite obtained by Experimentation (Izod Impact testing) in Hybrids with Respect to Pure Samples	51
4.8	Variation of the Impact Strength by varying the jute content in the pure matrix of Composite Obtained by Experimentation (Izod Impact Strength test)	52
4.9	Variation of the Impact Strength by varying the Glass content in the pure matrix of Composite Obtained by Experimentation (Izod Impact Strength test)	53
4.10	Young's Modulus (E_1) of Composite Obtained by Rules of Mixture, Ansys and Experimentation	58
4.11	Variation of Poisson's ratio (ϑ_{12}) in longitudinal direction	59
4.12	Variation of Poisson's ratio (ϑ_{21}) in Transverse direction	59
4.13	Variation of the Young's Modulus (E_1) of Composite Obtained by Rules of Mixture, Ansys and Experimentation in Hybrids With Respect to Pure Samples	61

Figure No.	Name	Page No.
4.14	Variation of the Young's Modulus (E_1) by varying the jute content in the pure matrix of Composite Obtained by Rule of Mixture, Ansys and Experimentation.	62
4.15	Variation of the Young's Modulus (E_1) by varying the glass content in the pure matrix of Composite Obtained by Rule of Mixture, ANSYS and Experimentation.	63
4.16	Variation of the Poisson's ratio (ϑ_{12}) of hybrid Composite Obtained by rule of Mixture with respect pure sample of glass and jute.	64
4.17	Variation of the Poisson's ratio (ϑ_{21}) of hybrid Composite Obtained by rule of Mixture with respect pure sample of glass and jute.	64
4.18	Variation of the Poisson's ratio (ϑ_{12}) by variation of jute content in the pure matrix Obtained by Rules of Mixture.	65
4.19	Variation of the Poisson's ratio (ϑ_{21}) by variation of jute content in the pure matrix Obtained by Rules of Mixture.	66
4.20	Variation of the Shear modulus (G_{12}) by variation of fiber content in pure matrix Obtained by Rules of Mixture.	67
4.21	Variation of the Shear Modulus (G_{12}) In Hybrids with Respect to the Pure Samples obtained by Rules of Mixture.	68

LIST OF SYMBOLS

V_f	Volume fraction of fiber
V_m	Volume fraction of matrix
E_1	Young's modulus in longitudinal direction
E_t	Young's modulus in transverse direction
ϑ_{12}	Major Poisson ratio (relating to the lateral strain, ε_2 when a stress is applied in the longitudinal (X_1) direction)
ϑ_{21}	Minor Poisson ratio (relating to the strain in the (X_1) direction when a stress is applied in the (X_2) direction)
G_{12}	In-plane shear modulus