

FIBER WEIGHT PERCENTAGE ON TAMARIND INDICA NATURAL FIBER COMPOSITE

Submitted in partial fulfilment of the requirements for the award of Bachelor of
Engineering degree in B.E Mechanical Engineering

By

AJAINATH R.E (38150006)

JENO R (38150043)



DEPARTMENT OF MECHANICAL ENGINEERING
SCHOOL OF MECHANICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

ACCREDITED WITH GRADE "A" BY NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600 119.

MAY - 2022



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE

www.sathyabama.ac.in

DEPARTMENT OF MECHANICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **AJAINATH R.E (38150006)** and **JENO R (38150043)** who carried out the project entitled "FIBER WEIGHT PERCENTAGE ON TAMARIND INDICA NATURAL FIBER COMPOSITE" under my supervision from **August 21 to March 22**.

Internal Guide

Dr. R. SIVA, M.E, Ph.D.,

Head of the Department

Dr. G. ARUNKUMAR, M.E, Ph.D.,

Submitted for Viva voce Examination held on _____

Internal Examiner

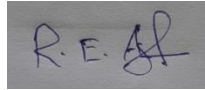
External Examiner

DECLARATION

We, **AJAINATH R.E. (38150006)** and **JENO R (3815000)** hereby declare that the project Report entitled “**FIBER WEIGHT PERCENTAGE ON TAMARIND INDICA NATURAL FIBER COMPOSITE**” done by us under the guidance of **Dr. R. SIVA, M.E, Ph.D.**, at Sathyabama Institute of Science and Technology, Jeppiaar nagar, Chennai — 600 119 is submitted in partial fulfilment of the requirement for the award Bachelor of Engineering degree in Mechanical Engineering.

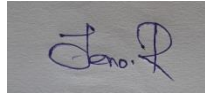
DATE: 21/04/2022

1.



PLACE: CHENNAI

2.



SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

We are pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our sincere thanks to **Dr. S. PRAKASH, M.E, Ph.D.**, Dean, School of Mechanical Engineering and **Dr. G. ARUN KUMAR, M.E, Ph.D.**, Head of the Department, Department of Mechanical Engineering for providing us necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our project guide **Dr. R. SIVA, M.E, Ph.D.**, for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

We wish to express our thanks to all Teaching and Non-teaching staff members of the Department, parents and friends of who were helpful in many ways for the completion of the project.

ABSTRACT

In the worldwide landscape, there has been a recent growth in the use of environmentally benign natural fibres as reinforcement for the fabrication of low-cost, light-weight polymer composites. Natural fibres provide a number of advantages, including cost efficiency, abrasion resistance, safety, low weight, nonflammability, biodegradability, and environmental friendliness. Physical, biological, chemical, and mechanical approaches can all be used to change them. High specific mechano-physicochemical characteristics are one of these composites' key advantages. Because of their exceptional mechanical qualities, Aloe tamarind fiber-based FRPs are gaining popularity in both the industrial and academic arenas. Tamarind fibre is a natural fibre that is used to strengthen polymer matrixes. Tamarind has been discovered to be a valuable fibre source for composites & industrial uses. The goal of hybridization is to acquire the synergistic effects on fibre reinforcement qualities upon this overall properties of the composites. Natural Tamarind fibres are used to fabricate composites in this project, and the mechanical properties of composites made of different volume ratios of Tamarind fibre are tested to determine their tensile, impact, and flexural properties, with the outcomes from laboratory testing to be manually analysed.

TABLE OF CONTENTS

CHAPTER NO.	CONTENTS	PAGE NO.
	ABSTRACT	v
	LIST OF FIGURES	vi
	LIST OF TABLES	xiii
1	INTRODUCTION	1
2	LITERATURE STUDY AND METHODOLOGY	3
	2.1 LITERATURE STUDY	3
	2.2 METHODOLOGY	9
3	OBJECTIVE AND SCOPE	10
	3.1 OBJECTIVE	10
	3.2 SCOPE	10
4	MATERIALS AND METHODS	12
	4.1 MATERIALS USED	12
	4.2 EXPERIMENTAL PROCEDURE	21
5	RESULTS	24
	5.1 TENSILE TEST	24
	5.2 FLEXURAL TEST	36
	5.3 IMPACT TEST	47

6	CONCLUSION	50
	REFERENCE	51

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
2.1	Methodology of project	9
4.1.a	Tamarind fruit fiber	12
4.1.b	Extracted fruit fiber	12
4.2.a	Extracted Tamarind seed husk	13
4.2.b	Tamarind seed husk powder	13
4.3	Epoxy resin (LY 556)	14
4.4	Hardener(HY 951)	15
4.5	Polyacrylic sheet	16
4.6	Sheenwax	17
4.7	Plywood	17
4.8	Beadings	18
4.9	Beakers	18
4.10	Stirrers	19
4.11	Gruadated cyclinder	20
4.12	Weighing scale	20
4.13.a	Mold front view	21
4.13.b	Mold side view	21

FIGURE NO.	TITLE	PAGE NO.
4.14	Resin mixing	21
4.15	Composite plate making	22
4.16	Composite plates	23
4.17	Composite plate measured	23
5.1	Measurement for tensile specimen	24
5.2	Tensile test apparatus	25
5.3	Tensile test samples	25
5.4	composite plate 1, sample 1	26
5.5	composite plate 1, sample 2	26
5.6	composite plate 2, sample 1	27
5.7	composite plate 2, sample 2	27
5.8	composite plate 3, sample 1	28
5.9	composite plate 3, sample 2	28
5.10	composite plate 4, sample 1	29
5.11	composite plate 4, sample 2	29
5.12	composite plate 5, sample 1	30
5.13	composite plate 5, sample 2	30

FIGURE NO	TITLE	PAGE NO
5.14	composite plate 6, sample 1	31
5.15	composite plate 6, sample 2	31
5.16	composite plate 7, sample 1	32
5.17	composite plate 7, sample 2	32
5.18	composite plate 8, sample 1	33
5.19	composite plate 8, sample 2	33
5.20	composite plate 9, sample 1	34
5.21	composite plate 9, sample 2	34
5.22	composite plate 10, sample 1	35
5.23	composite plate 10, sample 2	35
5.24	Measurement for flexural specimen	36
5.25.a	Flexural apparatus	36
5.25.b	Flexural tested specimen	36
5.26	composite plate 1, sample 1	37
5.27	composite plate 1, sample 2	37
5.28	composite plate 2, sample 1	38
5.29	composite plate 2, sample 2	38

FIGURE NO	TITLE	PAGE NO
5.30	composite plate 3, sample 1	39
5.31	composite plate 3, sample 2	39
5.32	composite plate 4, sample 1	40
5.33	composite plate 4, sample 2	40
5.34	composite plate 5, sample 1	41
5.35	composite plate 5, sample 2	41
5.36	composite plate 6, sample 1	42
5.37	composite plate 6, sample 2	42
5.38	composite plate 7, sample 1	43
5.39	composite plate 7, sample 2	43
5.40	composite plate 8, sample 1	44
5.41	composite plate 8, sample 2	44
5.42	composite plate 9, sample 1	45
5.43	composite plate 9, sample 2	45
5.44	composite plate 10, sample 1	46
5.45	composite plate 10, sample 2	46
5.46	Impact specimen measurement	47

FIGURE NO	TITLE	PAGE NO
5.47	Impact tested specimen	47
5.48	Impact test apparatus	48

LIST OF TABLES

TABLE NO	TITLE	PAGE NO
4.1	Properties of epoxy resin	14
4.2	Factors and levels of composite preparation	22
5.1	Impact test values	48

CHAPTER 1

INTRODUCTION

Tamarind may be a tropical African dicotyledonous plant that's widely cultivated in India for its delicious sour fruit pulp, which is utilised within the production of 'Indian Curries.' It belongs to the Leguminosae or Fabaceae family. The Caesaplinioideae subfamily includes tamarind tree L. it's a large range of applications. Plant with medicinal fruits and leaves that grows to a height of 25 metres. It takes 245 days from flowering to ripening for it involved fruit in its fourth year. The fruit includes six to eight seeds and is sepia in colour. It reaches a black colour and emits an odour. When the fruits are big, the hard pod shells are removed and discarded. After the seeds are removed, the fruit pulp is employed because the major ingredient. Acidulant is employed within the manufacturing of foods, spices, and other goods.

Glue is employed to stay them together. Fruit fibres with widths starting from 0.5 to 0.8 mm, also as seeds The fibres are coiled when straightened and home in length from 50 to 100 mm. tamarind (Tamarind Tree) It can live for 200 years with an annual fruit harvest of 150-500 kg per tree. A rough estimate of annual output is 3,00,000 tonnes of tamarind fruit. Before using these wasted natural fruit fibres from agricultural enterprises as reinforcement for polymer composites, they need to be thoroughly characterised. This study looks at the physicochemical, mechanical, and thermal properties of TFF. The pulp of a tamarind pod makes up 55%, the seed 34%, and therefore the shell and fibre structure 11%. Each tamarind pod includes 1–10 irregularly shaped seeds with test a (seed coat) and kernel (endosperm). Tamarind seeds are divided into two parts: testa (20–30 percent dry mass) and kernel (70–75 percent dry mass). Tamarind Seed Polysaccharide (TSP) may be a present biocompatible and biodegradable polymer. It's created from the tamarind seed's endosperm. TSP was identified as a galactoxyloglucan composed of glucose and xylose, consistent with its categorization. 3.1:1.7:1 molar ratio [9], and galactose 3.1:1.7:1 molar ratio Nonasaccharide and octasaccharide are the 2 main components, with three minor components. Minor components include hexasaccharide, hexasaccharide, and hendesaccharide. Nonasaccharide to octasaccharide ratio is 3:2, while

heptasaccharide to nonasaccharide ratio is 1:1.2.7 percent hexasaccharide and 1.9 percent hendesaccharide.

CHAPTER 2

LITERATURE STUDY AND METHODOLOGY

2.1 LITERATURE STUDY

Mechanical properties of natural fiber reinforced epoxy composites (Shahana Prabin, Nitin Kumar Waghmare, Suraj Kumar Singh, SabahKhan, 2019)

Natural fibres have lately piqued researchers' interest as composite reinforcements due to its low cost, availability, simplicity of fabrication, and possible environmental advantages. Many research efforts are part of the project. Thermodynamic, tribological, and mechanical characteristics of materials are being improved all around the world. The mechanical characteristics of the bio - composites they created were demonstrated. Use in a variety of biological and biotechnology businesses is a possibility. The goal of this research is to learn more about composites' mechanical characteristics. Natural fibre reinforcements and a variety of mechanical characteristics determine the qualities of natural fibre composites (NFC). It also demonstrates the importance of the data. In a number of applications, natural fibres can be utilised instead of synthetic fibres.

Mechanical properties of synthetic fibers reinforced mortars (Ahsan Habib and Mohammed Mydulalam, 2013)

The effect of synthetic fibers (glass, nylon, polypropylene fibers) on the mechanical properties of mortar (1: 1.5 cement: sand mixture) was investigated. Fiber is added to the mortar. The strength of mortar composite materials other than glass fiber has been improved. On the other hand, tensile strength and bending strength are almost unaffected by fiber-containing materials. The strength of the mortar is increased to a limited extent by stretching the fibers. A mortar composite using nylon shows potential among the fibres . A fake partition wall with enough mechanical strength to be used as a small partitioning wall. Ceilings and other home uses are frequent in disadvantaged communities. This is a likely answer, as according fibre reinforced composite polymer.

On the graphene nanoplatelets reinforcement of hand lay-up glass fabric/epoxy laminated composites (G.V.Seretis, G.Kouziolos, D.E.Manolokas, C.G.Provatadis 2017)

The bending and tensile properties of hand-laminated glass cloth / epoxy laminated composites were studied after strengthening the matrix using pre-dried graphite nanoplates (GNPs) at levels of up to 30 wt%. A composite sample was tested using a twill 22 and Eglass one-way fabric. The reaction of the resulting nanocomposite is explained by the mode of deposition of the entire GNP on the surface of the glass fiber filament, as seen with a scanning electron microscope. As the amount of GNP in the filament increased, clear fracture patterns were discovered due to different sedimentation mechanisms.

Next-generation high-performance sustainable hybrid composite materials made from granite waste particles with a high silica content and jute textile fibres in epoxy resin(ATAL 2022, Ranjan Chaturvedi, Soka Pappab)

This study used granite waste particles as a filler, which were coupled with sisal fibre reinforcement to make epoxy-based hybrid green composites. Milled granite particles were studied in terms of their chemical, physical, mineralogical, and morphological features. Hand layup was used to make the composites, that were then smashed with higher jute fiber filler proportions (30, 50, and 60 wt percent) (2 and 4 layers). The effects of filler and fibres on the physical parameters (water absorption, mass swell, and density), mechanical characteristics (impact, tensile, & flexural), electrical resistivity, and thermal conductivity of composites were studied. The , tensile strength, tensile strength and flexural strength of composites made with 60percentage granite wastes filler with four layers of fibres increased by 5%,16 percent, and 148 percent, respectively. When compared to pure epoxies, it has a 150 percent higher impact resistance and heat conductivity. Moreover, despite the lower volume resistance, the composite had a very low absorption rate (0.1%) and a slight increase in density with preserving electrical insulation. Mineral waste & natural fibres are commonly used in construction & building materials because they are low in materialised energy content, cost efficient, sustainable, and ecologically benign. This research also suggests a method for making optimal use of mineral waste, such as granite. Granite is quickly increasing, posing serious

environmental, ecological, and economic risks.

Evaluation of mechanical properties on kenaf fiber reinforced granite nano filler particulates hybrid polymer composite(T.Raja, V.Mohanavel, ATAL Dec 2021)

Natural fibers are being studied as a possible alternative to synthetic fibers in the manufacture of composite materials for automotive applications. In this work, kenaf fibers are used as reinforcements, granite powder is used as fillers, and epoxy polymers are used as matrices to manually lay up composite laminates with weight ratios of three different fibers and fillers. bottom. The mechanical properties of hybrid composites in terms of tension, bending, impact energy and hardness were studied.

The influence of particle size and weight percent of different wood dusts on the tensile strength of a glass fibre Epoxy/Saw dust composite was investigated using RSM (Shailendra singh chauhan, Nagendra kumar maurya, Shashi prakash dewariya OCT 2021)

The demand for epoxy-based fiberglass composites is constantly increasing. This study examines the effects of particle size, percent weight, and sawdust powder type on tensile strength. Samples were analyzed using the response surface methodology. The impact of the contribution of each process parameter is investigated using ANOVA. In addition, a regression model is created to predict the tensile strength of the fiberglass-epoxy / sawdust composite. Experiments in the test area showed that the model created the work. The maximum tensile strength value of 18.72 MPa was obtained using the process parameters of wood flour type rubber, 18% weight percent, and a particle size of 550.83 μm .

Tamarindus Indica L., an industrially wasted fruit fibre, has been thoroughly characterised as a possible eco-friendly bio-reinforcement for polymer composites (J.S. Binoj, R. Edwin Raj, B.S.S. Daniel SEP 2016)

The experimental results were validated and correlated with Hirsch's and Series models, and it was discovered that Hirsch's model matches the experimental results quite well. Thermal and aquatic stability. The decomposition temperature and water absorption are used to determine characteristics. Freshwater and

seawater have different qualities. The diffusion coefficient is discovered to be pseudofickian in nature. Action. The light compatibility of this material has been confirmed by scrutiny. Applications in the automotive and marine industries.

High strain rate mechanical behavior of epoxy under compressive loading: Experimental and modeling studies. (N.K.NaikParimi, JayaShankar ATAL MAY 2010)

The researchers' findings on the high strain rate behavior of epoxy LY 556 under compressive pressure are presented. A Hopkinson Compression Separation Bar (SHPB) device was used to perform the tests. The study looked at strain rates ranging from 683 to 1890 per second. When high strain rate loads are compared with static loads, compressive strength is improved. As demonstrated during the SHPB test of test pieces, the maximum force obtained from the strain gauge mounted on the generator bar is less than the maximum force obtained from the strain gauge mounted on the fault rod.

Synthesis and chemical resistance of aluminium oxide and silicon carbide (1:1) packed Bi-Directional woven E-glass fibre reinforcing epoxy polymer composites (Ragul sen, November 20, 2021)

Fiber Reinforced Polymers (FRP) composite have excellent corrosion, chemical, and abrasion resistance, as well as a reduced structural weight, thanks to their characteristics. Chemical tank, pickling & dip coating tank, underground fuel storage tank, chimneys and chimney liner, sludge washing tank and riser, petroleum transportation system and gas pipelines, laboratory equipment, & power plant manufacturing processes are just a few examples. Fiber Reinforced Polymers (FRP) composite have excellent corrosion, chemical, and abrasion resistance, as well as a reduced structural weight, thanks to their characteristics. Chemical tank, pickling & dip coating tank, underground fuel storage tank, chimneys and chimney liner, sludge washing tank and riser, petroleum transportation system and gas pipelines, laboratory equipment, & power plant manufacturing processes are just a few examples. The composite' absorption of chemical reagent (solvent and acid) increased as the number of voids and the

mass of aluminium oxide/silicon carbide increased (1:1). The composites' chemical resistance to acid (HCl, HNO₃, CH₃COOH), solvent (NaOH, Na₂CO₃), & alkalis (benzene, toluene, CCl₄) at 2% by weight for one day implies that it might be utilised to make chemical storage tanks.

Mechanical properties of Yttrium powder fillers in glass epoxy composites (SriramanN.SreehariV.M. ATAL, Feb 2022)

The application of loads will influence the mechanical characteristics of fiber-reinforced polymer composites. Experimental testing was used to explore the effect on yttrium powder as fillers in glass-epoxy composites as part of a research project. For the production of E-glass/epoxy composite panels, different amounts of Yttrium powder were initially used (0% and 5% by weight epoxy). The samples were tested for tensile strength according to ASTM 3039, and samples with 5% yttrium were found to have higher ultimate stress and percent elongation than samples without yttrium. The hardness is measured according to ASTM E9217, the sample containing 5% yttrium produces 22.7 ± 1 Hv and the sample without yttrium produces 2.39 ± 0.5 Hv. The importance of using pure yttrium powder as filler, as well as the effect of using yttrium powder as a filler, are demonstrated in this paper.

Mechanical Properties Evaluation of Pomegranate Peel Powder Filled Jute Fiber Reinforced Epoxy Composites (R.V.Saikumar, ReddyLakshmana, RaoJeeru ATAL Dec 2021)

Natural fiber polymer composites are gaining a lot of traction these days due to their cost effectiveness, renewable properties, biodegradability and outstanding mechanical properties. This study attempted to develop jute fiber epoxy composites filled with pomegranate peel powder. Hand lamination is used to create polymer composites. The removed pomegranate peel is reused and used as a filler in the mix. A 20% constant weight jute fiber reinforcement and a separate constant weight % pomegranate peel powder filler were used to generate the hybrid composites (2, 6 and 8). Impact, bending and tensile strength tests are performed on mechanical properties. When pomegranate peel powder fillers are used up to 6% by weight, impact strength, flexural strength and tensile

strength are improved, but beyond this % agglomeration is produced, resulting in reduced properties mechanics and loss of mechanical quality.

A overview of natural fibre reinforced composites from the perspectives of additive manufacturing and biodegradability (Anumoy Ganguly , Shiv Shankar ATAL Mar 2022)

Humans have used natural fibers obtained from plants, animals and minerals since the birth of civilization. These natural fibers have found new uses and functions as human requirements change. Natural fibers have been used as fillers in advanced composite materials in the 21st century due to their high specific strength, low density and biocompatibility. In an environmentally conscious and energy-intensive culture, the use of additive manufacturing is another important step towards sustainable engineering. Additive manufacturing has gained popularity as the standard of the future due to its low energy consumption, low raw material waste and the ease of manufacturing complex components. As a result, there has been a surge in interest in using additive manufacturing to create naturalfiber reinforced composites. We attempted to highlight recent advancements in the field of natural fibre reinforced composites additive manufacturing in this study. The many types of natural fibres, additive manufacturing approaches, natural fibre preprocessing, and biodegradability are all discussed in depth. Finally, we came to some conclusions and offered some research proposals.

2.2 METHODOLOGY

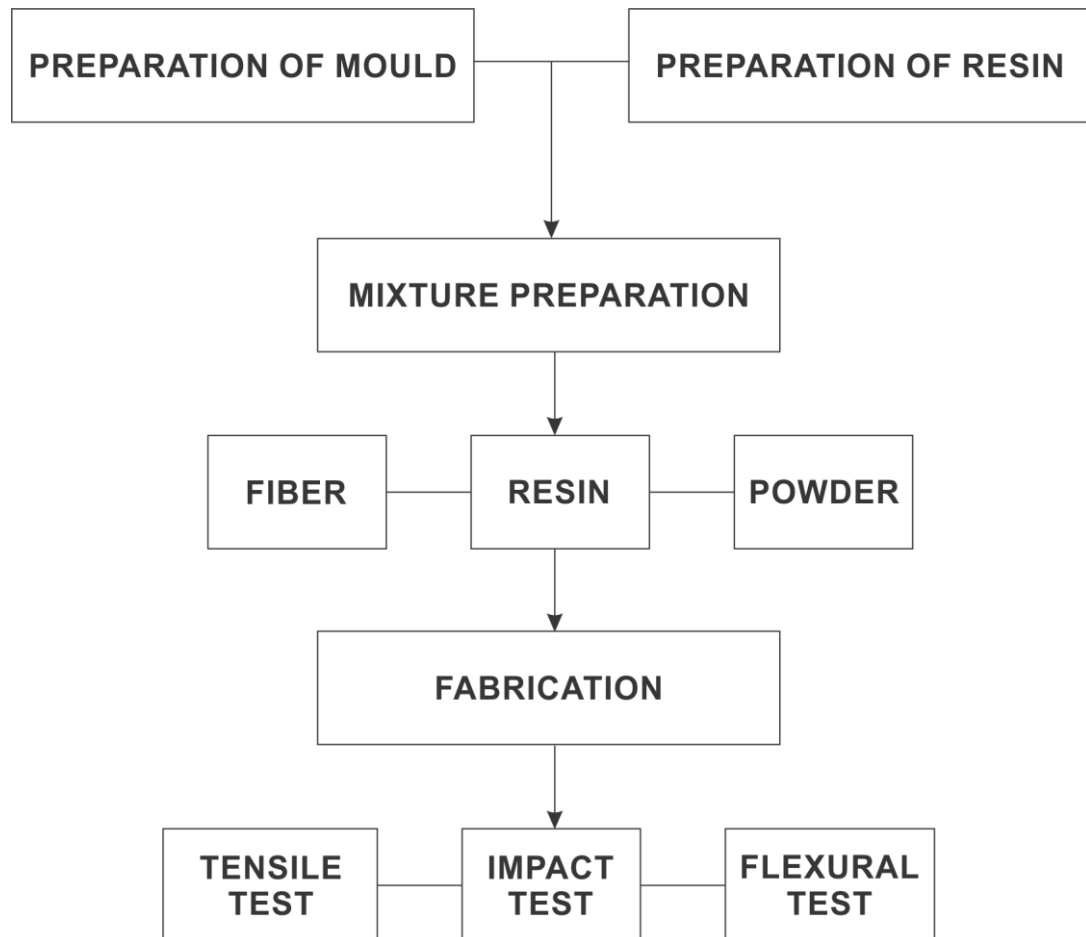


Fig:2.1 : Methodology of project

CHAPTER 3

OBJECTIVE AND SCOPE

3.1 OBJECTIVE

Building material, particle boards, insulation boards, food ingredients, cosmetics, medicines, biofilm producing agents, and fine chemicals are just a few of the applications for natural fibres. Natural fibre composite (NFCs) are composites constructed partly or entirely from sustainable and carbon-neutral materials like wood or plants. Natural fibre production, processing, and export are critical to many developing nations' economy, as well as the livelihood of millions small farmers & low-wage employees. Natural fibres are generally produced via agriculture, and the majority of them are gathered in developing nations. Natural fibres' key characteristics are efficiency, low density, non-abrasive nature, cheap cost, repeatability, biodegradability, ease of supply, and worldwide abundance. The key advantages for using FRPC are its light weight designability, varied strain behaviour, superior corrosion resistance, & low electrical conductivity (dependent on fibre composition). As a result, aircraft, automotive, medical technology, energy, and sports are among the industries with the most applications. Composites are made of two component with physical & chemical properties that differ from one another. When these elements are combined, a specialised material is created that can do a certain duty, such as becoming strong, lighter or more electrically resistant. They can also contribute to a decrease in stiffness and development of strength. Natural fibers can be found in a variety of settings. These sources include plants, animals, and minerals. Consumers are perhaps most familiar with plant and animal fibers.

3.2 SCOPE

The tensile strength of the finished product is provided by the composite fiber held in place by the matrix resin, which improves performance parameters such as

strength and stiffness while reducing weight. Boat covers, pool cladding, racing car bodies, shower enclosures, tubs, tanks, sinks and countertops of imitation granite and cultured marble are just a few examples of composite materials used in buildings, bridges and constructions. These are the ones most commonly used in non-automotive applications. Natural fibers can be used in high-tech applications such as synthetic components for cars. Natural fiber-reinforced composites have several advantages over glass-reinforced composites, including lower density, higher insulation, and less skin irritation.

CHAPTER 4

MATERIALS AND METHODS

4.1 MATERIALS USED

4.1.1 TAMARIND FRUIT FIBER – A fiber extracted from tamarind fruit. Tamarind fruit is used for cooking and sweets. Tamarind seeds are used for medicinal purposes. Tamarind fiber is an agricultural waste product. The tamarind is separated from the fruit and washed with water to remove the pulp and pulp. After washing the fiber 1 kg of fiber is soaked in water for 5 days and without chemical treatment. These processes are carried out at room temperature. Soaking water can be filtered and discarded again. After 5 days, the fiber can be manually extracted and sun-dried for 3 days. so we chose tamarind pulp and tamarind husk powder to make composite panels and did some tests on composite panels: tensile test, impact test, bending test.



Fig:4.1: a) Tamarind fruit fiber



Fig:4.1: b) Extracted fruit fiber

4.2 TAMARIND SEED HUSK POWDER – Tamarind seed powder is obtained from the seed coat of the red tamarind fruit. To get the powder, people dry the seeds in the sun for 3 days and use this method to crack the seeds, then the seed coat is manually separated from the seeds. The loose pieces are used to make powder by ball mill method.



Fig:4.2: a) Extracted Tamarind seed husk



Fig:4.2: b) Tamarind seed husk powder

4.3. EPOXY RESIN - Epoxy relates to either the essential components or the finished end products in epoxy resin, and it is a common nickname to the epoxy functional group. Epoxy resins are epoxide-containing reactive pre-polymers & polymers, commonly known as poly-epoxides. Catalytic homo polymerisation allows epoxy resins to react (cross-link) with a wide range of co-reactants, including polyfunctional amine, acid (including acid anhydride), phenol, alcohols, and thiols. These co-reactants are referred to as hardeners or curatives, whereas the cross-linking reaction is referred to as curing. Polyepoxides react with them other or with poly functional hardener to form a thermosetting polymer with excellent mechanical properties and chemical and thermal resistance. Epoxy is a kind of resin which has a wide range of uses. Epoxy is used in a variety of applications, including coating metal, electronic parts /LED, high-tension electrical insulator, paint brush manufacturing, fiber-reinforced plastic composite, and structural adhesives. Epoxy resins are low-molecular-weight pre-polymers or polymers have at two epoxide groups. . The epoxide group is also known as glycidyl or oxirane. Epoxy resins are available in a wide range of forms and sizes. Epoxy resin raw materials are mostly made from petroleum, but certain plant-based sources are also accessible commercially (for example plant derived glycerol is utilized to create epichlorohydrin). Epoxies are polymeric / semi-polymeric substances, and as a result of the polymerisation reaction's changing chain length, they are rarely encountered as pure compounds.



Fig:4.3: Epoxy resin (LY 556)

Table :4.2 PROPERTIES OF EPOXY RESIN

MECHANICAL PROPERTY	VALUE
DENSITY	1.15g/cm ³
YOUNG'S MODULUS	2.65Gpa
SHEAR MODULUS	0.98Gpa
POISSON' RATIO	0.35

4.4 HARDENER- The hardener is a chemical used in some types of mixtures. In certain cases, a hardener is employed merely to boost the tensile strength of the mixture after it has set. In other mixtures, a hardener is used as a curing component. A hardener can be a reactant or a catalyst with in chemical reaction that happens during the mixing process. A hardener is also known as an accelerator. Hardeners are almost usually necessary to make an epoxy resin useful for its intended purpose. Epoxy resins with out hardener will not have nearly as good mechanical and chemical properties as those that do. The proper sort of hardener should be used to ensure that epoxy mixture fits the application's requirements. . Conducting research is crucial. Always undertake study both on the in of the curing agent to make sure epoxy mix operates appropriately. Epoxy hardeners can be anhydride-based, amine-based, poly amide-based, aliphatic, or cyclo aliphatic. Hardeners are used to cure epoxy resins. In contrast, using a hardener to epoxy matrix may cause the resin mixture to dry too slowly. If that's the case, a different hardener may be required. It's also possible to use hardeners with specialised ingredients. These hardener chemicals function as catalysts,

allowing the cure time to be shortened.



Fig:4.4: Hardener(HY 951)

4.5 POLYACRYLIC SHEET -As a light weight material and as an option to shatterproof glass, a variety of thermoplastics are often utilised in sheet form. Crylux, Plexiglas, Acrylite, Astariglas, Lucite, Perclax, and Perspex are trade names for acrylic, and plexiglass. A similar product can be used as a molding resin, as well as in coatings and inks. Although not a common substance being glass made of silica, i.e. like any other thermoplastic, it is generally classified as any glass (due to the fact that it is a solid). crystallized glass), hence the commonly used name acrylic beaker. Chemically, it's a methyl methacrylate synthetic polymer. Although tensile strength, flexural, transparent, polishability, and UV resistance are more important than some other tests such as strength, impact, chemical resistance, and heat resistance, PMMA is a price alternative to polycarbonate (PC). PMMA is also a superior alternative for laser cutting since it does not include the potentially hazardous bisphenolA monomers present in polycarbonate. Due to its mild character, simplicity of transport & handling, cost effectiveness, it is a popular option. Unmodified PMMA is brittle under load, particularly under pressure, and is more prone to scratches than conventional inorganic glass, but modified PMMA may achieve good impact resistance, scratch resistance, and impact resistance under specific conditions.



Fig:4.5: Polyacrylic sheet

4.6 COATING WAX- At room temperature, waxes form a large group of organic substances that are lipophilic and plastic solids. Low viscosity liquid forms when higher alkanes and lipids melt at temperatures above 0 °C (10°F). Waxes are water insoluble yet solubility in non-polar organic solvents. Plants and animals produce natural waxes, which are present in petroleum. Despite the presence of esters in many natural waxes²³, paraffin waxes are hydrocarbons, which are alkanes of constant chain length. These materials make up a significant percentage of the oil used. Vacuum distillation is used to purify them. Paraffin wax is made up of saturated n- & naphthene-substituted aromatic compounds, as well as alkyl- & naphthene-substituted aromatic compounds. Hentriacontan, $C_{31}H_{64}$, is an example of a hydrocarbon with the general formula C_nH_{2n+2} . Give the standard chemical composition of alkane paraffin waxes. The number of branches has a significant effect on the qualities. Microcrystalline waxes are gasoline waxes that include more isoparaffinic (branched) & naphthenic hydrocarbons than some other waxes. Each year, millions of tonnes of paraffin are produced. They're found in chewing gum & cheese wrappers, as well as candles and cosmetics, as well as non-stick & waterproof coatings.



Fig:4.6: Sheenwax

4.7 PLYWOOD AND BEADINGS- Plywood consists of thin layers of wood veneer called "plies" that are bonded together by the wood grains of adjacent layers aligned 90 degrees to each other. These engineered woods belong to the same class of medium density fiberboard (MDF) and chipboard (chipboard). To uncover a composite, all plastics bond plywood and wood fiber boards (long, strong, and thin cellulose cells). Another way of interleaving with many advantages is called CrossGraining. This reduces the wood's tendency to break when nailing to the edges; It also allows the panel strength to remain constant in all directions, reducing expansion and contraction and improving dimensional stability. Most panels are balanced by having an odd number of stacks, which also helps prevent warping. Because it is bonded by overlapping grains and The plywood has a high rigidity perpendicular towards grain direction of surface layer because it is made up of an odd number of pieces.



Fig:4.7: Plywood



Fig:4.8: Beadings

In the wood working process, beading is a decorative treatment applied to various wooden furniture, boxes and other objects. Bead is a round shape that is cut into a square edge to soften and prevent the edge from splitting. Nuts come in many shapes and patterns, from simple circles to more complex ones. A power router, a special hand-held plane for molding, or scratch paper can all be used to make beads. The beads are usually etched into the rim of the thing on which they are placed. On the other hand, beads lying on top of beads are usually cut into a separate piece and then fixed in place.

4.8 BEAKERS AND STIRRERS- A beaker is a flat-bottomed cylindrical container used in scientific instruments. As shown in the picture, the small spout makes it easy to pour. Cups vary in size, from one milliliter to several liters. The beaked cup differs from the flask in that it has straight sides rather than inclined faces. The slightly tapered beaker known as the Philips cup is an exception to this rule. In ordinary glasses, the shape of the cup is comparable. Speakers are usually made of glass (mostly borosilicate glass today), but they can also be metal (such as stainless steel or aluminum) or plastic (including polyethylene, polypropylene, PTFE). Gamma spectral analysis of liquid and solid samples is a common application for polypropylene cups.



Fig:4.9: Beakers

A glass stirrer is a laboratory instrument used to mix chemicals. It is also known as a glass rod, a stirrer or a stirrer. They are usually made of sturdy glass and have rounded ends. They are about the thickness of a straw and a little more. The stirring rod is usually made of borosilicate glass (also known as Pyrex) or polypropylene plastic. They are usually 10 to 0 cm long with a diameter of about half a centimeter. Glass rods are made by cutting a thin length of glass into smaller pieces. To avoid damage to the surface of the glassware in use, the ends are usually rounded (for example, by flame polishing), which can lead to cracking if the glassware is subsequently damaged. heated. Other designs may be available, such as a flat impeller to circulate the sediment, a triangular impeller resembling a rubber cop, or a round stopper for grinding particles.



Fig:4.10: Stirrers

4.9 GRADUATED CYLINDER- A graduated cylinder, also known as a measuring cylinder or mixing cylinder, is an experimental device used to calculate the volume of a liquid. It is cylindrical and thin. The measured liquid volume is indicated by each mark marked on the graduated cylinder. Cylinders are usually made of polypropylene which is considered to be graduated, which is highly chemical resistant, or polymethylpentene, which is transparent and lighter than glass. Polypropylene (PP) graduated cylinders are autoclaved at temperatures above 250°F (121°C) (depending on chemical formula: Conventional commercial polypropylene melts at temperatures above 351°F (177° C)) may bend or damage them, affecting accuracy.



Fig:4.11: Graduated cylinder

4.10 WEIGHING SCALE - Weight is displayed as a number on an electronic digital scale, usually with a liquid crystal display (LCD). It is adaptable because measurements can be calculated and transferred to other digital devices. In a digital balance, the force of the weight deforms the spring and the amount of deformation is measured by one or more strain gauges. A strain gauge is an electrical conductor whose resistance changes as its length changes. Larger digital scales may use hydraulic transducers known as force sensors instead of strain gauges due to their limited capacity. The current through the device, which receives a voltage, varies with weight. An analog-to-digital converter converts the current into a digital number, which is then converted into the appropriate units using digital logic and displayed on the screen. The device is usually controlled by a microprocessor chip.



Fig:4.12: Weighing scale

4.11 MOLD-Mold is made of stain less steel which is used to make the composite, and according to the ASTM standard the mold is made. inner size of the mold is 200x200x3mm.the thickness is 3mm.

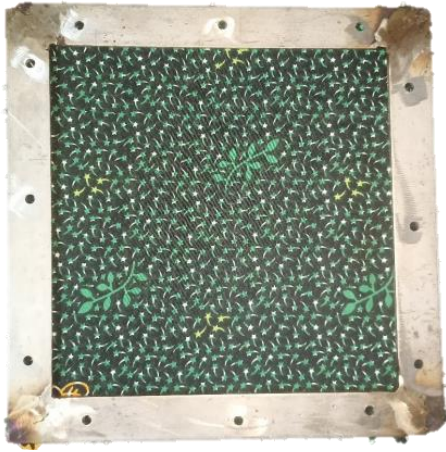


Fig:4.13: a) Mold front view



Fig:4.13: b) Mold side view

4.12 EXPERIMENTAL PROCEDURE

The most popular and oldest production process. Polyester or epoxy resin elements such as boat hulls, tanks, and vessels, as well as pick-up truck canopies, are commonly made with this method. The mold is fully applied by the wax and polyacrylic sheets are also waxed. The fibers were cutted according to the sizes and weighed. The powder taken in the beaker and pour the resin weighed according to the making the plate and mix well with the help of stirrer and put the fiber weighed In the beaker and mix well with stirrer and last pour the hardener required depending upon the resin and pour the mix in the mold. The resin and the hardener were mixed in the ratio of 10:1.



Fig:4.14: Resin mixing

Table 4.2: Factors and levels of composite preparation

Length of fiber (mm)	Volume of fiber (%)	Volume of powder(%)
15	20	1
15	25	3
15	30	5
20	20	1
20	25	3
20	30	5
25	20	1
25	25	3
25	30	5

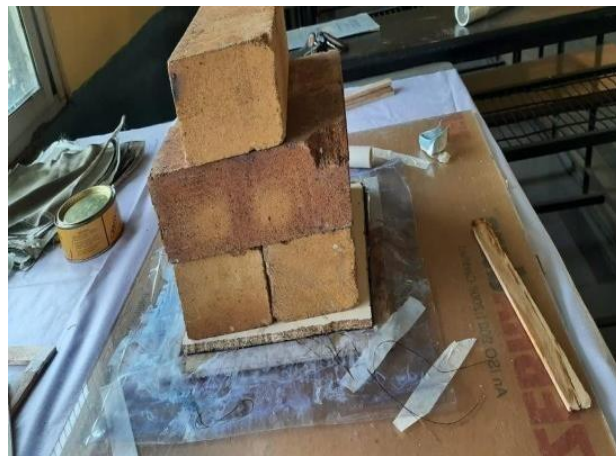


Fig:4.15: Composite plate making



Fig:4.16: Composite plates



Fig:4.17: Composite plate measured

CHAPTER 5

RESULTS

5.1 TENSILE TEST

Tensile testing, sometimes called tension testing, is a basic test in materials science and engineering that involves applying a controlled tension to a sample until it broken. The manner in which the test piece is prepared is influenced by the test objectives as well as the test technique or specification involved. Cross-section of a standardized test piece commonly used as a tensile test piece. It has two shoulders and a center gauge (section). The shoulder is large for easier grip, while the ruler has a smaller cross-section for easy deformation and damage. The manner in which the test piece is prepared is influenced by the test objectives as well as the test technique or specification involved. Cross-section of a standardized test piece commonly used as a tensile test piece. It has two shoulders and a gauge (section) in the center. "Standard test method for tensile properties of polymer matrix composites", ASTM D3039/D3039M.

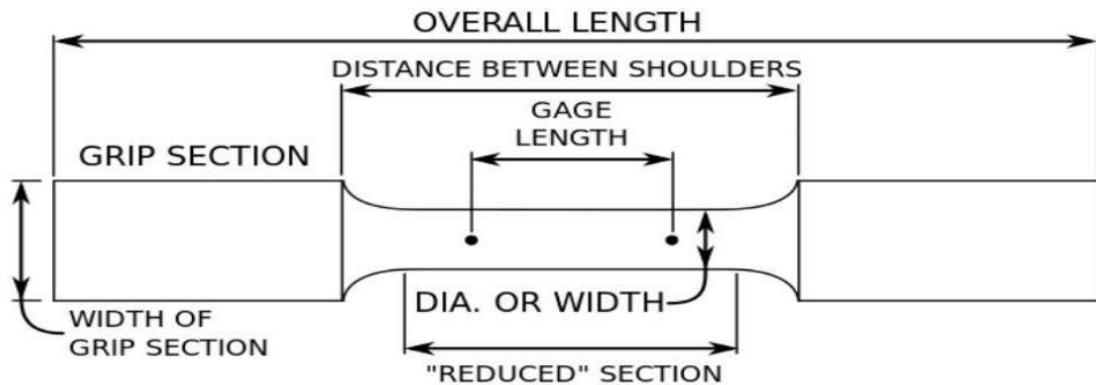


Fig:5.1: Measurement for tensile specimen



Fig:5.2: Tensile test apparatus



Fig:5.3: Tensile test samples

TENSILE TEST GRAPH

The below graphs are , the experimental data of ten composite plates.

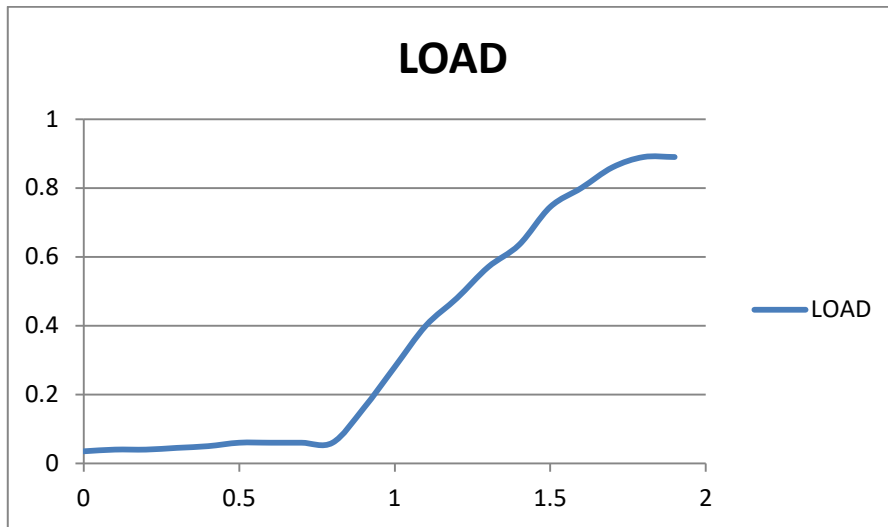


Fig:5.4: composite plate 1, sample 1

Load v/s Displacement graph for tensile test (composite plate 1,sample 1). The graph gives the tensile strength of composite plate which has 15mm length of 20% fiber and 1% of powder with epoxy. The attained stress is 14.615 MPa and load is 890.000 N.

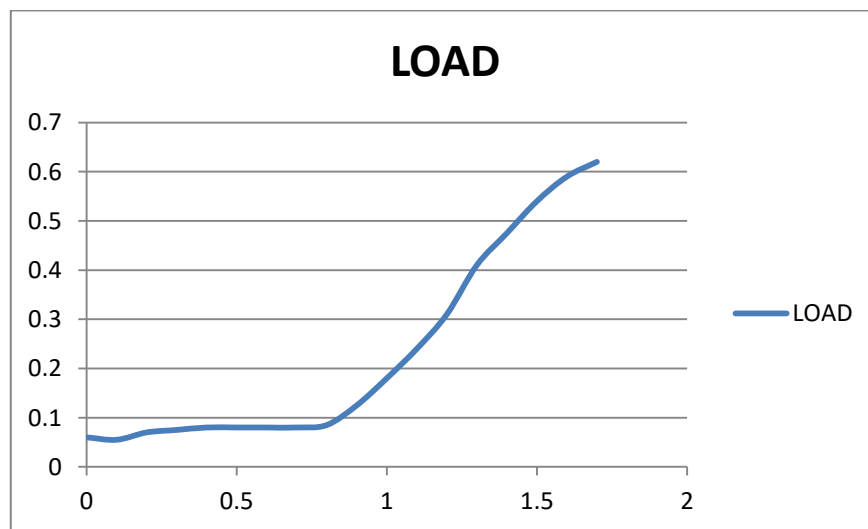


Fig:5.5: composite plate 1, sample 2

Load v/s Displacement graph for tensile test (composite plate 1,sample 2). The graph gives the tensile strength of composite plate which has 15mm length of 20% fiber and 1% of powder with epoxy. The attained stress is 10.181 MPa and load is 620.000 N.

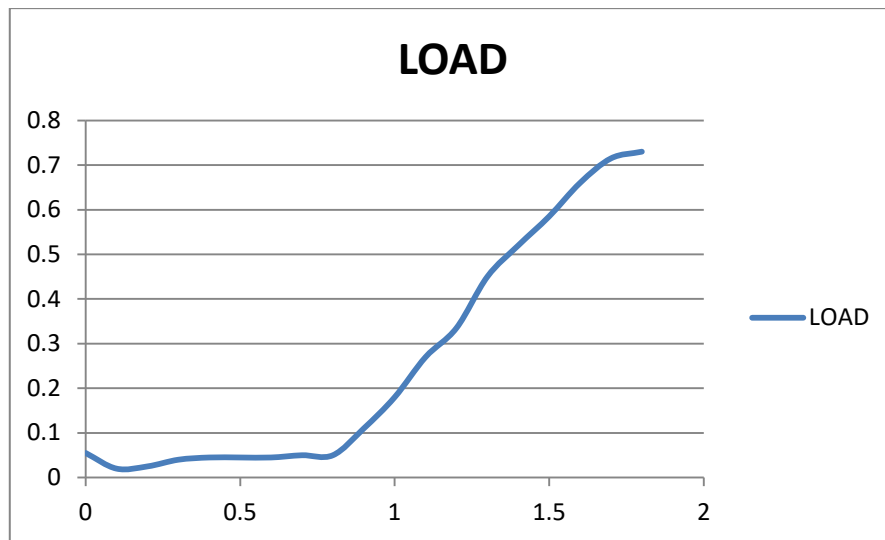


Fig:5.6: composite plate 2, sample 1

Load v/s Displacement graph for tensile test (composite plate 2,sample 1). The graph gives the tensile strength of composite plate which has 15mm length of 25% fiber and 3% of powder with epoxy. The attained stress is 11.988 MPa and load is 730.000 N.

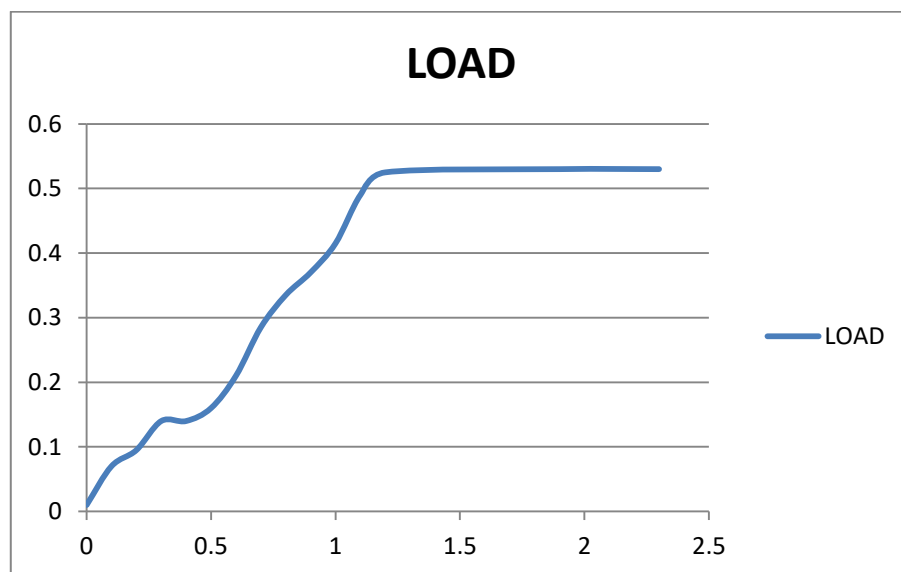


Fig:5.7: composite plate 2, sample 2

Load v/s Displacement graph for tensile test (composite plate 2,sample 2). The graph gives the tensile strength of composite plate which has 15mm length of 25% fiber and 3% of powder with epoxy. The attained stress is 9.569 MPa and load is 530.000 N.

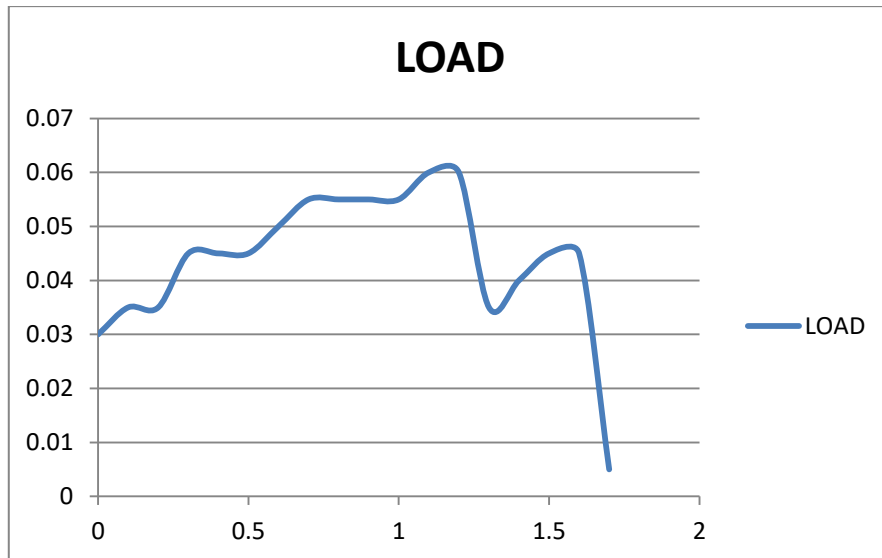


Fig:5.8: composite plate 3, sample 1

Load v/s Displacement graph for tensile test (composite plate 3,sample 1). The graph gives the tensile strength of composite plate which has 15mm length of 30% fiber and 5% powder with epoxy. The attained stress is 0.985 MPa and load is 60.000 N.

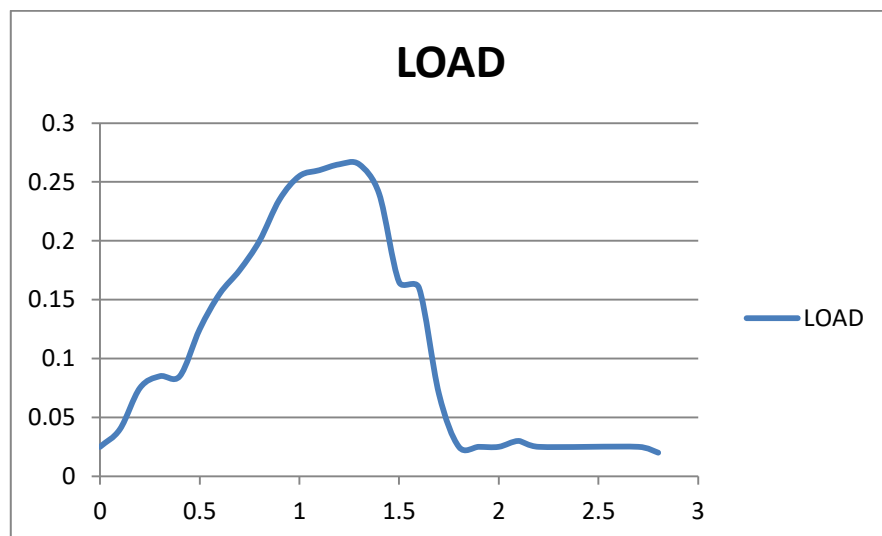


Fig:5.9: composite plate 3, sample 2

Load v/s Displacement graph for tensile test (composite plate 3,sample 2). The graph gives the tensile strength of composite plate which has 15mm length of 30% fiber and 5% powder with epoxy. The attained stress is 4.785 MPa and load is 265.000 N.

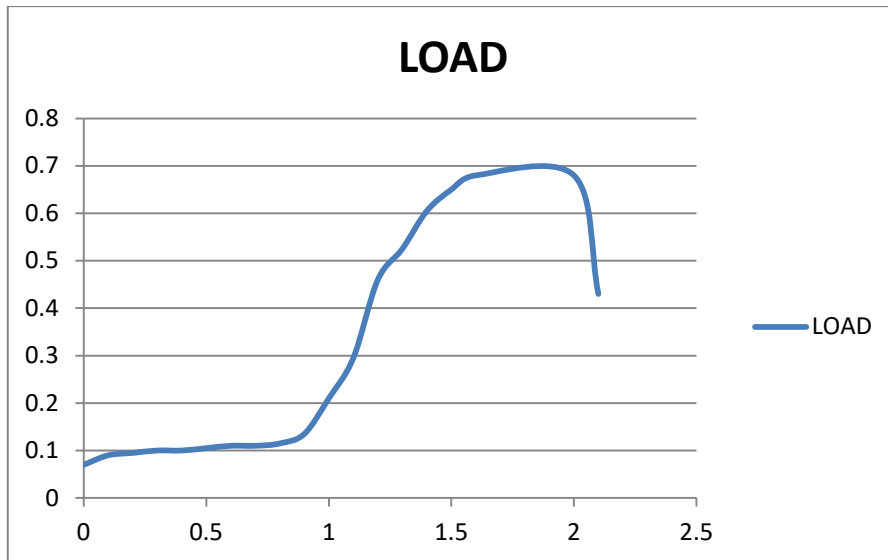


Fig:5.10: composite plate 4, sample 1

Load v/s Displacement graph for tensile test (composite plate 4,sample 1). The graph gives the tensile strength of composite plate which has 20mm length of 20% fiber and 1% powder with epoxy. The attained stress is 11.167 MPa and load is 680.000 N.

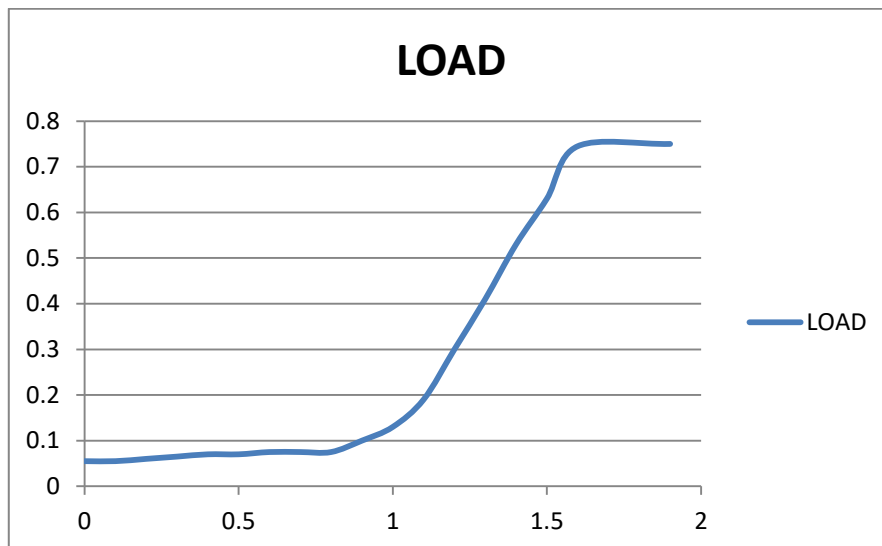


Fig:5.11: composite plate 4, sample 2

Load v/s Displacement graph for tensile test (composite plate 4,sample 2). The graph gives the tensile strength of composite plate which has 20mm length of 20% fiber and 1% powder with epoxy. The attained stress is 12.316 MPa and load is 750.000 N.

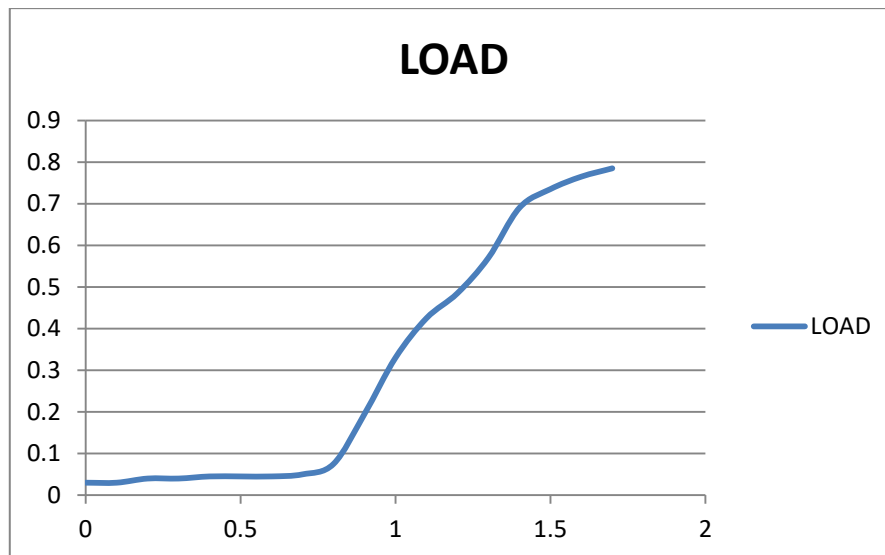


Fig:5.12: composite plate 5, sample 1

Load v/s Displacement graph for tensile test (composite plate 5,sample 1). The graph gives the tensile strength of composite plate which has 20mm length of 25% fiber and 3% powder with epoxy. The attained stress is 12.891 MPa and load is 785.000 N.

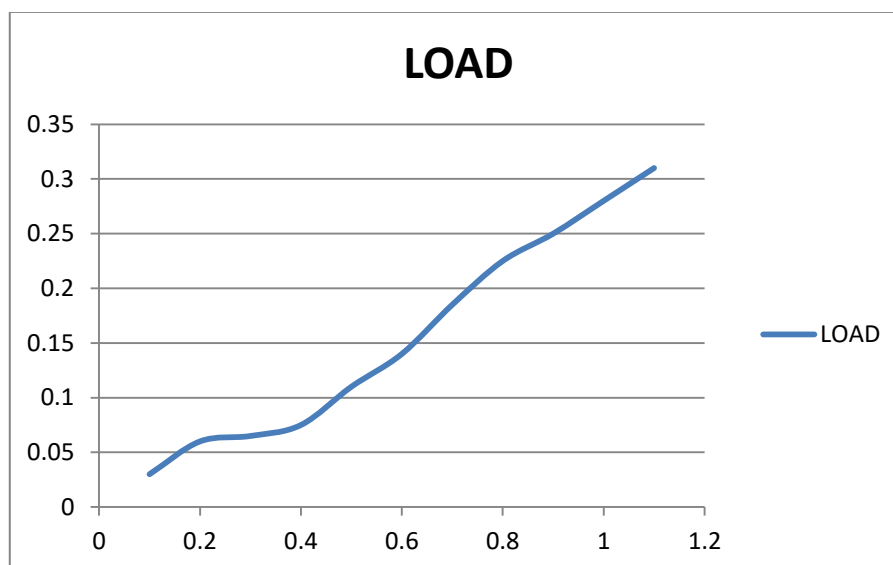


Fig:5.13: composite plate 5, sample 2

Load v/s Displacement graph for tensile test (composite plate 5,sample 2). The graph gives the tensile strength of composite plate which has 20mm length of 25% fiber and 3% powder with epoxy. The attained stress is 5.597 MPa and load is 310.000 N.

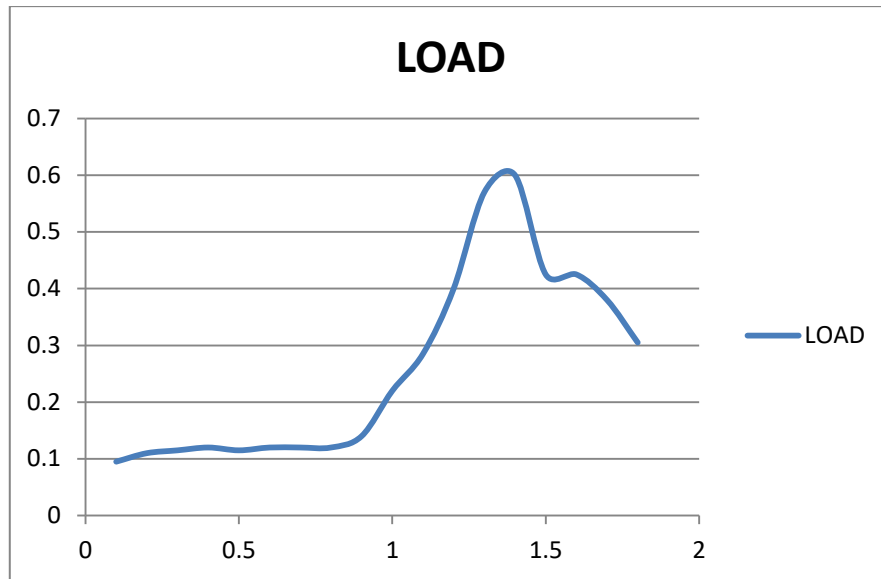


Fig:5.14: composite plate 6, sample 1

Load v/s Displacement graph for tensile test (composite plate 6,sample 1). The graph gives the tensile strength of composite plate which has 20mm length of 30% fiber and 5% powder with epoxy. The attained stress is 9.853 MPa and load is 600.000 N.

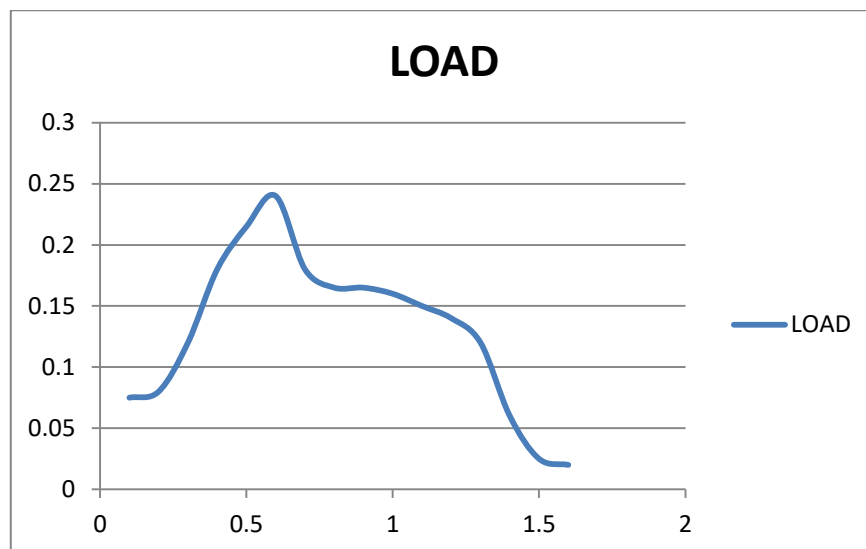


Fig:5.15: composite plate 6, sample 2

Load v/s Displacement graph for tensile test (composite plate 6,sample 2). The graph gives the tensile strength of composite plate which has 20mm length of 30% fiber and 5% powder with epoxy. The attained stress is 4.333 MPa and load is 240.000 N.

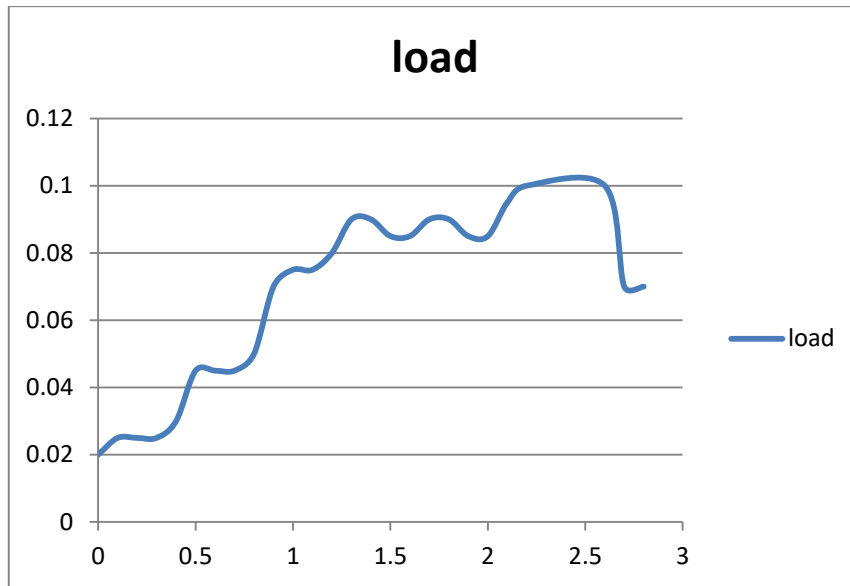


Fig:5.16: composite plate 7, sample 1

Load v/s Displacement graph for tensile test (composite plate 7,sample 1). The graph gives the tensile strength of composite plate which has 25mm length of 20% fiber and 1% powder with epoxy. The attained stress is 1.575 MPa and load is 100.000 N.

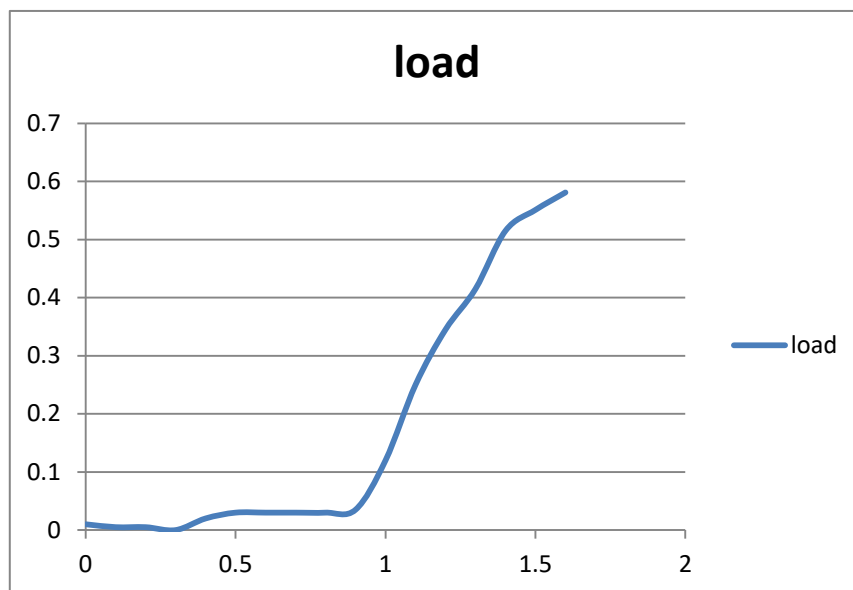


Fig:5.17: composite plate 7, sample 2

Load v/s Displacement graph for tensile test (composite plate 7,sample 2). The graph gives the tensile strength of composite plate which has 25mm length of 20% fiber and 1% powder with epoxy. The attained stress is 10.490 MPa and load is 581.000 N.

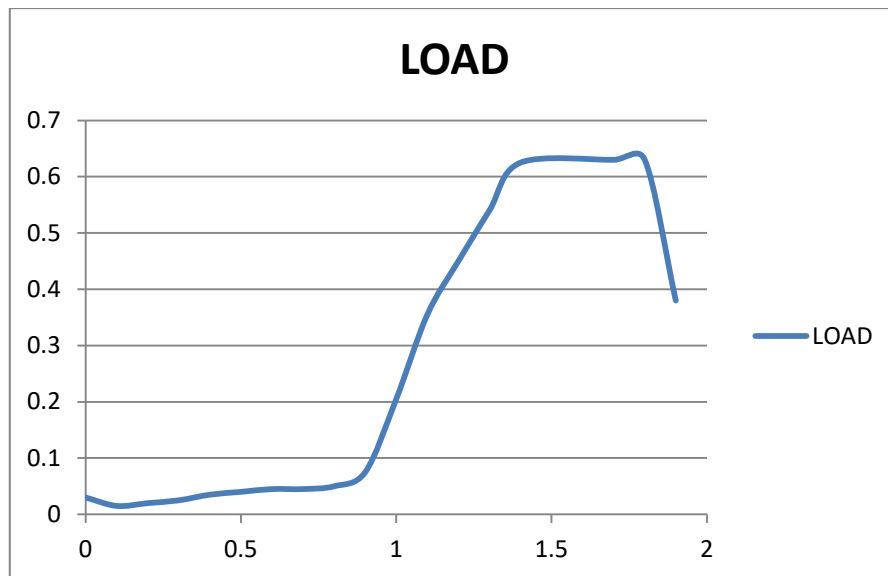


Fig:5.18: composite plate 8, sample 1

Load v/s Displacement graph for tensile test (composite plate 8,sample 1). The graph gives the tensile strength of composite plate which has 25mm length of 25% fiber and 3% powder with epoxy. The attained stress is 10.346 MPa and load is 630.000 N.

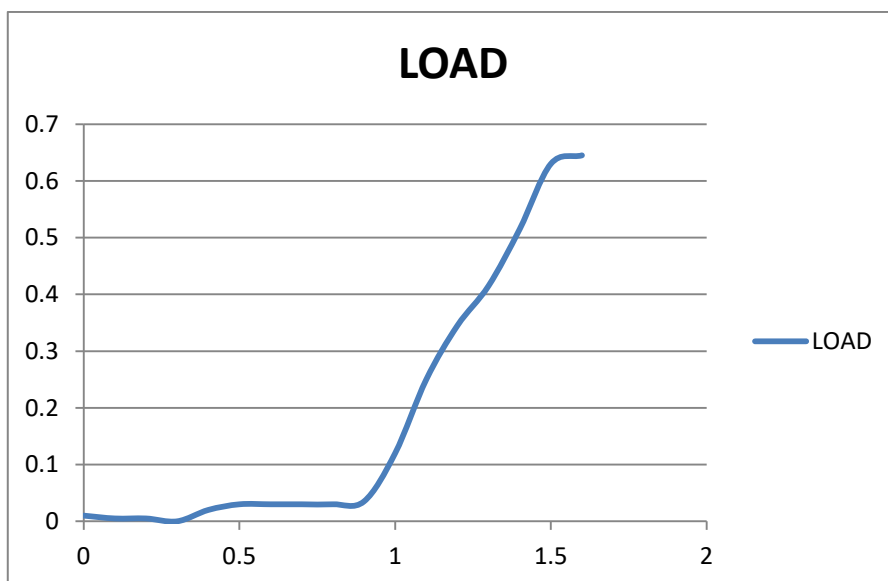


Fig:5.19: composite plate 8, sample 2

Load v/s Displacement graph for tensile test (composite plate 8,sample 2). The graph gives the tensile strength of composite plate which has 25mm length of 25% fiber and 3% powder with epoxy. The attained stress is 11.646 MPa and load is 645.000 N.

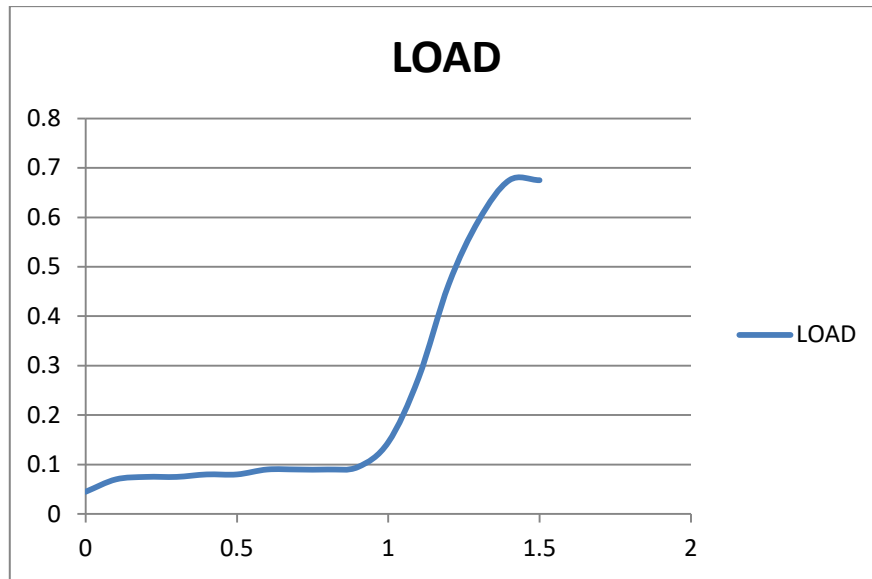


Fig:5.20: composite plate 9, sample 1

Load v/s Displacement graph for tensile test (composite plate 9,sample 1). The graph gives the tensile strength of composite plate which has 25mm length of 30% fiber and 5% powder with epoxy. The attained stress is 11.085 MPa and load is 675.000 N.

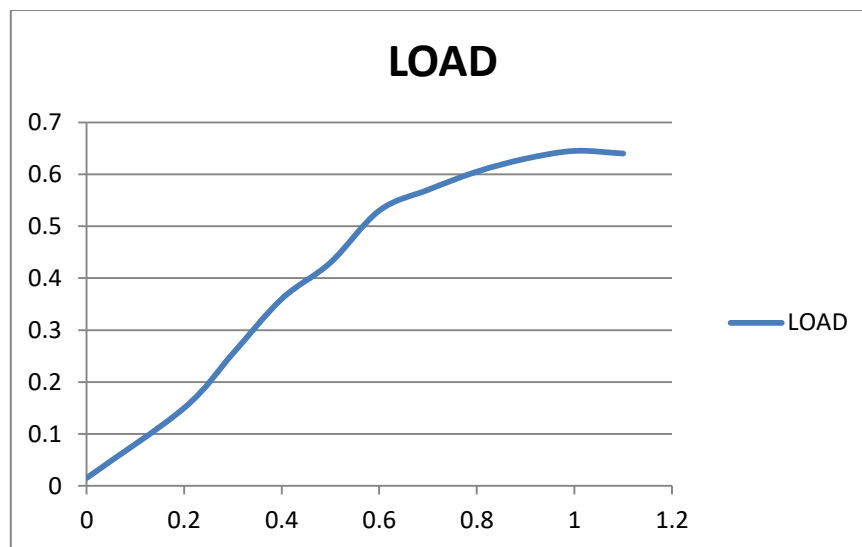


Fig:5.21: composite plate 9, sample 2

Load v/s Displacement graph for tensile test (composite plate 9,sample 2). The graph gives the tensile strength of composite plate which has 25mm length of 30% fiber and 5% powder with epoxy. The attained stress is 11.646 MPa and load is 645.000 N.

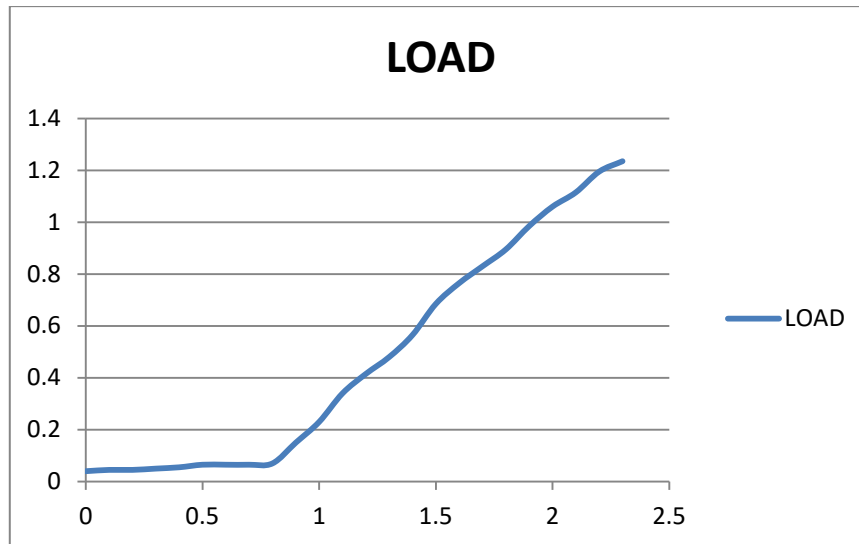


Fig:5.22: composite plate 10, sample 1

Load v/s Displacement graph for tensile test (epoxy plate 10,sample 1). The graph gives the tensile strength of composite plate which has pure epoxy. The attained stress is 20.281 MPa and load is 1.235.000 N.

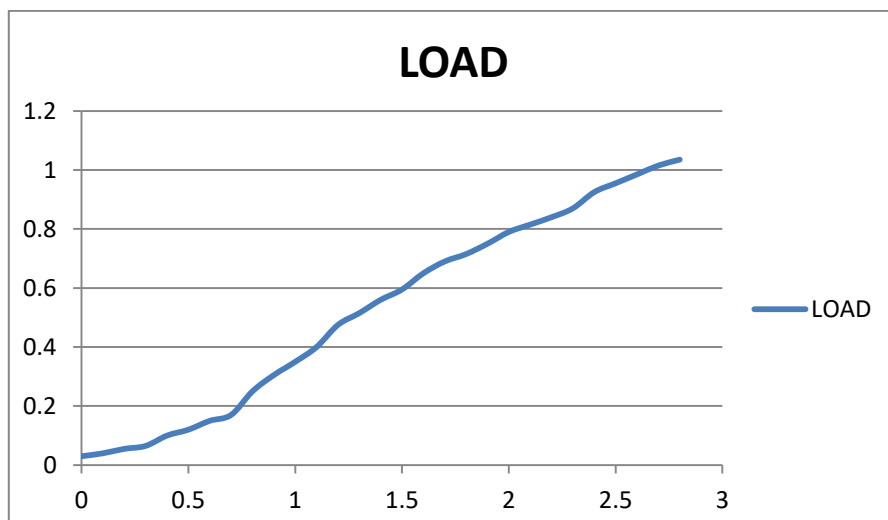


Fig:5.23: composite plate 10, sample 2

Load v/s Displacement graph for tensile test (epoxy plate 10,sample 2). The graph gives the tensile strength of composite plate which has pure epoxy. The attained stress is 18.687 MPa and load is 1.035.000 N.

5.2 FLEXURAL TEST

Flexural strength and flexural modulus are measured using the flexure test. Flexural strength is defined as the maximum stress at the outermost fibre on either the compression or tension side of the specimen. The flexural modulus is calculated using the slope of the stress vs. strain deflection curve. These two figures can be used to determine how well a sample can withstand bending or flexure forces. Bend (bend) test is commonly used to determine the flexural modulus or strength of a material. The cost of a bend test is less than a tensile test and the results are slightly different. A force is applied to the upper part of the material through 0 points of contact (lower support interval). The most commonly used sample size for ASTM is 3.2mm x 12.7mm x 125mm (0.125" x 0.5" x 5.0"), while the most commonly used sample size for ISO is 10mm x mm x 80mm ASTM D790 is a test method for determining the flexural properties of unreinforced and thermoplastics as well as insulating materials.

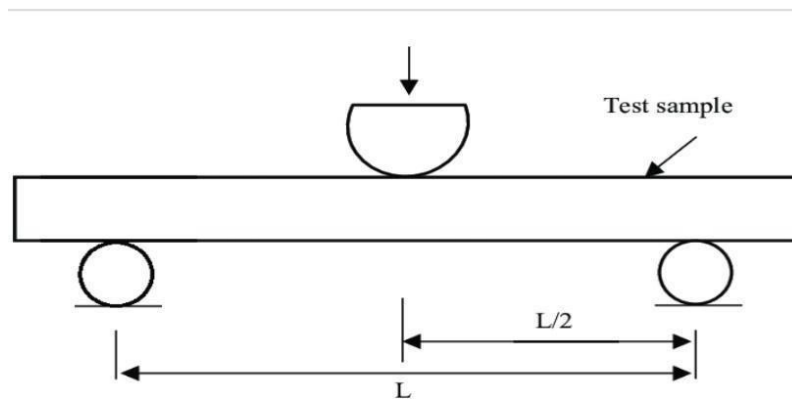


Fig:5.24: Measurement for flexural specimen.



Fig:5.25: a) Flexural apparatus



Fig:5.25: b) Flexural tested specimen

FLEXURAL TEST RESULTS

The below graphs are , the experimental data of ten composite plates.

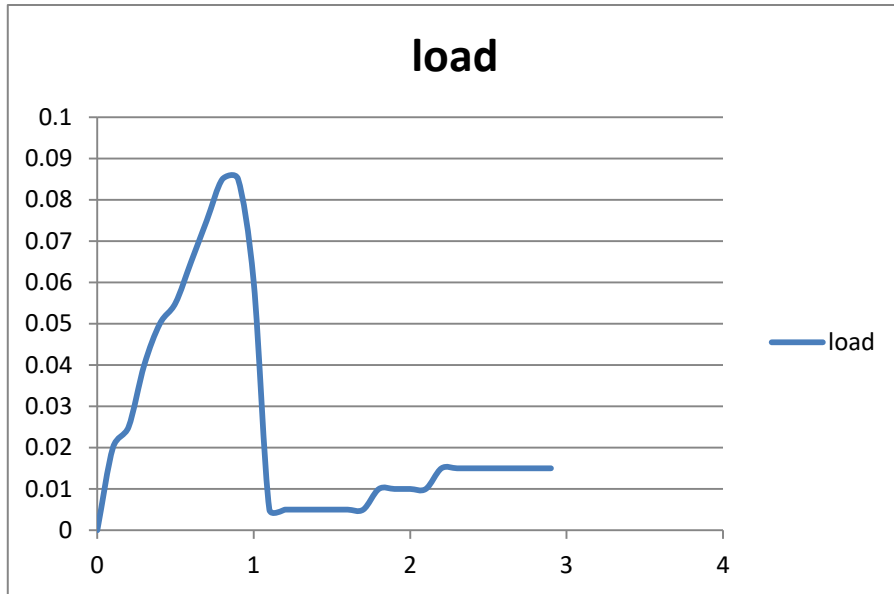


Fig:5.26: composite plate 1, sample 1

Load v/s Displacement graph for flexural test (composite plate 1,sample 1). The graph gives the flexural strength of composite plate which has 15mm length of 20% fiber and 1% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 0.08 KN.

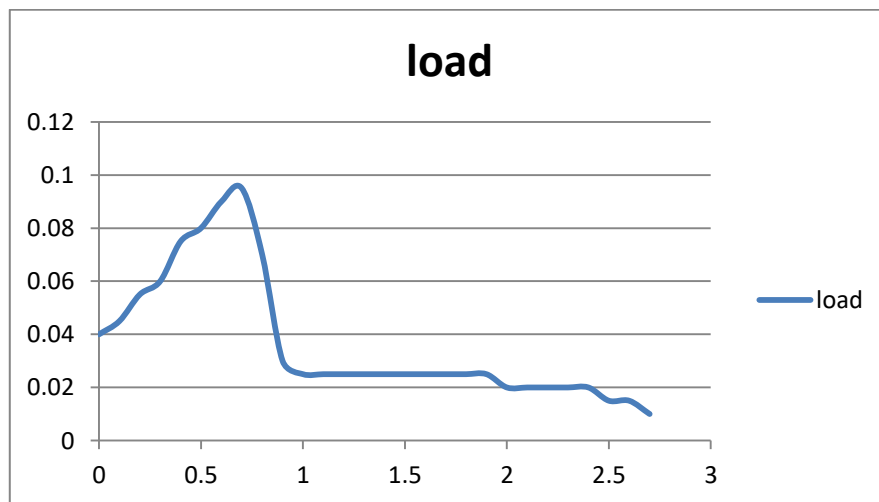


Fig:5.27: composite plate 1, sample 2

Load v/s Displacement graph for flexural test (composite plate 1,sample 2). The graph gives the flexural strength of composite plate which has 15mm length of 20% fiber and 1% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 0.095 KN.

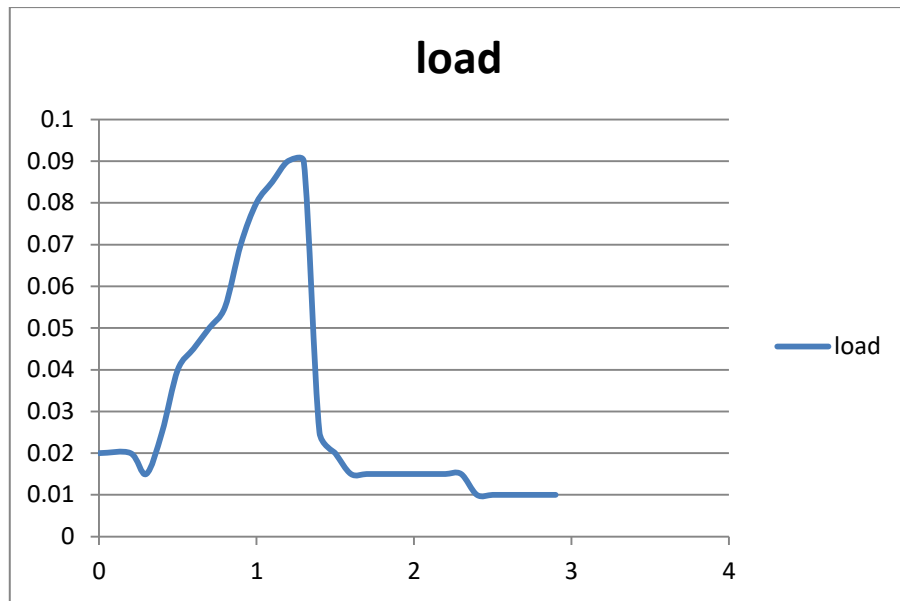


Fig:5.28: composite plate 2, sample 1

Load v/s Displacement graph for flexural test (composite plate 2,sample 1). The graph gives the flexural strength of composite plate which has 15mm length of 25% fiber and 3% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 0.090 KN.

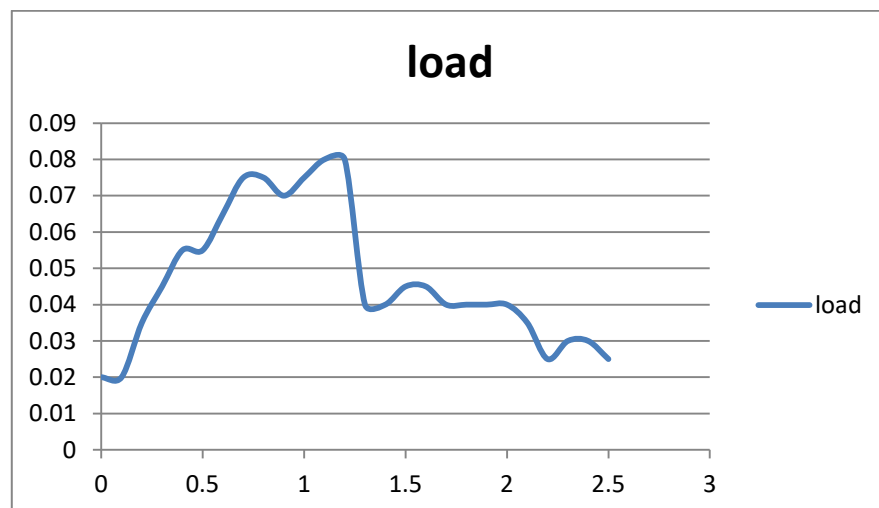


Fig:5.29: composite plate 2, sample 2

Load v/s Displacement graph for flexural test (composite plate 2,sample 2). The graph gives the flexural strength of composite plate which has 15mm length of 25% fiber and 3% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 80.000 KN.

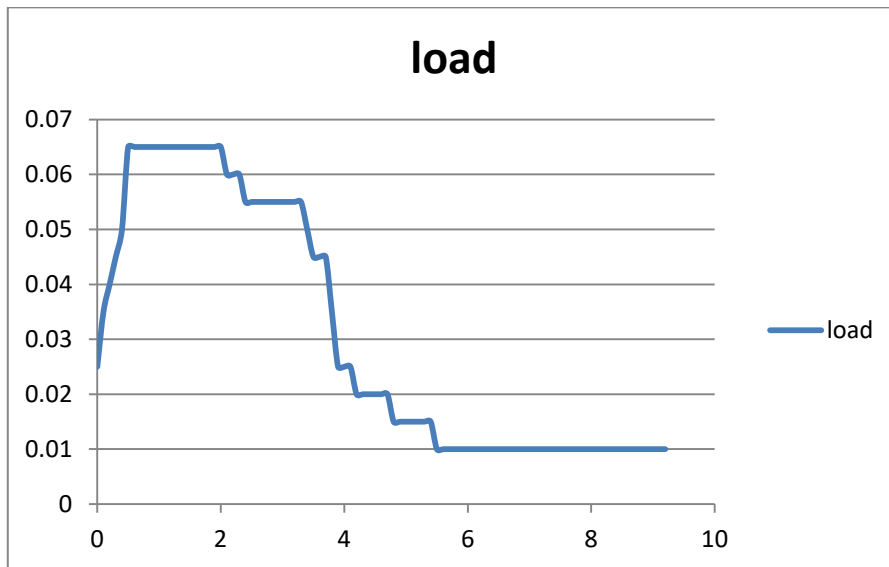


Fig:5.30: composite plate 3, sample 1

Load v/s Displacement graph for flexural test (composite plate 3,sample 1). The graph gives the flexural strength of composite plate which has 15mm length of 30% fiber and 5% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 0.065 KN.

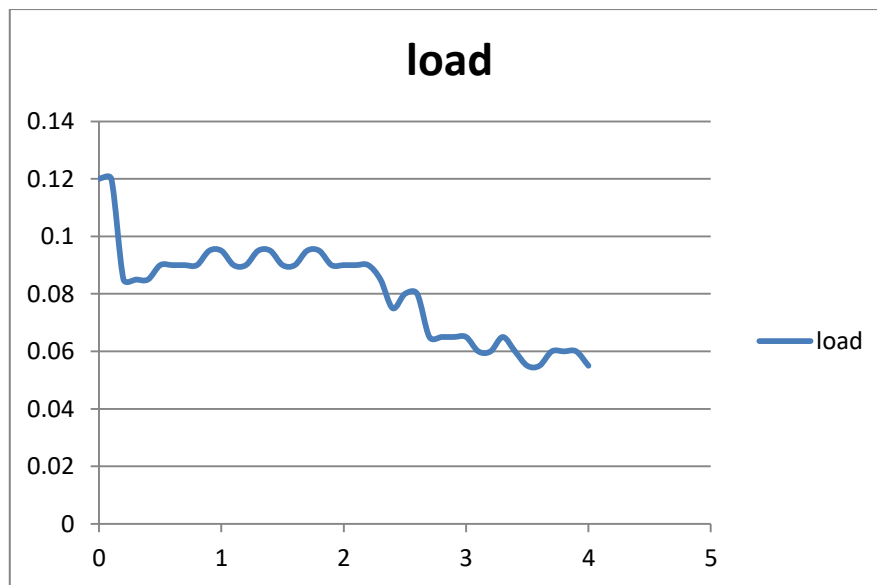


Fig:5.31: composite plate 3, sample 2

Load v/s Displacement graph for flexural test (composite plate 3,sample 2). The graph gives the flexural strength of composite plate which has 15mm length of 30% fiber and 5% powder with epoxy. The attained stress is 1.391 KN/mm^2 and load is 120.000 KN.

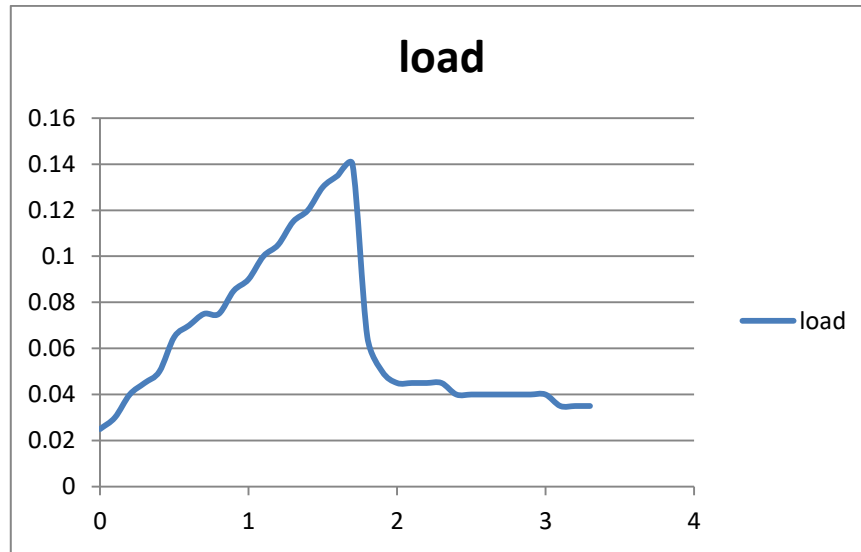


Fig.5.32: composite plate 4, sample 1

Load v/s Displacement graph for flexural test (composite plate 4,sample 1). The graph gives the flexural strength of composite plate which has 20mm length of 20% fiber and 1% powder with epoxy. The attained stress is 0.002 KN/mm^2 and load is 0.140 KN.

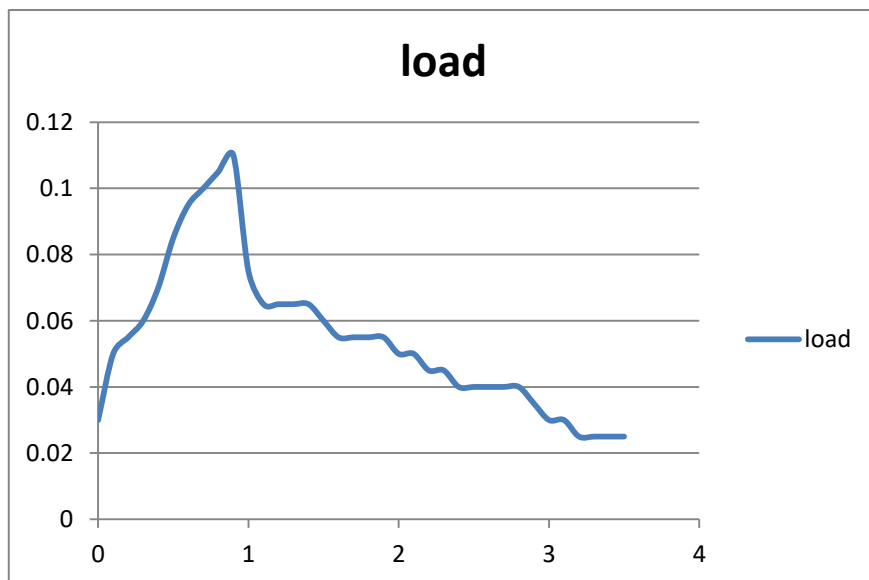


Fig.5.33: composite plate 4, sample 2

Load v/s Displacement graph for flexural test (composite plate 4,sample 2). The graph gives the flexural strength of composite plate which has 20mm length of 20% fiber and 1% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 0.110 KN.

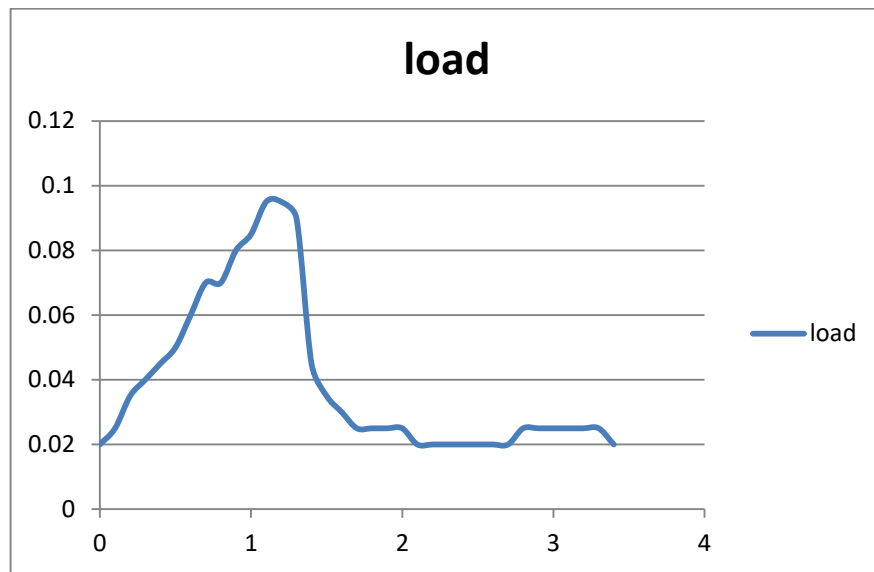


Fig:5.34: composite plate 5, sample 1

Load v/s Displacement graph for flexural test (composite plate 5,sample 1). The graph gives the flexural strength of composite plate which has 20mm length of 25% fiber and 3% powder with epoxy. The attained stress is 0.001 KN/mm² and load is 0.095 KN.

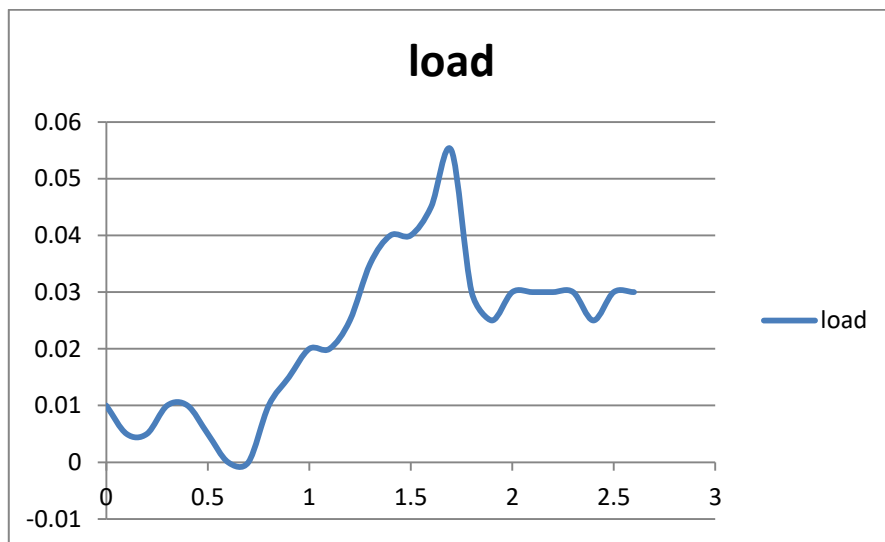


Fig:5.35: composite plate 5, sample 2

Load v/s Displacement graph for flexural test (composite plate 5,sample 2). The graph gives the flexural strength of composite plate which has 20mm length of 25% fiber and 3% powder with epoxy. The attained stress is 0.638 KN/mm² and load is 55.000 KN.

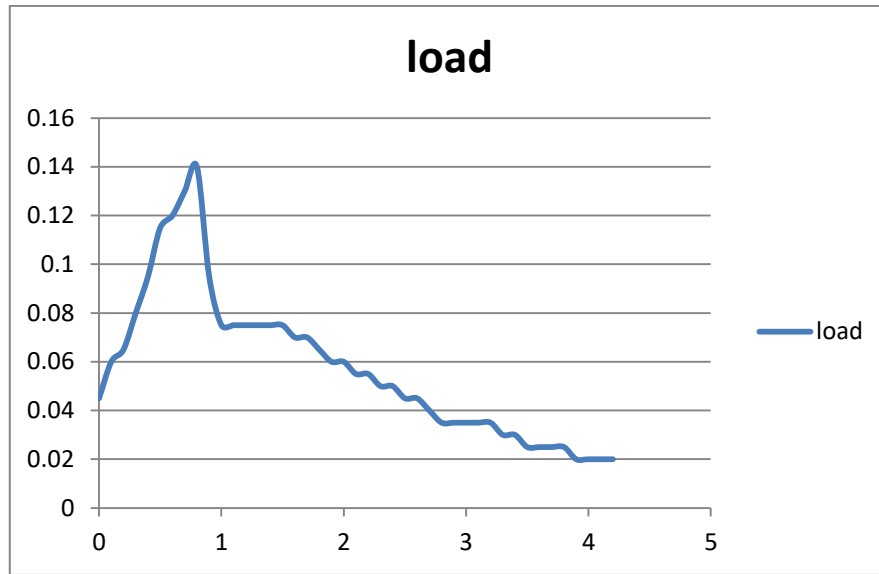


Fig:5.36: composite plate 6, sample 1

Load v/s Displacement graph for flexural test (composite plate 6,sample 1). The graph gives the flexural strength of composite plate which has 20mm length of 30% fiber and 5% powder with epoxy. The attained stress is 0.002 KN/mm^2 and load is 0.140 KN.

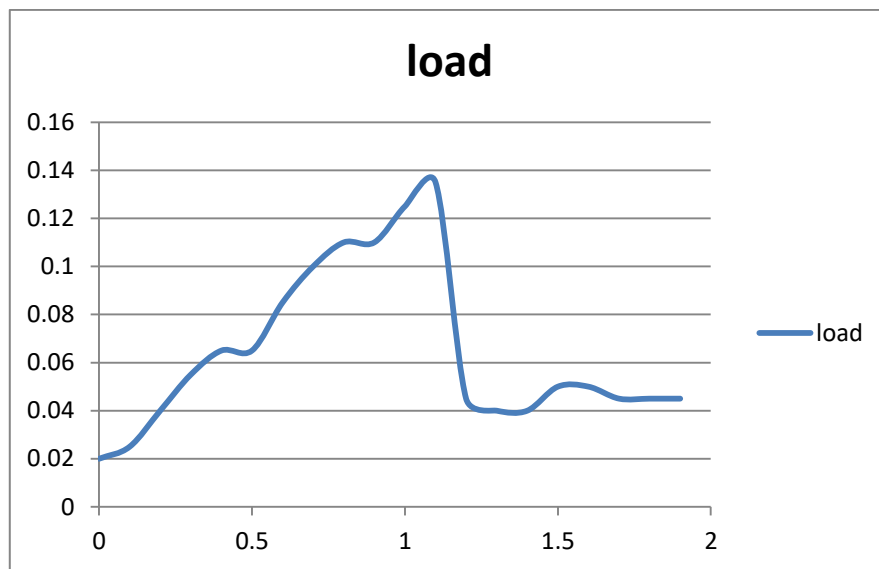


Fig:5.37: composite plate 6, sample 2

Load v/s Displacement graph for flexural test (composite plate 6,sample 2). The graph gives the flexural strength of composite plate which has 20mm length of 30% fiber and 5% powder with epoxy. The attained stress is 1.565 KN/mm^2 and load is 135.000 KN.

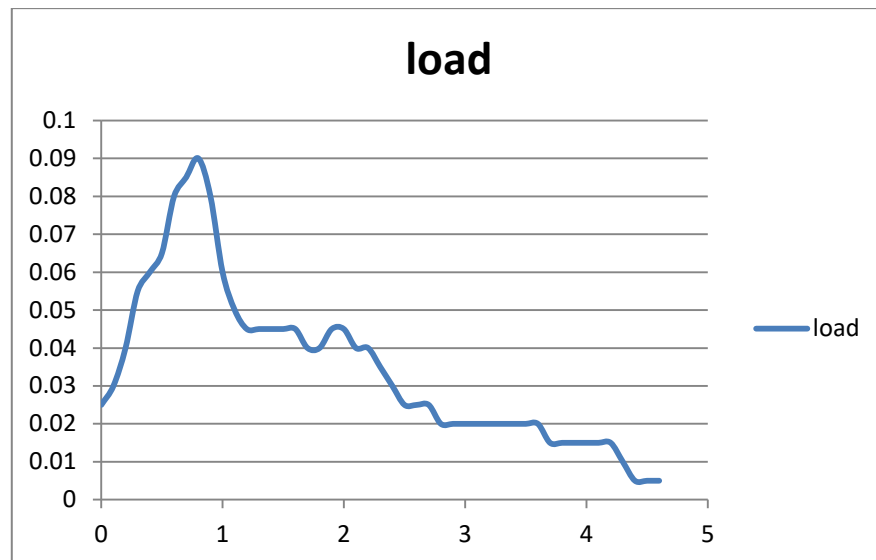


Fig:5.38: composite plate 7, sample 1

Load v/s Displacement graph for flexural test (composite plate 7,sample 1). The graph gives the flexural strength of composite plate which has 25mm length of 20% fiber and 1% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 0.090 KN.

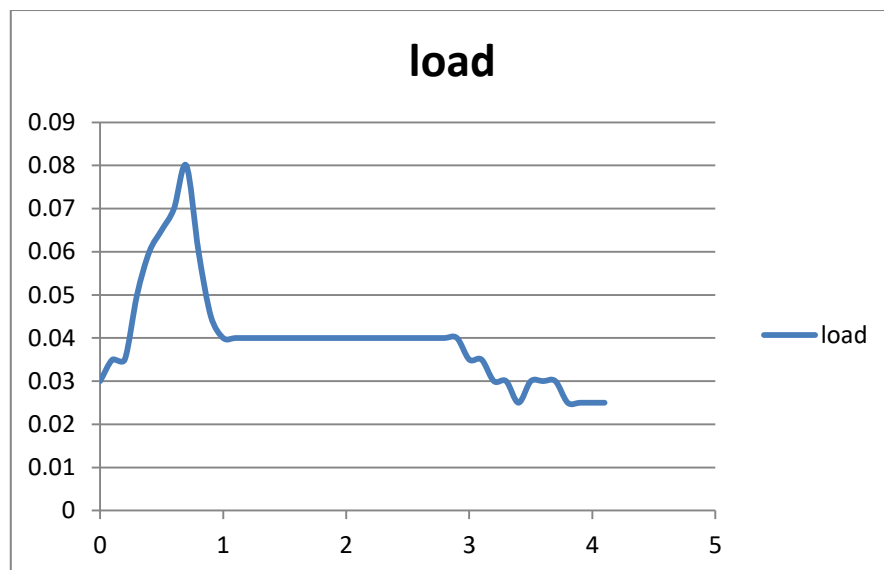


Fig:5.39: composite plate 7, sample 2

Load v/s Displacement graph for flexural test (composite plate 7,sample 2). The graph gives the flexural strength of composite plate which has 25mm length of 20% fiber and 1% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 0.080 KN.

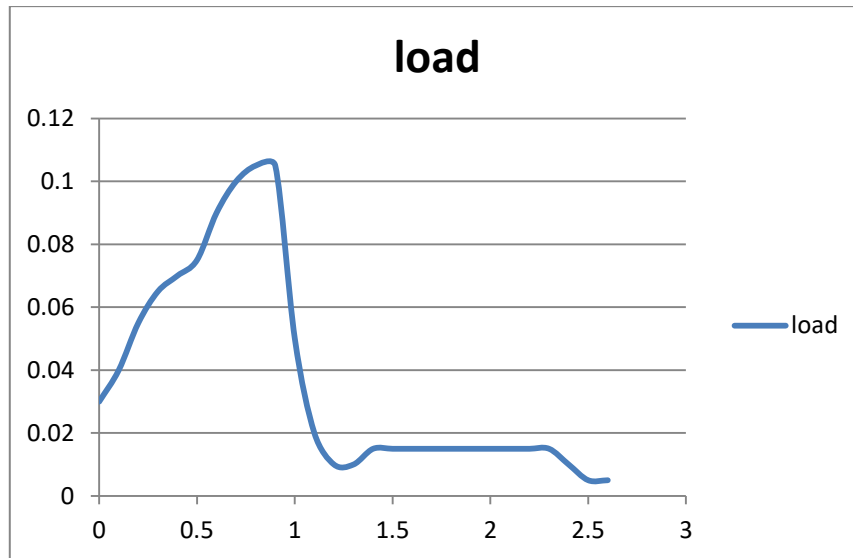


Fig:5.40: composite plate 8, sample 1

Load v/s Displacement graph for flexural test (composite plate 8,sample 1). The graph gives the flexural strength of composite plate which has 25mm length of 25% fiber and 3% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 0.105 KN.

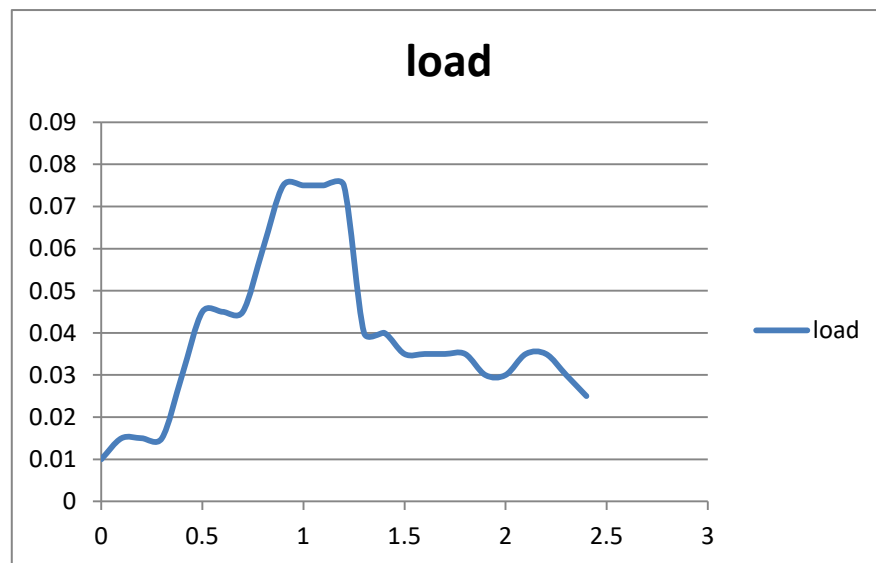


Fig:5.41: composite plate 8, sample 2

Load v/s Displacement graph for flexural test (composite plate 8,sample 2). The graph gives the flexural strength of composite plate which has 25mm length of 25% fiber and 3% powder with epoxy. The attained stress is 0.870 KN/mm^2 and load is 75.000 KN.

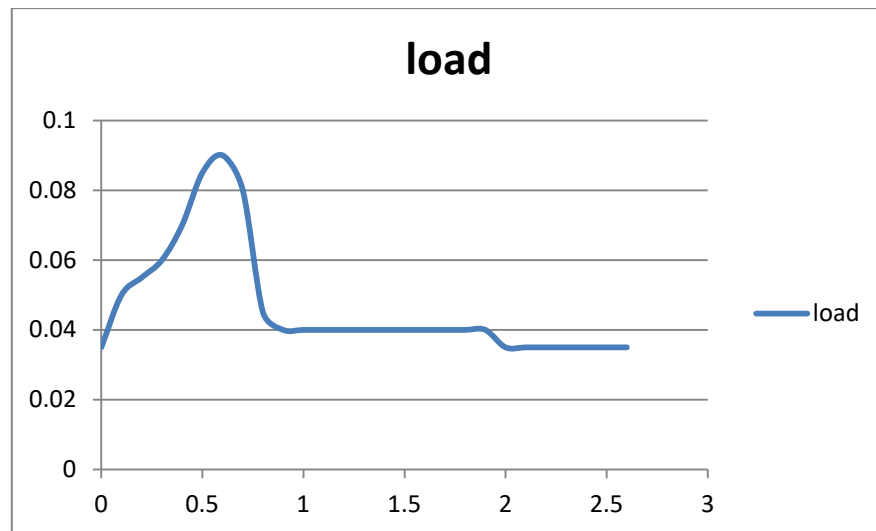


Fig:5.42: composite plate 9, sample 1

Load v/s Displacement graph for flexural test (composite plate 9, sample 1). The graph gives the flexural strength of composite plate which has 25mm length of 30% fiber and 5% powder with epoxy. The attained stress is 0.001 KN/mm^2 and load is 0.090 KN.

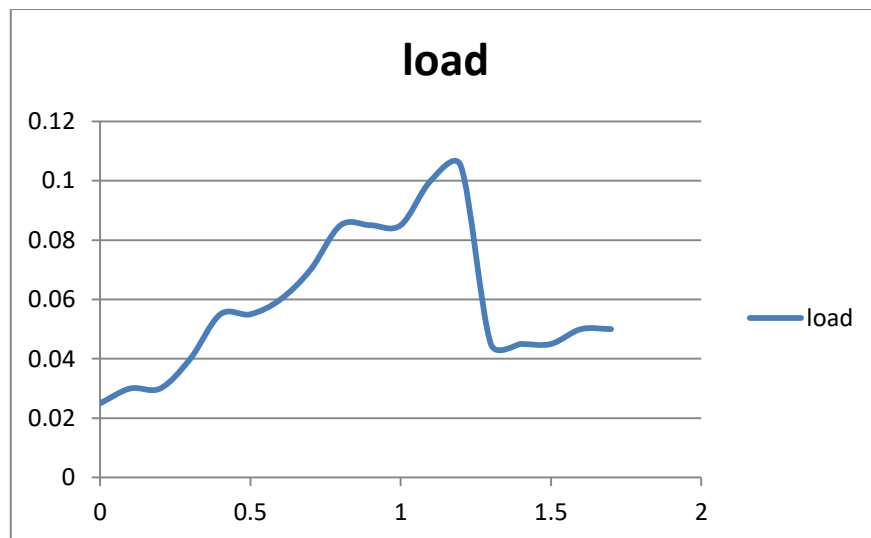


Fig:5.43: composite plate 9, sample 2

Load v/s Displacement graph for flexural test (composite plate 9, sample 2). The graph gives the flexural strength of composite plate which has 25mm length of 30% fiber and 5% powder with epoxy. The attained stress is 1.218 KN/mm^2 and load is 105.000 KN.

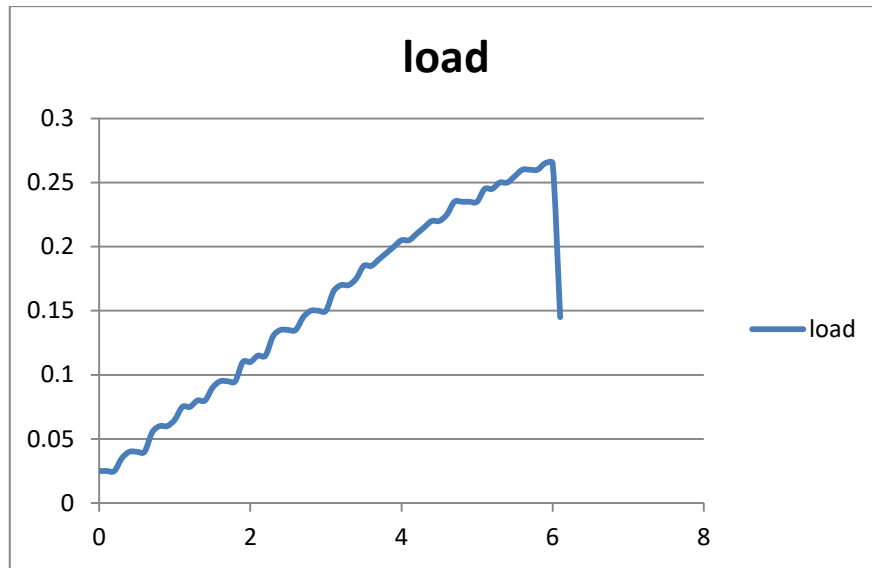


Fig:5.44: composite plate 10, sample 1

Load v/s Displacement graph for flexural test (epoxy plate 10, sample 1). The graph gives the flexural strength of composite plate which has pure epoxy. The attained stress is 0.003 KN/mm^2 and load is 0.265 KN.

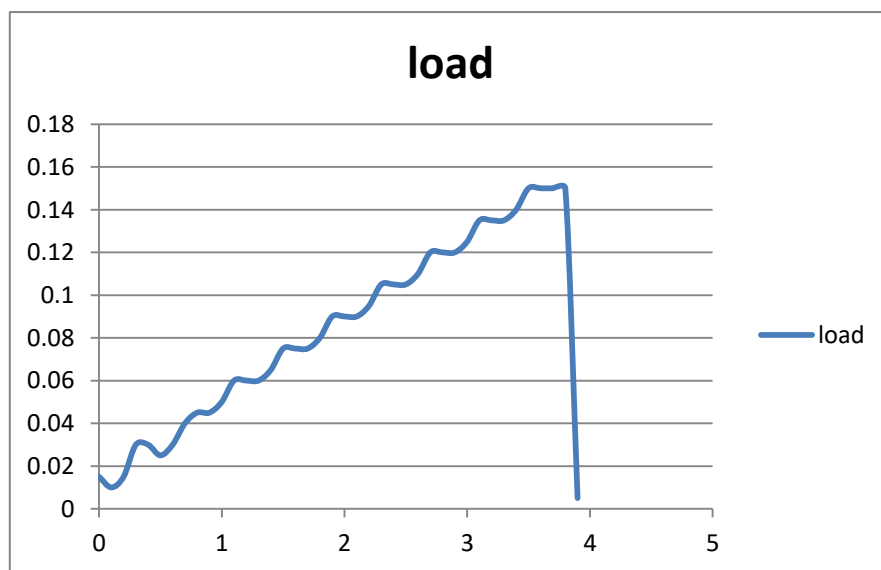


Fig:5.45: composite plate 10, sample 2

Load v/s Displacement graph for flexural test (epoxy plate 10, sample 2). The graph gives the flexural strength of composite plate which has pure epoxy. The attained stress is 1.739 KN/mm^2 and load is 150.000 KN.

5.3 IMPACT TEST

A material's ability to absorb energy on impact is determined by impact testing. This energy can be used to measure the toughness, impact strength, breaking strength, impact strength or breaking strength of a material, depending on the test and the property being examined. These numbers are important in selecting materials for situations where the material must withstand stress very quickly, such as an automobile crash.

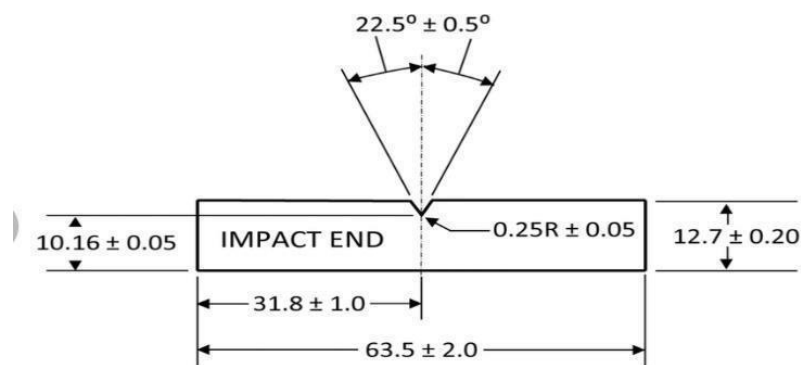


Fig:5.46: Impact specimen measurement

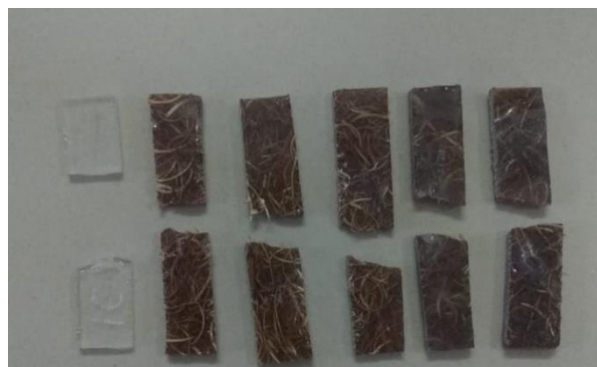


Fig:5.47: Impact tested specimen



FIG:5.48: Impact test apparatus

Table 4.3: Impact test values

Sample I.D	I Zod Impact Values, Joules
1-1	0.7
1-2	0.2
2-1	0.3
2-2	0.4
3-1	0.4
3-2	0.5
4-1	0.4
4-2	0.1
5-1	0.3
5-2	0.6
6-1	0.2

6-2	0.4
7-1	0.6
7-2	0.4
8-1	0.4
8-2	0.6
9-1	0.1
9-2	0.4
10-1	0.7
10-2	0.5

CHAPTER 6

CONCLUSION

According to the study conducted on ten composite specimens. our possession is to make natural fiber composite which is obtained from tamarind fruit fiber. The water is used to soak the fiber for five days to further extraction process and the same water can be filtered and reused for further soaking process because of the micro organisms. After extracted the fiber they have to sun dried for 3 days to prevent dehydration of fiber. After sun dried the fibers were cut depends on the length required for making composite plate. The experiments included tensile test , impact test , flexural test. From the results found and the data aquired, detailed analysis has been done and the tensile properties, impact properties and the flexural properties of the composite plates.the composites plates have been compared with each other to determine the optimum values. In comparing the tensile strength the composite plate no 9 has the higher tensile strength the mixing ratio of the plate is 25mm length of fiber which is 30%. And the composite plate filler is 5% ,according to the tensile test the composite plate is made. In flexural test the 6th plate has the high flexural value which has the combination of 20mm length,which is 30% volume of fiber. In impact test 1st plate has the high impact values according to the other plates. In the conclusion in each test different plates of different ratio has different values has been recorded. The physical properties of fibers extracted from tamarind fruits of tamarind tree. In the process of making composite plate we don't have to cut the trees or any part of the trees so making of composite plates are only from agro waste materials so it is not harmful to environment. The tamarind fruit seed coat powder used as the filler in composite plates. The tamarind fruit pulps are used to make indian curry receipe and playing major role in making of candies. These fibers may be used in a variety of applications, like used in boat hulls, swimming pool panels, shower stalls, counter tops.

REFERENCE

1. Gaurav, Hrithik gohal, Vishal kumar, and Hemalata jena, Study of natural fiber composite material and its hybridization techniques, *Materialstoday: Proceedings*, volume-26, part 2, 2019, pg.no 1368-1372.
2. Ghali, A. E., I. B. Marzoug, M. H. V. Baouab, and M. S. Roudesli. 2012. Separation and characterization of new cellulosic fibers from the *Juncus actus* Epoxy. *bioresources* 7 (2):2002–18. doi:10.15376/biores.7.2.2002-2018.
3. Geethamma, V. G., L. A. Pothan, B. Rhao, N. R. Neelakantan, and S. Thomas. 2004. Tensile stress relaxation of short-coir-fiber-reinforced natural rubber composites. *Journal of Applied Polymer Science* 94 (1):96–104. doi:10.1002/app.20746.
4. Fiore. V, G. Di Bella, Valenza. A, The effect of alkaline treatment on mechanical properties of kenaf fibers and their Epoxy composites, *Composites part B: Engineering*, volume-68, 2015, pg.no14-21.
5. Fong Sim, S., M. Mohamed, N. Aida Lu Mohd Irwan Lu, N. P. Safitri Sarman, and S. Nor Sihariddh Samsudin. 2012. Computational FTIR with PCA. *Bioresources* 7 (4):5367–80.
6. Espinach F.X, Granda L.A, Tares. Q, Duran. J, Fullan-I-Palmer. P, Mutje. P, Mechanical and micromechanical tensile strength of eucalyptus bleached fibers reinforced polyoxymethylene composites, *Composites part B: Engineering*, volume-116, 2017, pg.no 333-339.
7. Devipriya .D, Selvaraj mohana roopan, *Cissus quadrangularis* mediated eco-friendly synthesis of copper oxide nanoparticles and its antifungal studies against *Aspergillus Niger*, *Aspergillus flavus*, *National library of medicine*, 2017.
8. Bessadok, A., S. Marais, F. Gouanve, L. Colasse, I. Zimmerlin, I. Zimmerlin, and M. Metayer. 2007. Effect of chemical treatments of Alfa (*Stipa tenacissima*) fibers on water-sorption properties. *Compo. Sci. Technol* 67 (3–4):685–97. doi: 10.1016/j.compscitech.2006.04.013.
9. Basu, G., A. N. Roy, K. K. Satapathy, S. M. J. Abbas, L. Mishra, and R. Chakraborty. 2012. Potentiality for value-added technical use of Indian sisal.

10. Kaushik, N. K., A. Bagavan, A. A. Rahuman, D. Mohanakrishnan, C. Kamaraj, G. Elango, A. A. Zahir, and D. Sahal. 2013. Antipox Resin LY 556smodial Potential of Selected Medicinal Epoxy from Eastern Ghats of South India. *Experimental Parasitology* 134 (1):26–32. doi: 10.1016/j.exppara.2013.01.021
11. Hossain. S. I, Hasan .M, Hasan.MD. N, and Haasan. A, Effect of Chemical Treatment on Physical, Mechanical and Thermal Properties of Ladies Finger Natural Fiber, *Advances in materials science and engineering*, volume-13, 2013.
12. Henriksson, G. et al., 1997. Identification and retting efficiencies of fungi isolated from dew-retted flax in the United States and Europe. *Appl. Environ. Microb.* 63, 3950–3956 Hong C.K, Hwang. K, Kim .N, Park D.H, and Hwang B.S, Mechanical properties of salinized jute–polypropylene composites, *Journal of industrial and engineering chemistry*, volume-14, 2008, pg.no 71-76.
13. Hazarika, D., N. Gogoi, S. Jose, R. Das, and G. Basu. 2017. Exploration of future prospects of Indian pineapple leaf, an agro waste for textile application. *Journal of Cleaner Production* 141:580–86.
14. Reddy, N., and Y. Yang. 2009. Extraction and Characterization of Natural Cellulose Fibers from Common Milkweed Stems. *Polymer Engineering and Science* 49 (11):2212–17.
15. Kommula V.P, Obi reddy .K, Shukla .M, Marwala .T, Varada Rajulu .A, Physio-chemical, tensile, and thermal characterization of napier grass (native African) fiber strands, *International journal of polymer analysis and characterization*, volume-18, 2013, pg.no 303-314.
16. Madhusudhan reddy .B, Meenakshi reddy .R, Chandrasekhar reddy .B, Venkateshwar reddy .P, Raghavendra rao .H, Mohan reddy Y.V, the effect of granite powder on mechanical, structural and water absorption characteristics of alkali treated Cordia dichotoma fiber reinforced polymer composite, *Polymer testing*, volume-91, 2020.
17. Manimaran .P, Saravanan S.P, Prithiviraj .M, Investigation of physical chemical

properties and characterization of new natural cellulosic fibers from the bark of *Ficus racemosa*, Journal of natural fiber, volume-18, issue 2, 2019, pg.no 274-284.

18. Yan, Y. 2016. Developments in fibers for technical nonwovens. Advances in Technical Nonwovens 19–96.