

# Strength Evaluation of Spur Gear Made Up of Polymer Composite Materials

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**Abstract** - The polyamide and carbon fibre composite materials are used for spur gears. It is accurate, smooth, noiseless, smooth running, light in weight having high strength to weight ratio, more sound absorbent and corrosion resistance. In present days, polyamide (Nylon) with carbon fibre reinforced gear are in great demand. In many applications like light duty power and/or motion transmission in replacement of conventional (medium/high carbon) steel spur gear. These gears have good mechanical, physical, wear properties. It is found that, these gears give more tensile strength, flexural, endurance in some of polyamide, carbon fibre composite material spur gears.

In the proposed work, design and development of PA/CF specimens with varying percentages. The parameters or properties of composite material specimens are to be tested in the Laboratory. It is planned to design and fabricated mould of injection moulding machine. To develop and manufacture PA/CF Composite Spur Gear by injection moulding machine. Proceed the Performance is to be validate by comparing of PA/CF Composite Spur Gears with the Conventional Spur Gears of their Analytical and simulation Results.

**Key Words:** polyamide, carbon fibre, specimens, Composite Spur Gears, injection moulding, Analytical, simulation

## 1. INTRODUCTION

Gears play a prominent role in mechanical power transmission. Conventional Gears are generally used in power and motion transmission work under different loads and speeds. The spur gear is simplest type of gear manufactured and is generally used for transmission of rotary motion between parallel shafts. Steel spur Gears offer high strength and a wide range of heat treatment properties. Steel spur gears provide highest strength and durability.

## 2. Literature Review

B. Beylgeril et al. [1] In this carbon fiber (CF) composite were interleaved with polyamide-6,6 (PA66) nonwoven veils to improve their delamination resistance against load. It can be improve the strength of the composite material. The effect of

PA66 interleaving system on the mechanical performance of carbon fiber (CF) composites material.

M. Kalin et al [2] one of the key parameters that affect a polymers mechanical properties, interface contact condition and consequently, the wear fatigue behaviour is the temperature. Temperature is well known to have critical influence on polymers, either root, flank or bulk, also varies with the operating condition.

Yan Maa, et al [3] Two types of unidirectional carbon fiber reinforced plastic were fabricated using identical carbon fibers but different matrix systems. Thermoplastic polyamide 6 and thermosetting epoxy were used as matrices. A large number of on-axis tensile tests of unidirectional carbon fiber reinforced polyamide 6 (CF/PA6) and the unidirectional carbon fiber reinforced epoxy (CF/Epoxy) laminates were performed. Mechanical properties and failure behaviours are discussed based on fiber distribution, impregnation conditions and interfacial shear strength. Tensile strengths were predicted by means of a modified global load sharing model and compared with experimental results. Step-by-step tensile tests revealed the fracture process of 0-degree unidirectional CF/PA6 laminates.

Van-Ta-Do et al [4] Addition of pp to PA6 is low cost, provides good resistance against moisture. The increasing pp has a negative effect on the mechanical properties of matrix and resulting composites.

Fengxia dong et al. [5] The lubricity of carbon fiber was only found occurring at high temperature of 180 ° to 260 ° attribute to graphitization. This research mainly focuses on the friction and wear behaviour of composites at room temperature.

P.B. Pawar et al [6] .Gears can be used for transmitting almost 24kw power. Al-SiC composite prepared by stir casting provides improved hardness, Tensile strength. Gears manufactured from composite having less weight. FEM Analysis also shows less chances of failure in Al-SiC gear. Gears can be used for transmitting almost 24kW power. Bending strength of nylon is less than aluminium-silicon composite.

AljazPogacnik et.al.[7]The raw materials were produced in granular form and then injection moulded to the desired gear geometry using a BOY35 M machine (BOY limited, UK). However, because the selected materials have different mould shrinkages (between 0.6% and 2.0%), different gear moulding inserts were used for production of the test gears. The tool matrix was linearly scaled in all axes.

NevinGamzeKarsli, et.al [8]Mechanical test results showed that, increasing CF content increased the tensile strength, modulus and hardness values but decreased strain at break values of composites.DSC results showed that Tg and Tm values of composites were not changed significantly with increasing CF content and length. However, heat of fusion and the relative degree of crystallinity values of composites decreased with ascending CF content. DMA results revealed that storage modulus and loss modulus values of composites increased with increasing CF content. Study is pending on strain value of composite is decreases.

K.D.Dearn et.al. [9] To improve the contact properties between dry running mating polymer gear teeth. It has not been possible to measure the coefficient of friction between mating gears directly using this experiment.

S. Kirupasankar et.al. [10]The properties of pristine polyamide and polyamide nano composites used in the present study. Dynamic mechanical analysis is carried out to characterize the temperature and dependency and viscoelastic nature of PA6 and PNC materials.

K. Mao et.al. [11] Polymer gears have unique advantages over metal gears: low cost and weight; high efficiency; quietness of operation; functioning without external lubrication. There would be major impacts on automotive and aerospace engineering as well as others if the gear could be used for higher power transmissions. However, the main limitations of their application are to understand their performance under relative high load conditions their complex thermal mechanical behaviour their hyper elastic and visco elastic behaviour.

Masayakurokawa et.al.[12] The gear performance of a CF reinforced polyamide12(PA12) which was prepared by injection molding, was investigated in comparison with those of CF reinforced polyamides such as Polyamide6(PA6), Polyamide66(PA66), Polyamide 46(PA46).It is found that PA12/CF gear has excellent wear property under condition that grease exists at engagement region . PA12/CF gear indicated the highest load capability, excellent noiseless property & the lowest water absorption among all polyamides investigated.

E.C. Botelho et.al.[13]The specimen failure modes appeared to be compressive buckling or compressive yielding in the upper part of the beam under combined compression and shear. The polyamide 6/6 composites with higher carbon fiber content exhibited higher shear compression values.

### 3 Problem Statement

- 1) Steel spur gears are heavy in weight- Spur gears which is made up of steel material is relatively heavy than spur gears which is made up of composite polymer material. Also, composite polymer material has five times strength more than steel gears.
- 2) Steel spur gears are easily corroded-It is iron based material. So that their always chances corrosion.
- 3) Steel spur gear need more lubrication and attention-At high speed, temperature will increase. So that it needs lubrication and more attention.
- 4) Steel spur gears fail when load increases above certain limit- Steel spur gears are made for high speed, So that it can fail when load is increasing above certain limit.
- 5) Steel spur gears are easily reacted with any liquid or chemical-Steel is made up of different composition of materials. So that it could be chances of chemical reactions with liquid or oils in chemical industry.
- 5) Steel spur gears are easily moisturized.

### 4. Objectives

1. Prepare specimen of PA/CF composite material of varying percentages.
2. Estimate the Mechanical Properties of specimen.
3. Prepare the Spur Gear mould and Manufacturing of Spur Gear pair.
4. Validate the Analytical and Simulation result of Spur Gears.

### 5. CONCLUSIONS

- Hence, we have studied steel spur gear and polyamide, carbon fiber composite spur gear.
- The composite material spur gear gives more strength than the steel gear.
- It can be replaced by convectional steel gear with same/good performance.

### REFERENCES

1. Bertan Beylergila, Metin Tanoglua, Engin Aktasb, "Effect of polyamide-6,6 (PA 66) nonwoven veils on the mechanical performance of carbon fiber/epoxy composites", science direct (Elsevier), Composite Structures 194 (2018) 21-35.
2. M. Kalin, A.Kupec,"The dominant effect of temperature on the fatigue behaviour of polymer gears", science direct (Elsevier), Wear 376-377(2017)1339-1346.
3. Yan Maa, Masahito Ueda, Tomohiro Yokozeki, Toshi Sugahara, Yuqiu Yang, Hiroyuki Hamada, "A comparative study of the mechanical properties and failure behavior of carbon fiber/epoxy and carbon

- fiber/polyamide 6 unidirectional composites”, Science direct(Elsevier), Composite Structures 160 (2017) 89–99.
4. Van-Ta Do, Huu-Duc Nguyen-Tran, Doo-Man Chun, “Effect of polypropylene on the mechanical properties and water absorption of carbon-fiber-reinforced-polyamide-6/polypropylene composite”, Science direct(Elsevier), Composite Structures, 150, (2016), 240–245.
  5. Fengxia Dong, Guoliang Hou, Fengxiang Cao, Fengyuan Yan, Liang Liu ,Jianzhang Wang, “The lubricity and reinforcement of carbon fibers in polyamide at high temperature”, science direct tribology international, tribology international 101(2016) 291-300.
  6. . P.B.Pawar, Abhay A.Utpat, “Analysis of Composite Material Spur Gear under Static Loading Condition”, science direct (Elsevier), Materials Today: Proceedings2 (2015) 2968 – 2974.
  7. Aljaz Pogacnik, Joze Tavcar, “An accelerated multilevel test and design procedure for polymer gears, science direct (Elsevier), Materials and Design 65 (2015) 961–97.
  8. Nevin Gamze Karsli, Ayse Aytac , “Tensile and thermo mechanical properties of short carbon fiber reinforced polyamide 6 composites”, Science Direct Composites: Part B, 51 (2013) 270–275.
  9. T.J.Hoskins, K.D.Dearn, Y.K.Chen, S.N.Kukureka, “Applications of dry film lubricants for polymer gears”, science direct (Elsevier), Wear 298-299(2013) 99-108.
  10. S. Kirupasankar, C. Gurunathan, R. Gnanamoorthy, “Transmission efficiency of polyamide nanocomposite spur gears, Materials and Design 39 (2012) 338–343.
  11. K. Mao, W.Li , C.J.Hooke , D.Walton. “Polymer gear surface thermal wear and its performance prediction”, science direct (Elsevier), Tribology International 43 (2010) 433–439.
  12. Masaya Kurokawa, Yoshitaka Uchiyama, Tomoaki Iwai, Susumu Nagai, “Performance of plastic gear made of carbon fiber reinforced polyamide 12”, Science direct(Elsevier), wear 254 (2003) 468–473.
  13. E.C. Botelho, Figiela, M.C. Rezende, B. Laukea, “Mechanical behavior of carbon fiber reinforced polyamide Composites”, Composites Science and Technology 63 (2003) 1843–1855.