REPLACEMENT OF ALUMINIUM ALLOY 6061 BY ALUMINIUM MATRIX COMPOSITES FOR BI-CYCLE SPROCKET

PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **"REPLACEMENT OF ALUMINIUM ALLOY 6061 BY ALUMINIUM MATRIX COMPOSITES FOR BI-CYCLE SPROCKET"** is the bonafide work of **"KIRAN KUMAR M , MANI KANDAN M, KARUPPIYA PULLAVAR K** and **RAJA B "** who carried out the project work under my supervision.

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INTERNAL EXAMINER

EXTERNAL EXAMINER

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ABSTRACT

Materials are much used for the auxiliary applications since they are found to have attractive mixes of mechanical characteristics. The aluminium matrix composites which contain the reinforced particles like SIC, Graphite are used in the project to enhance the mechanical properties such as tensile strength, yield stress, hardness, and SEM analysis and wear resistance. In the present work, aluminium is taken as a matrix phase with silicon carbide and graphite as a reinforcement phase. The aim of the project is to investigate the properties which have to be enhanced of aluminium matrix in different micrometer size amount of reinforcement. So, Al5052, and silicon carbide, and graphite is taken as the base material and the process which is involved in the system is Stir Casting which is also cheapest and simple with the mechanical properties and the properties to be tested are evaluated.

Sprockets are widely used in automobile and industrial sectors. They are most commonly used in two wheelers and four wheelers such as bikes, cycles, and cars. The mechanism which is involved in transmitting motion between two shafts where gears are found to be incompatible and undeviating motion leads to a pathway. They are found to exist in various dimensions and no of teethes differ and are made up of different materials. The faulty chains which are used in the sprocket will cause wear in the material. The out cause of these problems is overload, breakage, and high impact pressure and chain beyond the replacement level. To ensure power transmission the sprocket should be properly designed. There is a possibility of weight reduction in the system

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CHAPTER 1

INTRODUCTION

As we have seen in couple of years the demand of Aluminium materials with many characteristics have developed which states the fact in today's world requirement is compatible. Ferrous materials which have a brighter scope in this advanced world of technology because of characteristics and performance are suited based on the particular product. They also provide the information of mechanics behind them. The composite materials are extensively utilized as a part of auxiliary, aviation and car enterprises. The metal matrix composites are made up of metallic base material called the grid.

In aeronautical applications the excess of 80% used are composites. The actual performances that are measured by adding various composites give different mechanical and tribological properties. They are excellent for electrical closures and high wear conditions which are found in the water and water treatments. The material scope is further expanded with the help of alloys present in them which combines the properties to produce an enhanced one. This paper will contribute the effect of reinforcing of composites with aluminium-alloy (5052) with the help of **"STIR CASTING"** process as it has more corrosion resistance for further use in the development of automotive applications.

Aluminum plays a major role in today's world. It is a chemical element with atomic number 13 and contains 8% of earth's crust. Therefore, of aluminum contains bauxite. It is merged with 270 different materials. They play a major role in aerospace industry as well as in transportation and building industries. They are

well tolerated by plants and animals. Thefactor which is mainly responsible for low density and the ability to resist corrosion is of passivation.

Aluminium has been shaped by the word alum. It was created by Greek historian **Herodotus**. Its production is energy consuming and smelters of aluminium are China, Russia and SouthAfrica in which china is the top producer of aluminium with 50%.

1.1. ALLOYS

Alloys are combination of two metals and are bonded by a metallic character. They are also considered as a mixture of metallic phases. Their combination can also reduce the overall cost of the material. The constituents of alloys are measured by the mass percentage. They can be further classified in to two types which are homogenous and heterogeneous. Some alloys such as Inconel may consist of multitude with different elements.

1.1.2. TYPES OF ALLOY

(1) NICKEL ALLOYS

(2) CUPRO NICKEL (BRONZE, COPPER)

(3) FERRO NICKEL (IRON)

(4) CHROMEL (CHROMIUM)

(5) GERMAN SILVER (COPPER, ZINC)

1.1.2. ALLOYS FORMING TECHNIQUE

The alloys are formed by mixing metals in the molten conditions. The mixture which is obtained is poured in to the sand moulds for the process of solidification. The main mixture is melted firstly and then ingredients are added to dissolve in the system. The main purpose of the system is to increase the hardness of the material by alloying with another element like metals.

1.2. ALUMINIUM ALLOY 6061

Aluminium alloy 6061 is the mostly used alloys in the aluminium series 6000.This alloy consists of standard structures and also versatile to the heat treatments which is most commonly used in both medium as well as high standard requirements. Their applications are related from transportation to equipment and machinery selection.

1.2.1 PROPERTIES

The Aluminium alloy 6061 has excellent corrosion for both atmospheric conditions as well as well as sea water conditions. Its composition which includes is mentioned Silicon (0.4%), Iron (0.7%), Copper (0.15%), Magnesium (0.8%), and Chromium (0.04%) Zinc (0.25%) and Titanium (0. 15%).Their characteristics are of good finishing and which leads to the anodizingprocess. Theappearance in the cosmetic is found to be in critical stage.

While welding aluminium alloy the material may lose its ability to withstand strength. But with the way of re-heat treating the material will have the ability to regain its strength with the help of this process. The hardness of the alloy is found to be 33 and the tensile properties are found to be 130MPa.

1.2.2 APPLICATIONS

The aluminium alloy are used in the constructing material and widely used in the automotive components for structural purpose which includes yachts, motorcycles, bicycle sprockets, frames and scuba tanks. In the electrical fields such as fittings, couplings and valves. The alloys are widely used in the manufacturing of aluminium cans and used inside the wrapper of food containers. They are also used in the span structures for the bridge decks and arenas. Their availability is in solid shapes like seamless and structural pipes." **BMX**" Cycles are manufacturing sprockets based on the aluminium alloy 6061.

1.3. METAL MATRIX COMPOSITES

A **metal matrix composite** (**MMC**) is composite material which consists of two constituent parts, First part being a metal and the another part of material consists of different metal or another material, such as a ceramic. When at least three materials are present in the composition, it is called a **hybrid composite**

1.3.1. MATRIX

The matrix is the monolithic material in which the reinforcement is embedded, and completely continuous. This creates that there is a path through the matrix to any point in the material. The matrix is used in structural applications and found to be a lighter metal such as aluminum, magnesium, or titanium, and provides a support for the reinforcement.

1.3.2. REINFORCEMENTS

The reinforcement material is embedded into a matrix and does not always serve a purely structural task. It is also used to change physical properties such as wear resistance, friction coefficient, or thermal conductivity. It can be either continuous, or discontinuous. Discontinuous MMCs can be isotropic, and can be worked with s metalworking techniques, such as extrusion, forging, or rolling and are commonly would need the use of polycrystalline diamond tooling.

Continuous reinforcement obtains monofilament wires such as carbon fiber or silicon carbide. The result is found to be anisotropic structure in which the alignment of the material affects its strength. The most common reinforcing materials in this category are alumina and silicon carbide. The reinforcements are used in the component to achieve the minimum mechanical properties to be enhanced in the system and they can be only determined by using of alloying elements.

1.3.3. APPLICATIONS

Carbide cutting tools cementing the hard tungsten carbide particles; lower performance tools can use other metals such as bronze as the matrix.

Tank armors can be made from metal matrix composites, probably reinforced with boron nitride, which is found to be good reinforcement for steel because it is very stiff and they do not dissolve in molten steel.

Some automotive disc brakes use MMC. Modern high-performance cars use rotors made of carbon fiber with addition to silicon carbide matrix because of its high specific heat and thermal conductivity.

Metal matrix composites are nearly always more expensive than the more conventional materials they are replaceable. As a result, they are obtained improved properties and performance can justify the added cost.

They increase resistivity towards fire, can operate in wider range of temperatures and do not absorb moisture, have better electrical and thermal conductivity, are resistance to radiation damage, and do not display out gassing.

Metal matrix composites used in large industries to determine the mechanical properties and they play a major role in today's world and with addition of composites the mechanical properties can be increased and properties which has to be enhanced and resistivity towards wide range of temperatures can be determined with the help of system.

1.4. APPLICATION USED IN THE PROJECT

BI-CYCLE SPROCKET:

The sprocket is a profiled with a wheel of both teethes and cogs which is meshed with a chain, track and perforated materials. The wheel upon which radial projections occur over the chain passing it tends to be a**" SPROCKET"**. Thesprockets which are used in bicycles, cars, vehicles are used to transmit motion in rotary form between two shafts. They are of various designs and maximum efficiency can be claimed from its originator. In the Early automobiles were completely depending upon on the sprockets.

1.4.1. PROPERTIES

It controls the size of the specimen in which the diameter is specified (or) the transmission ratio.

If you change the diameter size of the driver sprocket, the driven sprocket diameter also changes. The dimensional parameters of the sprocket should be customized depending upon the tooth gap shape and sprocket hub size. The number of strands in the sprocket can be customized depending upon on the number of strands in the chain.

The power ratio ranges from 0 to 1.0 which depends upon the power distributed by a given sprocket. The inertia moment is not considered for the sprocket, but for entire rotating mass which carries the sprocket.

The sprocket is designed for theoretical tooth form with specified number of teeth and also the dimensions are specified based on them.

1.4.2. DEFECTS

The major defects which arefound in the sprockets.

(1) **Bushing galling**- It causes overloading due to inadequate lubrication.

(2) **Turned Pins**- It leads to overloading because of inadequate lubrication.

(3) **Excessive Noise**- Too much slack in chaining-obstruction.

1.4.3. DEFECTS IN THE ALUMINIUM ALLOY 6061 SPROCKET

(1) The life time of the component is found to be fixed for a particular period of time.

(2) The component gets easily ruptured and the mechanical properties can't for a longer period.

(3) The pitch which is between two teethes of sprocket gets affected due to the loose chain slacking moment.

Our idea to the project panel is to enhance the mechanical properties of the component by using different aluminium series along with the mixture of composites with the help of stir casting process.

1.5. ALUMINIUM CHOSEN- AL5052

1.5.1. COMPOSITES CHOSEN- SIC AND GRAPHITE

SIC-4% Gr-3%

Silicon carbide is chosen at4% as they are used in the system to determine greater hardness of the system and silicon carbide creates better mechanical properties than the alloying elements present in the specimen and the Graphite is used in the system to determine the wear properties of the specimen it can be enhanced easily by adding graphite at less percentage because of carbon content because of rupturing the material and they can be witnessed using SEM analysis.

1.6. ALUMINIUM ALLOY 5052

Fig.1.1- Aluminium alloy 5052

The Aluminium alloy 5052 belongs to the aluminium series 5000 and the Magnesium present in the alloy is considered as major alloying element. It is considered as non-heat treatable alloy which will be hardened for higher strength by the process of cold work. Their structures are subjected for excessive vibrations. They are machined by conventional methods. The alloy is mainly considered for well behavior of mechanical properties and ability to withstand its fame in this advanced world of technology. These elements are all used in many industries to determine the mechanical properties of the specimen and the specimens are all measured in appropriate size to determine the efficiency of the component. The alloys are found in the various parts of the world and create a vast diversity in the world to enhance the mechanical properties of the system and they are again used in large structures to determine the efficiency of the components to replace with composites to increase the factors.

1.6.1. PROPERTIES

1. CORROSION RESISTANCE

Aluminium alloy 5052 has high resistance towards general corrosion other than the non-heat treatable alloys and also high resistance towards alkaline conditions which is found to be common in Aluminium 5000 series.

The resistance in marine atmosphere is found to be excellent with the corrosion. When the damage is created it is further rectified by reaction of both aluminium and oxygen. It can be anodized by thickening the surface film.

2. MACHINABILITY

The Aluminium alloy-5052 is machinable through conventional methods. They are machined at high speeds to avoid the lubrication which leads to thermal distortion in the workpieace.

3. WELDABILITY

They are weld able by using standard techniques which includes TIG (TUNGSTEN INERT GAS) Welding. To avoid the contamination and porosity in the material the alloy must be of dry cleaned in the equipment.

4. CHEMICAL COMPOSITION

It’s composition which includes various mixtures

1. Aluminium (97.2%)
2. Magnesium (2.5%)
3. Chromium (0.25%)

1.6.2. APPLICATIONS

The Aluminium alloy 5052 is used in the manufacturing of various components which includes,

1. Milk Crates
2. Hydraulic Tubes
3. Appliances
4. Kitchen Cabinets
5. Small boat home freezers
6. Air fences
7. Fencing

They are also widely used in the manufacture of sheet metal works and parts.

1.7. COMPOSITES

A composite material is a material which is made up of combining two or more materials which differs from chemical properties, while combining an individual component is produced where the properties different from each other components. The new component is preferred mostly because of following reasons Stronger, Lighter, orless expensive compared to traditional materials.

One of oldest man made composite materials is Wattle and Daub which is approximately 6000 years old and the material concrete is the most widely used composite in the world.

1.7.1. TYPES OF COMPOSITES

There are three types of composites which are mentioned below,

1. ORGANIC- MATRIX COMPOSITE

2. METAL -MATRIX COMPOSITES

3. CERAMIC -MATRIX COMPOSITES

1.7.1.1. ORGANIC MATRIX COMPOSITES

The composites can be formed from the materials which results with the association of continuous phase called as matrix and phase which is dispersed is called strengthening. The matrix could be a mineral (or) organic in nature. They distribute stress and give the external shape to the part.

1.7.1.2. METAL MATRIX COMPOSITES

Metal matrix composites consist of metal and many other materials like ceramics. They provide specific strengths to the weight ratios and resist moisture and fire and they are used for wide range of temperatures. They also have excellent resistivity towards electrical and thermal conductivity.

1.7.1.3. CERAMICS MATRIX COMPOSITES

Ceramics matrix composite are also part of composite materials. They consist of ceramic fibers embedded in a ceramic matrix where carbon and carbon fibers are found to be ceramic materials. They tend to have increased fracture toughness and dynamic load capability.

1.7.3. SILICON-CARBIDE

Fig.1.2- Silicon carbide

Silicon carbide is a compound of both silicon and carbon with creation condition. It occurs in the nature at extreme conditions which is exceptional to the mineral moissanite. The powder has been mass conveyed since the year 1983 which is found to be used in the grinding part. The silicon carbide grains are sustained together by the process of sintering which enables to frame hard earth ware productions.

Their productions are generally used for high continuance for ex-(auto brakes, auto grips and fire plates). In the electrical field it is used in light emitting diodes. They are used in the semiconductor devices that operate under high temperatures.

In the aluminium alloy 5052 (0.8%) of silicon carbide is present in the system. So, silicon carbide is considered as good ceramic.

1.7.4. GRAPHITE

Fig.1.3- Graphite

Graphite which is also known as "**PLUMBO**" in the ancient period is in crystalline form of carbon (or) semi-metal (or) a native element and also one of the allotropes of carbon. It has consistent stable form under standard conditions. Therefore, it is used in thermo chemistry for the heat formation of carbon compounds.

The crystal system which is found to be in hexagonal in structure. It occurs in metamorphic rocks and the minerals associated with graphite include quartz, calcite, and micas. It occurs in two forms like alpha and beta. Graphite content contains carbon content which contains of higher hardness and they can be used in various applications to enhance the mechanical properties of the specimen and in various components they can be used to determine the strength of the specimen and the component tends to have longer life time and they determine the basic function of the system and create a better scope in future industries and because of carbon content they tend to have more hardness.

1.8. WHY ALUMINIUM IS USED IN AUTOMOTIVE APPLICATIONS?

Aluminium is one of the major elements which is widely used in today's world. Its characteristics and performance are getting enhanced by mixing with various elements. People are also having scope on the ferrous materials which is playing vital role in the system. They are used in the various parts of the automotive system such as frames, structures, sprockets etc. They are used mainly because of light weight purposes. It has high strength ability and consists of smooth surface. It defines the high corrosion resistance and the properties are ideal for electrical enclosures and weld-ability.

Thus, the aluminum is considered as important criteria in the automotive field for future purposes and their enhancement of output are found to be gradually increasing in today's world. The aluminium alloy is used in various industries and it can be utilized in various purposes and with addition of composites the mechanical properties can be enhanced and mainly in automotive applications such as brake calipers, frames they are used in strengthening of materials an aluminium is considered as major role in today's world and environment and alloying elements which are used in the aluminium consists of larger percentage and effectively used in various parts of the industries and create a better knowledge in the future world.

Thus, the aluminium is extensively used in automotive applications for better purposes and it can be utilized with better properties with addition of composites which indirectly enhances the mechanical properties of the component.

CHAPTER 2

LITERATURE SURVEY

2.1.1. Manoj single et.al suggests that with increase in composition of SiC, an increase in hardness, impact strength and normalized displacement have been observed. The best results have been obtained at 25% weight fraction of 320 grit size SiC particles. The Hardness which is found to be 45.5 BHN and the Maximum Impact Strength is 36 N-m. Continuous dispersion of SiC particles in the Al matrix shows an increasing in the samples prepared by without any applying stirring process, with manual stirring and with two-step method of stir casting technique respectively.

2.1.2. The research work of **RajeshAM** et.al concludes that by stir casting technique the hybrid metal matrix composite can be developed effectively. Wear rate got increased with increase in load and sliding distance. Amount of wear reduces at higher speed than at lower speed of disc. The addition of Sic as secondary ceramic reduces the noise and vibration during themotion.By analyzing all the graphs and hardness number we can conclude that aluminum metal matrix composite is having higher strength when 10% of silicon carbide and aluminum oxide is added to aluminium7075 alloy.

2.1.3. SuswagataPoria et.al concludes that aluminium matrix composites reinforced with TiB_2 micro particles are prepared using stir casting method. Tribological characterization of the composite is done using block-on-roller contact configuration in a multi-tribotester against hardened steel counter face for varying weight percentage of reinforcement, normal load and speed. TiB_2ceramicparticle has high hardness value, hence hardness of the composite increases with addition of TiB_2 particles which is in line with earlier observations

reported in literature. SEMmicrographs reveal that the composite is compact and TiB_2particles are almost uniformly distributed in the matrix.XRD plots confirm the presence of TiB_2 in the composite. The observation is in line with the same reported earlier for composites prepared through in-situ methods. It is also observed that both friction and wear increase with applied load andspeed. SEM micrographs of worn surfaces reveal that both abrasive and adhesive wear mechanisms are present with abrasive wear being predominant in nature.

2.1.4. SureshBabu B et.al suggests that Al 6063 matrix composites have been successfully fabricated by the stir casting route and friction stir welding process. The particles SiC, B_4C and Graphite exhibit better wet ability and interfacial bonding together with Al 6063 matrix. The presence ofhard B_4C particles prevents the dislocation of atoms inside the composites, resulting higher hardness compared with other set 2 composites as well as base alloy. The yield strength and ultimate tensile strength of stir cast composites exhibit also higher than the base alloy.Also the particle dispersions inside the composites were evidently exposed using optical microscope study. The maximum FSW joint efficiency was achieved atmaximum tool rotation speed of 1000 rpm for all setsof hybrid composites, on the other hand the axial loadof 10 kN and welding speed 20 mm/min exhibitoptimistic tensile behavior for all three sets of composites. As compared to base alloy Al 6063, FSWprocessed hybrid composite shows improved physicaland mechanical properties.

2.1.5. Manoj Kumari et.al has concluded that Aluminium was chosen as the base material since its application is chosen worldwide for various purposed and it consists of very low melting point. Metal Matrix composites are prepared under the process of stir casting process. Silicon carbide and graphite is used for both temperature and abrasive resistance. The silicon carbide is used for the hardness

increasing whereas; the graphite is used for increasing the wear resistance of the component.

Aluminium 6061 was taken because of the following properties corrosion resistance, lightweight, smooth surface, and high strength. The alloy 6061 contains magnesium and silicon as its major alloying elements. It is primarily allowed with magnesium and chromium. The mechanical properties of tensile strength are found to be 150Mpa and the yield strength is 83.6Mpa.

Then silicon carbide ceramics which is in the form of fine grained structure with grain size of 0.11. The composites containing SIC and Al will have high modulus, strength, wear resistance, less weight, and a more effective load carrying factors. The silicon carbide forms a protective coating of silicon oxide at 1200C.

The aluminium also displays the similar reaction. Therefore, it can be seen in material that satisfies the advantages which are used in the aerospace industry with application with good thermal and tensile properties. It also states that silicon carbide exhibit good corrosion and oxidation properties.

There are generally two types of carbons (1) Carbons which are considered to be said Graphitizing and the Carbon those are not considered is said to be Non-Graphitizing. The main difference between them is the apparent layer size and stack height. Those factors are to be considered for the first stage in the process of carbonization.

2.1. FACTORS AFFECTING THE PROPERTIES OF AL-SIC

Although we have discussed some properties of Al-sic, the composites which contain exact set of properties depend upon the number of factors. The changes which occur in micro structure of both matrix and reinforcement which results in hardening (or) heat treatment process. The work has been identified with some set of factors from the existing literature that could affect the properties of Al-Sic.

1. The reinforcing material and reactivity of the matrix.
2. Type of reinforcing material.
3. Volume fraction of reinforcing material.
4. Distribution of the reinforcing material.

2.2. ALLOYS VS COMPOSITES

2.2.1. ALLOYS

The alloy is a homogenous substance that can be made from melting one or two elements in which one of them is metal.

1. The alloy can be either homogenous or heterogeneous mixture composition.
2. The alloy is lustrous due to the presence of metal in the composition.
3. The alloys always contain metals in the mixture.

2.2.2. COMPOSITES

The composite is a mixture of non- metallic components.

1. The composites are always heterogeneous mixtures.
2. The composites are not lustrous as they don’t contain metal in their composition.
3. The composite doesn’t contain any metals.

CHAPTER 3

DESIGN OF SPROCKET

3.1. CALCULATIONS

Pitch diameter =P/Sin (180/Z)

Outside diameter = P [0.6 * Cot (180/Z)]

Bottom diameter = Pitch diameter - Roller outside diameter

Caliper diameter = Pitch diameter *(Cos (90/Z)) - Roller diameter

Maximum hub diameter = [Cot (180/Z)-1] - 0.03

Number of teeth:

Z_1=18

Z_2=42

$I = Z_2/Z_1$

I =42/18

I=2.33

Pitch: a= (30-50) P

Maximum pitch: P max =300/30 = 10 **mm**

Minimum pitch: P min =300/50 =6 **mm**

Pitch= 12.7mm

Pitch circle diameter of Rear sprocket

D_1= P/ (sin/ (180/Z))

=12.7/sin (180/18)

D_1= 73.16 **mm**

Pitch circle diameter of Front sprocket

$D_2 = P / \sin(180/Z)$

$= 12.7 / \sin(180/42)$

D_2= 169.94 mm

SPROCKET OUTSIDE DIAMETER

Sprocket outside diameter (Rear)

$Do_1 = D1 + 0.8(Dr)$

$Dr = 8.51$ mm

$= 73.16 + 0.8(8.51)$

Do_1 = 79.944 mm

Sprocket outside diameter (Front)

$Do_2 = D2 + 0.8(dr)$

$= 169.94 + 0.8(8.51)$

Do_2 = 176.748 mm

BOTTOM DAIMETER OF THE SPROCKET

Bottom diameter(front) = Pitchdiameter - Roller outside diameter

$= 169.94 – 8.51$

= **161.43 mm**

Bottom diameter(rear) = Pitch diameter - Roller outside diameter

$= 73.136 – 8.51$

= **64.62 mm**

Where,

P = Pitch of the sprocket

Z = number of teeth

Z_1 =Number of teeth in rear sprocket

Z_2 =Number of teeth in front sprocket

Dr = Roller outside diameter

Do_1 = outside diameter of rear sprocket

Do_2 =outside diameter of front sprocket

3.2. DESIGN OF FRONT SPROCKET USING SOLID WORKS SOFTWARE

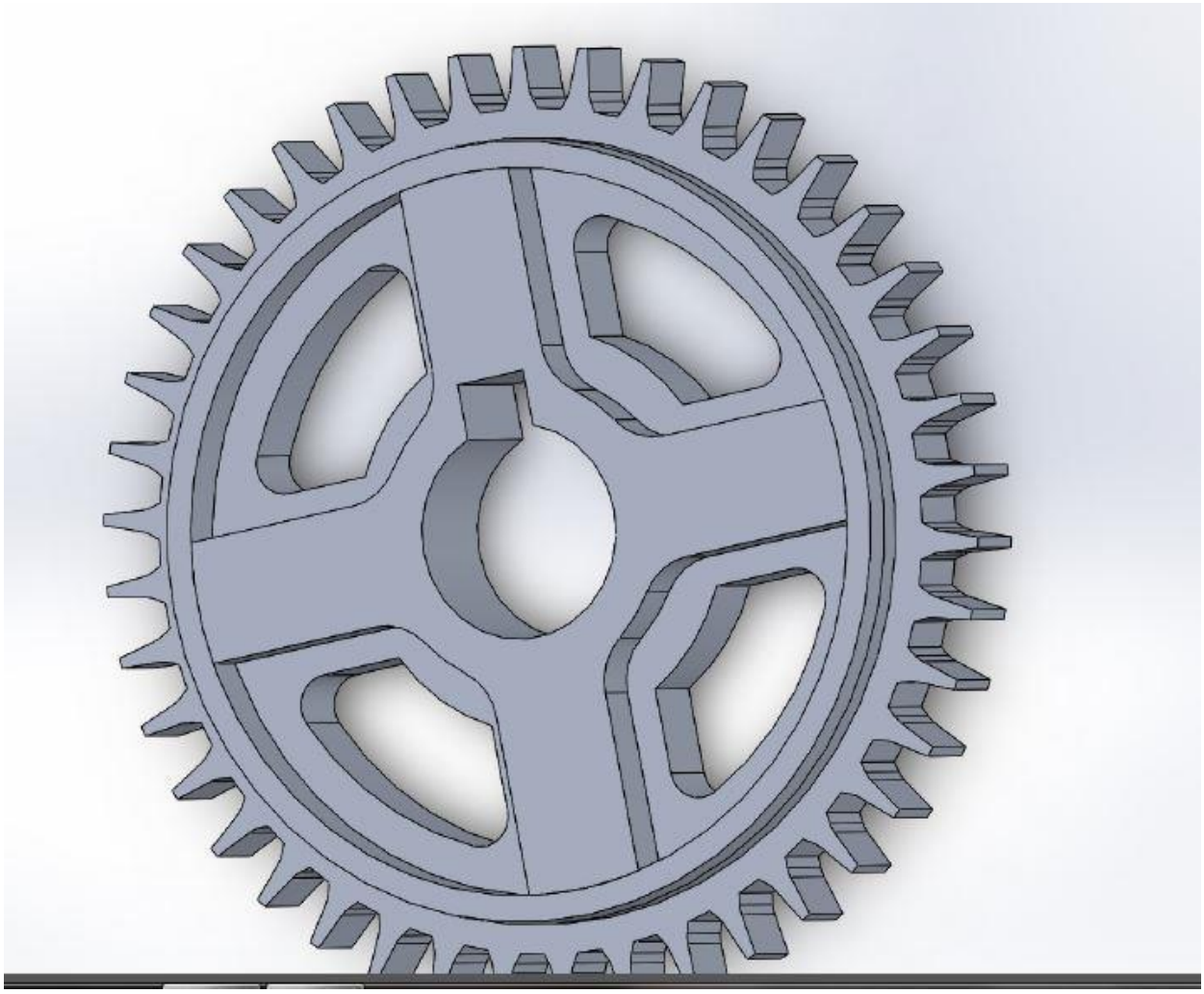

Fig.3.1- Front sprocket

No of Teeth's: **42**

3.2.1. DESIGN OF REAR SPROCKET USING SOLID WORKS SOFTWARE

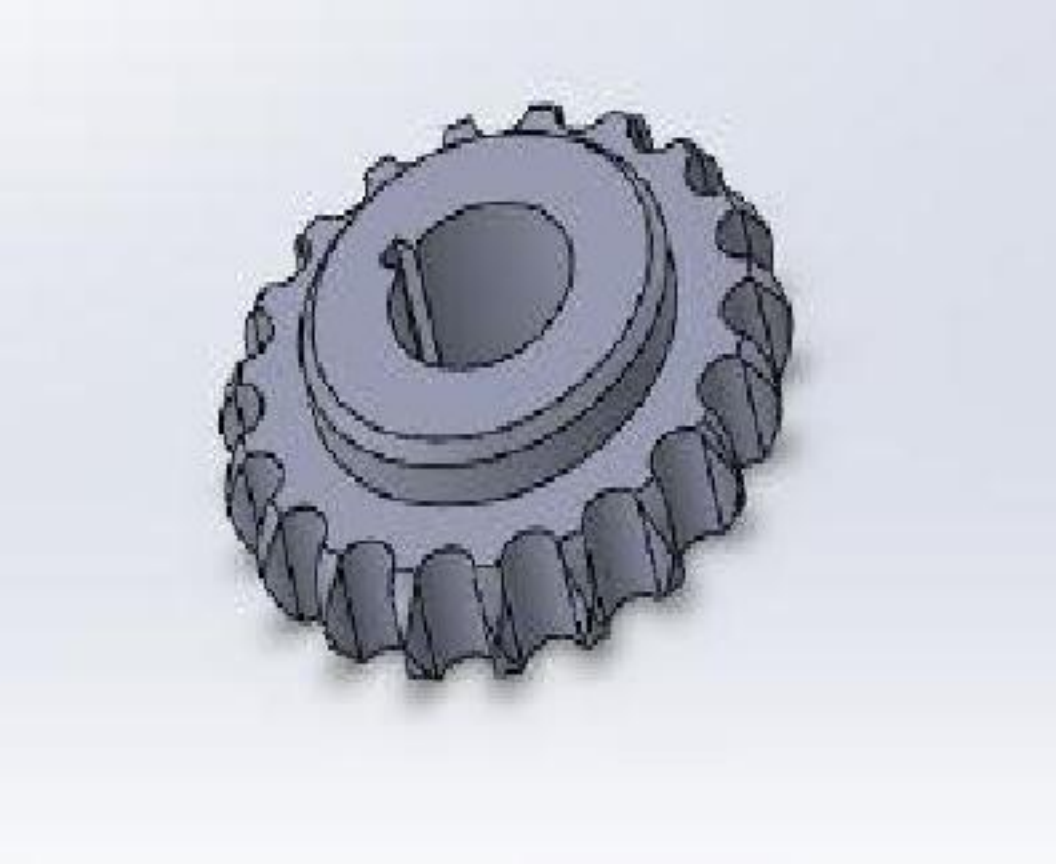

Fig.3.2- Rear sprocket

No of Teeth's: **18**

3.2.2. 2D VIEW OF FRONT SPROCKET

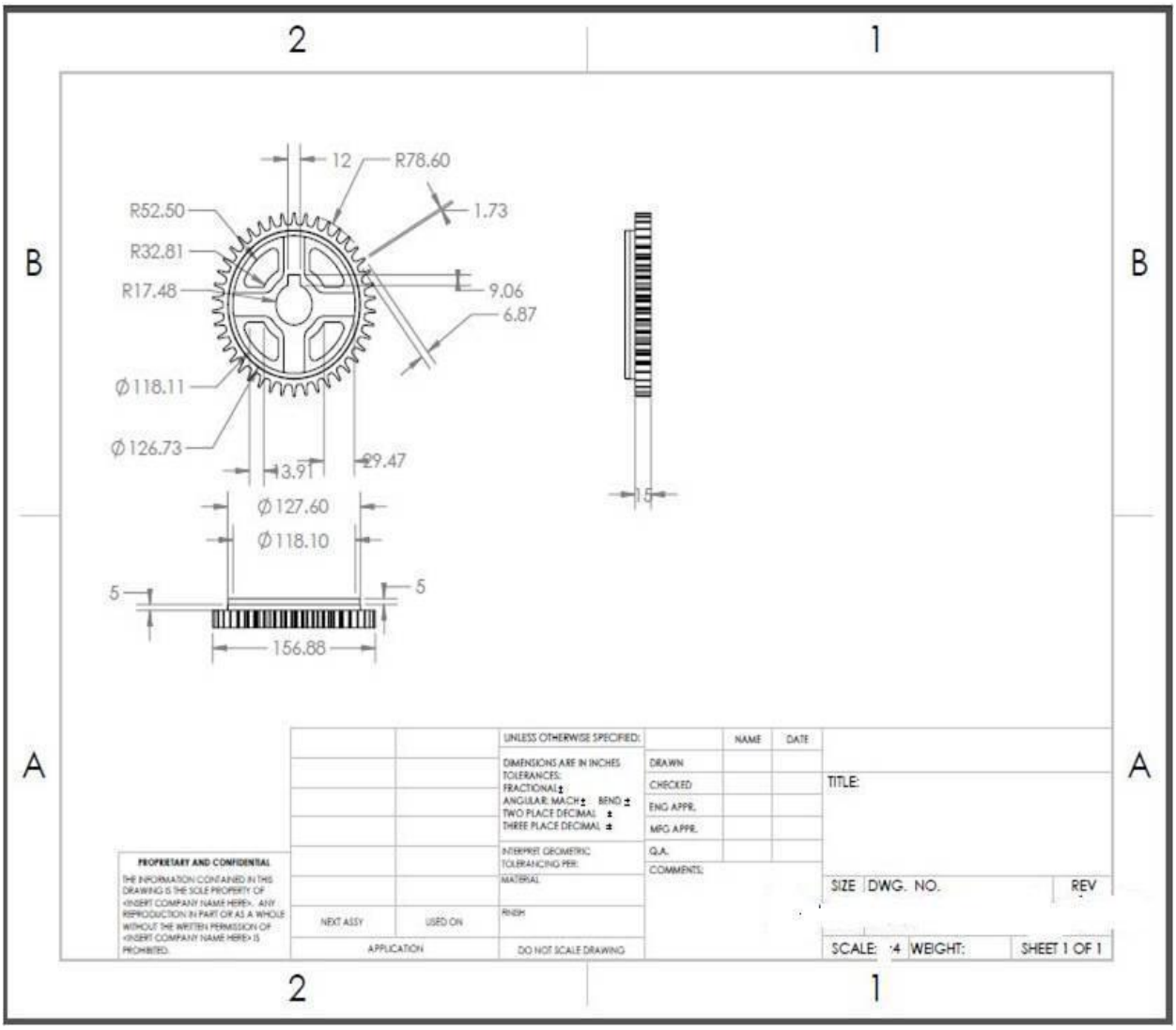

Fig.3.3- 2D view of front sprocket

3.2.3. 2D VIEW OF REAR SPROCKET

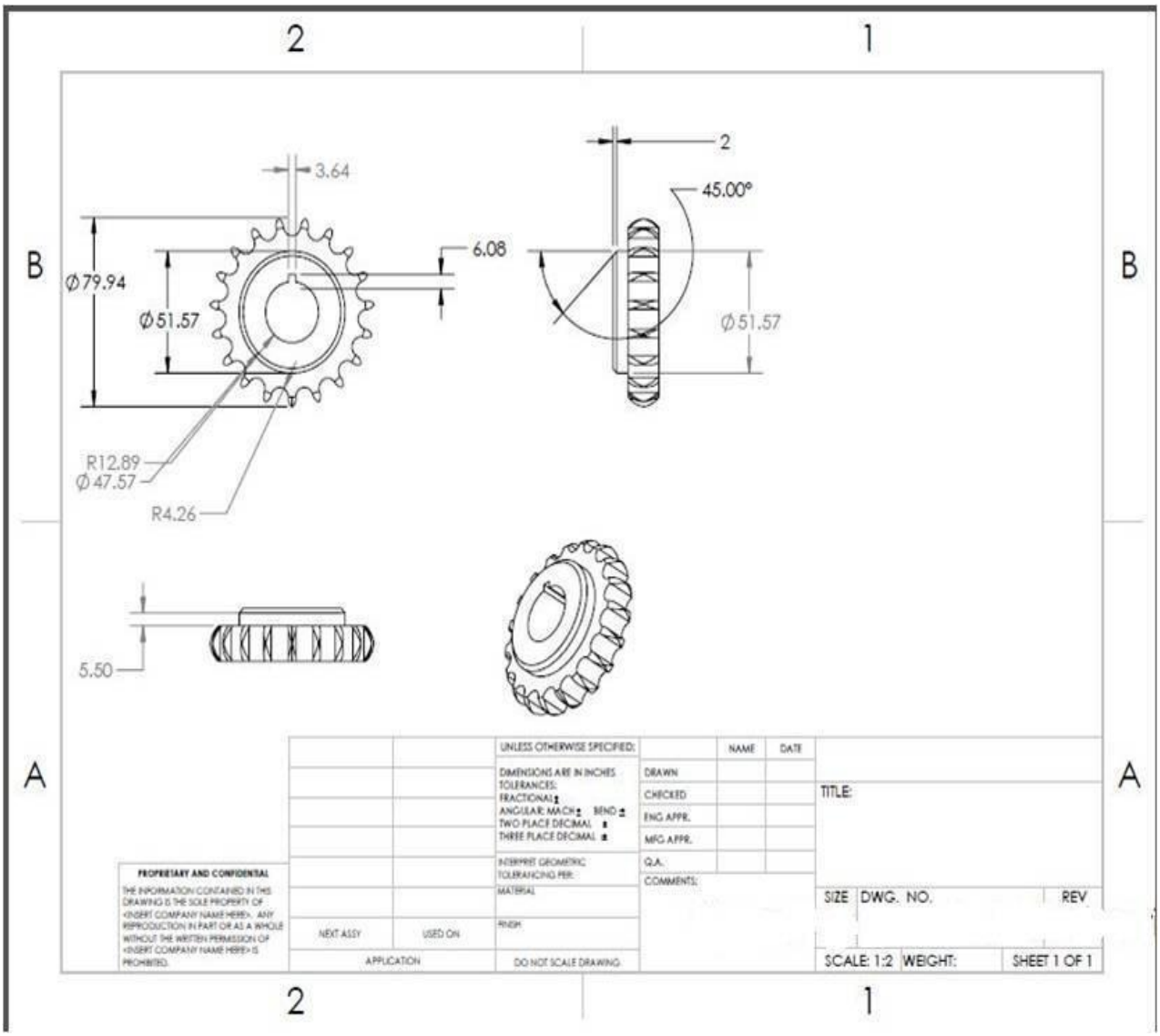

Fig.3.4- 2D view of rear sprocket

CHAPTER 4

PROPOSED METHODOLOGY

4.1. STIR CASTING METHOD

Fig.4.1- Aluminium stir casting furnace

Stir casting method is also known as **"BLEND THROWING PROCESS"**. The stages are circulated through a liquid section by the means of mechanical mixing. The mix throwing process of metal lattice composites were started in the year 1968. The alumina particles are made aluminium by mixing certain quantity of liquid in them. The stir casting is a technique which is used for softening the texture by the means of blending and spouting the dissolved mixture in to the preformed depression. At the similar point of time the mixture is made to cool them and after some time it is made to harden. In the blend throwing process

the particles tend to make more agglomerates which might break down at typical mixing at warm.

Fig.4.2- Adding of composites

The mix throwing process consists of chamber, vessel and a rotor which is fixed to the engine. The metallic component metal was fusible inside the system which is heated under the temperature of 720^0C while in the meantime the silicon carbide and the graphite are weighed under the weighing machine and both the mixtures of composites are taken with percentage of SIC (4%) and Gr (3%). The aluminium alloy 5052 along with (Sic-Gr) is poured inside the crucible which is made to heat under the temperature of 720^0C and the metal is melted in the crucible after a couple of hours. The composites which are weighed are poured inside the crucible and the stirrer which is fixed inside the component is allowed to stir the composition at the regular speed of hundred cycles for every moment with the assistance of rotor.

The excessive materials are taken out and poured in to the sand moulds. The die which is in the form circular shaped is fixed beneath the crucible system and after some period of time the composites which are in liquefied state are poured in to the circular die and the composites are formed in a circular shape and the material is removed with certain period of time and allow some time to get it harden.

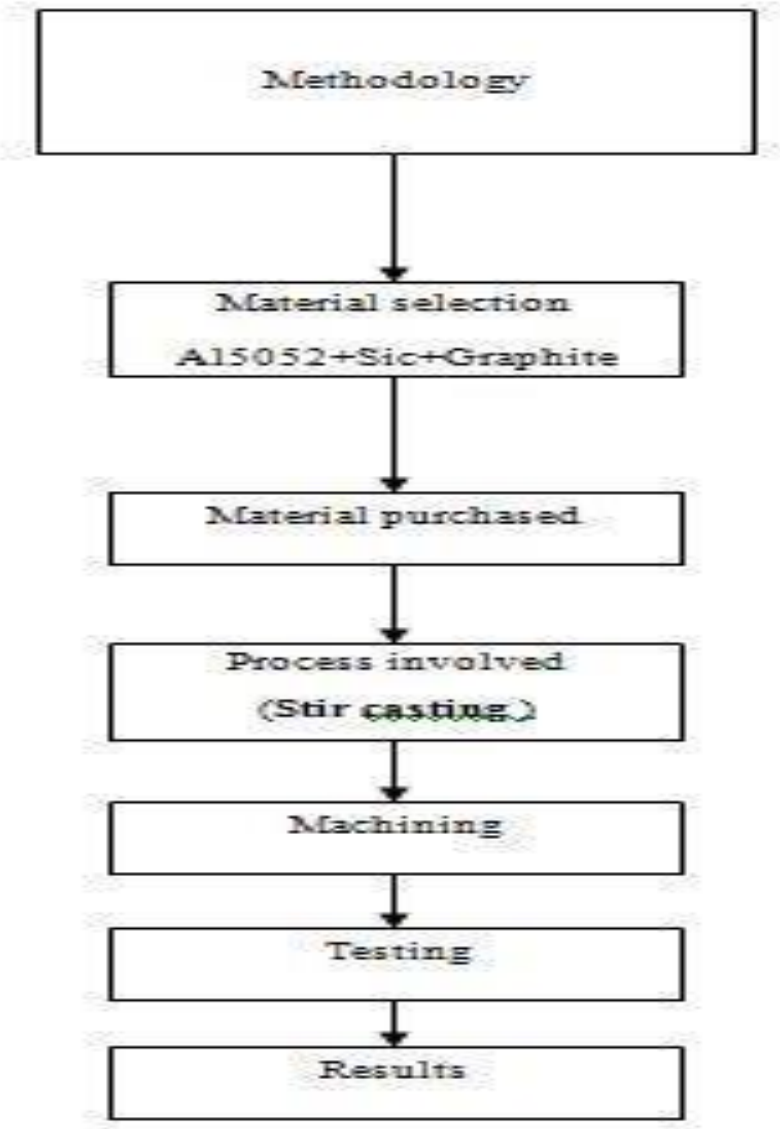

Fig.4.3- Process methodology

CHAPTER 5
EXPERIMENTS

5.1. TENSILE TEST

Fig.5.1- Universal testing machine

Tensile testing which is found to be tension testing and completely based on the fundamentals of material science and engineering where the sample is subjected under controlled tension. Properties that are measured for tensile test which includes are ultimate tensile strength, breaking strength, elongation and reduction in area. For the following measurements the properties which are to be determined are Young's modulus, Poisson ratio, and strain hardening.

The shoulders of the test specimen can be manufactured in various ways in determining the various grips in the testing machine. Threaded shoulders and grips also give good alignment. The preparation of test specimen depends on the purpose of testing and based on the specification. A tensile specimen is usually based on standard cross section. A standard specimen is basically of circular or square in cross section depending upon the gauge length. Both the ends of the specimen have

sufficient length and surface condition which is found to be gripped during testing. The most common testing machine used in the tensile testing is universal testing machine and the machine consist of two cross heads one acts for the length of machine and another for applying tension to the specimen.

The machine must abilities for the test specimen being tested. The parameters which are engaged are precision, speed, accuracy, and force capacity and force capacity enables the enough force to break the specimen and machine should able to measure the gauge length very precisely. The strain measurements are commonly measured with an extensometer and where Poisson's ratio is measured.

From the previous paper we have observed with an addition of SIC (10%) the tensile strength found to be (172-185) N/mm^2 and again with the addition of SIC (8%) the tensile strength found to be 190.5N/mm^2. So, we have taken silicon carbide (4%), Graphite (3%) and aluminium alloy 5052 and graphite is added to increase the wear resistance.

5.2. HARDNESS TEST

Fig.5.2-Rockwell hardness machine

Hardness is the measure of resistance which is offered by plastic deformation and completely induced by mechanical indentation. Microscopic hardness is generally characterized by intermolecular bonds and behavior is found to be complex with force. The basic parameters are elasticity, strain, strength, viscosity. The hardness consists of three main measurements which include scratch, indentation, and rebound. The principle behind scratch hardness is object made of a harder material will scratch an object made of a softer material. Another tool which is used to test is pocket hardness tester. The indentation process deals with resistance offered to the material deformation due to the constant compression and hardness scales are Rockwell and Brinell test.

The mechanism behind the hardness is to determine the metallic microstructure and arrangement of atoms at atomic level configuration and atoms are arranged in a three dimensional array called crystal lattice. The irregularities which affect the grain structure are point and line defects. Dislocations are the type of line defect which occurs due to the misalignment in the planes. The most common test is the Mohr's test which is found to be in mineralogy. Hardness increases with decrease in size particle.

Fig.5.3- Rockwell hardness machine

The hardness of the material to deformation depends upon the shear modulus at any point of direction. Hardness of the material can be determined by indenting the diamond pointer which is pointed towards the center of the component or specimen and the material is based upon the material which includes type (a, b, c) depending upon the material the specimen is chosen and hardness of the material can be easily found out. The hardness of the specimen can be determined using various scales based on the material which are used and point at which material got indented at the center determines the maximum hardness in the specimen. The hardness can be determined by both Vickers and Rockwell testing.From the previous paper it is observed that the hardness of aluminium 5052 is around 54. When the silicon carbide is added to the aluminium material the hardness starts increasing. There is gradual increase from 54 to 60and with addition of silicon carbide 4% and graphite 3% and composites can be used where higher hardness is required.

5.3. IMPACT TEST

Fig.5.4-Impact testing machine

The impact test for the composite materials which is reinforced with the aluminium alloy is done by Charpy impact test which is also known as strain rate test that determines energy absorbed by a material during fracture. The energy gives material's toughness and temperature dependent brittle transition. The test was developed by Russell around 1900.The main aim of the test is to determine the fracture problems of ships and it is utilized in many industries to determine how storms will affect the materials.

The apparatus consists of a pendulum with appropriate mass and length dropped from a known height to fracture notched specimen of material. The notch which is present in the sample affects the result of impact test. The defect in the sample affects the results and it also determines whether the material is in plain strain. The energy which fractures the material defines the toughness of the specimen and strain rate can be established to analyze the effect of fracture. The results can be used to engage the ductility of the material if the material tends to break in flat plane then the fracture is brittle and if fracture occurs in edges of specimen and it tends to be ductile.

High strength materials have initially low impact energy and get fractured easily and initiate crack propagation at less time and they are not widely used for the fracture resistance of low strength materials which determines the fracture mode remains unchanged with the temperature as body centered cubic as transition metals. The impact of the materials can be easily determined in KJ and energy completely depend upon the temperature dependent and it can be loss at lesser amount of time to engage the strain present in the material and specimen should be in V-Notch type which should be placed horizontally so that axe which follows the specimen with higher amount of energy and strain gets displaced and impact energy of the specimen is obtained.

5.4. SEM ANALYSIS (SCANNING ELECTRON MICROSCOPY)

Fig.5.5-SEM Analysis machine

A scanning electron microscope is also known as electron microscope which gives the images of sample by scanning the surface of the beam under the focus of the electron beams. The electron interacts with the atoms to determine various signals in surface topography. They achieve better in resolution than nanometer. The specimens are found to be observed in high vacuum or wet conditions to determine variable pressure of environmental conditions. The signals which are produced by scanning electron microscopy give detailed image o from various interactions of electron beams at various depths of the specimen. In secondary electron imaging the electrons are emitted very close to the specimen.

SEM Samples have sample enough either of rectangular or square or circular cross section of minimum diameter 5mm and they may need preparation to increase the electrical conductivity and need to stabilize them so that they can withstand high vacuums and they are extensively used to identify the defects of semi-conductor

wafers. Hence they are used to determine the composition of elements present in the specimen and they determine the actual percentage. They are used to determine micro structural image of the specimen and the amount of wear resistance present in the system.

SEM is done for the aluminium alloy 6061 where the depth effect of the specimen is captured and properties of the specimen are noted with the help of the computer and the specimen which we are manufacturing are the aluminium alloy 5052 with silicon carbide and graphite to determine number of percentage of composition present in the specimen and the micro structural image of the specimen. They are used for further development of properties in the specimen and used to identify whether the specimen has improved parameters and can be used for future purposes.

5.5. FATIGUE TEST

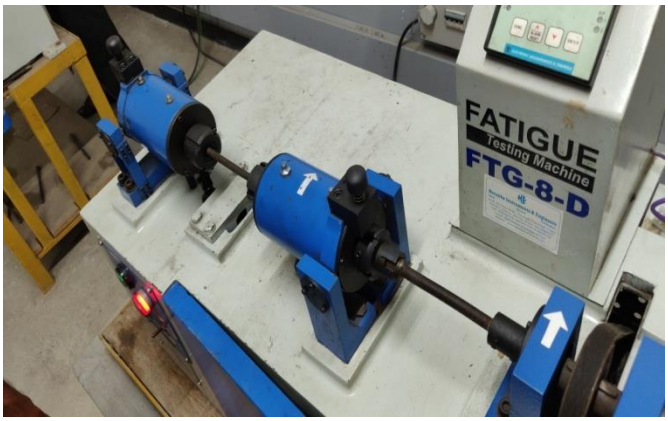

Fig.5.6-Fatigue testing machine

Fatigue testing is a process in which the material is subjected to a structural change or fracture at some point when fluctuating stress or strain occurs in the specimen. They may culminate in cracks with numerous fluctuations occurs in the component. It is also weakening the specimen by applying continuous loads

in the system and if the loads tend to be above threshold then the specimen might to begin with microscopic cracks in the component and they will develop a size which will propagate a crack easily and causes structure to fracture at minimal time. The structural shape will cause defect to its life. The specimen made up of round holes will improve the fatigue strength of structure. The fatigue life of material depends upon the stress-life, strain-life and fracture mechanics method. Uniform Material Law was developed for fatigue life which includes titanium and aluminium alloys.

The fatigue life is influenced with parameters which includes temperature, surface finish and metallic structures and the material which consist of high strength consist of frequencies 5-20 Hz and breaking at the maximum of 10^8cycles which determines the properties of specimen. Fatigue has a degree of randomness which is considerably scattered in all parts of specimen in well controlled environment and amount of stress applied at higher ranges the life depends upon them. Fatigue is basically associated with tensile stresses and cracks will depend upon on compressive loads.

They are determined by S-N curves which are influenced by many parameters such as frequency, temperature, corrosion, and presence of notches. The line method determines the estimation of stress on fatigue strength. The material will develop cell structures and will get hardened when the load is applied to the specimen which indirectly responsible for formation of slip bands in the specimen. Increased in fatigue life are directly proportional to the depth of residual stresses of specimen. Hence the fatigue of the material will depend on the type of material and loads applied to them. It leads to improper properties which have to be influenced with similar composites to achieve greater strength and also life time of the specimen.

5.6. WEAR-RESISTANCE TEST

Fig.5.7-Wear resistance testing machine

Wear resistance is the process of losing material from surface with means of mechanical action. It is measured with help of Pinon instrument which is used to measure the wear rate or wear volume of the specimen. Wear which occurs in metals are of plastic displacement of surface and detachment of particles which will create wear debris and particle size which varies from millimeters to nanometers. The wear rate is being affected by the parameters such as loading, motion, and temperature. There are many types of wear which includes adhesive, abrasive and surface fatigue and they occur in direct contact and deformation of synergistic manner which produces greater wear rate and they are caused by plastic deformation which leads to wear debris.

They occur when two solid surfaces slide or pressed over each other and are separated by measurable distance. The amplitude and the mechanism of surface attraction vary between different materials and hence there is an increase in density energy of surface. The surface fatigue is the process in which the surface of the specimen gets fractured by cyclic loading. Micro-cracks are either based on super cracks or sub surface cracks and surface which adapt to each other depends upon

wear rate of high or low precision. When the surface is subjected to failure of high wear rate.

The wear coefficient is a physical process used to determine the measurement and characterization of materials. The wear of the material can be determined with the help of pinon instrument and machine is able to run for 10-20 minutes based on the type of material the wear volume is defined which enables the stiffness of the material and the duration of the machine enables the specimen to withstand the strength and the wear volume states the load which is applied and no load conditions are also applied and depending upon the carbon content of the material the wear volume is established and more the percentage of the carbon content the wear rate of specimen is increased and it determines the toughness of the material. Hence the wear resistance of the specimen gets increased with the help of the graphite content.

5.7. SOFTWARE USED

Software which is used to draw the sprocket is done on the SOLIDWORKS 14 and the sprocket dimensions are calculated by the formulas which are used in the design data book (PSG.DB). SOLIDWORKS is a software where various structures can be drawn of various dimensions and they can be determining as product which is the output of the system and various finishes can be determined with the help of this system. Parameters whichrefers to constraints and their values determine the shape or geometry of the model. It consists of numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal etc.

Numeric parameters can be allocated with each other through the use of relations, which in turns give them to capture design intent and sketch consists of geometry such as points, lines, arcs, conics, and splines. Dimensions which are added to the sketch define the size and location of the geometry. Solid Works that are dimensions and relations drive the geometry, not the other way around.

The dimensions which are present in the sketch can be controlled independently, or by relationships to other parameters inside of the sketch.

They are used to determine how a product will function with different specifications, without obtaining building test products or conducting crash tests and they may simulate how a bridge will hold up after years of traffic, how to create process salmon in a cannery to reduce waste, or how to design a slide that uses less amount of material without sacrificing safety.

Mostly simulations are performed with the help of the Ansys Workbench software, which is one of the company's main products. Typically, the users create down larger structures into small components which are each modeled and tested individually and they may start by defining the dimensions of an object by adding weight, pressure, temperature and other physical properties. Finally, the software simulates and analyzes movement of fatigue, fluid flow, temperature distribution, electromagnetic efficiency and other effects over time.

CHAPTER 6

TESTING& RESULTS

6.1. TENSILE TESTING

Fig.6.1-Testing specimen

Fig.6.2-Tested specimen

Fig.6.1 (2) - Clamping of specimen

INPUT DATA	OUTPUT DATA
Specimen shape: Solid round	**Load at yield:** 15.76KN
Specimen type: Aluminium	**Yield stress:**168.45MPa
Specimen description: Al5052+SiC+Graphite	**Load at peak:** 25.61KN
Specimen dia:15.54 mm	**Tensile strength:** 221.35 MPa
Final gauge length:62.3 mm	**Elongation:**2.56%
Specimen CS area:163.8 mm^2	

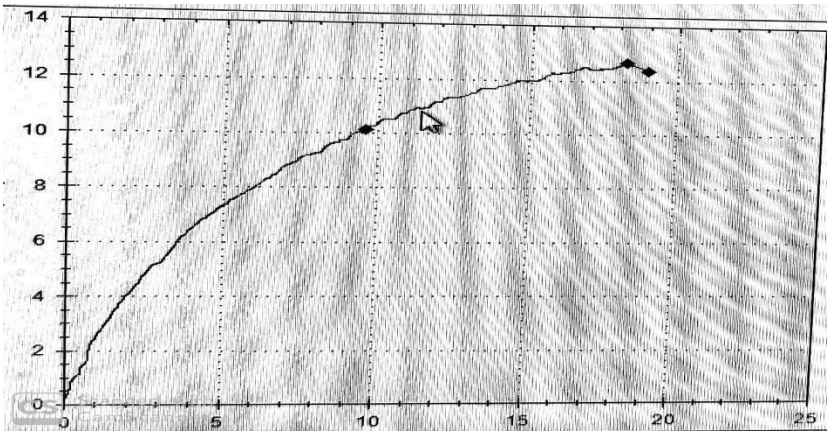

Fig.6.3- Stress vs. Strain

Thus the aluminium alloy 6061 has tensile properties of 198MPa whereas, the composite mixture of aluminium alloy 5052 with presence of silicon carbide and graphite has tensile strength of 221.35 MPa and the tensile properties is found to be increased with ceramics which is added in the composition and the weight of the specimen is also reduced when the composites or alloying elements added to the

mixture. It is found that the aluminium alloy 5052 along with the composites present in the specimen is found to have more tensile strength. Hence the properties are justified.

6.2. HARDNESS TESTING

Fig.6.4- Hardness tested specimen

Material	**Scale**	**Intender**	**Load**	**Dial**	**Observed values(HRD)**	**Average value(HRD)**
Al5052 +SiC +Graphite	D	Diamond	150 Kg	Black	59	60
					61	
					60	

Hardness value of the aluminium is around 54. Whereas, the hardness of the aluminium alloy 5052 along with silicon carbide and graphite present in the specimen is found to be 60. Hence the hardness properties is found to be increased with amount of composites added in the specimen and thus the properties is found

to be justified along with minimum percentage of the composites present in the specimen.

6.3. IMPACT TESTING

Fig.6.5-Impact tested specimen

Material of the specimen=**Al5052+SiC+Graphite**

Type of notch=**V-Notch**

Length of the specimen=**55mm**

Breadth of the specimen=**10mm**

Depth of the specimen=**10mm**

Position of groove from one end=**25mm**

Depth of the grove=**5mm**

Width of the groove=**2mm**

Initial scale reading=**300 Kgm**

Final scale reading=**54 Kgm**

Specimen	**Charpy impact value(J)**	**Charpy impact strength(J/mm^2)**
Al5052+SiC+Graphite	29	0.58

Calculation:

Area = b (depth-depth of groove)

= 10 (10-5)

= 50**mm**^{2}

= 29/50

= 0.58**J/mm**^{2}

Thus, the impact strength is found to enhance the mechanical properties of the sprocket and they can be used for various purposes mostly for to withstand the specimen under high pressure and the impact value of the composites is found to be 29J. Hence the properties are justified. The impact of the specimen is found to be increased with addition of composites to the specimen which are measured using the dial present in the machine and the work is calculated in terms of Joules (J).

6.4. SEM ANALYSIS

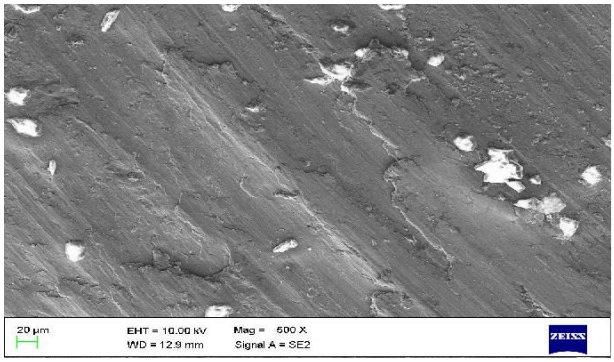

Fig.6.6-SEM analysis sample (1)

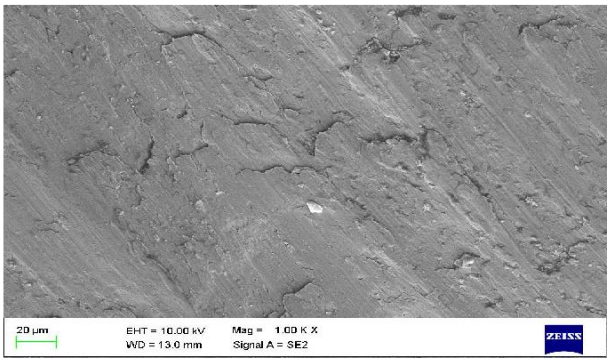

Fig.6.7- SEM analysis sample (1)

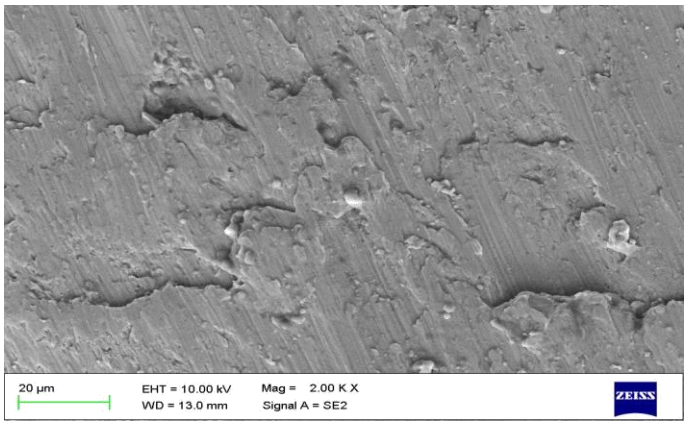

Fig.6.8-SEM analysis sample (1)

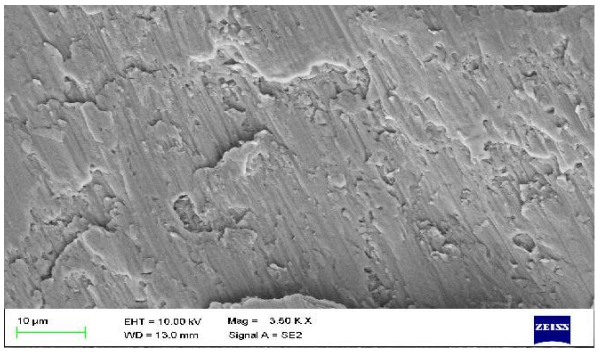

Fig.6.9-SEM analysis sample (2)

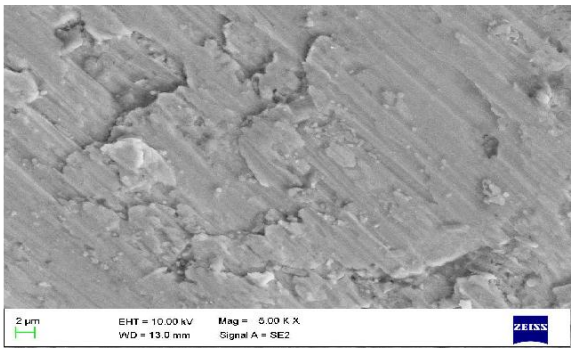

Fig.6.10-SEM analysis sample (2)

The SEM analysis is also known as scanning electron microscopy which is used in micro analysis. In this analysis we can see the micro structural image of the specimen and the number of percentage of composition present in the specimen. In the specimen we can identify the depth of the composites and rupture which occurs in them. The samples are taken out and the visible things in the specimen are ploughings, wedges, and debris in which we can see various stages of ceramic particles mixed in the specimen along with their composition percentage present in them. Analysis with Sample (1) is found with composition of both silicon carbide and graphite found in the specimen whereas; Sample (2) is with the analysis of

aluminium alloy 6061 where the number of alloying elements along with aluminium is present in the specimen.

6.5. FATIGUE TESTING

Fig.6.11- Fatigue tested specimen

Bending stress(N/mm^2)	**Load (Kg)**	**Trial 1**	**Trail 2**	**Average (cycles/sec)**
448	50	75000	132000	103500

The fatigue life of a specimen is defined as the total number of cycles that a material can be subjected to under a single loading scheme. A fatigue test is also used for the determination of the maximum load that a sample can withstand for a specified number of cycles. Thus the value obtained from the fatigue life for the load 50 Kg as input to the machine is 103500 cycles/ second. Thus these properties enhance the mechanical properties of the specimen and thus they are justified to the system.

6.6. WEAR TESTING

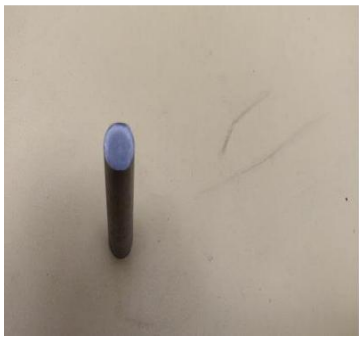

Fig.6.12- Before wear testing

Fig.6.13- Wear tested specimen

Calculation

Wear rate =Wear loss/ Sliding distance

Wear loss = 6.04-5.719

= 0.321

Sliding distance=

Pi*D*N*T Where,

Pi= 3.14

D= Diameter

N= Speed T=

Time

= 3.14*0.06*1000*5

= 942.5 m

Wear rate:

= (0.321/942.5)

$=340*10^{-6}$

Specimen	Time	Speed	Wear Rate (*10^{-6})
Aluminium Alloy	5	1000	340
	10	1000	341
	15	1000	343
Composite Al5052+SiC+Graphite	5	1000	300
	10	1000	305
	15	1000	308

GRAPH

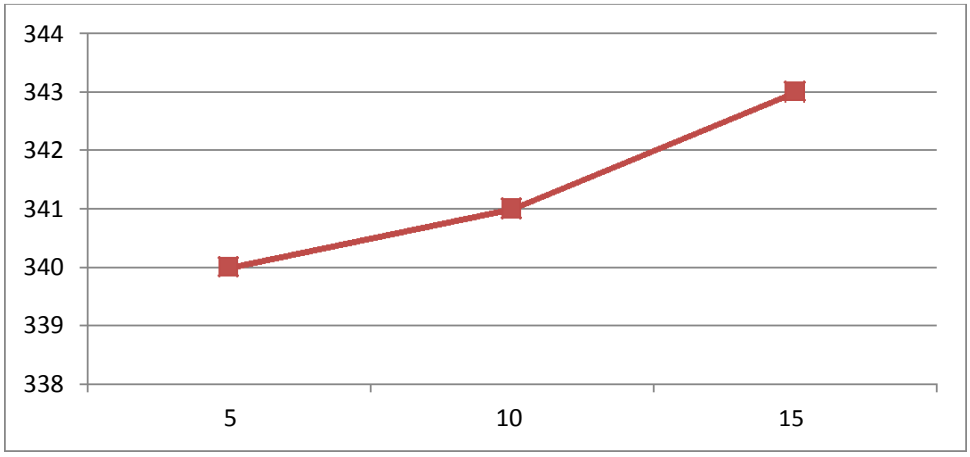

Fig.6.14-Time vs. Wear rate for **Aluminium Alloy 6061**

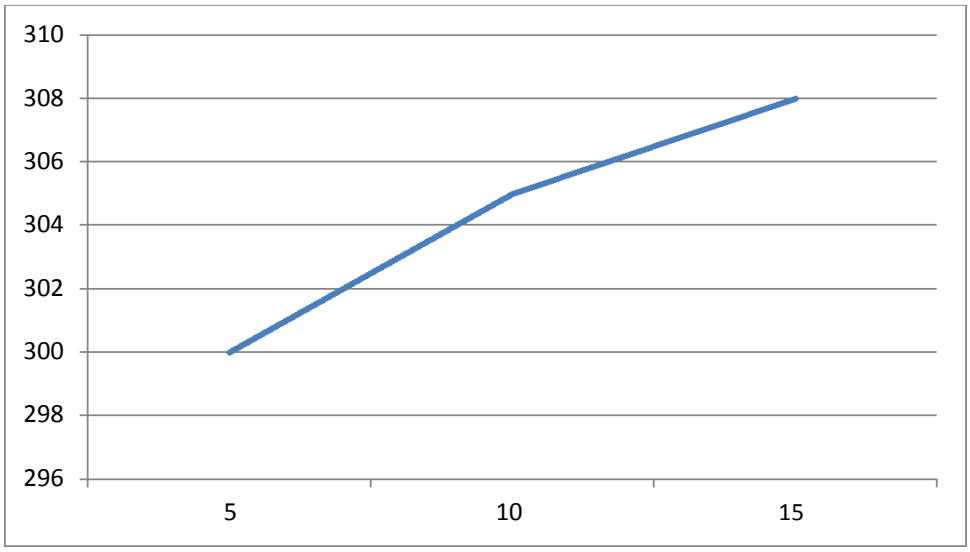

Fig.6.15-Time vs. Wear rate for **Composite**

6.7. ANSYS REPORT

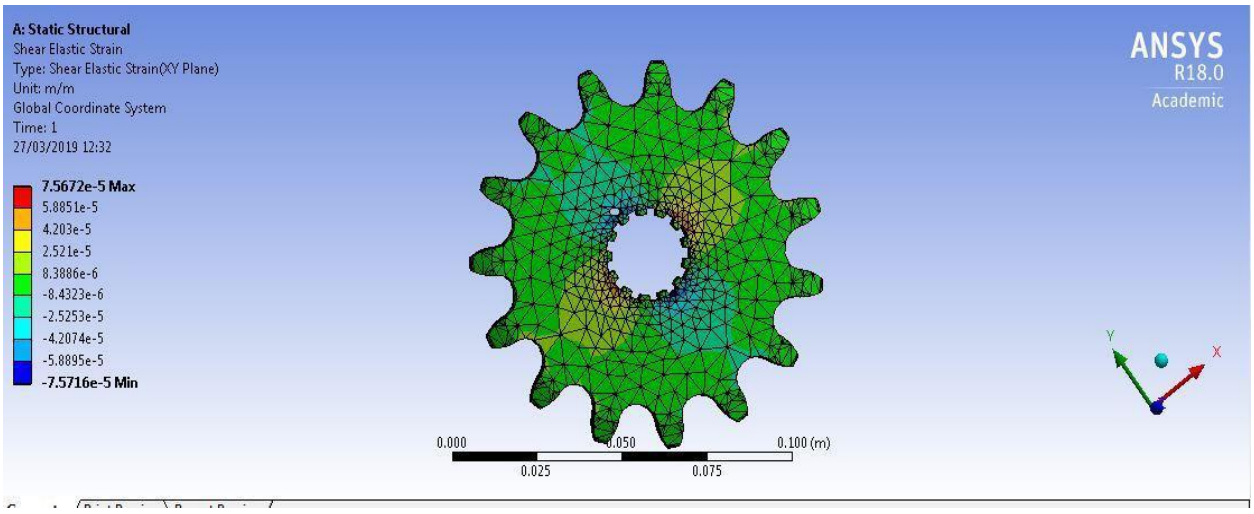

Fig6.16-Shear Elastic Strain

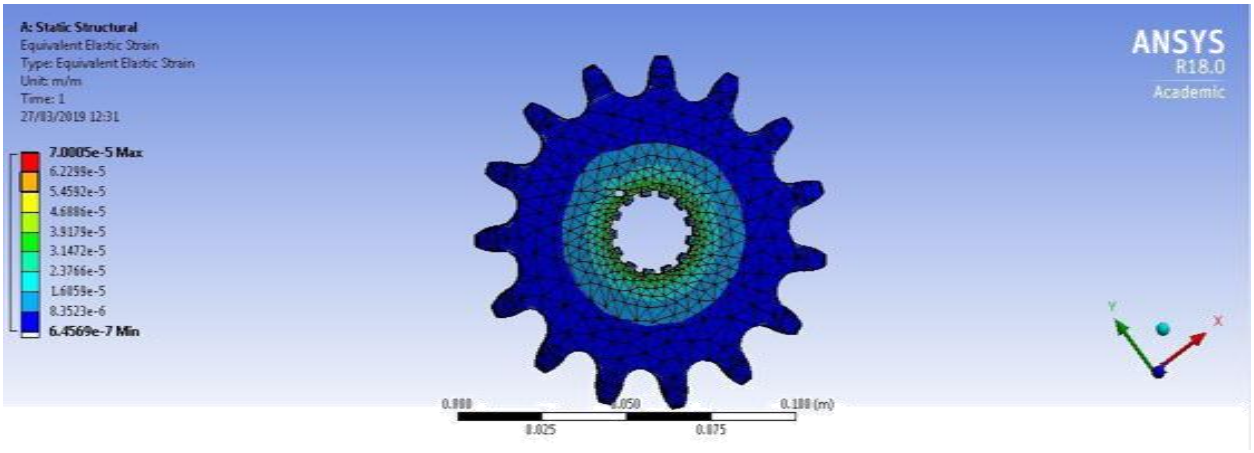

Fig.6.17-Equivalent Elastic Strain

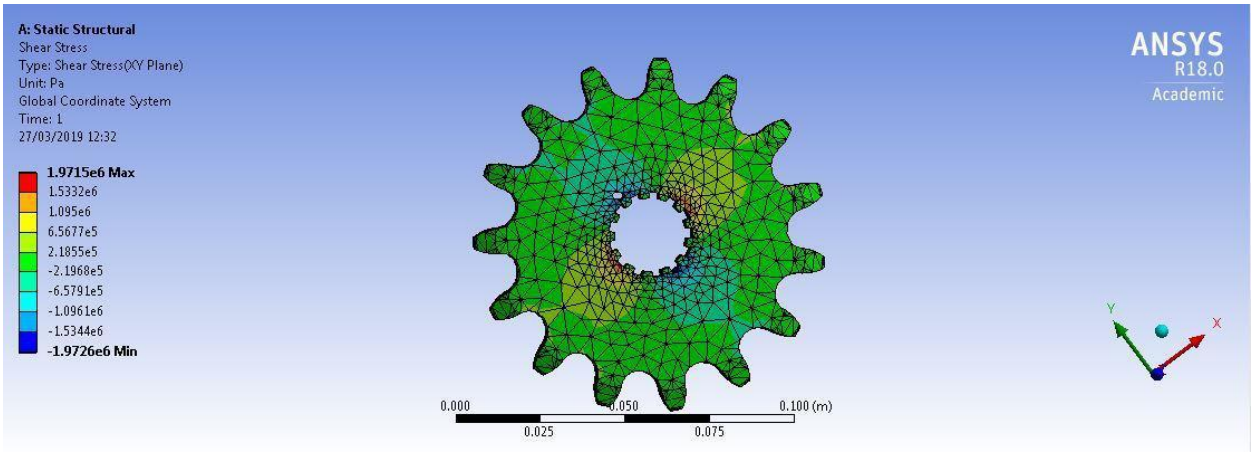

Fig.6.18-Shear Stress

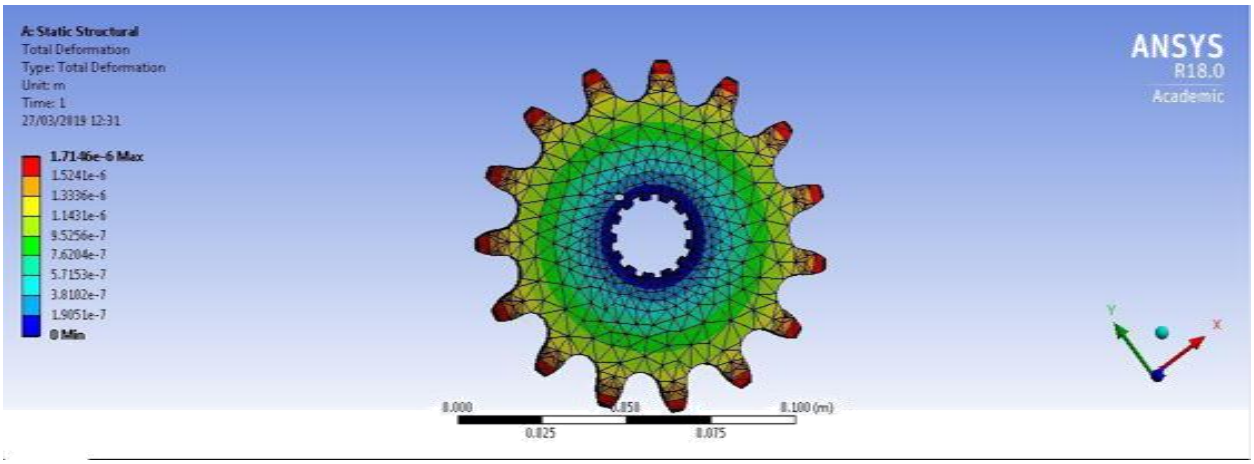

Fig.6.19-Total Deformation

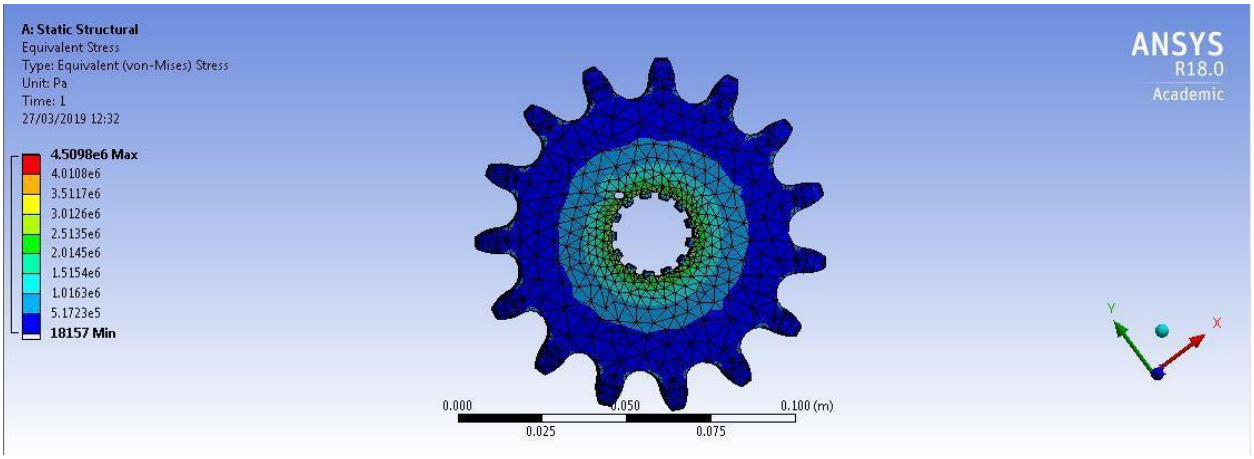

Fig.6.20-Equivalent Stress

CHAPTER 7

FUTURE SCOPE

The work done in present investigation has led to some conclusions which have been described in this chapter. However, the possibilities of further investigations of these developed composites based on above work can be explored. These are as below: The developed composites can be further investigated for their tensile strength, corrosion resistance along with some electrical and thermal measurement. It will help to widen their area of application in different engineering designs and applications. The wear behavior of the composites can be further analyzed at different environmental conditions like under lubricating condition and corrosive environment where temperature variation can be done. Effect of heat treatment on wear properties of the composites can also be examined to have their wider applications. High strain rate properties of the developed composite can be found out to explore the possibilities of using retile reinforced composite for different military applications.

CHAPTER 8

CONCLUSION

Al-Sic-Gr of various proportions is fabricated by using Stir casting process. Based on the conclusion various results have been drawn. It is found that Density of the composites keeps on decreasing by adding the ceramic content of the reinforcement. Hence it is found the combination of (Al-Sic-Gr) have a better performance. So, the composites can be used in various application for the weight reduction purposes is found to be desirable and the SEM analysis is used to determine the micro structural image of the specimen and number of percentage of each composites present in the specimen. Increase in the area of friction with next percentage, decrease in the rate of elongation of the metal matrix composites. As we can conclude the combination of (Al-Sic-Gr) is exceptional in industries for light weight purposes and the properties to be enhanced are found to be essential. It is found to be that the tensile properties got increased with slight changes of adding composition where the silicon carbide is used to increase the hardness and the graphite is used to increase the wear resistance of the specimen. The SEM analysis is detected to determine various compositions present in the specimen.

Al 6061 has tensile properties of 150 MPa, where the composition of (Al-Sic-Gr) is found to have 221.35 MPa and the hardness of the specimen is found to have 60 whereas the hardness of the aluminium is found to have 54. The tensile strength and the hardness of the specimen for the (Al-Sic-Gr) are found to be increased with minimum percentage of silicon carbide (4%) and graphite of (3%). The analysis is done under the laser technique to detect the composition and their percentage present in the specimen. Various results are taken out to determine the mechanical properties of the composition and hence there is an improvement in the properties

which has to be enhanced. Wear resistance of the specimen got increased with amount of graphite added in the specimen and graphite is used for the smoothness in the system which decreases wear rate and improvement in life time of the specimen. Hence, we can conclude that the composition of (Al-Sic-Gr) is found to be desirable and can be used in the industries for light weighing purposes.

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