

MECHANICAL PROPERTY AND ANALYSIS OF GLASS FIBER AND COIR FIBER FOR REINFORCED COMPOSITE IN SPUR GEAR

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in mechanical engineering

By

**SANTHOSH BALAJI (REG. NO. 37150166)
KARTHICK M (REG. NO. 37150092)**



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**

APRIL 2021



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with “A” grade by NAAC

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119

www.sathyabama.ac.in



DEPARTMENT OF MECHANICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Santhosh balaji P (37150166)** and **Karthick M (37150092)**, who carried out the project entitled “Mechanical Property and analysis of glass fiber and coir fiber for reinforced composite in spur gear” under my supervision from December 2020 to March 2021.

Internal Guide

Dr. B. Kanimozhi, 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 **SANTHOSH BALAJI P (37150166)** and **KARTHICK M (37150092)** declare that the Project Report entitled “**Mechanical Property and analysis of glass fiber and coir fiber for reinforced composite in spur gear**” done by us under the guidance of **Dr. B. Kanimozhi, M.E., Ph.D.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical engineering.

DATE:

1.

PLACE:

2.

SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

I am 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. I am grateful to them.

I convey my 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, Dept. of Mechanical engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. B. Kanimozhi. M.E., Ph.D.**, for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of **Mechanical engineering** who were helpful in many ways for the completion of the project.

ABSTRACT

This project gives the fabrication and investigation of mechanical properties of glass fibre and coir with epoxy composite. In this process the fabrication is done by hand-layup method with random orientation of epoxy and glass fibers. Here by changing the volume fraction of the glass and coir fibers to 96% & 4% composite also 98% in 2% coir fibre laminates were prepared and tested for its mechanical properties such as tensile and compression test. The final composition is fabricated as better strength from 98% composition of glass while comparing to 96% composition and the final fabrication of gear is made as better strength from 98% glass and 2% coir composition.

TABLE OF CONTENT

CHAPTER No.	TITLE	PAGE No.
	ABSTRACT	v
	LIST OF FIGURES	ix
	LIST OF TABLES	xi
	LIST OF SYMBOLS AND ABBREVIATIONS	xii
 1	 INTRODUCTION	 1
1.1	Composite	1
1.2	Characteristics of composites	2
1.3	Definition of composite	3
1.4	Classification	3
1.4.1	Particulate composite	3
1.4.2	Fibrous composite	4
1.5	Components of a composite material	6
1.5.1	Role of matrix in a composites	6
1.5.2	Materials used as matrices in composites	6
1.6	Types of composite material	7
1.6.1	Fiber reinforced composites	7
1.6.2	Dispersion hardened material	7
1.6.3	Particulate composite	7
 2	 LITERATURE SURVEY	 9
2.1	Natural fiber : source and classification	12
2.2	Natural fiber reinforced polymer composites	15
2.3	SEM micrographs of treated fibers	16

2.4	FTIR spectroscopy	17
3	AIM AND SCOPE	18
3.1	AIM	18
3.2	SCOPE OF THE PROJECT	18
4	MATERIALS AND METHODOLOGY	19
4.1	Composite fabrication	19
4.1.1	Glass fiber	19
4.1.1.a	types of glass fibers	20
4.1.1.b	E-Glass fiber and its properties	21
4.1.2	Epoxy resin	23
4.1.3	Coir fibers	25
4.2	Design and analysis	27
4.3	Methodology	29
4.3.1	Spray layup method	29
4.3.2	Vacuum bag technique	30
4.3.2.a	advantages of vacuum bag technique	30
4.3.3	Hand layup method	32
4.3.3.a	procedure for fabrication of composite	33
4.3.3.1	preparation of mold	33
4.3.3.2	applying the gel coat	33
4.3.3.3	preparation of resin	33
4.3.3.4	laying reinforcement	33
4.3.3.5	curing	34
4.3.3.6	remove part from mold	34
4.3.3.7	surface finish	34
4.4	Composites- different w.t% of fiber and resin	35

	4.4.1 design of spur gear	35
	4.4.2 calculations	36
4.5	Fabrication	39
5	TESTING AND RESULTS	47
5.1	Compression test	48
5.2	Tensile test	59
5.3	Bending test	51
6	CONCLUSION	52
7	REFERENCE	53

LIST OF TABLES

TABLE No	TITLE	PAGE No.
2.1	Properties of natural fiber	13
4.1	Properties of glass fiber	22
4.2	Properties of epoxy resin	24
4.3	Properties of coir fiber	26
4.4	Sample wt %	35
5.1	Compression test	48
5.2	Tensile test	50
5.3	Bending test	51

LIST OF FIGURES

FIGURE No	TITLE	PAGE No.
1.1	Classification of composites	5
1.2	Types of Composite material	7
2.1	Overview of natural fiber	14
2.2	Classification of natural fiber	15
4.1	Woven-E- Glass fiber	22
4.2	Epoxy resin	24
4.3	Coil fibre	26
4.4	Spur gear	27
4.5	Strain energy gear	27
4.6	Total deformation	28
4.7	Normal stress gear	28
4.8	Spray layup method	30
4.9	Vacuum bag technique	31
4.10	Hand layup method	32
4.11	Mixture of epoxy resin	39
4.12	Mixture of epoxy resin with hardner	39
4.13	Weight balance	40
4.14	Spur gear shaped acrylic sheets	40

4.15	Mold for making composite spur gear	41
4.16	Glass fiber	41
4.17	Epoxy resin	41
4.18	Coil fiber	42
4.19	Sample piece 1	43
4.20	Sample piece 2	44
4.21	Composite spur gear	45
5.1	Compression testing machine	47
5.2	Maximum shear stress	51

LIST OF SYMBOLS AND ABBEREVIATIONS

Pd	Pitch diameter
Pc	circular pitch
ha	addendum
hf	dedendum
c	clearance
Ht	whole depth
hk	working depth

CHAPTER 1

INTRODUCTION

1.1 Composite

Composite material plays a major role in aircraft parts manufacturing industries. The characteristics like high strength, high stiffness, light weight and low density are attracting the research and development of the aerospace and automobile sector. Within the proceeding journey for progressed execution, which may be indicated by different criteria counting less weight, more quality and lower taken a toll, right now utilized materials habitually reach the restrain of their convenience. Thus material scientists, engineers and scientists are always striving to produce either improved traditional materials or completely new materials. Composites are an case of the last mentioned category. Within last forty to fifty years, there has been a rapid increase in the production of synthetic composites, those incorporating fine fibers in various plastics (polymers) dominating the market. With the expanding worldwide vitality emergency and biological dangers, researchers all over the world are moving their consideration towards elective arrangement to manufactured fiber. Since 1990s, normal fiber composites are rising as reasonable elective to glass-reinforced composites in numerous applications. Characteristic fiber composites are claimed to offer natural preferences such as diminished reliance on non-renewable energy/material sources, lower poison emanations, lower green house gas emanations, improved vitality recuperation and conclusion of life biodegradability of components. Such predominant natural exhibitions are critical driver of expanded future utilize of characteristic fiber composite.

Over the final thirty a long time composite materials, plastics and ceramics have been the prevailing rising materials. The volume and number of applications of composite materials have developed consistently, entering and prevailing unused markets tenaciously. Cutting edge composite materials constitute a critical extent of the designed materials showcase extending from regular items to advanced specialty applications. Whereas composites have as of now demonstrated their worth as weight-saving materials, the current challenge is to create them fetched compelling. The endeavors to deliver financially appealing composite components have brought about in a few imaginative manufacturing techniques right now being utilized within the

composites industry. It is clear, particularly for composites, that the improvement in fabricating innovation alone isn't sufficient to overcome the taken a toll jump. It is fundamental that there be an coordinates exertion in plan, fabric, handle, tooling, quality affirmation, fabricating, and indeed program administration for composites to ended up competitive with metals. The composites industry has started to recognize that the commercial applications of composites guarantee to offer much bigger commerce openings than the aviation division due to the sheer estimate of transportation industry. In this way the move of composite applications from airplane to other commercial employments has gotten to be noticeable in later a long time.

1.2 Characteristics Of The Composites

Composites comprise of one or more irregular stages implanted in a persistent stage. The spasmodic stage is as a rule harder and more grounded than the ceaseless stage and is called the 'reinforcement' or 'reinforcing material', while the persistent stage is named as the 'matrix'. 5 Properties of composites are strongly dependent on the properties of their constituent materials, their distribution and the interaction among them. The composite properties may be the volume division whole of the properties of the constituents or the constituents may associated in a synergistic way coming about in made strides or superior properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and size distribution) influences the properties of the composite to a great extent. The concentration dispersion and introduction of the support to influence the properties. The shape of the spasmodic stage (which may by round, round and hollow, or rectangular cross-sanctioned crystals or platelets), the estimate and measure dispersion (which controls the surface of the fabric) and volume division decide the interfacial zone, which plays an critical part in deciding the degree of the interaction between the support and the lattice. Concentration, ordinarily measured as volume or weight division, decides the commitment of a single constituent to the generally properties of the composites. It isn't as it were the single most critical parameter impacting the properties of the composites, but moreover an effectively controllable fabricating variable utilized to modify its properties.

1.3 Definition Of Composite

The foremost broadly utilized meaning is the taking after one, which has been expressed by Jartiz [1] “Composites are multifunctional fabric frameworks that give characteristics not reachable from any discrete fabric. They are cohesive structures made by physically 4 combining two or more compatible materials, different in composition and characteristics and sometimes in form” The shortcoming of this definition dwelled within the reality that it permits one to classify among the composites any blend of materials without showing either its specificity or the laws which ought to given it which recognizes it from other exceptionally commonplace, aimless blends.

Kelly [2] exceptionally clearly stresses that the composites ought to not be respected straightforward as a combination of two materials. Within the broader importance; the combination has its possess unmistakable properties.

in deciding the degree of the interaction between the fortification and the framework.

1.4 Classification

Composite materials can be classified in different ways. Classification based on the geometry of a agent unit of fortification is helpful since it is the geometry of the support which is capable for the mechanical properties and tall execution of the composites. A typical classification is presented in Table1.1. The two broad classes of composites are:

(i) Particulate composites

(ii) Fibrous composites

1.4.1 Particulate Composites

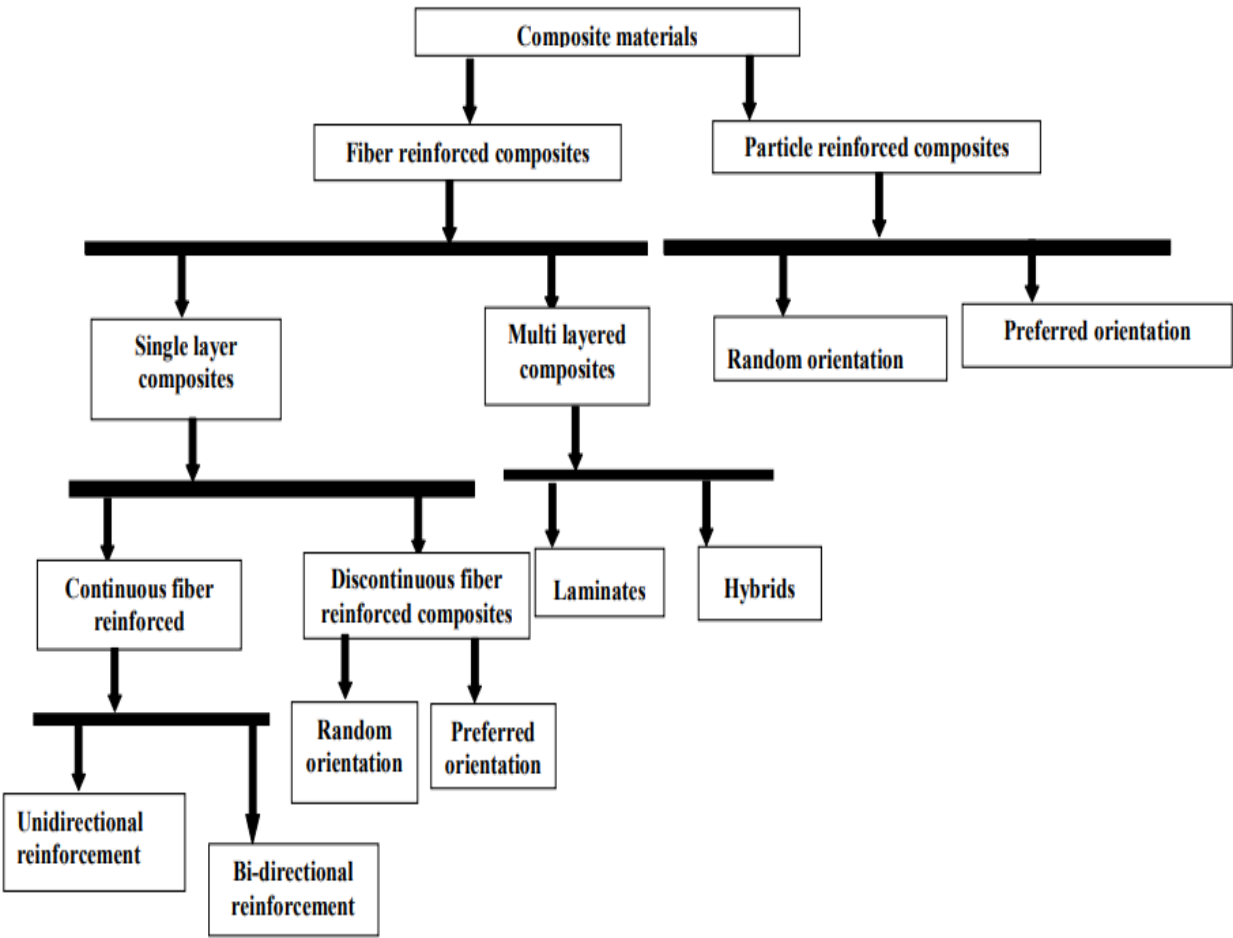
As the name itself indicates, the reinforcement is of particle nature (platelets are also included in this class). It may be circular, cubic, tetragonal, a platelet, or of other customary or sporadic shape, but it is around equiaxed. In common, particles are not exceptionally viable in making strides break resistance but they improve the solidness of the composite to a restricted degree.

Molecule fillers are broadly utilized to progress the properties of lattice materials such as to adjust the warm and electrical conductivities, make strides execution at raised temperatures, a diminish grinding, increment wear and scraped spot resistance, progress machinability, increment surface hardness and decrease shrinkage.

1.4.2 Fibrous composites

A fiber is characterized by its length being much more prominent compared to its cross sectional measurements. The measurements of the fortification decide its capability of contributing its properties to the composite. Strands are exceptionally viable in moving forward the break resistance of the lattice since a support having a long measurement disheartens the development of early splits ordinary to the fortification that might other astute lead to disappointment, especially with fragile frameworks. Man-made fibers or filaments of non polymeric materials display much higher quality along their length since huge imperfections, which may be show within the bulk fabric, are minimized since of the little cross-sectional dimensions of the fiber. Within the case of polymeric materials, introduction of the atomic structure is mindful for tall quality and firmness .Fig 1.5 shows the classification of composites.

Figure1.1 Classification of composite



1.5 Components Of A Composite Material

In its most fundamental shape a composite fabric is one, which is composed of at slightest two components working together to create fabric properties that are diverse to the properties of those components on their claim. In hone, most composites comprise of a bulk fabric (the 'matrix'), and a fortification of a few kind, included essentially to extend the quality and solidness of the framework.

1.5.1 Role of matrix in a composite

Numerous materials when they are in a stringy shape display exceptionally great quality property but to attain these properties the strands ought to be fortified by a appropriate network. The lattice separates the filaments from one another in arrange to anticipate scraped spot and arrangement of unused surface blemishes and acts as a bridge to hold the filaments in put. A great lattice ought to have capacity to misshape effortlessly beneath connected stack, exchange the stack onto the strands and equally distributive stretch concentration.

1.5.2 Materials used as matrices in composites

In its most essential frame a composite fabric is one, which is composed of at slightest two components working together to deliver fabric properties that are diverse to the properties of those components on their claim. In hone, most composites comprise of a bulk fabric (the network) and a fortification of a few kind, included fundamentally to extend the quality and solidness of the framework.

1.6 Types Of Composite Materials

1.6.1 Fiber-Reinforced Composites:

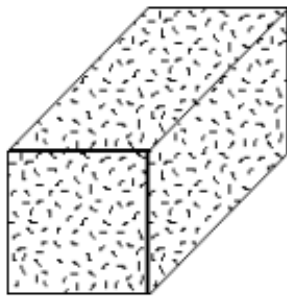
More often than not the fiber fortification is done to get high strength and high modulus. Thus it is fundamental for the strands to possess higher modulus than the network fabric, so that the load is exchanged to the fiber from the matrix more successfully.

1.6.2 Dispersion Hardened Material:

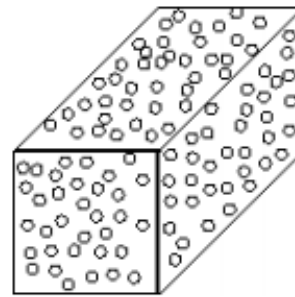
In this type of material, fine particles of sizes ranging from $0.01\mu\text{m}$ to $0.14\mu\text{m}$ are dispersed in matrix. Their concentration varies from 1% to 15% volume. These fine particles block separation development within the fabric and thus result in exceptionally high quality. Moreover these materials have moved forward high temperature quality and crawl resistance.

1.6.3 Particulate composite:

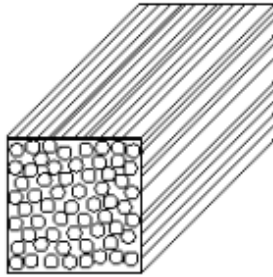
In this type of composites, $1\mu\text{m}$ to $200\mu\text{m}$ estimate particles are scattered within the network and volume division is for the most part between $0.01 V_f$ to $0.85 V_f$.



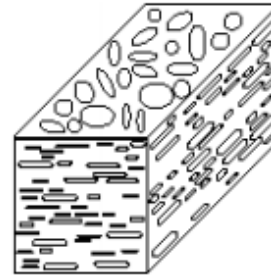
(a) Random fiber (short fiber) reinforced composites



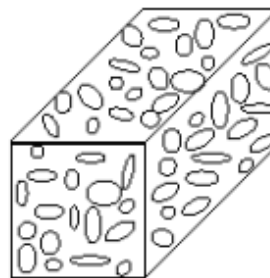
(b) Particles as the reinforcement (Particulate composites)



(c) Continuous fiber (long fiber) reinforced
Composites



(d) Flat flakes as the reinforcement
(Flake composites)



(e) Fillers as the reinforcement (Filler composites)

Figure-1.2 types of composite materials

CHAPTER 2

LITERATURE SURVEY

Dipen Kumar, et al said Composites have been found to be the foremost promising and perceiving material available in this century. Presently, composites strengthened with filaments of engineered or common materials are gaining more significance as requests for light weight materials with high quality for specific applications are developing within the market.

P. Yuvaraj depicts around the fabricating of composite spur gears strengthened with soluble base treated Lantana Camara powder (LCP) with distinctive volume divisions as 5%, 10% and 15%. Unsaturated polyester resin chosen as framework material while LCP as support. At last, 3 gears are machined by equip hobbing prepare.

Prasanna said Fiber reinforced polymer composites (FRPCs) are utilized in almost all type of advanced designing structures like airplane, vessels, ships and, helicopters, automobiles, donning merchandise, chemical handling equipment etc. In the field of composite materials the fiber reinforced composite consisting of one fiber is used for long time. The results would have appeared for certain area.

K . Mao, 2007 said that the analysis of the flash temperature for polymer composite gears and the heat partition between gear teeth problem is treated as an unsteady one where the intensity distribution and velocity of heat source changes as meshing proceeds. A numerical method has been developed in the current paper for polymer composite gear flash temperature prediction.

R . Yakut, 2009 said that In this study, Load carrying capacity and occurring damages of gears which are made of PC/ABS blends were investigated. PC is hard material and ABS is soft material. The usage of material limits these drawbacks. The usability of PC/ABS composite plastic materials as spur gear was investigated. PC/ABS gears were tested by applying three different loading at two different numbers of revolution on the FZG experiment set.

J.L. Moya, A.S. Machado, 2007 have performed a theoretical analysis of a procedure to determine the lewis factor and also performed the contact analysis of spur gears to find the stress distribution between gear teeth.

M.H. Tsai, 1997 said that the established characterization method for seven polyamide grades to determine the major material to manufacture an automotive worm gear. According to worm gear loadings: tensile strength, young's modulus, abrasion and impact resistance the composite properties were measured. They were also correlated to the polyamide moisture absorption and its glass fiber reinforcement. A higher difficulty to process polyamide 6/6 30% glass fiber was found due to its lower apparent viscosity. The best performance of polyamide were polyamide 6 with 30% glass fiber gear and with polyamide 60% glass fiber pinion.

R. Prabu Sekar et al. have said to study to minimize the wear of the gear teeth by adopting the non- standard gear. Discussed the parametric study between standard and non – standard gear. Detailed study on wear by using or comparing the results between FEM and analytical approach. Suggested the one possible solution for the enhancement of wear resistance and load carrying capacity of the gear tooth in bending and contact. Judging the change in gear and drive parameters of non – standard pinion and gear.

Ankur Saxena et al said to study the effect of shaft misalignment and friction force on mesh stiffness for spur gear pair. This effect was also studied for cracked gear pair and results are discussed.

Marina Franulovic et al said It is the state of influence of pitch deviations on the loading capacity of contact ratio of spur gear by experimentally and analytically. The experimental method was done by the photoelastic investigation. In this paper analytical calculations are presented and this will considerably improve the loading capacity calculation of higher contact ratio gears and also further provide optimization of their design.

Naresh k. Raghuwanshi et al discussed the results of back side contact which affect the mesh stiffness of spur gear by using FEM. From the observation, the result shows that the back side contact occur to mesh stiffness value is slightly increased. It may affect the vibration response.

Paras Kumara et al studied the bending and contact stress of spur gear tooth by using AGMA equation for the purpose of investigated of fatigue failure. The results shown in single tooth contact zone the maximum chance of contact fatigue failure occurs. In comparison of bending fatigue life the contact fatigue life is less. He compared analytical results to the FEA.

Deepika Potghan et al said that In this paper studied the stress analysis of spur gear with three different materials to determine the contact stresses in gear tooth. The materials were grey cast iron, high carbon steel and medium carbon steel. The result of analytical solution by hertz equation and FEA results are comparing, the less difference between values are found.

Abhijit M. Sankpal et al studied about the contact stress of spur gear by FEM and experimental method. The contact stresses of spur gear found by the photoelastic techniques as an experimental method. This results are compared with FEM. With the help of result the selection of proper module size an important factor before designing gear maximum contact stress decrease with increasing module.

Sanjay K. Khavdu et al said by using FEA investigated contact stress when acting same load on metallic spur gear and hybrid spur gear. And also investigated the weight optimization on ANSYS work bench . The result shows instead of metallic spur gear the hybrid spur gear shows better results. The result found that the stresses developed within hybrid gears are near about stresses in metallic gears. By using hybrid gear there advantage was reduced the weight of mechanism. He carried analysis using FEA.

2.1 NATURAL FIBERS; Source and classification:

The use of lignocellulosic fibers as reinforcements for polymeric materials has been developing amid the final decade or so to replace manufactured fibers, particularly glass fibers in composites, for different industrial divisions, such as packaging, automobiles and indeed within the building sector. This is mainly due to their unique characteristics, such as availability, biodegradability, low density, non-toxic nature, less abrasiveness to plastic processing equipment, useful mechanical properties and low cost (The price of glass fiber is around Rs. 300/- per kg and has a density of 2.5 g/cc. On the other hand, common fiber costs Rs. 15 to 25/- per kg and has a density of 1.2-1.5 g/cc.) . The leading driver for substituting common fiber for synthetic fiber i.e. glass can be well recognized from the fact that the pliable quality of common fiber is significantly lower than that of glass fibers in spite of the fact that the modulus is of the same order of magnitude. However, when the particular modulus of characteristic fibers (modulus per unit particular gravity) is considered, the natural fibers show values that are comparable to or even better than glass fibers. Table 2.1 clearly demonstrates this.

Common natural fibers can be derived from either animal or plant sources. The larger part of valuable characteristic material fibers are plant derived, with the exemptions of wool and silk. All plant filaments are composed of cellulose, while fibers of creature origin comprise of proteins. Natural fibers in common can be classified based on their origin, and the plant-based strands can be further categorized based on portion of the plant they are recuperated from. An diagram of characteristic filaments is displayed in figure 2.1.

Generally, plant or vegetable strands are utilized to strengthen polymer matrices and a classification of vegetable fibers is given in figure 2.2. Plant filaments are a renewable asset and have the capacity to be reused. The plant fibers leave little residue if they are burned for disposal, returning less carbon dioxide (CO₂) to the atmosphere than is removed during the plant's growth. Fig 2.1 shows overview of natural fiber and Fig 2.2 shows the classification of natural fiber that can be used as reinforcements in polymer.

Table 2.1: Properties of natural fibers

S.NO	PROPERTIES	E- glass fibre	Hemp fibre	Flax fibre	Jute fibre	Sisal fibre	Coir fibre	Ramie fibre
1	Density (gm/cc)	2.5	1.48	1.4- 1.5	1.3 - 1.46	1.33 - 1.5	1.2	1.5
2	Tensile strength (Mpa)	2000- 3500	550 - 900	345 - 1500	393 - 800	400 - 700	175 - 220	220 - 938
3	Young's modulus (Gpa)	70	70	27.6 - 80	10 - 30	9 - 38	4 - 6	44 - 128
4	Elongation (%)	2.5 - 3	1.6	1.2 – 3.2	1.5 – 1.8	2 - 14	15 - 30	2 – 3.8
5	Moisture absorption (%)	-	8	7	12	11	10	12 - 17

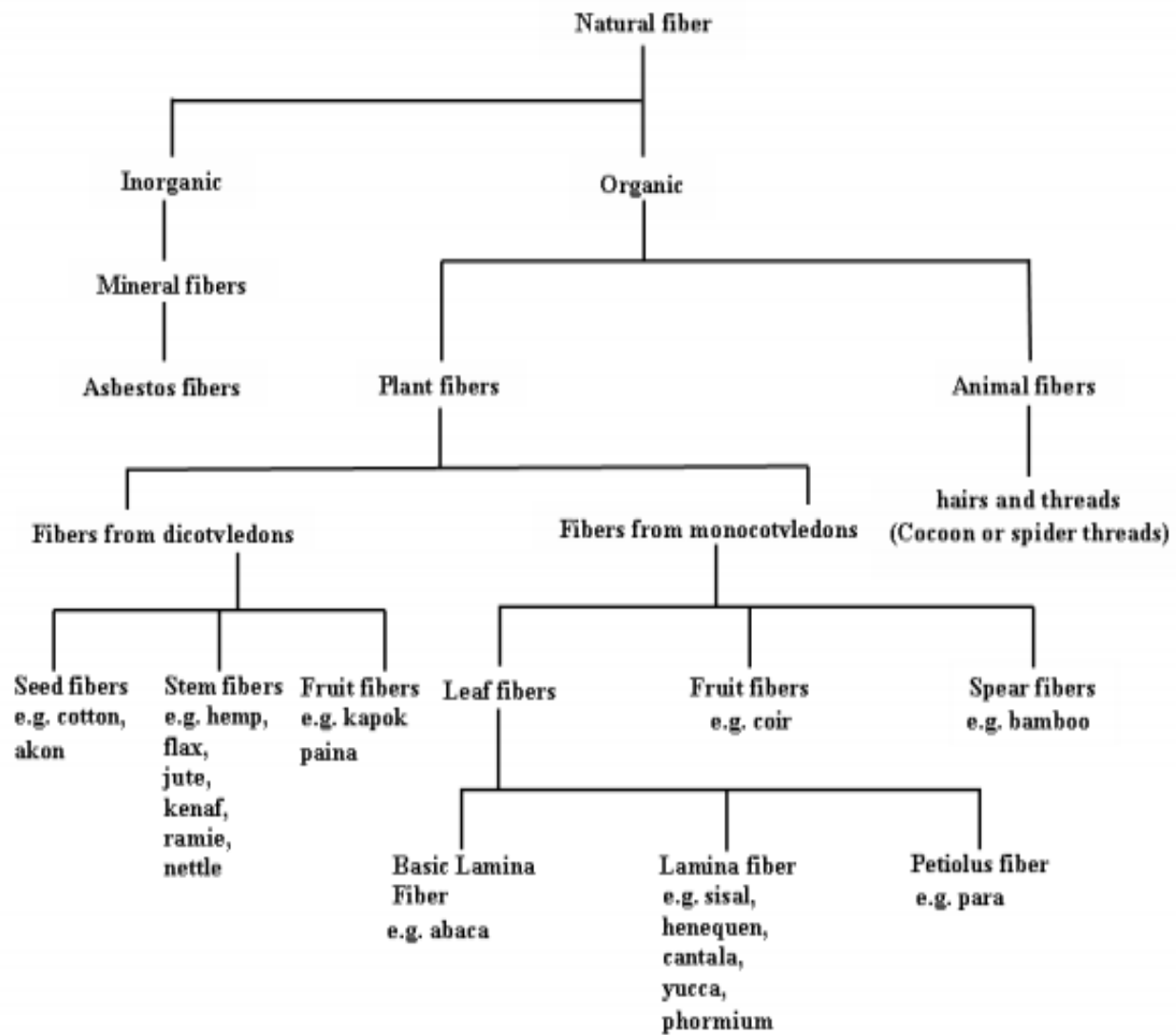


Figure-2.1 Overview of natural fiber

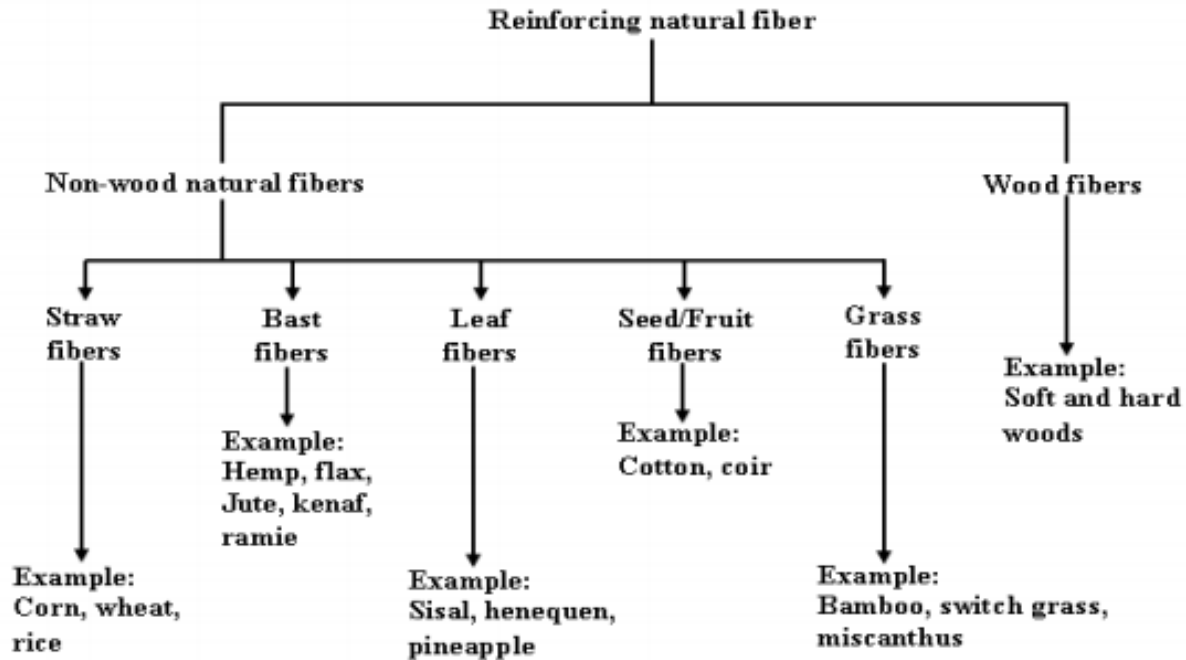


Figure-2.2 Classification of natural fiber that can be used as reinforcements in polymers

2.2 Natural Fiber Reinforced Polymer Composites

Polymer materials by themselves have found broad utilize in noncritical items. Such products are used in advanced engineering applications when reinforced with stronger 28 materials. Hence fiber fortified composites comprised of thermoplastics and common fibers are a well research area at present for their high particular quality and modulus. The advantages of characteristic lignocellulosic strands over conventional fortifying materials such as carbon, glass strands, powder and mica are low cost, acceptable particular strength properties, low density, non absorptivity, good thermal properties, upgraded vitality recovery and biodegradability. The use of common fibers in plastic lattice incorporates numerous benefits such as low volumetric cost, increment of heat deflection temperature, increment of firmness of thermoplastics and change of wood surface appearance. So characteristic fibers have accomplished applications in making several complex structures such as tubes, insides paneling, sandwich plates, decking, furniture parts, sports utilizations etc.

One of the biggest zones of later development in characteristic fiber plastic composites in world-wide is the automotive industry, where common strands are profitably utilized as a result of their low thickness and increasing environmental pressures. They are moreover utilized in electrical and electronic application for their nonconductive and excellent insulation against heat and noise. Common strands composites found application where load bearing capacity and dimensional stability beneath moist and high thermal conditions are of second order significance. For example, flax fiber strengthened polyolefins are broadly utilized nowadays within the automotive industry, but the fiber acts basically as filler fabric in non-structural interior boards . Characteristic fiber composites utilized for basic purposes do exist, but at that point usually with manufactured thermo-set matrices which of course restrain the environmental benefits.

2.3 SEM Micrographs of Treated Fibers

The morphology of the untreated and treated fiber surfaces has been studied using scanning electron magnifying instrument (SEM) JEOL JSM-6480LV. The test surfaces were gold coated to create them conductive earlier to SEM perception. SEM micrographs of the untreated and treated banana fibers. It is well established that the cellulose chains of normal fiber are strongly bound by chemical constituents, lignin, and hemicellulose, coming about within the arrangement of multi-cellular fiber. The surface of untreated fiber appeared unpleasant due to the presence of lignin, wax, oil, and surface debasements , which are mostly expelled with acetone and encourage evacuated with alkali treatment, These clean surfaces are expected to provide direct bonding between the fiber cellulose and a matrix such as epoxy resin. By comparing treated fibers with the untreated fibers, it can be seen that the alkali treatment resulted in separation of the micro fibrillar structure (fibrillation) and decrease in thickness of fiber since of the evacuation of cemented materials (i.e. lignin and hemicellulose).The fibrillation increases effective surface area available for contact with the matrix and hence the interfacial adhesion was improved. Additionally these two treatments increase the viable surface range by fibrillation which promotes the mechanical interlocking between the fiber and the matrix where as the acetone treatment does not affects the fiber surface very much.

2.4 FTIR Spectroscopy

The impact of chemical adjustments on the fiber surface was observed by utilizing FTIR spectroscopy. FTIR estimation was performed using an IR-Prestige-21 spectrometer. A total of 100 checks were taken from 400-4000 cm^{-1} with a determination of 2 cm^{-1} for each test. The comparison of the agent FTIR spectra of untreated banana before and after chemical treatment (acetone and antacid treatment) is appeared. In comparison to the unmodified banana fiber, the acetone treated and alkali treated banana showed a reduction in O-H stretching intensity and shifting of the peak from 3409.76 cm^{-1} to 3421.61 and 3418.88 cm^{-1} respectively, demonstrating participation of a few free hydroxyl groups in these chemical responses. The point of response was likely at the lignin –OH and C2-OH of the glucopyranose unit within the cellulose component. The band of medium intensity at 828.32 cm^{-1} due to β -glycosidic linkage in the unmodified banana fiber underwent shifting to a lower wave number, except acetone treated fiber accompanied by an increase in the intensity.

CHAPTER – 3

AIM AND SCOPE OF THE PROJECT

3.1 AIM

To compare the performance and characteristics of spur gear using composite material of glass fiber and coir fiber with mild steel of Spurger and to determine the best combination of glass fiber and coir fiber along with epoxy resign for optimum performance.

3.2 SCOPE OF WORK

To determine the parameters of compression testing, tensile strength testing and also finally bending test for composite material of spur gear with glass fiber and coir fiber along with epoxy resign. It passes the failure testing and also compared with mild steel spur gear and so it can be replaced with plastic material for the applications such as washing machines, blenders and so on.

CHAPTER 4

MATERIALS AND METHODOLOGY

4.1 Composite Fabrication

For preparation of composite the following materials have been used;

- i) Glass fiber
- ii) Coir fiber
- iii) Epoxy resin
- iv) Hardner

4.1.1. Glass fiber

The Glass fibers, also known commercially as „fiberglass“, are most extensively use reinforcements for polymer matrix composites due to their combination of low cost, high strength and relatively low density. Unlike carbon fibers, glass fibers are isotropic(substance having a physical property which has the same value when measured in different directions) thus avoiding loss of properties when loaded in the transverse direction.Fiberglass is delivered by pulling liquid glass through holes at a temperature where the glass has fair the correct sum of viscosity(measure of resistance to flow). Glass fiber may be a lightweight, greatly solid, and vigorous fabric. Strength properties are lower than carbon fiber and it is less stiff, the material is typically far less brittle and is much less expensive. Its weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes.This handle is beginning with strong glass dots that are remelted and metered into a drawing box, the foot of which contains gaps lined with platinum bushings. From three hundred to three thousand such bushings, which act to meter out the correct sum of glass, may be utilized. The fibers are shaped into a nonstop fibers by high-speed exactness winders (Draw Rolls). Different estimate strands, from 10 μm to 40 μm , can be shaped from the same bushing distance across by changing the speed of the drawing roll. A chemical treatment, ordinarily alluded to as "measuring" or "folio," is connected to the fibers amid the winding prepare to the fibers and decreased fiber breakage amid ensuing preparing

steps. these basic fibre glass strands are composed of filaments which are then twisted to achieve a product which meets the requirements for further processing. Single yarns can at that point be changed over to utilized yarns by turning two or more singles together in a moment turning operation.

4.1.1.a. Types of Glass Fibers

E-glass Strong and low cost, but modulus is less than other (500,000 psi). Alumina-calcium-borosilicate glasses with a maximum alkali content of 2% w/w used as a general purpose reinforcement where strength and high electrical resistivity are required.

E-CR glass Corrosive resistance with the fortifying characteristics of E-glass.

AR glass : Alkali safe glasses composed of antacid zirconium silicates, created for utilize in utilize in cement and concrete. Basically utilized for GRC (Glass strengthened Cement) material and sheeting boards.

C glass : Calcium borosilicate glasses used for their exceptional stability in acidic environments. Also known as corrosion and chemical resistant glass fibers. To protect against water erosion, a moisture-resistant coating such as a silicone compound is coated onto the fibers during manufacturing. Adding resin during composite formation provides additional protection. C-Glass fibers are used for manufacturing storage tanks, pipes and other chemical resistant equipment. Such as application in surface mats, glass flakes for coatings and acid resistant surface cloth.

D glass : Borosilicate glasses with low dielectric constant used for random and other specialty applications requiring permeability to electromagnetic waves.

E- CR glass : Calcium alumino silicate glasses with a maximum alkali content of 2% w/w used where acid corrosion resistivity is required in addition to strength and electrical resistivity. Introduced in 1980.

R - glass : Calcium aluminosilicate glasses with higher quality and temperature resistance.

S - glass : Magnesium alumino silicate glasses utilized for material substrates or fortification in composite auxiliary applications, which require tall quality, modulus and strength beneath conditions of extraordinary temperature of destructive environments. Letter designation Property or Characteristic

- E - Electrical Low electrical conductivity
- S - Strength High strength
- C - Chemical High chemical durability
- M - Modulus High stiffness
- A - Alkali High alkali or soda lime glass
- D - Dielectric Low dielectric constant

4.1.1.b.E-Glass Fiber and its properties

The E-Glass Fiber is the foremost common sort of glass fiber utilized in fiberglass. The E-Glass Fiber is alimino-borosilicate glass with less than 1% w/w (10% by weight) antacid oxides. The composition of E-Glass Fiber is 55%SiO₂, 11%Al₂O₃, 6%B₂O₃, 18%CaO, 5%MgO, 5%Other. E-Glass fibers are mixture of oxides and therefore do not burn in air or oxygen, however they can soften, melt and fuse at high temperatures (850 to 900 °C).

The thermal conductivity of E-Glass Fiber is 10.4, Wm⁻¹K⁻¹. The coefficient of thermal expansion of E-glass is very low. The thermal expansion of glass fiber is 5 x10⁻⁶/oK. The strength of E-Glass fiber is 498V/mil. The density of E-Glass Fiber is 2.54g/cc. The tensile strength of glass fibre is 2000MPa. They are available at low cost. The E-Glass Strands are light weight and amazingly solid. A combination of great mechanical properties and moderately lower taken a toll makes the glass fiber an alluring choice for the marine structures. The glass fiber chosen was E-glass, a most common sort utilized within the composites. The woven meandering (Rovcloth) was chosen as one of the textures because of its wide use in boat construction and its inexpensive way of applying a large quantity of the glass in one ply. Fig 4.1 shows woven E-Glass fiber.

Table 4.1. properties of glass fiber

S.NO	FIBER PROPERTIES	GLASS FIBER
1	Density (g/m ³)	2.59
2	Tensile strength (Mpa)	1380 - 2070
3	Tensile modulus (Gpa)	72.45
4	Linear coefficient of thermal expansion (10 ⁻⁶ /k)	5.0 – 6.0
5	Elongation at break (%)	3 - 4

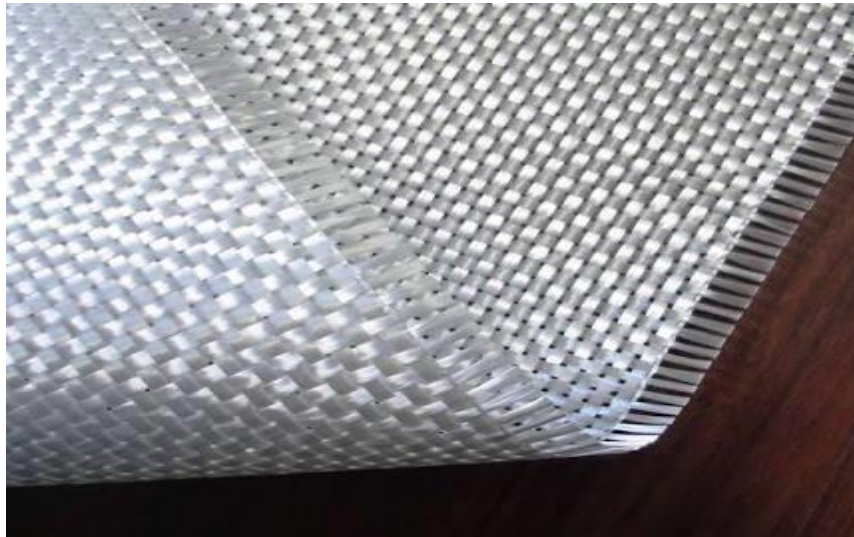


Fig.4.1. Woven E-Glass Fiber

4.1.2. EPOXY RESIN

Epoxy resin alludes to a sort of responsive pre polymer and polymer containing epoxide bunches. These tars respond either with themselves within the nearness of catalysts, or with numerous co-reactants like amines, phenols, thiols, etc. The mechanical execution of composite materials is as a rule related with the properties of their fortification. The framework materials moreover play an imperative part as is the case for thermosetting tar network composites which can be planned for particular applications by legitimately changing the polymer utilized as network. The mechanical, physical and chemical properties of the polymer lattice can be custom-made by changing the handling conditions and the sort and sum of the chemical substance utilized as hardener. Epoxy tar is diverse from polyester gums with respect to curing. It is cured by a curing agent called "hardener" instead of a catalyst.

Right now, adjusted epoxy tars are broadly utilized in manufacture of common fiber-reinforced composites and in making its diverse mechanical items since of their prevalent mechanical, warm, and electrical properties. Epoxy gum has numerous mechanical applications for a assortment of purposes. It has higher mechanical properties and more warm and chemical resistance than other sorts of tar. Subsequently, it has select utilize in making airplane components. Epoxy tar is additionally called polypeoxides. Epoxy tar may be a sort of gum that has extreme mechanical properties, great chemical resistance, and tall cement quality, which makes it exceedingly valuable for different applications. Epoxy resin's employments are:

- i) Metal coatings
- ii) Use in electronic and electrical components
- iii) Electrical insulin
- iv) Fiber-reinforced plastic materials



Fig 4.2 Epoxy resin

Table 4.2 properties of epoxy resin

S.NO	PROPERTY	EPOXY RESIN
1	Appearance	Pale yellow colour
2	Viscosity (cps) at 25°C	10000
3	Density (gms/cc)	1.15 - 1.20
4	Elongation at break (%)	0.8
5	Tensile strength (Mpa)	85
6	Young's modulus (Mpa)	968

4.1.3 COIR FIBRES

Coir or coconut fiber, could be a characteristic fiber extricated from the external husk of coconut and utilized in items such as floor mats, doormats, brushes and sleeping cushions. Coir is the stringy fabric found between the difficult, inside shell and the external coat of a coconut. Other employments of brown coir (made from ready coconut) are in upholstery cushioning, sacking and cultivation. White coir, gathered from unripe coconuts, is utilized for making better brushes, string, rope and angling nets. It has the advantage of not sinking, so can be utilized in long lengths on profound water without the included weight dragging down pontoons and buoys.

Coir fibres are found between the difficult, inner shell and the external coat of a coconut. The person fiber cells are limit and empty, with thick dividers made of cellulose. They are pale when juvenile, but afterward gotten to be solidified and yellowed as a layer of lignin is kept on their dividers. Each cell is approximately 1 mm (0.04 in) long and 10 to 20 μm (0.0004 to 0.0008 in) in diameter. Filaments are ordinarily 10 to 30 centimetres (4 to 12 in) long. The two assortments of coir are brown and white. Brown coir collected from completely aged coconuts is thick, solid and has tall scraped area resistance. It is ordinarily utilized in mats, brushes and sacking. Develop brown coir strands contain more lignin and less cellulose than strands such as flax and cotton, so are more grounded but less adaptable. White coir filaments collected from coconuts some time recently they are ready are white or light brown in color and are smoother and better, but moreover weaker. They are by and large spun to form yarn utilized in mats or rope.

The coir fiber is generally waterproof, and is one of the few common strands safe to harm by saltwater. New water is utilized to prepare brown coir, whereas seawater and new water are both utilized within the generation of white coir. It must not be confounded with coir essence, or once cocopeat, which is the fine fabric coming about from the handling of the coir fibre. coir is the longest assortment of coir fiber. It is fabricated from retted coconut husks through a handle called defibring. The coir fiber in this way extricated is at that point combed using steel combs to create

the fiber clean and to evacuate brief filaments. Bristle coir fiber is utilized as bristles in brushes for household and mechanical application.

Table 4.3 PROPERTIES OF COIR FIBER

S.NO	PROPERTIES	VALUE
1	Color	Brown
2	Average diameter (mm)	0.25
3	Average length (mm)	25
4	Aspect ratio	100
5	Average tensile strength (N/mm ²)	405.9
6	Density (g/cm ³)	1.45
7	Young's modulus (kN/m ²)	4.0*10 ⁶



Fig 4.3 coir fiber

4.2 DESIGN AND ANALYSIS:

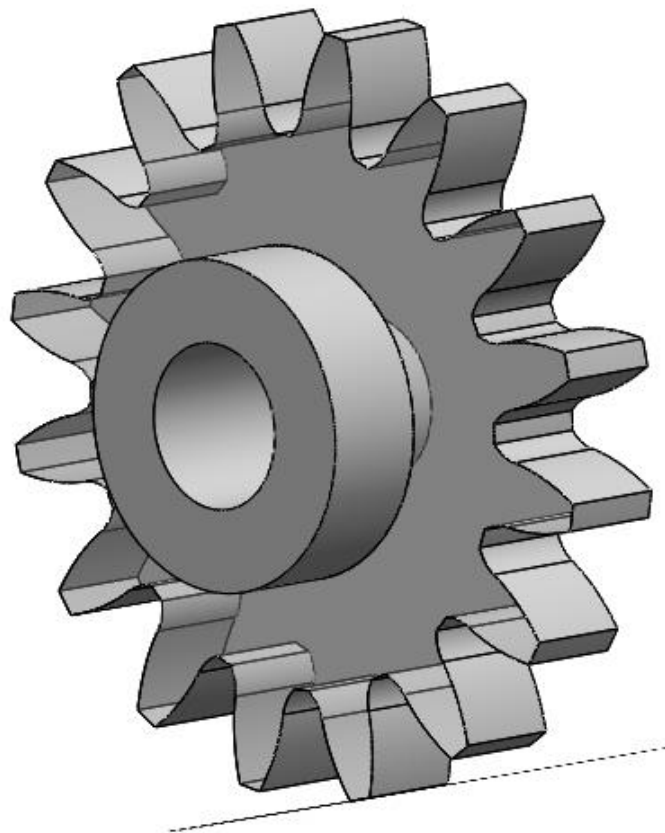


Fig 4.4 spur gear

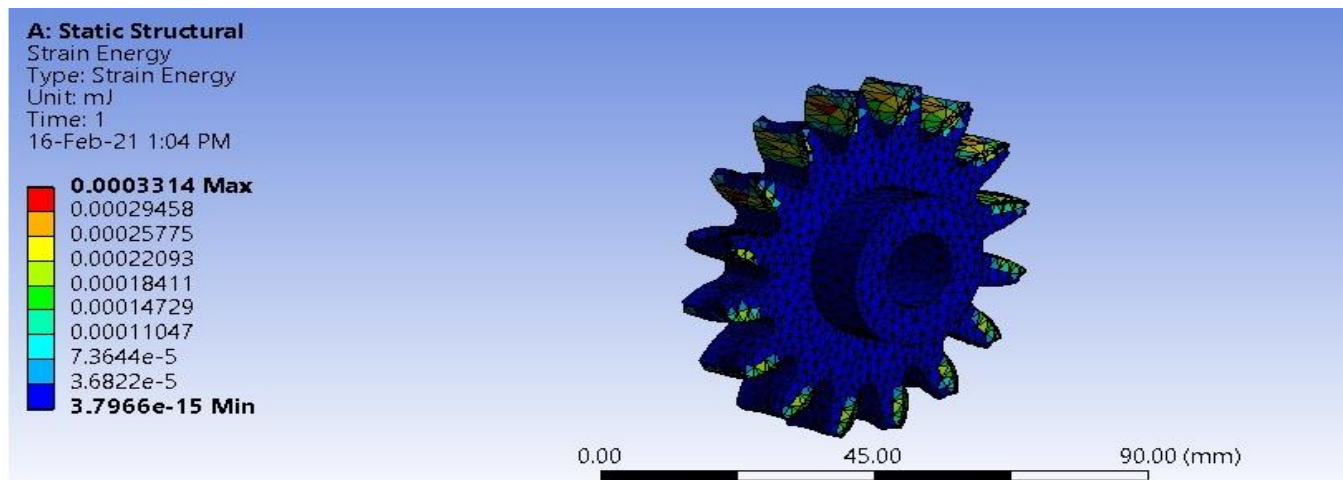


Fig 4.5 strain energy gear

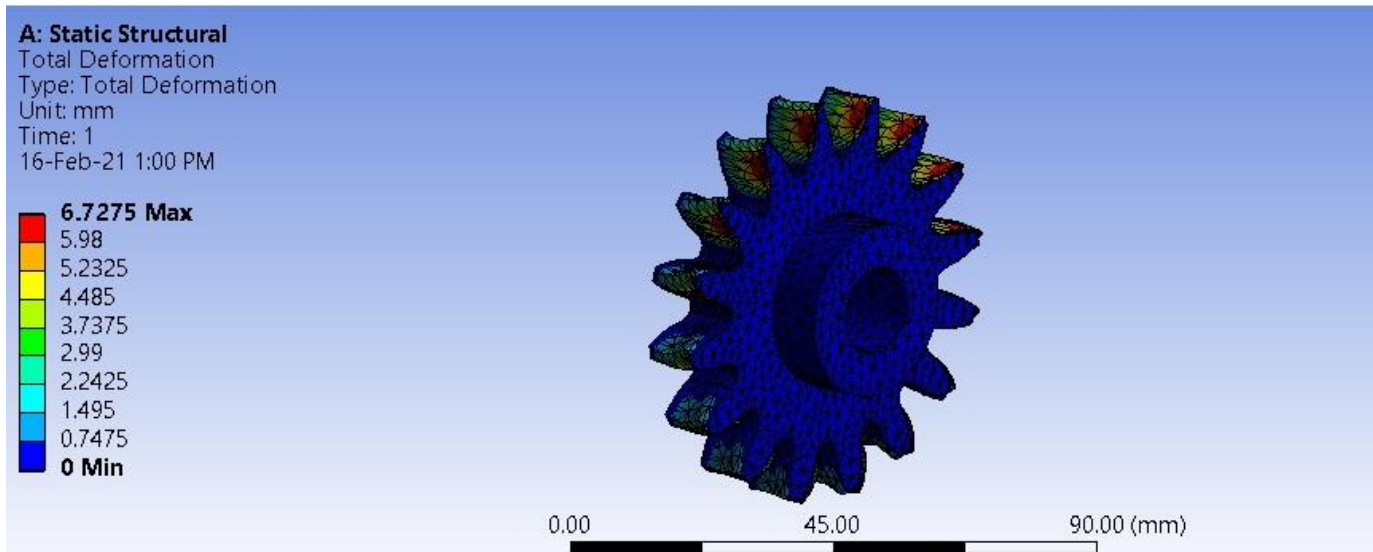


Fig4.6. Total deformation

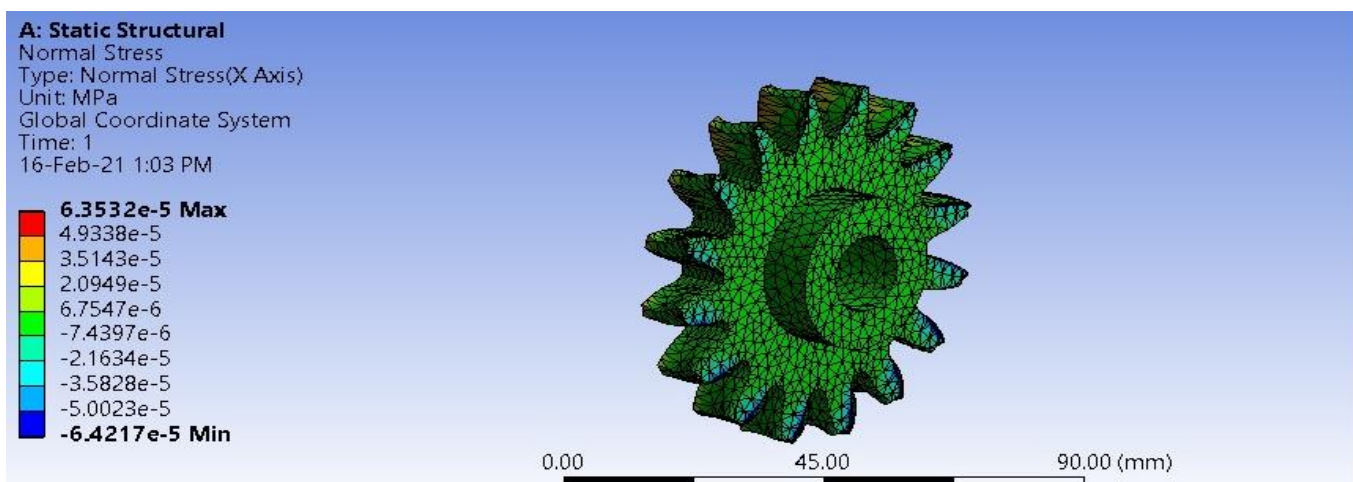


Fig 4.7 normal stress gear

4.3 METHODOLOGY

There are various strategies for creating composite components. Numerous were created to meet particular plan or fabricating challenges. Determination of a strategy for a specific portion, hence, will depend on the materials, the portion plan and end-use or application. They different methods for creating composites are

- i) Spray Lay Up Method
- ii) Vacuum Bag Technique
- iii) Hand Lay UP Method

4.3.1 SPRAY LAY UP METHOD

The splash lay-up strategy can be said to be an expansion of the hand lay-up strategy. In this method, a shower weapon is utilized to shower pressurized gum and fortification which is within the shape of chopped strands. By and large, glass wandering is utilized as a support which passes through shower weapon where it is chopped with a chopper weapon. Framework fabric and fortification may be showered at the same time or independently one after one. Spray discharge gel is connected on to the shape surface to encourage the simple evacuation of component from the shape. A roller is rolled over the splashed fabric to evacuate discuss caught into the lay-ups. After splashing fiber and tar to required thickness, curing of the item is done either at room temperature or at hoisted temperature. After curing, shape is opened and the created composite portion is taken out and assist prepared further.

The time of curing depends on sort of polymer utilized for composite preparing. The schematic of the shower lay-up prepare is appeared. Shower lay-up strategy is utilized for lower stack carrying parts like little water crafts, shower tubs, fairing of trucks etc. This strategy gives tall volume division of support in composites and essentially, there's no portion estimate confinement in this procedure. Applications are gently stacked basic boards e.g. caravan bodies, truck fairings, shower tubes, little vessels etc. This Fig shows 4.8 spray layup method

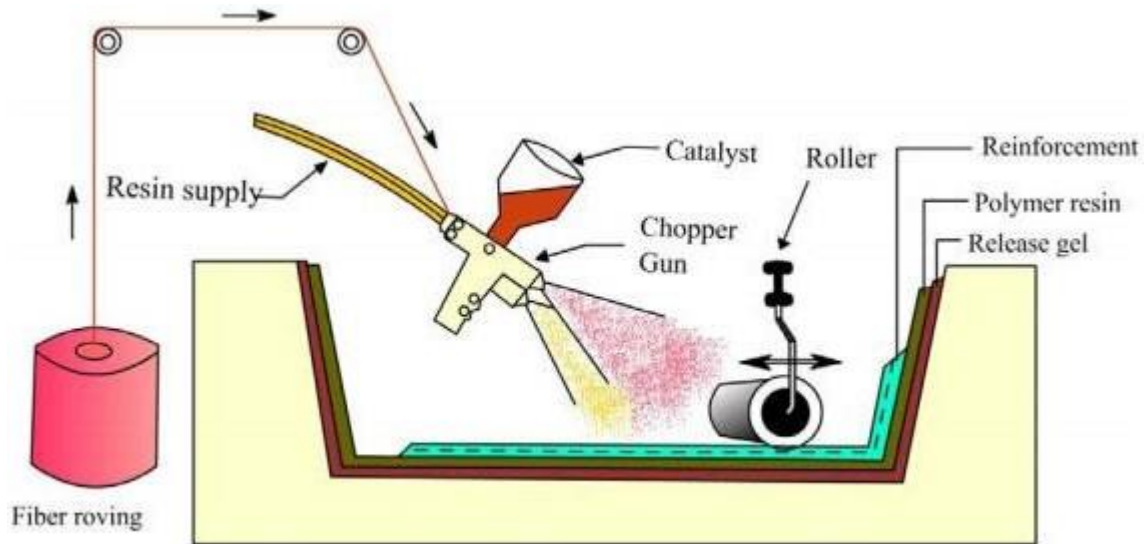


Fig 4.8 Spray Lay Up Method

4.3.2 VACUUM BAG TECHNIQUE

The vacuum-bag prepare was created for making a assortment of components ,counting generally expansive parts with complex shapes. Vacuum sacking does not need to be an amazingly complex prepare.A manufacturer who would like to improve the strength-to-weight ratio of a part will generally profit from a simple vacuum bag construction. As the process is refined or expanded, the project may become more and more complex or if larger parts are made, the technique may become quite sophisticated. These elaborate techniques unfortunately tend to scare fabricators from using this helpful and effective approach to improving almost any hand laminates. It show Fig 4.9 vacuum bag technique

4.3.2.a Advantages of using vacuum bag technique

Vacuum sacking may be a method utilized to form mechanical weight on a cover amid its curing cycle. This serves several purposes:

- i) To compress layers with foam cores into complex and curved shapes, for example an aircraft wing profile.
- ii) Removes trapped air between laminate layers.
- iii) Compacts the fibre layers for more efficient force-transmission amongst fibre bundles.
- iv) Optimizes the fibre-to-resin ratio in the composite part(discussed in further detail later on).

- v) Reduces humidity.
- vi) Prevents shifting of fibre orientation throughout the curing process.

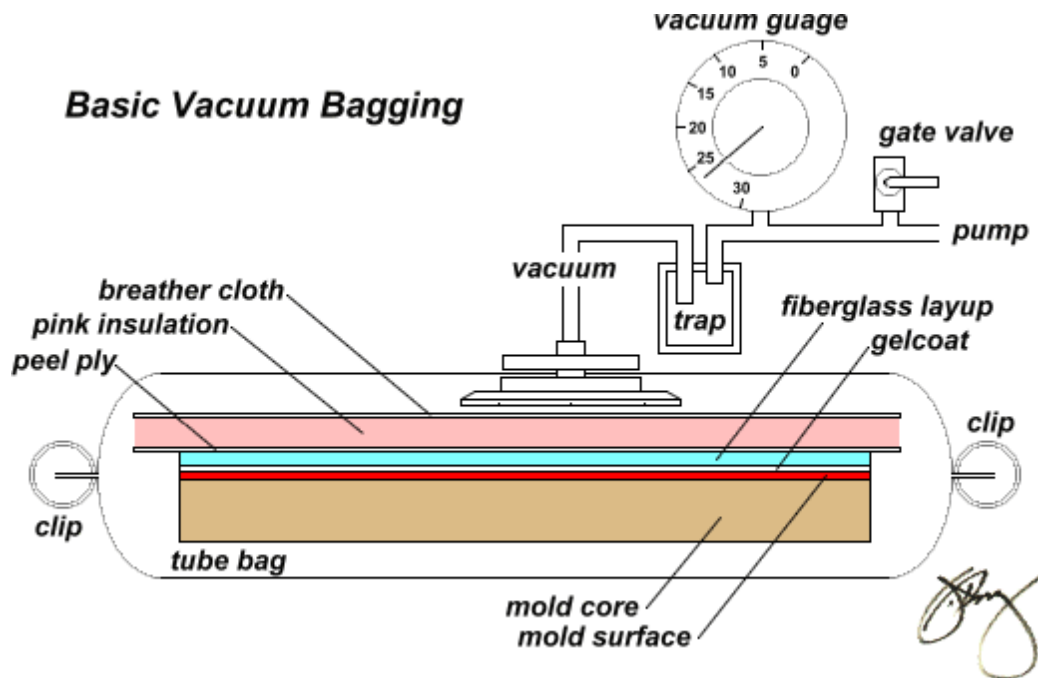


Fig .4.9 Vacuum Bag Technique

4.3.3 HAND LAY UP METHOD

Hand lay-up is the most widely used fabrication technique employed in the reinforced fiber industry. It is regularly utilized for generally brief runs, but it has moreover been adjusted effectively for arrangement generation. It is a production method which takes full advantage of the two most important characteristics of Vinlyester resin i.e. that it cures without heat and without pressure. Hand lay-up is the most common and least expensive method because it requires least amount of equipments. This handle is utilized to form both huge and little things, counting pontoons, capacity tanks, tubs and showers. This shows Fig 4.10 Hand layup method

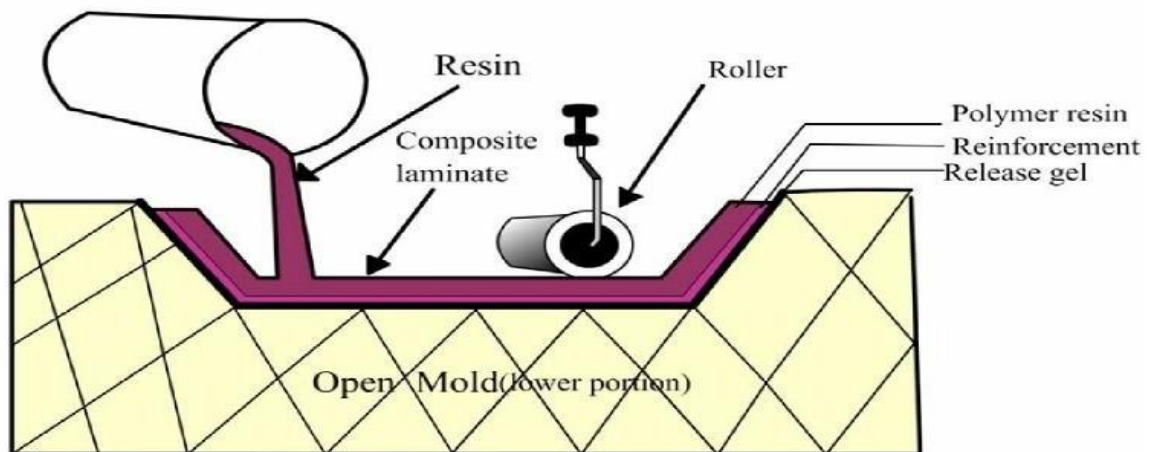


Fig. 4.10 Hand Lay Up Method

4.3.3.a PROCEDURE FOR FABRICATION OF THE COMPOSITE USING HAND LAY UP METHOD

4.3.3.1. Preparation of mold

Remove any dust and dirt from mold. If mold is of plaster, wood, or new fiberglass, apply soft wax and buff with soft towel. Spray or brush with Poly Vinyl Alcohol(PVA) solution, parting compound and allow to dry. Within the occasion that shape texture is glass, metal, ceramic, or well-cured fiberglass, apply three coats of troublesome wax, buffing between each coat.

4.3.3.2. Applying the gel coat

In case gel-coat is to be brushed on, permit to begin with coat to remedy and after that apply the moment coat to create beyond any doubt there are no light spots. On the off chance that gel-coat is to be showered on with a gel-coat weapon, shower up to a thickness of .015" to .020". When gel-coat has cured long sufficient that your fingernail cannot effortlessly rub it free (test at edge of form where harm will not appear on portion) at that point continue with following step.

4.3.3.3. Preparation of resin

The epoxy resin is take in a beaker. Finally the hardner is added to the resin and it is stirred with help of mechanical stirrer for 15 mins at a speed of 800rpm

4.3.3.4. Laying reinforcement

After first later of fiber mat apply the resin. Add resin to this layer and use roller to remove air bubbles. Further continue this process with alternate layers of fiber mat with epoxy resin. This process must be continued for multiple layers of mat. Apply each layer as in step 3, but it'll not be essential to hold up for curing between these layers. Be beyond any doubt to shake all acetone out of brushes and rollers some time recently applying gum. Acetone dribbles can result in uncured spots within the lay-up.

It cannot effortlessly rub it free (test at edge of form where harm will not appear on portion) at that point continue with another step.

4.3.3.5. Curing

It may take from 24 hours to 48 hours to remedy, depending upon temperature and nature of the portion. On the off chance that laid up in a female form, longer remedy will influence shrinkage and less demanding separating. Within the case of the male form, the portion comes off more effectively some time recently it recoils obviously. In the event that the portion is subject to twisting, a longer remedy may be essential. In any case, when the portion is evacuated it ought to be bolstered in its wanted shape until completely cured.

4.3.3.6. Remove part from mold

To begin with, look at the trim edge all the way around the form and make beyond any doubt there's no tar bridging the line between the form and the portion. Sand this edge where vital. At that point wooden wedges, such as "tongue sticks," can be pushed into the edges to begin the partition. Proceed partition by pulling and flexing. In a few cases it is fundamental to bore a small gap within the form and apply discuss or water weight.

4.3.3.7. Surface finish

Trim edges and back of part may need to be fine-sanded and coated with surfacing resin.

4.4 COMPOSITES - DIFFERENT WT.% OF FIBRE AND RESIN

S.NO	SAMPLES	GLASS FIBRE (wt.%)	COIR FIBRE (wt.%)
1	1	96	4
2	2	98	2

Table 4.4 sample wt%

4.4.1 Design of spur gear

Pitch Diameter:

$$D_G = \frac{N_G}{Pd} = \frac{44 \text{ teeth}}{12 \text{ t/in}} = 3.667 \text{ inch}$$

Circular Pitch:

$$P_c = \frac{\pi D_G}{N_G} = \frac{(\pi)3.667\text{in}}{44 \text{ t}} = .2617 \text{ in/t}$$

Addendum:

$$a = \frac{1}{Pd} = \frac{1}{12 \text{ t/in}} = .0833 \text{ in}$$

Dedendum:

$$b = \frac{1.25}{Pd} = \frac{1.25}{12 \text{ t/in}} = .1042 \text{ in}$$

Clearance:

$$c = \frac{.25}{Pd} = \frac{.25}{12 \text{ t/in}} = .0208 \text{ in}$$

Whole Depth:

$$Ht = a+b = .1875 \text{ in}$$

Working Depth:

$$hk = 2*a = .16667 \text{ in}$$

4.4.2 Calculations

E glass + Resin (Epoxy) +Coir

Type of glass fiber used = E-GLASS (180gsm)

Total number of sheets/laminates of glass fiber used = 5

Orientation = 0°/45°/45°/45°/0°

Ratio of fiber and resin = 20:55:25

Density of E-glass fiber (ρ_f) = 2500 kg/m³

Density of resin (ρ_r) = 1150kg/m³

Volume fraction of fiber (V_f) = 25

Volume fraction of resin (V_r) = 55

Volume fraction of coir (V_b) = 20

Mass of fiber (w_f) = 0.409 kg (51g per sheet x 5sheets)

Density of coir (ρ_b) = 1320 kg/m³

Density of composite (ρ_c) = (ρ_f) (V_f) + (ρ_r) (V_r) + (ρ_b) (V_b)

$$\text{Density of composite } (\rho_c) = (2500)(0.5) + (1150)(0.4) + (1320)(0.1)$$

$$(\rho_c) = 1842 \text{ kg/m}^3$$

$$\text{Mass fraction (weight fraction) of fiber } (W_f) = (\rho_f / \rho_c) \times V_f (2500 / 1842) \times (0.5)$$

$$(W_f) = 0.67861$$

$$\text{Mass fraction (weight fraction) of resin } (W_r) = (\rho_r / \rho_c) \times V_r (1150/1842) \times (0.4)$$

$$(W_r) = 0.24972$$

$$\text{Mass fraction (weight fraction) of bagasse } (W_h) = (\rho_h / \rho_c) \times V (1320)/(1842) \times (0.1)$$

$$(W_r) = 0.071661$$

$$\text{Sum of mass fractions (weight fractions) } [(W_f) + (W_r) + (W_h)]$$

$$= [0.67861 + 0.24972 + 0.071661] = 0.99991$$

$$= 1$$

Sum is 1, therefore safe.

To find mass of FIBER:

$$\text{Mass of fiber } (w_f) = (\rho_f) \times (v_f)$$

$$0.67861 = 2500 \times (v_f)$$

$$\text{Volume of fiber } (v_f) = 0.0002714 \text{ m}^3$$

$$(v_f) = (V_f) \times (v_c)$$

$$0.0002714 = 0.5 \times (v_c)$$

$$\text{Volume of composite } (v_c) = 0.0005428 \text{ m}^3$$

$$(v_c) = (w_c) / (\rho_c)$$

$$0.0005428 = (w_c) / (1842)$$

$$\text{Weight of composite (wc)} = 0.9999 \text{ kg}$$

$$\text{Volume of resin (Vr)} = (Vr) \times (vc)$$

$$(Vr) = 0.4 \times 0.0005428$$

To find mass of RESIN:

$$\text{Volume of resin (Vr)} = 0.0002171 \text{ m}^3$$

$$\text{Mass of resin (wr)} = (pr) \times (Vr)$$

$$(wr) = 1150 \times 0.0002171$$

$$\text{Mass of resin (wr)} = 0.24966 \text{ kg (or 250 g)}$$

To find mass of bagasse:

$$\text{Volume of coir (Vb)} = (Vb) \times (vc)$$

$$(Vb) = 0.1 \times 0.0005428$$

$$\text{Volume of coir (Vb)} = 0.00005428 \text{ m}^3$$

$$\text{Mass (wh)} = (ph) \times (V_h)$$

$$(wh) = 1150 \times \mathbf{0.00005428}$$

$$\text{Mass of coir (wh)} = 0.06242 \text{ kg (or 62.42 g)}$$

4.5 FABRICATION:



Fig 4.11 mixture of epoxy resin

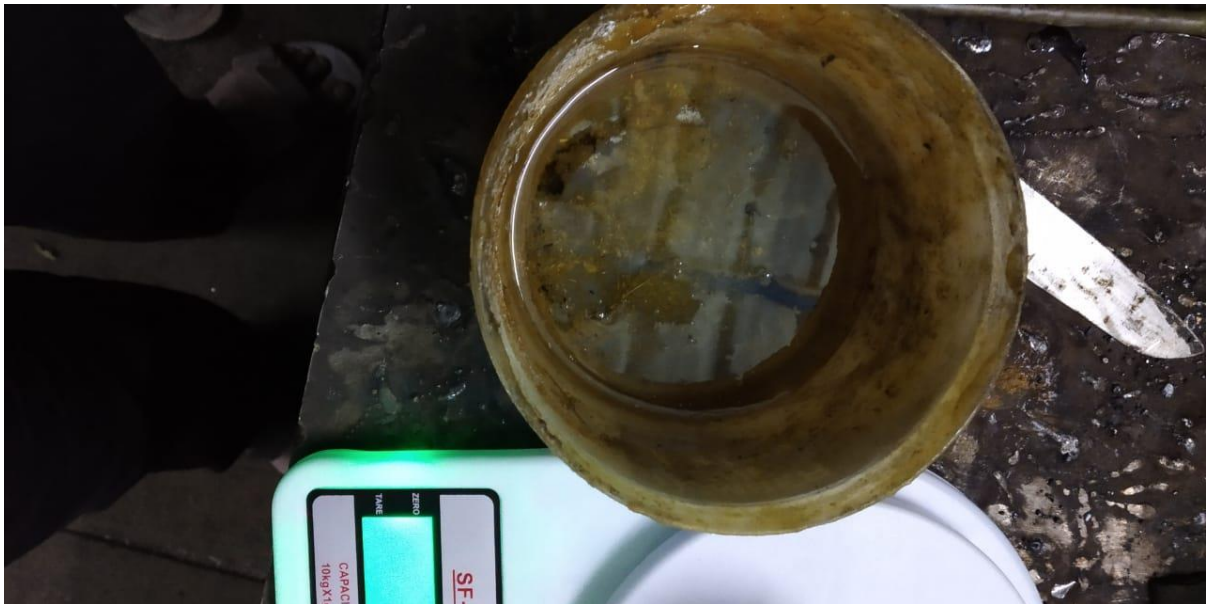


Fig 4.12 mixture of epoxy resin with hardner



Fig 4.13 weigh balance



Fig 4.14 spur gear shaped acrylic sheets



Fig 4.15 MOULD FOR MAKING COMPOSITE SPUR GEAR

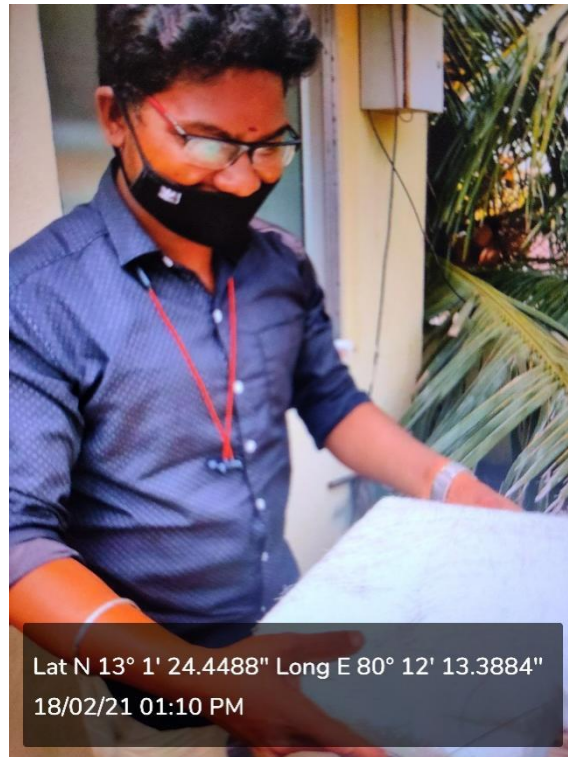


Fig 4.16 GLASS FIBRE

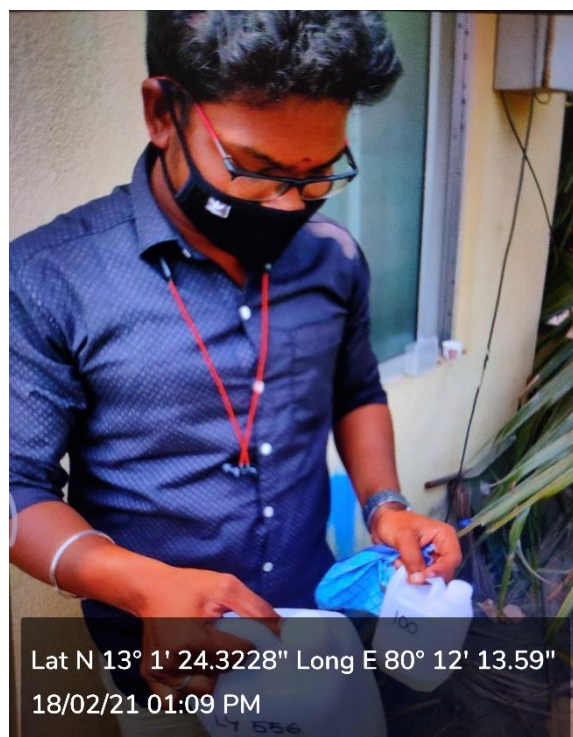


Figure 4.17 epoxy resin

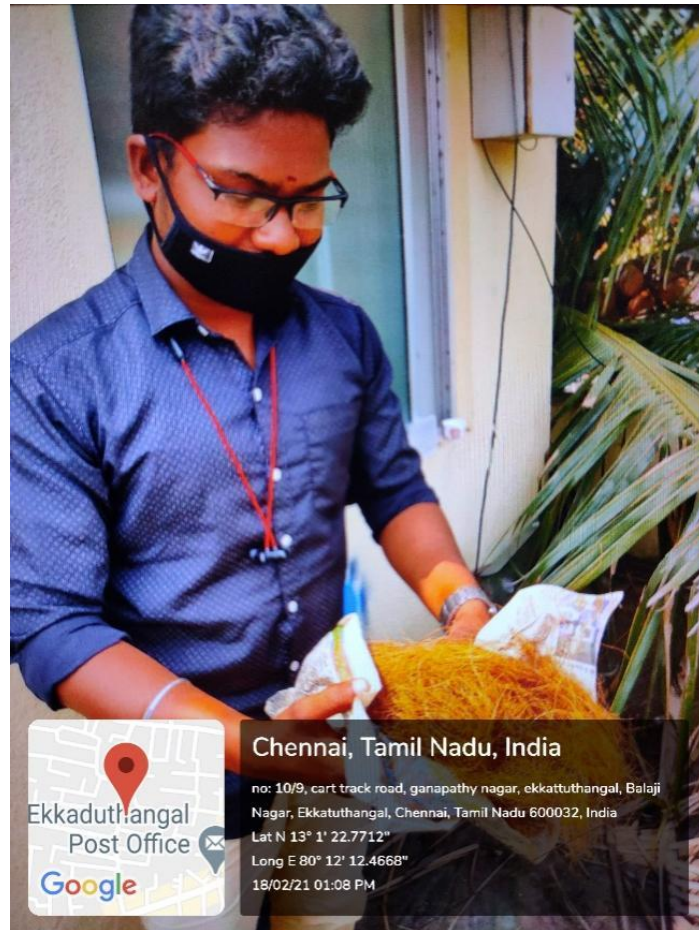


Fig 4.18 coir fibre

SAMPLES

SAMPLE PIECE 1 FOR TESTING

96% GLASS FIBRE + 4% COIR FIBRE

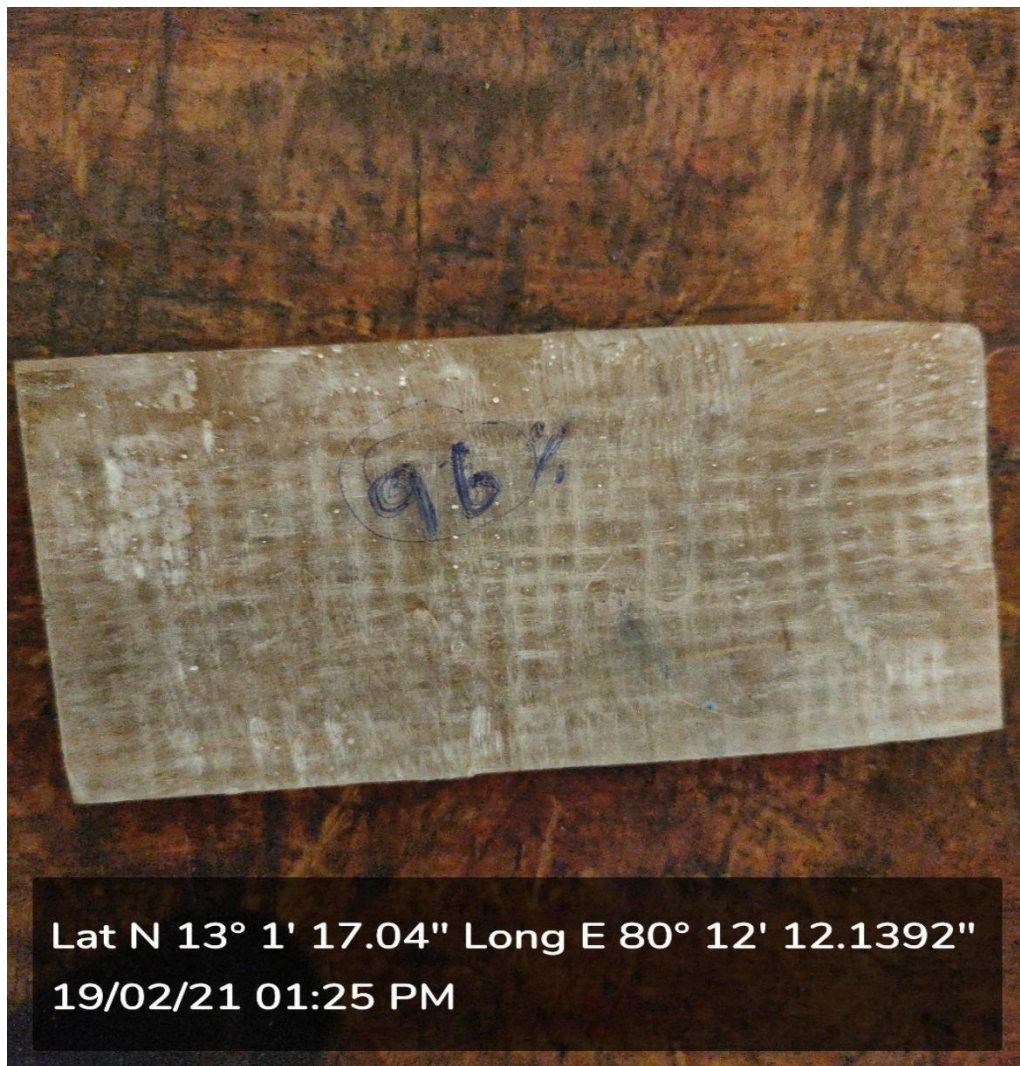


Fig 4.19 sample piece 1

SAMPLE PIECE 2 FOR TESTING
98% GLASS FIBRE + 2% COIR FIBRE

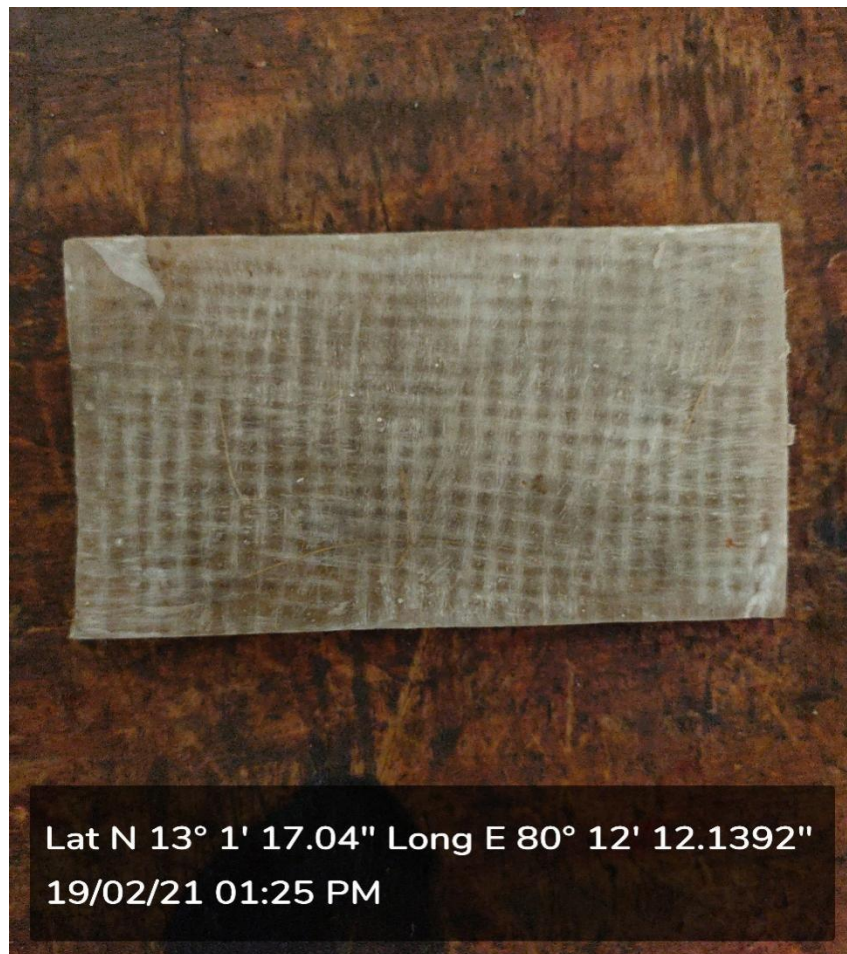


Fig 4.20 sample piece 2

FINAL OUTPUT OF COMPOSITE SPUR GEAR



Fig 4.21 composite spur gear

CHAPTER 5

TESTING AND RESULTS

5.1 Compression test:-

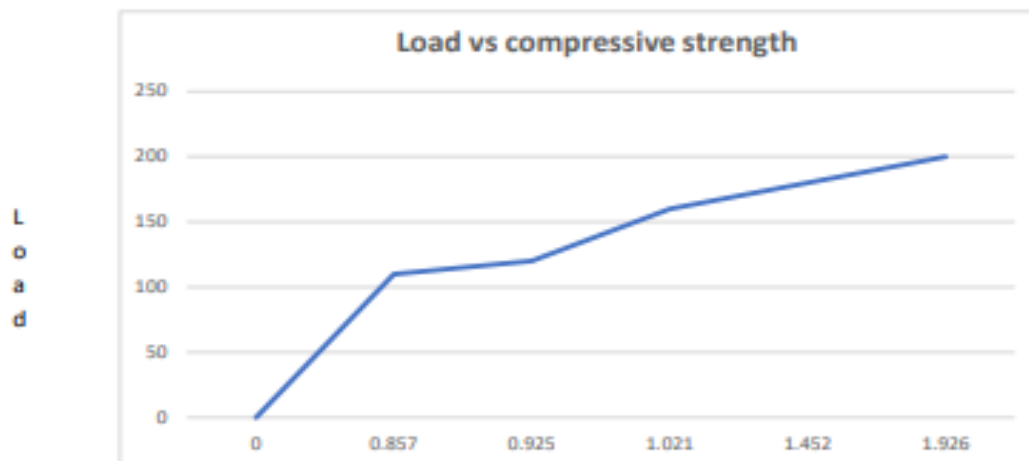
The most commonly used specimen geometries such as the dog-bone specimen and straight-sided specimen with end tabs were prepared from the flat samples. A uni-axial stack is connected through the closes. The standard test method as per ASTM D 3039-76 has been used; length of the test example utilized is 154 mm. The malleable test is performed in all inclusive testing machine INSTRON H10KS. A cross head speed of 10 mm/min has been used for the test. Each composite of five tests were tried and normal esteem was taken for examination.



Fig 5.1 compression testing machine

Compression test

Sample Number	Peak Load (N)	Compressive Strength(N/mm ²)
1	0	0
2	110	0.867
3	120	0.925
4	160	1.021
5	180	1.452
6	200	1.926



Sample 2-

Compression test

Sample Number	Peak Load (N)	Compressive Strength(N/mm2)
1	0	0
2	110	0.924
3	120	1.085
4	160	1.254
5	180	1.862
6	200	1.981

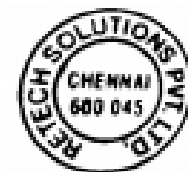
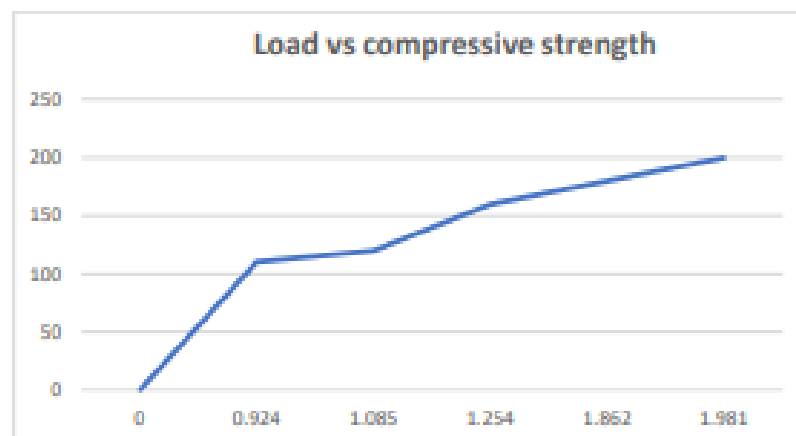


Table 5.1 compression test

5.2 Tensile test

Table 5.2 tensile test

Tensile test

Sample 1

Sample no	Peak Load (N)	Tensile Strength(N/mm ²)
1	400	2.45

Sample 2

Sample no	Peak Load (N)	Tensile Strength(N/mm ²)
1	400	3.24



5.3 Bending test

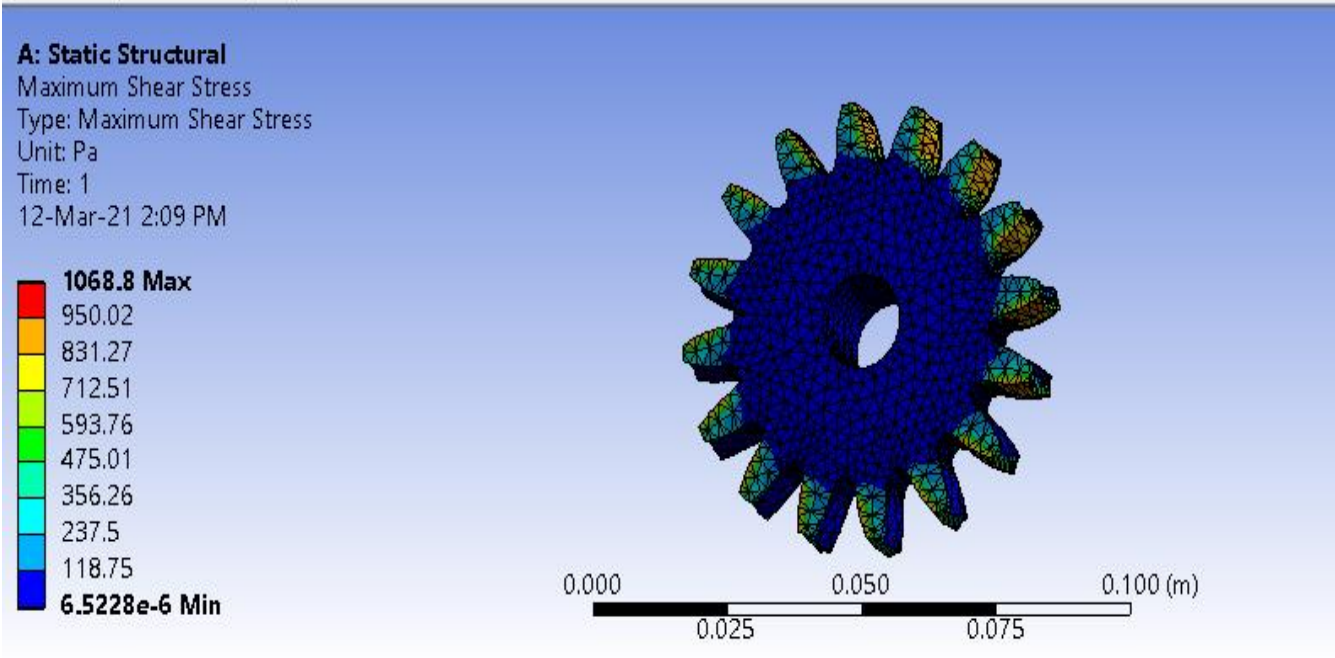


Fig 5.2 maximum shear stress

Table 5.3 bending test

S.NO Bending stress	ANSYS	MATERIAL
1	1460 mpa	Structural steel
2	1068mpa	Composite fibre

CHAPTER 6

CONCLUSION.

There are two samples: Sample 1 and Sample 2. The Sample 1 which contains 96% glass fibre + 4% coir fibre and Sample 2 which contains 98% glass fibre + 2% coir fibre. Samples are fabricated and are subjected to the ASTM testing conditions and the results are compared with each other. Composite material is one the widely growing area in the industrial applications. In future the use of plastics and metal becomes extinct as they are harmful to the environment. Since the society moves towards a green economy it's our due duty to provide and use a bio-degradable product. Now a days most of the heavy parts are replaced by the composites only.

As we can see in the above testing result, the tensile strength of both the samples 1 and 2 are 181.70MPa and 196.26MPa respectively. The compressive strength for both the samples 1 and 2 are 0.44KN and 0.92KN respectively. Where the sample 2 shows a relatively high tensile strength and high compressive strength.

CHAPTER 7

REFERENCE

1. Dipen Kumar Rajak 1,2, Durgesh D. Pagar, K.; Madhu, P.; Senthamaraikannan, P.; Yogesha, B. SSPolymer matrix-natural fiber composites: An overview. *Cogent. Eng.* 2018, 5, 1446667. [CrossRef]
2. P.Yuvaraj.; Chukov, D.; Tcherdyntsev, V.; Torokhov, V. Effect of formation route on the mechanical properties of the polyethersulfone composites reinforced with glass fibers. *Polymers* 2019, 11, 1364. [CrossRef] [PubMed]
3. Prasanna.; Zadorozhnyy, M.; Tcherdyntsev, V.; Stepashkin, A.; Zhrebtsov, D. Structure, mechanical and thermal properties of polyphenylene sulfide and polysulfone impregnated carbon fiber composites. *Polymers* 2019, 11, 684. [CrossRef] [PubMed]
4. K. Mao, "A numerical method for polymer composite spur gear flash temperature prediction", Mechanical Engineering, School of Engineering and Design Brunel University, Uxbridge, Middlesex UB8 3PH, UK, accepted 8 January 2007.
5. R. Yakut, H. Duzcukoglu, M.T. Demirci Mechanical Education Department, University of selcuk, Campus, Konya, Turkey, Received 30.09.2009: published in revised form 01.11.2009.
6. J. L. Moya, A. S. Machado "A new approach for polyamide composite gear design", *Wear* 262 (2007) 432-441.
7. M. H. Tsai, Y. C. Tsai, "A method for calculating static transmission errors of plastic spur gears using FEM evaluation, *Finite Elements in Analysis and Design*" 27(1997) 345-357.
8. R. Prabu Sekar and R. Sathishkumar, Enhancement of Wear Resistance on Normal Contact RatioSpurgearpairthroughNonstandardgears,*Wear*,(<http://dx.doi.org/10.1016/j.wear.2017.03.022>)

9. Ankur Saxena, Anand parey, Manoj Cooksey, Effect of shaft misalignment and friction force on time varying mesh stiffness of spur gear pair, Engineering Failure Analysis 49 (2015) 79-91
10. Franulovic, Kristina Markovic, Zeljko Vrcan, Matija soban, Ezperimental and analytical investigation of the influence of pitch deviations on the loading capacity of HCR spur gears, Mechanism and Machine Theory 117 (2017) 96-113
11. Naresh k. Raghuwanshi et al. "Effect of Back side contact on mess stiffness of spur gear by Finite Element Method."Procedia Engineering 173 (2017) 1538-1543
12. Paras Kumar, Harish Hirani, Atul Agarwal Fatigue failure prediction in spur gear pair using AGMA approach, Materials Today: Proceedings 4 (2017) 2470-2477
13. Deepika Potghan, Prof. Suman Sharma Potghan, Finite element analysis of spur gear used in lathe headstock, 4.(7):july, 2015 ISSN: 2277-9655(I2OR), Publication Impact Factor: 3.785
14. Abhijit Mahadev Sankpal, M. M. Mirza, Contact Stress Analysis of Spur Gear by Photoelastic Technique and Finite Element Analysis, ISSN(Print): 2319-3182, Volume -3, Issue-2, 2014
15. Sanjay K. Khavdul, Prof. Kevin M. Vyas, comparative finite element analysis of metallic spur gear and hybrid spur gear, Volume 6, Issue 4, April (2015), pp. 117-125