Design, Modelling and Analysis of Lathe Tumbler Gear by using Different Materials

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***Abstract*- Spur gear is the simplest & widely used component in power transmission system. A spur Gear is generally subjected to bending stress which causes teeth failure. However it is observed that performance of the spur gear is not satisfactory in certain applications and therefore it is required to explore some alternate materials to improve the performance of the spur gears. Composite materials provide adequate strength with weight reduction and they are emerging as a better alternative for replacing metallic gears. In this project analysis is done by considering different materials for gears like Cast Iron, Carbon fiber / Epoxy, Glass filled Nylon 6, Aluminium Silicon Carbide, Nylon 101, Polyoxymethylene, Aluminium Alloy and Titanium Alloy.**

***Keywords*- Gear, Composite, Ansys, fibre, Epoxy**

I. INTRODUCTION

1.1 Background of Gear

Gears are the most useful and common means of transmitting motion and power in the today modern engineering field. They vary from tiny size used in watches to the large gears used in the lifting devices and speed reducers. Gears are the valuable mechanical element of mechanism such as rolling machinery, metal cutting machinery and automotive machinery. Gears with toothed shape generally used to vary or change speed power ratio also to change the direction of input and output shaft. Gears are used in pairs and each gear is usually attached to a rotating shaft. Geared devices can change the speed, torque, and direction of a power source. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape. Two or more meshing gears, working in a sequence, are called a gear train or a transmission. A gear can mesh with a linear toothed part, called a rack, producing translation instead of rotation. Gear is the one of the important machine element in the mechanical power transmission system. Because of the high degree of reliability and compactness gears dominates the field of mechanical power transmission. Gearbox is used to convert the input provided by a prime mover into an output required by end application. Due to increasing demand for quiet and long-term power transmission in machines, vehicles, elevators and generators, people are looking for a more precise analysis method of the gear systems.

Gears are very useful due to its beneficial characteristics like constant velocity ratio and simple attachment for increase or decrease in speed of shaft so it is widely used in most of power transmission system. They form vital elements of main and ancillary mechanism in many machines such as automobiles, tractors, metal cutting machine tools, rolling mills, hoisting and transmitting machinery and marine engines, etc. Successful gear systems often depend as much on selecting the right gear for the job as on the proper design of the individual parts. Gears can be made in a wide variety of forms, each with its own strengths and weaknesses. In some applications different gear types can be used with equal success. There are other cases where a specific type of gear has become the “standard” due to its unique characteristic. The increasing demand for quiet power transmission in machines, vehicles, elevators and generators, has created a growing demand for a more precise analysis of the characteristics of gear systems. In the automobile industry, the largest manufacturer of gears, higher reliability and lighter weight gears are necessary as lighter automobiles continue to be in demand. In addition, the success in engine noise reduction promotes the production of quieter gear pairs for further noise reduction. Noise reduction in gear pairs is especially critical in the rapidly growing field of office-automation equipment as the office environment is adversely affected by noise, and machines are playing an ever widening role in that environment. Ultimately, the only effective way to achieve gear noise reduction is to reduce the vibration associated with them. The reduction of noise through vibration control can only be achieved through research efforts by specialists in the field.

II. LITERATURE SURVEY

There has been a great deal of research on gear analysis, and a large body of literature on gear modeling has been published. The gear stress analysis, the transmission errors, prediction of gear dynamic loads, gear noise and the optimal design for gear sets are always major concerns in gear design.

M. Keerthi, K. Sandya, K. Srinivas[1] carried out “Static & Dynamic Analysis of Spur Gear using Different Materials” The objective of the project is to reduce the stress distribution, deformation and weight of spur gear by using composite materials in the application of gear box. The designed composite spur gear is compared with the existing gear materials, such as structural steel, gray cast iron and aluminium alloy. The tool which is used to analyze the different spur gear materials is ANSYS. In this, the analysis of torque loading and stress induced are to be performed for the materials chosen. The final outputs of these analyses for all the materials are to be compared. From this comparison, the stress induced, deformation and weight for composite spur gear materials are to be less than that of the general spur gear materials. It was concluded that the stress values are calculated for composite materials is approximately same as compared to the structural steel, gray cast iron and aluminium alloy. So from these analysis results, we conclude that, the stress induced, deformation and weight of the composite spur gear is almost same as compared to the structural steel spur gear, gray cast iron spur gear and aluminium alloy spur gear. So, Composite materials are capable of using in automobile vehicle gear boxes instead of existing cast steel gears with better results. The natural frequencies of structural Steel Spur Gear varies from 2019.7 Hz to 6399.7 Hz. For Gray Cast Iron Spur Gear the natural frequency varies from 1575.2 Hz to 4990.8 Hz, whereas for Aluminium Alloy Spur Gear the natural frequencies varies from 2003.8 Hz to 6353.2 Hz. The design is safe since the frequencies obtained exceeded the natural frequency of the spur gear (41.66 Hz).

Mahebub Vohra, Prof. Kevin Vyas[2] made experiment on the topic Comparative Finite Element Analysis Of Metallic And Non Metallic Spur Gear, the purpose of this is to Check comparative effect of produced stress in conventional metallic material of spur gears using a static finite element method, Check the non-metallic material using static finite element analysis, Check the stress analysis of gear parameter like as face width and module under loading condition, Check the possibility to replace metallic gear by other material like as polymer, composite or hybrid material for spur gear. And they found Different material study provides the information for the bending stress of each material. Simulation result has good agreement with the theoretical result, which implies that deformable body is correct. This study provides a sound foundation for future studies on bending stresses. The study is applied in to finite element method software ANSYS. It was found that numerically obtained values of stress distributions were in good agreement with the theoretical results

Nonmetallic material spur gear provides extra benefits like as less cost, self-lubricating, low noise, low vibration and easy manufacturing if it is used in limit of yield strength. It can be used in place of metallic gear in limit of yield strength of nonmetallic material.

S. Prabhakaran, D. S. Balaji and R. Praveen Kumar[3] Department of Mechanical Engineering, C hennai, India, carried out “Bending stress analysis of a spur gear for material steel 15NI2CR1MO28” and they used lewis equation. The experiment is concluded as, In spur gear, the design of the teeth is purely based on bending and contact stresses. The bending stress using AGMA for different modules in spur gear were calculated for steel 15Ni2Cr1Mo28 materials. The bending stresses were also calculated for spur gear using the Lewis and equation. The results obtained for the bending stress by AGMA and Lewis equation are validated using the FEA approach. The spur gear tooth profile are geometrically modeled by applying constraints and suitable loads for steel 15Ni2Cr1Mo28 material. Meshing was performed using the finite element method. The analysis results yielded by ANSYS were compared with the AGMA and Lewis equation. The results of spur gear for steel 15Ni2Cr1Mo28 clearly show that the bending stresse decrease with an increase in the module. Hence, higher modules can be for larger power transmission with minimum bending stress values.

Ms. Swati B. Gurav Gayatri Patil[4] did experiment on “Finite Element Analysis of Spur Gear with Glass Fibre as Material”, their basic idea is to study the strength and durability & weight optimization that can be achieved using glass fibre as alternative material to Cast Iron. Low density of Glass Fibre can significantly reduce the weight of Spur gear. Linear static analysis performed on Spur Gear made of Cast iron. Also considerable weight reduction is achieved due to low density of glass fibre. They found that the comparison, between linear static analysis results of Spur Gear with Cast iron and Glass Fiber as materials, has been performed and it is summarized in table.4 shown above. The comparison, between Spur Gear with Cast iron and Glass Fiber as materials for same Strength and durability has been performed and it is summarized in table.5 shown above. Percentage decrease in weight through iterations for same dimensions of gear is 73.61 %. Percentage decrease in weight through iterations for same strength and durability is 93.998 %. Below 10 mm, the deflection increase will be unsafe because, if the deflection increases further then there might be the failure in the gear pair.

Vivek Karaveer, Ashish Mogrekar and T. Preman Reynold Joseph[5] made “Modeling and Finite Element Analysis of Spur Gear”.This paper presents the stress analysis of mating teeth of spur gear to find maximum contact stress in the gear teeth. The results obtained from Finite Element Analysis (FEA) are compared with theoretical Hertzian equation values. For the analysis, steel and grey cast iron are used as the materials of spur gear. The spur gears are sketched, modeled and assembled in ANSYS Design Modeler. As Finite Element Method (FEM) is the easy and accurate technique for stress analysis, FE is done in finite element software ANSYS 14.5. Also deformation for steel and grey cast iron is obtained as efficiency of the gear depends on its deformation. The results show that the difference between maximum contact stresses obtained from Hertz equation and Finite Element Analysis is very less and it is acceptable. The deformation patterns of steel and grey cast iron gears depict. It was found that the results from both Hertz equation and Finite Element Analysis are comparable. From the deformation pattern of steel and grey cast iron, it could be concluded that difference between the maximum values of steel and grey CI gear deformation is very less.

Harshal P. Rahate, R. A. Marne[7], Department of Mechanical Engineering, AISSMS COE, SPPU, PUNE, did “Contact Stress Analysis of Composite Spur Gear Using FEM and Hertz Theory”. This paper represent contact stress analysis of steel gear and composite gear using Hertz equation and by Finite Element Analysis using Ansys 16.0 Workbench. When compared, the results of both theoretical method and FEA show a good degree of agreement with each other. It was found that the results from both Hertz equation and Finite Element Analysis are comparable. The results are well within the difference of 5%. Also it is observed that stress is reduced by nearly 25% due to the use of composite material.

III.OBJECTIVES

The main objective of our project is to suggest alternate materials which can replace conventional material used for gear manufacturing. The era in which we live is purely dominated by brilliance and excellence of composite material due to their excellent properties. Following are the objectives we tried to achieve in our project work.

1. To design lathe tumbler gear by using different materials.
2. To model the designed tumbler gear in SOLID WORKS 2016
3. To carry out static analysis on designed tumbler spur gear on ANSYS WB
4. To find and compare the effect of contact stresses on different materials under the same loading condition.
5. Suggesting alternate materials for gear manufacturing.
6. To increase strength to weight ratio of lathe tumbler gear.

IV.PROJECT DESCRIPTION

4.1 Specifications:

Manufacturer Name = NATARAJ BRAND (MOST PRECISION)

Power (P) = 2HP = 2 x 0.746 = 1.492 kW

Gear type = Parallel Spur Gear

Speed (N) = 1440 rpm

Face width (b) = 25 mm

Pressure angle(ϕ) = 20^0 involute

Pitch Circle Diameter (d) = 50 mm

Module (m) = 2

Design Calculations:

Torque (T) = (P x 60) / (2πN)= (1.429 x 103 x 60) / (2π x 1440)

T= 9.894 Nm

T = Ft x (d/2)

Where, Ft = Tangential force

Ft = T x d / 2

Ft = 9.894 x 50 x 10e-3 x 0.5

Ft = 395.76 N

Using Lewis Bending Equation,

σb = Ft / (Kv x b x y x Pc) Where, b = face width

y = 0.154 – 0.912 / z where z= no. of teeth

y = 0.154 – 0.912 / 25

y = 0.11752

Pc = π x m = π x 2

Pc = 6.283 mm

Ft = 395.76 N

Kv = 6 / (6+V)

V = (π × D × N) / 60000

V = (π × 50 × 1440) / 60000

V = 3.769 m/s^2

Therefore,

Kv = 6 / (6+3.769)

Kv = 0.614

Therefore,

σb = 395.76 / (0.614 x 25 x 0.11752 x 6.283)

σb = 34.917 N/mm^2

Ultimate tensile strength for cast iron = 700 N/mm2

Assuming factor of safety = 2 Allowable stress for cast iron = 700/2

Allowable stress for cast iron = 350 N/mm2

Since, Allowable stress > Bending stress (σb)

Hence the design is safe.

Calculations of Gear Tooth Properties:

Pitch circle diameter (P.C.D) = z × m = 25×2 = 50mm

Base circle diameter (Db) = D cosα = 50×cos20= 46.984mm

Outside circle diameter = (z+2) × m= (25+2) × 2 = 54mm

Circular pitch (C): m × 3.142 = m ×3.142 = 2 × 3.142= 6.283 mm

Clearance = circular pitch/20 = 6.283/20 = 0.31415mm

Addendum (a) = 1/ Diametral pitch = 1 /Pd = 1 / 2 = 0.5 mm

Dedendum (b) = 1.157 / Diametral pitch = 1.157 / Pd = 1.157 / 2 = 0.5785 mm

Total depth (dt) = 2.157 / Diametral pitch = 2.157 / Pd = 2.157 / 2 = 1.0785 mm

Face width (F) = 4×3.14×m = 4×3.142× 2 = 25.136 mm… (4.12)

Clearance (C) = 0.2×Diametral pitch = 0.2×Pd = 0.2×2 = 0.4 mm

4.2 Material Selection

4.2.1 Aluminium Alloy

Aluminium alloys (or aluminum alloys; see spelling differences) are alloys in which aluminium (Al) is the predominant metal. The typical alloying elements are copper, magnesium, manganese, silicon, tin and zinc. There are two principal classifications, namely casting alloys and wrought alloys, both of which are further subdivided into the categories heat-treatable and non-heat-treatable. About 85% of aluminium is used for wrought products, for example rolled plate, foils and extrusions. Cast aluminium alloys yield cost-effective products due to the low melting point, although they generally have lower tensile strengths than wrought alloys. The most important cast aluminium alloy system is Al–Si, where the high levels of silicon (4.0–13%) contribute to give good casting characteristics. Aluminium alloys are widely used in engineering structures and components where light weight or corrosion resistance is required.

4.2.1.1 Properties of Aluminium Alloy

Density = 2770 kg/m^3

Young's modulus = 71 GPa

Poisson's ratio = 0.33

Tensile strength = 310 MPa

4.2.2Aluminium Silicon Carbide

AlSiC is a metal matrix composite consisting of aluminium matrix with silicon carbide particles. It has high thermal conductivity (180–200 W/m K), and its thermal expansion can be adjusted to match other materials, e.g. silicon and gallium arsenidechips and various ceramics. It is chiefly used in microelectronics as substrate for power semiconductor devices and high density multi-chip modules, where it aids with removal of waste heat.The Aluminium matrix contains high amount of dislocations, responsible for the strength of the material. The dislocations are introduced during cooling by the SiC particles, due to their different thermal expansion coefficient.

4.2.2.1 Properties of AlSiC

Density= 2810 kg/m^3

Young's modulus = 150 GPa

Poisson's ratio= 0.3

Tensile strength = 500 MPa

4.2.3Carbon fiber / Epoxy

Carbon fibers display linear stress-strain behavior to failure, the increase in strength also means an increase in the elongation-to-failure. The commercial fibers thus display elongations of up to 2.2%, which means that they exceed the strain capabilities of conventional organic matrices. Carbon fibers are available from a number of domestic and foreign manufacturers in a wide range of forms having an even wider range of mechanical properties. The earliest commercially available carbon fibers were produced by thermal decomposition of rayon precursor materials. The process involved highly controlled steps of heat treatment and tension to form the appropriately ordered carbon structure. Carbon fibers are also manufactured from pitch precursor for specialty applications. Pitch fiber properties typically include high modulus and thermal conductivity.

4.2.3.1 Properties of Carbon fiber/ Epoxy

Density= 1800 kg/m^3

Young's modulus= 450 GPa

Poisson's ratio= 0.3

Tensile Yield strength = 52 MPa

Compressive Yield Strength = 600 MPa

4.2.4 Polyoxymethylene Acetal Copolymer

Polyoxymethylene (POM), also known as acetal, polyacetal, and polyformaldehyde, is an engineering thermoplastic used in precision parts requiring high stiffness, low friction, and excellent dimensional stability. As with many other synthetic polymers, it is produced by different chemical firms with slightly different formulas and sold variously by such names as Delrin, Celcon, Ramtal, Duracon, Kepital, and Hostaform

POM is characterized by its high strength, hardness and rigidity to −40 °C. POM is intrinsically opaque white, due to its high crystalline composition, but it is available in all colors. POM has a density of 1.410–1.420 g/cm^3.

4.2.4.1 Properties of PolyoxymetheleneAcetal Copolymer

Density= 1390 kg/m^3

Young's modulus = 2.6 GPa

Poisson's ratio= 0.3859

Tensile Ultimate strength= 71.5 MPa

4.2.5Cast Iron

Cast iron is a group of iron-carbon alloys with a carbon content greater than 2%. Its usefulness derives from its relatively low melting temperature. The alloy constituents affect its colour when fractured: white cast iron has carbide impurities which allow cracks to pass straight through, grey cast iron has graphite flakes which deflect a passing crack and initiate countless new cracks as the material breaks, and ductile cast iron has spherical graphite "nodules" which stop the crack from further progressing.

Carbon (C) ranging from 1.8–4 wt%, and silicon (Si) 1–3 wt% are the main alloying elements of cast iron. Iron alloys with lower carbon content (~0.8%) are known as steel. While this technically makes the Fe–C–Si system ternary, the principle of cast iron solidification can be understood from the simpler binary iron–carbon phase diagram. Since the compositions of most cast irons are around the eutectic point (lowest liquid point) of the iron–carbon system, the melting temperatures usually range from 1,150 to 1,200 °C (2,100 to 2,190 °F), which is about 300 °C (540 °F) lower than the melting point of pure iron of 1,535 °C (2,795 °F).

4.2.5.1 Properties of Cast Iron

Density = 7300 kg/m^3

Young's modulus= 35 GPa

Poisson's ratio = 0.28

Tensile Ultimate strength = 700 Mpa

Compressive Ultimate strength = 840 MPa

4.2.6 Nylon 101

Nylon is a generic designation for a family of synthetic polymers, based on aliphatic or semi-aromatic polyamides. Nylon is a thermoplastic silky material that can be melt-processed into fibers, films or shapes

Nylon was the first commercially successful synthetic thermoplastic polymer. DuPont began its research project in 1930. The first example of nylon (nylon 6,6) was produced using diamines on February 28, 1935, by Wallace Hume Carothers at DuPont's research facility at the DuPont Experimental Station.

Nylon is one of the most widely used and versatile thermoplastic resins. Its combination of physical properties and reasonable price make it a favourite choice for numerous applications. Nylons toughness, wear resistance, tensile strength and lubricity makes it a good choice for many mechanical machine parts.

4.2.6.1Properties of Nylon 101

Density= 1150 kg/m^3

Young's modulus = 1 GPa

Poisson's ratio= 0.3 Tensile

Yield strength= 60 MPa

Tensile Ultimate Strength = 79.29 MPa

4.2.7 Glass filled Nylon 6

Nylon, one of the most widely used engineering thermoplastics, is an extremely versatile engineering plastic. An excellent combination of mechanical performance (toughness, low coefficient of friction, and good abrasion resistance) and cost make Nylon an ideal replacement for a wide variety of materials from metal to rubber

Cast Nylon 6 (polycaprolactam) exhibits all the properties that generally make nylon a superior engineering material: high strength, low friction and wear resistance. Because of the casting process, part size and thickness are almost unlimited without degradation of the material's internal structure. Cast Nylon 6 provides one of the largest array of sizes and custom shapes of any thermoplastic.

By varying the conditions through the addition of various additives, fillers, lubricants and colorants during polymerization, the mechanical properties of cast nylon may be altered to suit specific applications. Formulations include molybdenum-disulfide filled, moly and oil filled (blue), and glass-filled grades. Variants within these nylon grades are available to match specific application demands such as FDA compliance, Internally lubricated, heat stabilized, UV stabilized, anti-static, fire retardant, or impact modified.

4.2.7.1 Properties of Glass Filled Nylon 6

Density = 1390 kg/m^3

Poisson's Ratio = 0.35

Young's modulus = 11.17 Gpa

Tensile Strength Ultimate = 185 MPa

4.2.8 Titanium Alloy

Titanium alloys are metals that contain a mixture of titanium and other chemical elements. Such alloys have very high tensile strength and toughness (even at extreme temperatures). They are light in weight, have extraordinary corrosion resistance and the ability to withstand extreme temperatures

Titanium alone is a strong, light metal. It is stronger than common, low-carbon steels, but 45% lighter. It is also twice as strong as weak aluminium alloys but only 60% heavier. Titanium has outstanding corrosion resistance to sea water, and thus is used in propeller shafts, rigging and other parts of boats that are exposed to sea water and its alloys are used in airplanes, missiles and rockets where strength, low weight and resistance to high temperatures are important. Further, since titanium does not react within the human body, it and its alloys are used *to create* artificial hips, pins for setting bones, and for other biological implants.

4.2.8.1 Properties of Titanium Alloy

Density = 4620 kg/m^3

Young's modulus= 96 GPa

Poisson's ratio= 0.36 Tensile

Yield strength = 930 MPa

Compressive Yield strength = 930 MPa

Tensile Ultimate strength = 1.07 GPa

The Spur gear model were created using SolidWorks 2016 software. The assembly is shown below.

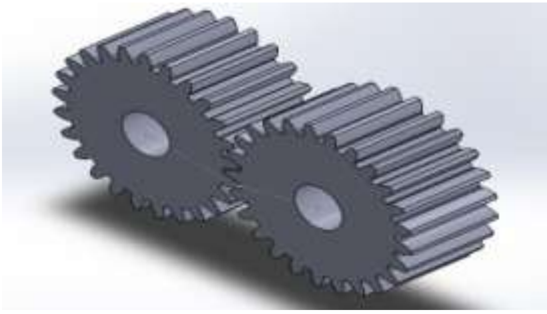


Fig 4.1 Spur Gear Model

The model is then imported to ANSYS Workbench to conduct Static structural Analysis.

V. RESULTS AND DISCUSSION

5.1 Analysis results of spur gear in Various Materials

5.1Reports for Cast Iron Spur Gear

Torque = 9.984 N-m; Speed = 1440 rpm

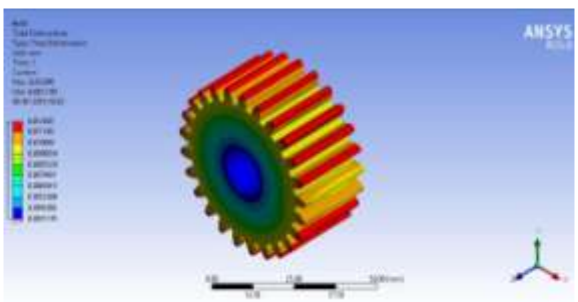


Fig 5.1 Total deformation on Cast iron spur gear

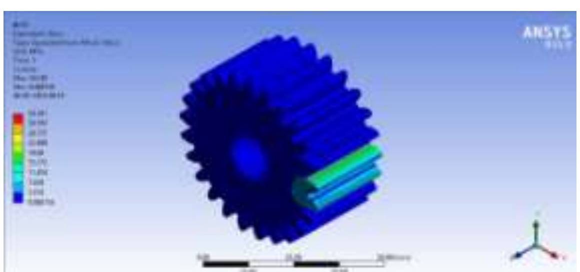


Fig5.2 Von- Mises stress induced for cast iron spur gear

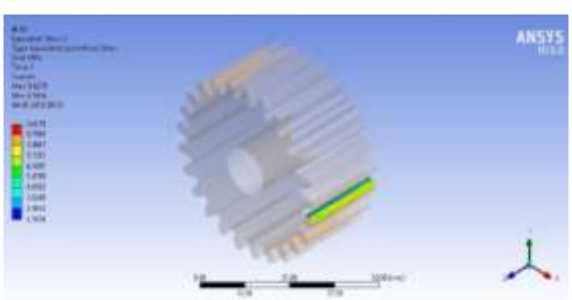


Fig 5.3 Von Mises Contact stress Induced for Cast Iron spur gear

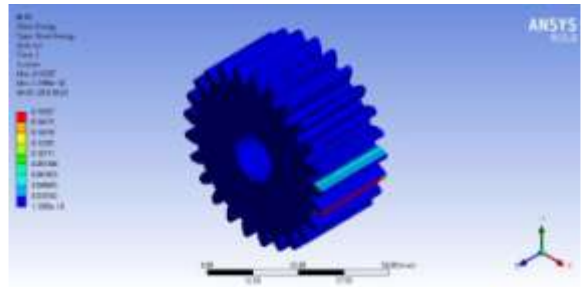


Fig 5.4 Strain Energy for Cast Iron Spur Gear

Reports for Carbon fiber /Epoxy Spur Gear

Torque = 9.984 N-m; Speed = 1440 rpm

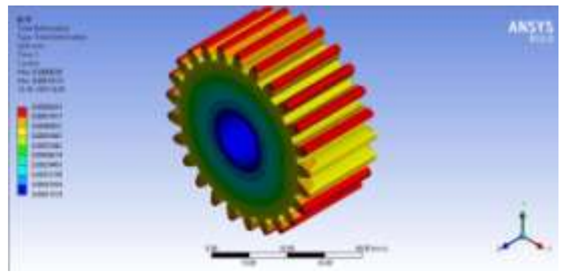


Fig. 5.5 Total deformation for Carbon fiber/ Epoxy Spur Gear

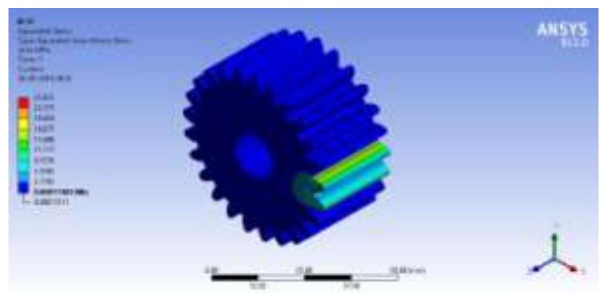


Fig. 5.6 Von - Mises Stress Induced for Carbon Fiber/ Epoxy Spur gear

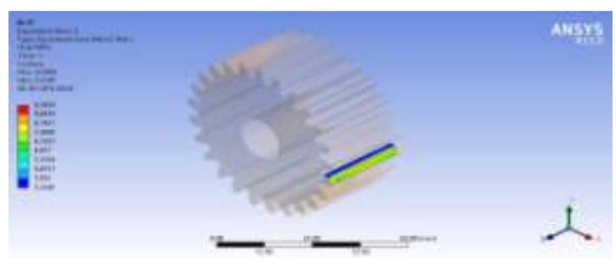


Fig. 5.7 Von - Mises Contact Stress Induced for Carbon fiber/ Epoxy Spur Gear

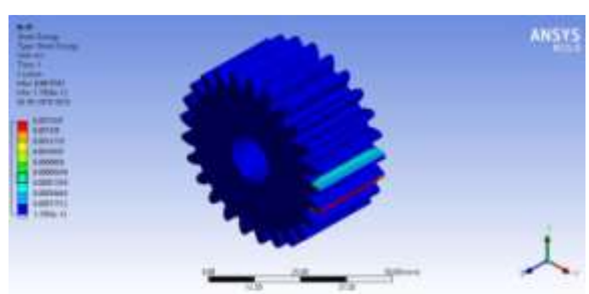
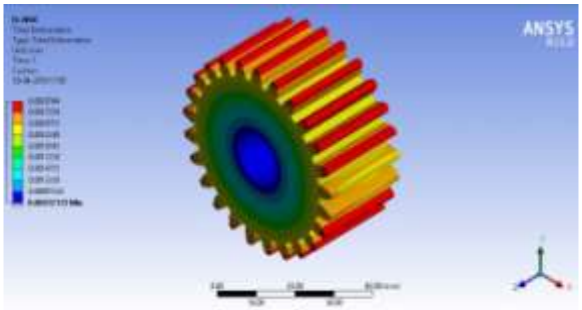


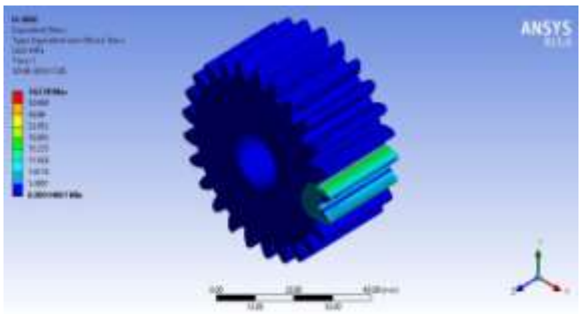
Fig. 5.8 Strain Energy for Carbon Fiber / Epoxy Spur Gear

Reports for Al-SiC

For Torque = 9.894 N-m; Speed = 1440 rpm



Fig, 5.9 Total Deformation of Al-SiC



Fig, 5.10 Von-Mises Stress Induced for Al- SiC Spur Gear

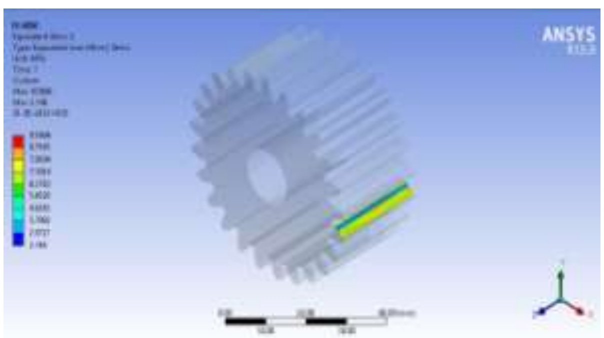


Fig. 5.11 Von Mises Contact Stress Induced for Al- SiC Spur Gear

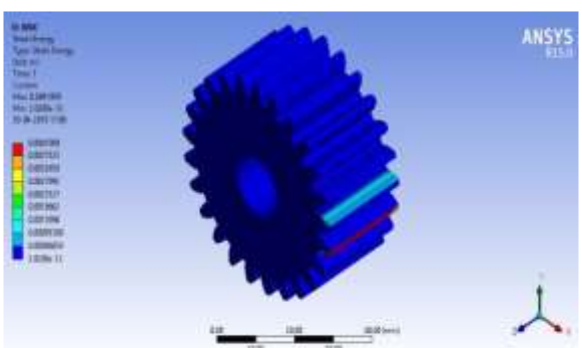


Fig. 5.12 Strain Energy for Al -SIC

Reports for Glass Filled Nylon 6

For Torque = 9.894 N-m; Speed = 1440 rpm

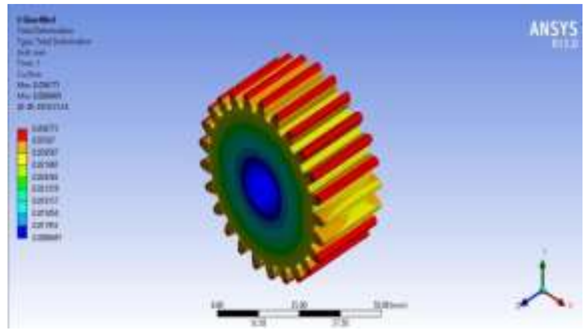


Fig. 5.13 Total Deformation for Nylon 6

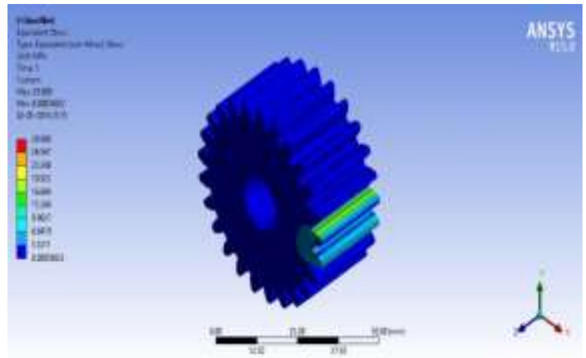


Fig. 5.14 Von Mises Stress Induced for Nylon 6 Spur Gear

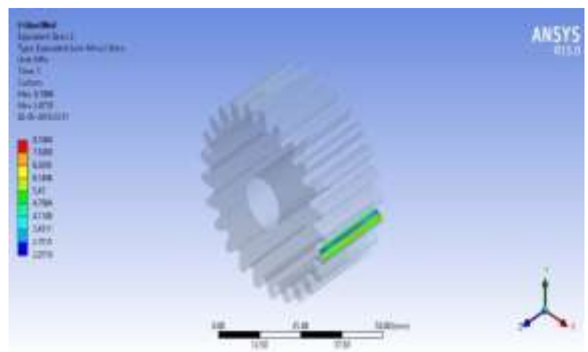


Fig. 5.15 Von Mises Contact Stress Induced for Nylon 6 Spur Gear

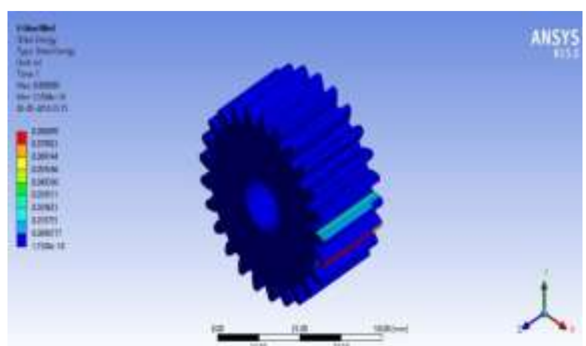


Fig. 5.16 Strain Energy for Nylon 6 Spur Gear

Reports for POM

For Torque = 9.894 N-m; Speed = 1440 rpm

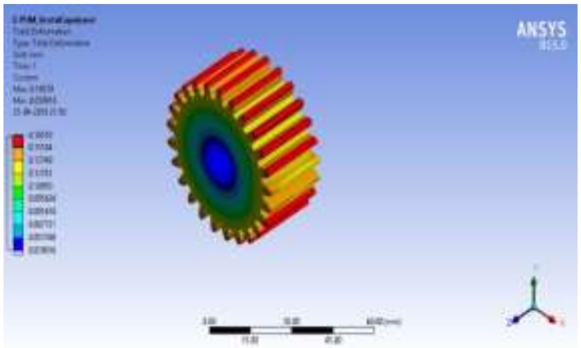


Fig.5.17 Total Deformation of POM

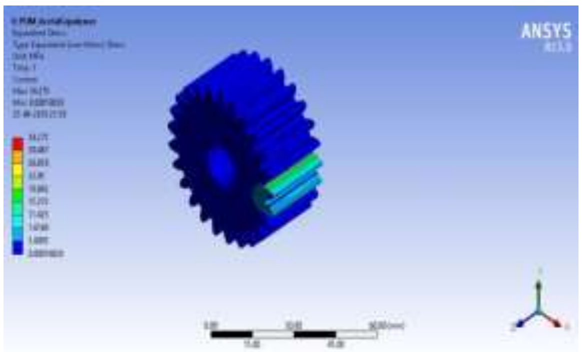


Fig 5.18 Von Mises Stress induced for POM Spur Gear

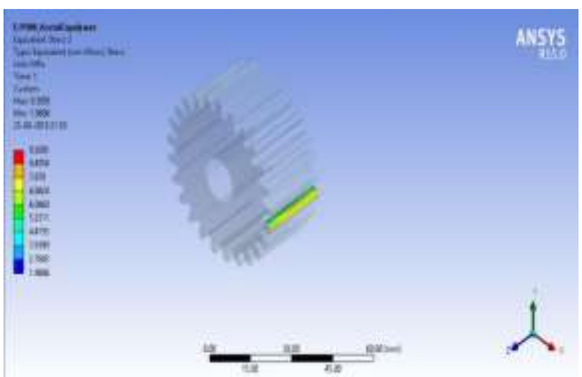


Fig. 5.19 Von Mises Contact Stress for POM Spur Gear

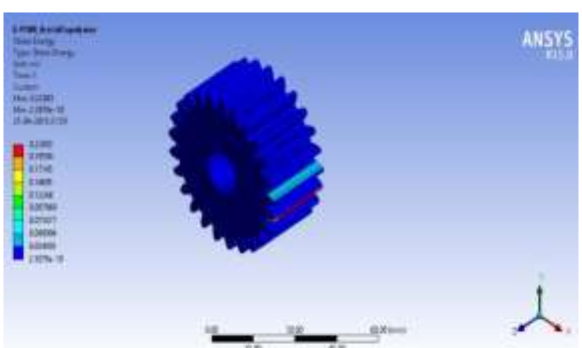


Fig.5.20 Strain Energy for POM Spur Gear

Reports for Nylon 101

For Torque = 9.894 N-m; Speed = 1440 rpm

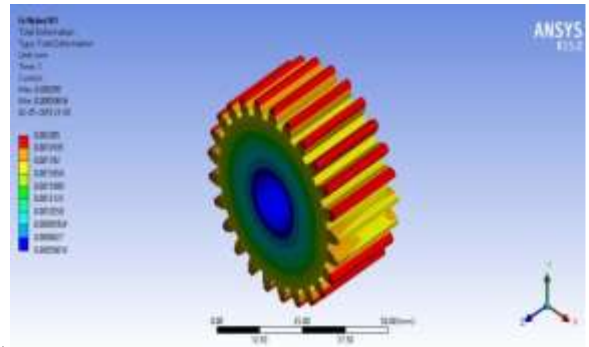


Fig. 5.21 Total Deformation for Nylon 101

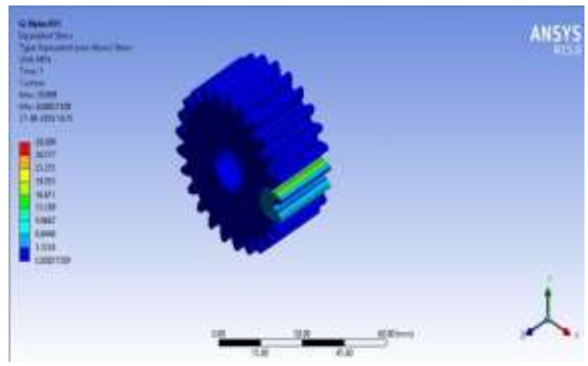


Fig.5.22 Von Mises Induced for Nylon 101 Spur Gear

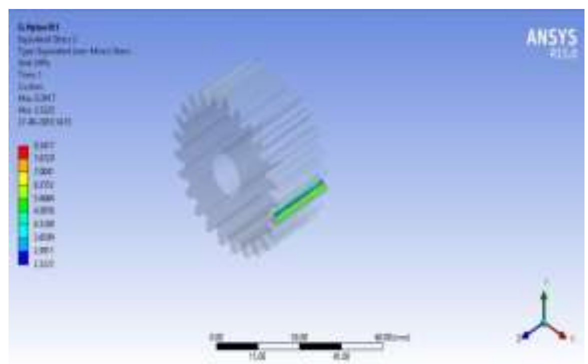


Fig.5.23 Von Mises Contact Induced for Nylon 101 Spur Gear

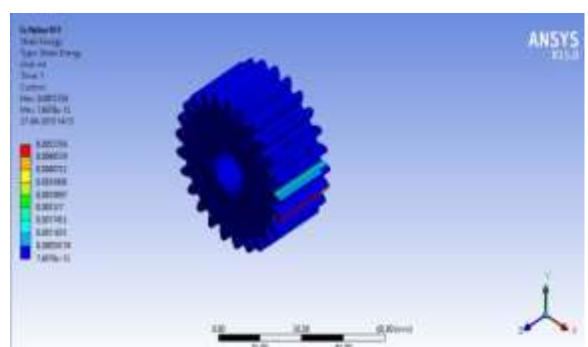


Fig. 5.24 Strain Energy for Nylon 101 Spur Gear

Reports for Aluminium Alloy

For Torque = 9.894 N-m; Speed = 1440 rpm

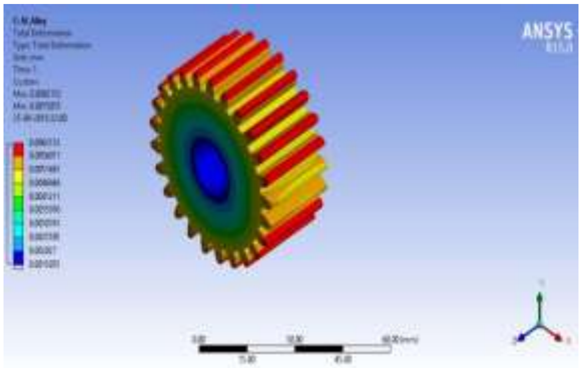


Fig.5.25 Total Deformation of Aluminium Alloy

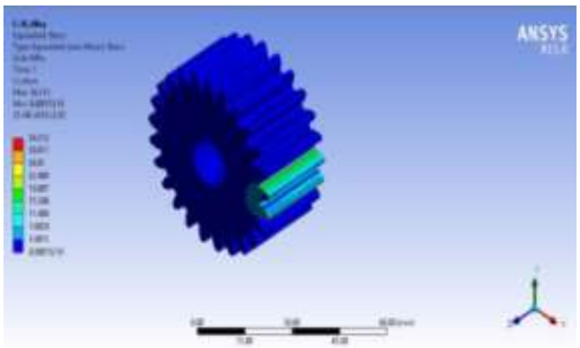


Fig.5.26 Von Mises Stress Induced for Aluminium Alloy Spur Gear

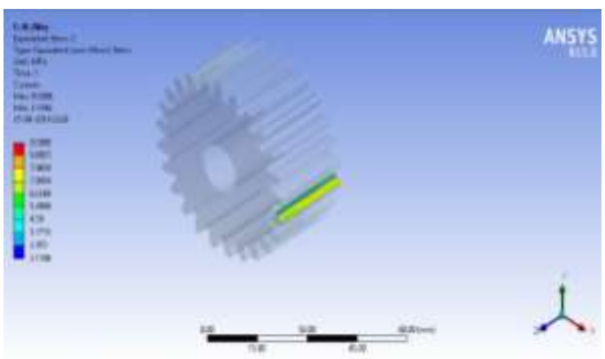


Fig. 5.27 Von Mises Contact Stress Induced for Aluminium Alloy Spur Gear

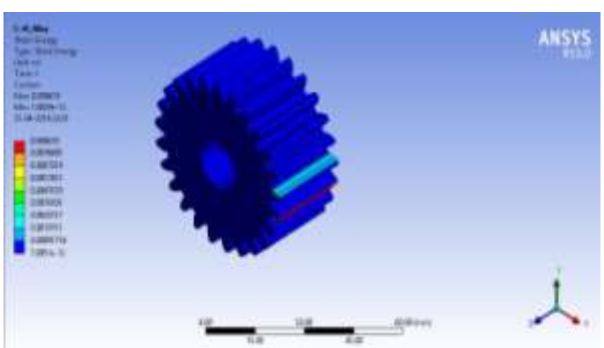


Fig. 5.28 Strain Energy for Aluminium Alloy Spur Gear

Reports for Titanium Alloy

For Torque = 9.894 N-m; Speed = 1440 rpm

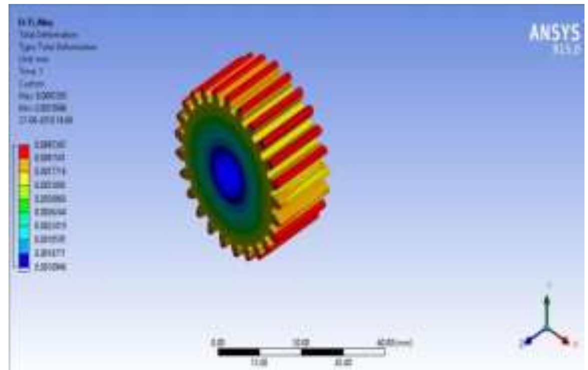


Fig.5.29 Total Deformation of Titanium Alloy Spur Gear

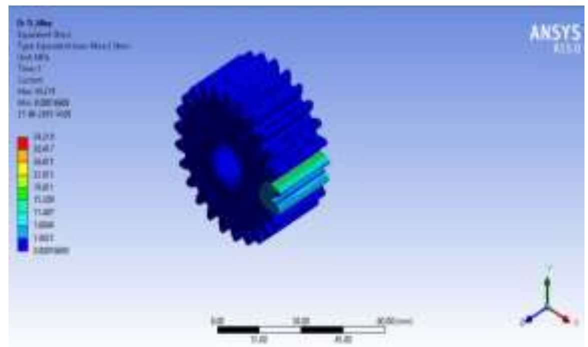


Fig.5.30 Von Mises Stress Induced for Titanium Alloy Spur Gear

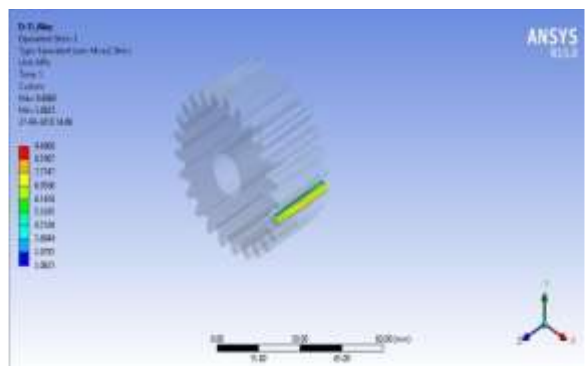


Fig. 5.31 Von Mises Contact Stress Induced for Titanium Alloy Spur Gear

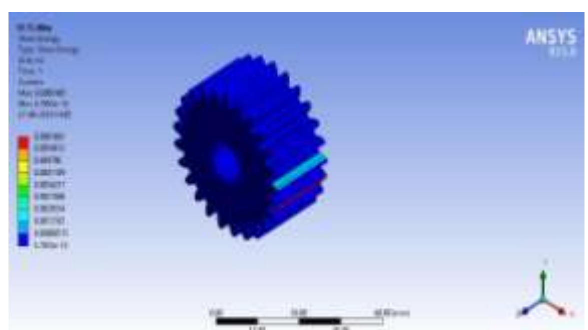


Fig. 5.32 Strain Energy for Titanium Alloy Spur Gear

Comparison table between Cast Iron and other alternate materials

Failure Theories	Cast Iron	Carbon Fiber Epoxy	Al-SiC	Glass-filled Nylon 6	POM	Nylon-101	Al-alloy	Ti-Alloy
Total Deformation (mm)	0.012945	0.0008	0.00297	0.036773	0.16539	0.00209	0.00621	0.00453
Equivalent Stress Induced (Mpa)	34.361	25.01	34.278	29.888	34.275	29.899	34.212	34.219
Contact Stress Induced (Mpa)	9.6279	9.5454	9.5806	8.1804	9.3093	8.341	9.5008	9.4068
Strain Energy(mJ)	0.18307	0.0015	0.00419	0.8889	0.2204	0.0052	0.00861	0.00636

Fig. 5.33 Comparison between cast iron and other alternate materials

VI. CONCLUSION

It can be concluded that the stress values are calculated for Carbon Fiber/Epoxy is approximately same as compared to Cast Iron and aluminium alloy. So from these Static analysis results, we conclude that, the stress induced, deformation and weight of the Composite spur gear is almost same or even better in some cases when compared to Cast Iron spur gears. Hence, composite materials are capable of being used in Lathe machine instead of existing cast iron gears with better results.Analysis of gear manufactured by Carbon fiber / Epoxy shows that it is light in weight when compared with Cast Iron and can handle comparatively higher loads than Nylon 101, Glass filled Nylon 6 and Cast Iron..

So Carbon fiber / Epoxy gears can be employed for:-

Applications where the priority is reducing weight instead of cost. Hence the application would be

- Gears in F1 racing cars
- Space vehicles
- Aircrafts

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