SPURGEAR

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ABSTRACT

The creep nature of metallic spur gear results in the deficiency because of the deformation of teeth when pressure angle of 20 acting on it. At the replacing points of tooth between driving and driven the disturbances such as in-evitable random noise, elastic deformation and manufacturing error, alignment error in assembly all these together causes the high level of gear vibration and noise and leads to loss in efficiency. The main motto is to reduce the deformation of teeth, by replacing the metallic cast iron gear with Nylon gear and proved that the deformation of Nylon gear is less compared to metallic and polycarbonate. Since the deformation is less the loss in efficiency is also less compared to metallic gear.

KEYWORDS: *Gear, Spur gear, nylon spur gear.*

I. INTRODUCTION

The spur gear is simplest type of gear manufactured and is generally used for transmission of rotary motion between parallel shafts. The spur gear is the first choice option for gears except when high speeds, loads, and ratios direct towards other options. Other gear types may also be preferred to provide more silent low-vibration operation. A single spur gear is generally selected to have a ratio range of between 1:1 and 1:6 with a pitch line velocity up to 25 m/s. The spur gear has an operating efficiency of 98-99%. The pinion is made from a harder material than the wheel. A gear pair should be selected to have the highest number of teeth consistent with a suitable safety margin in strength and wear. The minimum number of teeth on a gear with a normal pressure angle of 20 degrees is 18.Mild steel is a poor material for gears as as it has poor resistance to surface loading. The carbon content for unhardened gears is generally 0.4%(min) with 0.55%(min) carbon for the pinions. Dissimilar materials should be used for the meshing gears - this particularly applies to alloy steels. Alloy steels have superior fatigue properties compared to carbon steels for comparable strengths. For extremely high gear loading case hardened steels are used the surface hardening method employed should be such to provide sufficient case depth for the final grinding process used.

SPUR GEAR STRENGTH AND DURABILITY CALCULATIONS:

Designing spur gears is normally done in accordance with standards the two most popular series are listed under standards below:

Bending : The basic bending stress for gear teeth is obtained by using the Lewis formula $\sigma = F_t / (b_a .\ m.\ Y)$ where F_t = Tangential force on tooth, σ = Tooth Bending stress (MPa)b_a = Face width (mm),Y = Lewis Form Factor,m = Module (mm), v Where $y = Y/\pi$ and p = circular pitch .When a gear wheel is rotating the gear teeth come into contact with some degree of impact. To allow for this a velocity factor (K_v) is introduced into the equation. This is given by the Barth equation.

For cut or milled gears $K_v = \frac{6,1 + V}{6,1}$

For cast iron , cast gears $K_v = \frac{3,05 + V}{3,05}$

For hobbed or shaped gears $K_v = \frac{3,56 + \sqrt{V}}{3,56}$

For shaved or ground gears $K_v = \sqrt{\frac{5,56 + \sqrt{V}}{5,56}}$

The Lewis formula is thus modified as follows :

$$\sigma = K_v . F_t / (b_a . m. Y)$$

Through advancements in plastic resins and manufacturing techniques plastic gears today can be utilized in a multitude of crucial applications, from transmitting amounts of torque to accurate positioning of critical components in medical devices. Plastic offers many benefits, including design flexibility and significant cost savings. Plastic gears possess many advantages over those made of metal. Plastic gears are lighter, quieter, retain an inherent lubricity and are corrosion resistant. They can be produced in a variety of types, including bevel gears, offset bevel gears, spiral bevel gears, helical gears, metric gears, metric spur gears, plastic worm gears and more. Cams, lugs, ribs, webs, shafts and holes can be moulded into plastic gears in one integral design in a single operation, opening the door to significantly lower production costs.

SPECIFICATION OF EXISTING CAST IRON GEAR:

The typical chemical composition of the cast iron material : Carbon - 2.5 to 3.7%, Silicon - 1.0 to 3.0%, Manganese - 0.5 to 1.0%, Phosphorus - 0.1 to 0.9% and Sulphur - 0.07 to 0.10%.

SPECIFICATIONS OF NYLON AND POLYCARBONATE PLASTIC MATERIALS:

Chemical composition of Nylon:

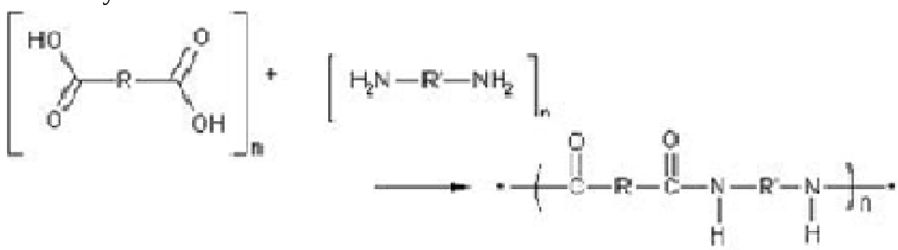

Fig 1.1 Chemical Composition Of Nylon

Its properties are determined by the R and R' groups in the monomers. In nylon 6. 6, R' = 6C and R = 4C alkanes, but one also has to include the two carboxyl carbons in the di acid to get the number it donates to the chain. The majorities of nylons tends to be semi-crystalline and are generally very tough materials with good thermal and chemical resistance. The different types give a wide range of properties with specific gravity, melting point and moisture content tending to reduce as the nylon number increases. Nylons can be used in high temperature environments. Heat stabilized systems allow sustained performance at temperatures up to 185^{o}C.

Chemical composition of Polycarbonate:
The main polycarbonate material is produced by the reaction of bisphenol A and phosgene COCl2. The overall reaction can be written as follows:

Polycarbonates received their name because they are polymers containing carbonate groups (–O–(C=O)–O–). Most polycarbonates are derived from rigid monomers. A balance of useful features include temperature resistance and impact resistance.

MATERIAL PROPERTIES OF CAST IRON, NYLON AND POLYCARBONATE:

Material property	Cast Iron	Nylon	polycarbonate
Young's modules	1.65e5	2.1e5	2.75e5
Poisions Ratio	0.25	0.39	0.38
Density (kg/mm)	7.2e-6	1.13e-6	1.1e-6
Co-efficient of friction	1.1	0.15-0.25	0.31
Ultimate Tensile strength	320-350	55-83	55-70

MODELING

The modeling of Spur gear using ANSYS Finite Element Analysis for cast iron, Nylon and polycarbonate are shown as follows:

Displacement pattern of Cast Iron gear:

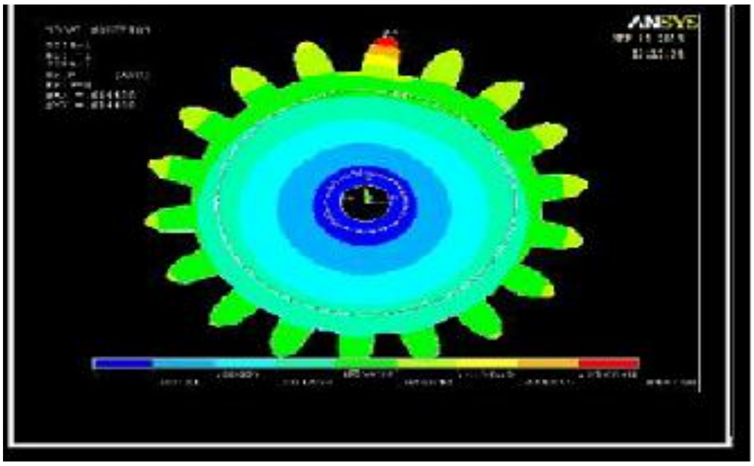

Fig 2.1 Displacement pattern of Cast Iron gear

Displacement pattern of Nylon:

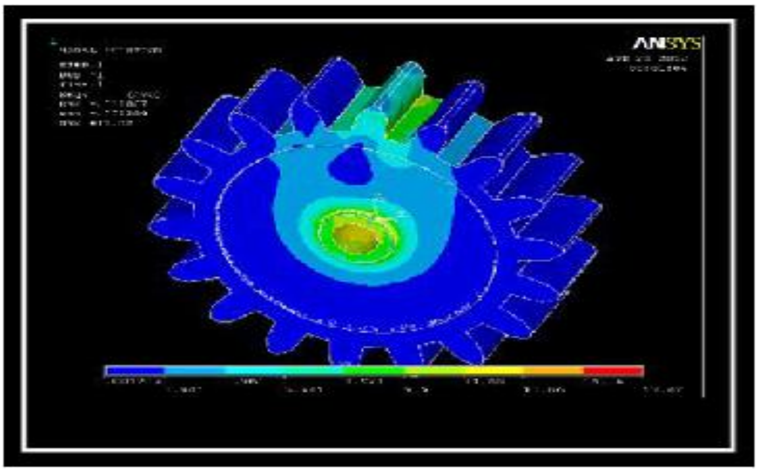

Fig 2.2 Displacement pattern of Nylon gear

Stress Distribution of Cast Iron

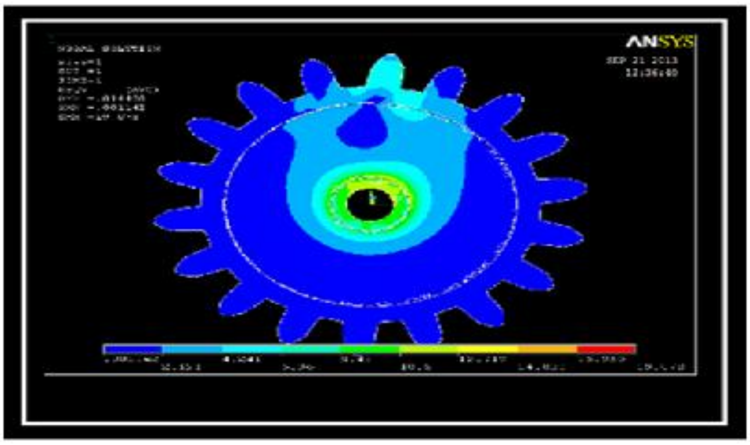

Fig 2.3 Stress Distribution of Cast Iron gear

Stress Distribution Of PolyCarbonate

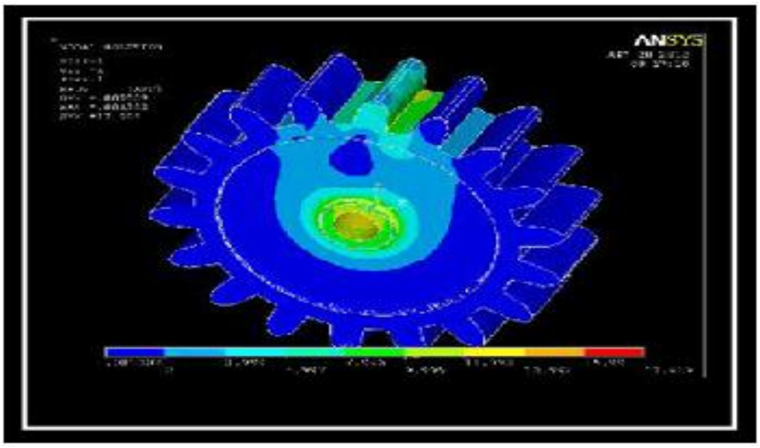

Fig 2.4 Stress Distribution of Polycarbonate gear

Stress Distribution OF Nylon Spur GEAR

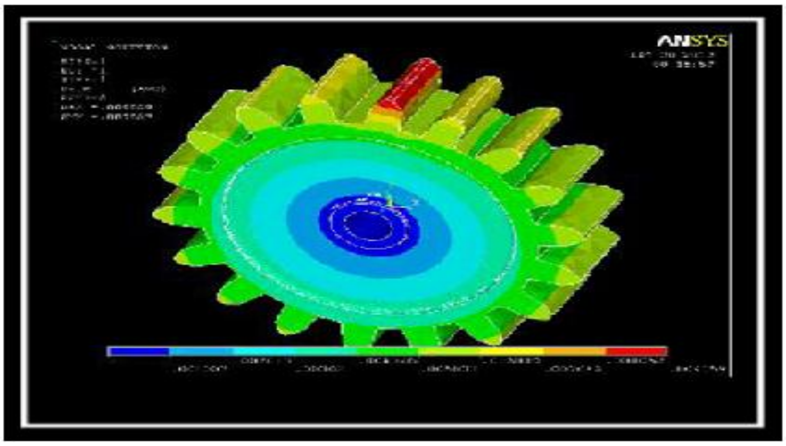

Fig 2.5 Stress Distribution of Nylon gear

II. RESULTS

From the static analysis , the deflections and Vonmises stress and strain values for the cast iron, Nylon and polycarbonate are obtained as following

FOR CAST IRON SPUR GEAR

Pressure (N/mm2)	Vonmise Stress (N/mm2)	Deflection (mm)	Strain
1	3.832	0.002905	2.21e-4
2	7.665	0.005811	4.41e-4
3	11.497	0.008716	6.62e-4
4	15.33	0.011622	8.82e-4
5	19.078	0.014488	1.14e-3

Tab 4.1 Analysis for Cast Iron spur gear

FOR NYLON SPUR GEAR

For Nylon Spur gear: Pressure (N/mm2)	Vonmise Stress (N/mm2)	Deflection (mm)	Strain
1	3.582	0.002381	2.19e-4
2	7.163	0.004762	4.37e-4
3	10.745	0.007143	6.56e-4
4	14.327	0.009524	8.74e-4
5	17.82	0.011867	1.29e-3

Tab 4.2 Analysis for Nylon spur gear

FOR POLYCARBONATE SPUR GEAR

Pressure (N/mm2)	Vonmise Stress (N/mm2)	Deflection (mm)	Strain
1	3.615	0.001817	2.20e-4
2	7.863	0.003635	4.45e-4
3	10.846	0.005452	6.61e-4
4	14.462	0.007274	8.82e-4
5	17.989	0.009059	1.38e-3

Tab 4.3 Analysis for Polycarbonate spur gear

III. CONCLUSION

Since the deflections are less the efficiency of nylon spur gear is more than the cast iron spur gear, results in less noise and long life, The metallic gear results is more deflection compared to nylon and polycarbonate, the cost price and life of nylon is also good. When we replace the metallic spur gear with nylon gear there would be better results we can find in the automobile, robotic and in medical fields where the need of nylon gear is there.

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