

# MODELLING AND STRESS ANALYSIS OF HELICAL GEAR USING FEM APPROACH

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**Abstract—** Gear transmissions play a fundamental role in power transmission industries. Gears are usually subject to fluctuating load factors. Due to these loads, the bending and friction stresses will be advanced within the gears. The aim of this project is to estimate bending pressure changed Lewis beam energy method is used, to calculate the contact stress AGMA equation is used, aspect which effect the bending stress of helical equipment is quantity of tooth on gear and the factor effect the contact stress or frictional stress between two gear is angle of contact that is angle of helix, hence for bending stress calculation gears with 18, 23 and 27 is used, and to find the contact stress two opposite gears with same specification except opposite direction of helix angle gears are made to contact, gears with angle of 16, 24, and 30 deg are used to analyze the contact stress, and will conclude the gears factors which will give good strength and life to gear.

## I. INTRODUCTION

One of the best methods of transmitting power among the shafts is gears. Gears are primarily used to transmit torque and angular velocity. The speedy improvement of industries including automobile, deliver constructing and aircraft require advanced application of equipment technology. Customers opt for motors with exceedingly green engine. This wished up a demand for quite power transmission. Automobile sectors are one in every of the largest producers of gears. Higher reliability and lighter weight gears are necessary to make car low in weight as lighter vehicles stay in high demand.

A system or cogwheel is a rotating device element having lessen tooth, or cogs, which mesh with some other toothed part to transmit torque, in maximum instances with tooth on the one tools being of identical form, and often additionally with that shape on the opportunity gear. Two or greater gears going for walks in a series (educate) are referred to as a equipment train or, in plenty of instances, a transmission; such gear arrangements can produce a mechanical gain thru a tools ratio and hence may be taken into consideration a easy device. Geared devices can trade the rate, torque, and course of a power deliver. The most not unusual situation is for a equipment to mesh with some different device; but, a equipment can also mesh with a non-rotating toothed component, known as a rack, thereby generating translation in place of rotation. The gears in a transmission are analogous to the wheels in a crossed belt pulley device. A bonus of gears is that the teeth of a gear prevent slippage. When gears mesh, and one equipment is greater than the opportunity (despite the fact that the dimensions of the enamel need to healthy), a mechanical benefit is produced, with the rotational speeds and the torques of the 2 gears differing in an inverse courting.

Helical gears are mostly used for parallel shaft drives. For that reason for the same width, their tooth are longer than spur gears and have higher load wearing capacity. Their contact ratio is higher than spur gears and that they perform smoother and quieter than spur gears. Their precision rating is right. They may be endorsed for extremely excessive speeds and loads. Hence, those gears discover giant applications in vehicle gearboxes. Their performance is barely lower than spur gears. The helix attitude moreover introduces axial thrust at the shaft.

## II. LITERATURE REVIEW

**Nitin Kapoor, Virender Upneja, Ram Bhool and Puneet Katyal.** The principal goal of this paper is to advanced parametric model of differential Gearbox by the use of CATIA-V5 underneath diverse design tiers. It is found that Glass filled polyamide composite material is selected as fine cloth for differential gearbox and is discovered to suitable for exceptional revolutions (2500 rpm, 5000 rpm and 7500 rpm) below static loading conditions. Comparisons of various stress and strain effects the usage of ANSYS-12 with Glass filled polyamide composite and metallic substances (Aluminum alloy, Alloy Steel and Cast Iron) also are being done and discovered to be decrease for composite material.

Glass filled polyamide composite material is used for gears and are analyzed the usage of ANSYS for equal (VonMisses) strain, displacement (overall deformation) and maximum shear elastic stress for distinctive revolutions (2500 rpm, 5000 rpm and 7500 rpm) under static situations. Comparisons of numerous pressure and strain consequences with Glass stuffed polyamide composite and metal materials (Aluminium alloy, Alloy Steel and Cast Iron) are also being accomplished and determined to be lower for composite fabric. By staring at these analysis outcomes, Glass Filled Polyamide composite fabric is selected as a satisfactory material for Differential gear field which in turn increases the general mechanical efficiency of the system

**Utkarsh.M.Desai, Prof.Dhaval.A.Patel**

In this project work, A steel equipment of Alloy Steel is changed by the composite tools of 30% Glass filled Poly-ether-etherKetone (PEEK). Such Composites material offers a good deal progressed mechanical houses inclusive of better strength to weight ratio, greater hardness, and for this reason less chances of failure. In this paintings, an evaluation is made with replacing steel tools with composite cloth together with PEEK for you to increase the running life of the gears to improve universal overall performance of system. Finally the Modeling of spur tools is carried out the usage of SOLID WORK and bending stress analysis of spur tools is accomplished the use of ANSYS V14.Von mises strain for alloy metal is to be discovered as 6.50 Mpa and for composite fabric it's far to be determined as 5.96 Mpa as shown in the determine. For that, analytical and finite detail approach are carried out for determining bending stress of gear enamel. The acquired FEA end result is in comparison with the analytical result and determined that both result are comparable. Result indicates that through stress evaluation the power of the GF 30 PEEK spur equipment is extra whilst in comparison with alloy steel spur equipment. Also the density of the GF 30 PEEK is very much less whilst in comparison with alloy metallic. So we are able to finish that the alloy metal spur gear can be replaced via GF 30 PEEK(composite) spur equipment because of its high energy, low weight and damping characteristics.

### S.Mahendran, K.M.Eazhil, L.Senthil Kumar

In this paper the analysis of spur equipment with forged steel and composite cloth like fiber and epoxy is completed via the usage of fea. Their price for weight and strain has been in comparison and determined that composite substances are greater better than forged metallic. Fibers produce excessive-energy composites due to their small diameter; they include far fewer defects (usually floor defects) in comparison to the cloth produced in bulk. As a popular rule, the smaller the diameter of the fiber, the better its energy, but frequently the price will increase because the diameter turns into smaller. In addition, smaller-diameter excessive-power fibers have more flexibility and are extra amenable to fabrication techniques which include weaving or forming over radii. Epoxy resins are extensively used in filament-wound composites and are appropriate for molding prepress. They are reasonably solid to chemical attacks and are exquisite adherent shaving slow shrinkage throughout curing and no emission of risky gases. These blessings, but, make the usage of epoxies rather high-priced. Also, they can't be anticipated beyond a temperature of 140°C. Their use in excessive technology areas in which service temperatures are better, as a end result, is ruled out. Epoxy resins are easily and quickly cured at any temperature from 5°C to one hundred fifty°C, depending on the choice of curing agent. One of the most tremendous properties of epoxies is their low shrinkage in the course of therapy which minimizes material print-via and inner stresses. High adhesive electricity and high mechanical houses are also enhanced by excessive electrical insulation and proper chemical resistance. Epoxies find makes use of as adhesives, caulking compounds, casting compounds, sealants, varnishes and paints, as well as laminating resins for a ramification of industrial programs. From these evaluation we were given the pressure values for composite substances is less as compared to the solid steel spur gear. Composite substances are able to using in automobile vehicle tools containers up to at least one.5KN within the utility of Tata superb ace version as opposed to current cast steel gears with better results. V. Siva Prasad, Syed Altaf Hussain, V.Pandurangadu,

### III MODELING AND ANALYSIS OF HELICAL GEAR:

SOLID WORKS is mechanical modeling automation software that takes benefit of the acquainted Microsoft Windows graphical consumer interface. It is an smooth-to-analyze device which makes it feasible for mechanical designers to fast caricature ideas, experiment with capabilities and dimensions, and bring models and precise drawings.

ANSYS offers innovative, dramatic simulation technology advances in every foremost Physics area, at the side of upgrades in computing speed and improvements to permitting technologies together with geometry dealing with, meshing and post-processing. These improvements alone constitute a prime step beforehand on the path ahead in Simulation Driven Product Development.



Fig. 1. Model of 18 teeth helical gear:

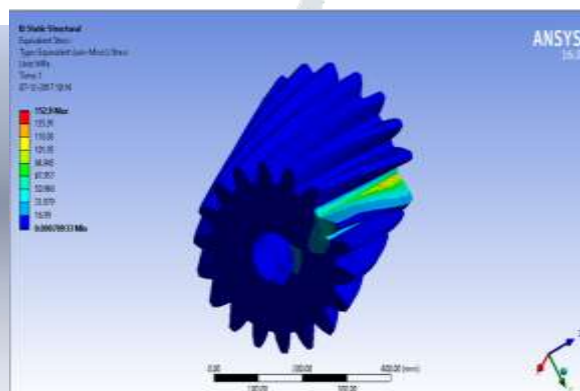


Fig.2. Analysis of 18 teeth helical gear

### IV RESULTS AND DISCUSSION:

Analytical Bending Stress Calculation by AGMA equation:

18 No Teeth Helical Gear

$$\sigma_b = \frac{F_t P_d K_o K_s K_m K_v K_b}{b J}$$

Where  $F_t = F \cos \phi$

$F$  = force applied = 350 KN

$B$  = face width (mm) Hence  $\sigma = 142474 \times 0.0522 \times 1.5 \times 1.25 \times 1.8 \times 1.24 \times 1/420 \times 0.49 = 151.63 \text{ MPa}$

Analytical Contact Stress Calculation by AGMA equation:

16° Angle Teeth Helical Gear

$$\sigma_c = C_p \sqrt{\frac{F_t K_o K_s K_m K_v C_f}{D_p b I}}$$

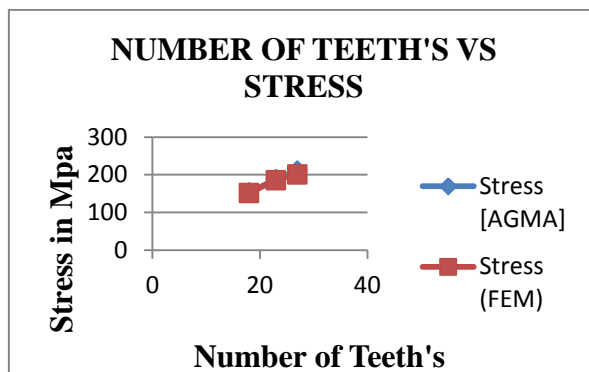
$$\sigma = 191 \sqrt{\frac{(142473.629 \times 1.5 \times 1.25 \times 1.24 \times 1.8 \times 0.56)}{(420 \times 344.7 \times 0.239)}} = 593.33 \text{ MPa}$$

### Comparing bending stress FEM and Analytical

Number of Teethes	Stress [AGMA] (MPa)	Stress (FEM)(MPa)	Difference(%)
18	152.90	151.63	0.83
23	187.87	185.66	1.18
27	210.73	201.10	4.67

Table no: 1 Comparing Bending Stress Fem And Analytical

## NUMBER OF TEETHES VS STRESS



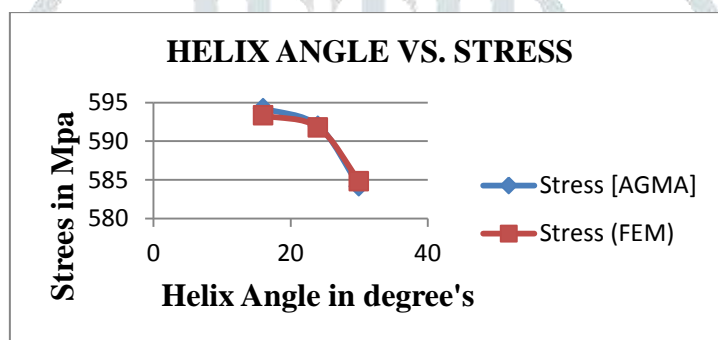
Graph no: 1 Number Of Teethes Vs Stress

## COMPARING CONTACT STRESS FEM AND ANALYTICAL

Helix Angle	Stress [AGMA] (mpa)	Stress (FEM)(mpa)	Difference(%)
16°	594.26	593.33	0.15
24°	591.98	591.79	0.03
30°	584.16	584.82	0.11

Table no: 2 Comparing Contact Stress Fem And Analytical

## HELIX ANGLE VS. STRESS



Graph no: 2 Helix Angle Vs. Stress

## DISCUSSION

Three different geometrical helical gears with teeth numbers 18, 23, 27 are modeled and analyzed by using solid works and ansys software respectively. On applied load, bending stresses will generate on face of tooth of helical gear, stress value are noted and tabulated and plotted the graph, table no 1 and graph no 1. According the graph we can conclude that as the teeth numbers are increasing bending stresses also getting increasing gradually, hence the least bending stress is generated by helical gear with least teeth numbers and max bending stress are generated by max number of teeth numbers. Meanwhile bending stresses also calculated by using AGMA method, results and graph are tabulated and plotted in table no 1 and graph no 1. We can observe the simulation and calculated value analytical both are approximately same max error difference is 4.667%.

## V CONCLUSION

Bending stress and contact stresses due to FEM method and modified Lewis beam strength method are tabulated and difference between two methods are calculated. Max error % is up to 4.67% in bending stress and 0.15% in contact stress. From bending stress result table we can conclude that as the number of teethes increased stress value will increase. And as per contact stress result table we can observe that as the helix angle increase stress will decrease. Hence we can conclude that gear with low teeth number and high helix angle can prefer to provide better strength and life of helical gear.

## FUTURE SCOPE

The present study is performed under static structural load conditions of the gears to find the bending and frictional stresses, for example contact stresses. In the future, the stress analysis must be carried out for the dynamic state of the transmissions, to study the behavior under dynamic load conditions, we can perform modal analysis to find its natural frequency based on different modes of deformation and we can perform harmonic vibration analysis to find the effect of vibration on the gears while it will be mounted on the machine.

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