ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Monthly Peer Reviewed Open Access International e-Journal

Stress Distribution in Gear Contact Pair Including Effects Due To Positioning in Gear Box

N. Rohinidevi
M.Tech Student,
Department of Machine design Engineering,
Anurag Engineering College.

Mr. Ch.Ashok
Asst Professor,
Department of Machine design Engineering,
Anurag Engineering College.

ABSTRACT:

A method for the determination of load and stress distributions along the contact lines of the instantaneously engaged teeth of spur and helical gears is represented in this paper. The calculation includes the tooth profile modifications and crowning, manufacturing and alignment errors of gears, tooth deflections, local contact deformations of teeth, gear body bending and torsion, and deflections of supporting shafts. The influence of gear parameters on load and stress distributions is discussed. On the basis of the obtained results, by regression analysis, equations are derived for the calculation of load and stress distribution factors.

Keywords:

stress distribution, gear contacts, positioning of gear box, internal spur gear, modeling of spur gear, driven gear, driving gear.

INTRODUCTION:

Gear is a mechanical part.Widely used in industries. A gear is a rotating machine part having cut teeth, or cogs, which mesh with another toothed part in order to transmit torque. Spur gear is the simplest type of gear which consists of a cylinder or disk. Its form is not straight-sided, thus, the edge of each tooth is straight and aligned parallel to the axis of rotation.

As the most common type, spur gears are often used because they are the simplest to design and manufacture. Besides, they are the most efficient. When compared to helical gears, they are more efficient. Because helical gears have sliding contact between their teeth, they produce axial thrust, which in turn produces more heat.

MATERIALS OF SPUR GEAR:

While manufacturing spur gears, wide variety of materials can be used. These include.

- Steel
- Nylon
- Aluminum
- Bronze
- Cast iron
- Phenolic
- Bakelite

SCOPE OF WORK:

The present thesis describes the results of finite element analyses for different cases of gear assembly, namely

a) Main gear under line load.

b) Pinion gear under line load.

c) Gear pair under contact without any support of shaft.

d) Gear pair under contact as supported in a gear box. The objective was to examine and asses the deformation and stress.For purpose of analysis the gear are modeled in pro/e software and the IGES files of these models are imported in to the commercial software ,ansys 11.0. From the results of analyses, it is proposed to assess the effects of gearbox.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Monthly Peer Reviewed Open Access International e-Journal

DESIGN OF GEAR BY SOLID MODELING:

The available gear design software's are mathematical in nature for the proper modeling of the involute curve and the tooth profile generated from the curve. Dedicated gear design programs perform the calculations, which are necessary to create the true profile of the gear tooth, but this is a tedious and time-consuming operation.

However, CAD/CAM applications can do this in seconds to generate a correct involute tooth profile quickly and easily due to their graphical nature. They are graphical modeling tools and there are a finite number of calculations they can perform and a finite number of points they plot along the involute curve.

CAD systems approximate shapes such as involute tooth profile by defining points along a curve and then simply connecting those points with a straight lines. The more points you can plot, the smaller the lines are used to draw the curve. While they can plot many of points along the curve, coming close to the involute profile, there is always an error due to the need for the software to approximate using points and lines.

Dedicated gear design programs allow to make a gear that is within the AGMA or ISO quality rating. In fact the standards are already in corporate into many gear design programs. For application where precise tooth profiles are not necessary as in the gear design itself, solid-modeling systems are very useful. Solid modeling is a good downstream tool, good for defining tool paths for EDMs, lasers and other systems that can draw data from CAD systems. Solid modeling is also the basis for stereo lithography and other rapid prototyping systems.These capabilities and applications make modern CAD/CAM systems such as Pro/Engineer very power full engineering design tool with a great deal to offer for the designer. All of this flexibility is possible by the process called parametric modeling.

FEATURES OF PRO/ENGINEER:

Pro/Engineer is a powerful program that is used to create virtually unlimited range of products with a great precision. The major front- end module of Pro/E is used for part and assembly design and model creation and production engineering drawings.

There is wide range of additional modules available to handle tasks ranging from sheet metal operations, piping layout, mold design, numerically controlled machining and other functions. In a nutshell Pro/Engineer is feature based bi-directional and parametric nature solid modeling system.

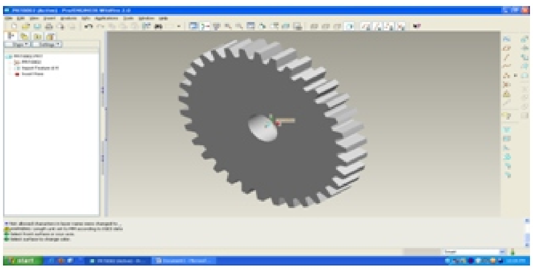
KEY GEOMETRIC PARAMETERS OF SPUR GEAR USED:

The geometric dimensions and other parameters are given in table

Geometric model:

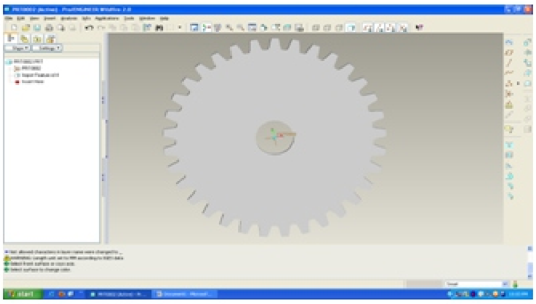
PROPERTIES	MAIN GEAR	SUB GEAR
Module	10mm,	10
Pressure angle	20deg	20
No. teeth	33	21
Pitch circle diameter	300mm	200
Root diameter	276.86mm	176.86
Centre distance	270mm	270
Pitch diameter	330mm	210
Addendum circle	350mm	230
Deddundum circle	309.05mm	188.51
Base circle	310.06mm	197.3
Addendum height	10mm	10
Deddundum height	12.5mm	12.5
Circular pitch	31.4mm	31.4
Tooth depth	23.14mm	23.14
Face width	50mm	50
Tooth radius	41.25mm	26.25
Half tooth thick	7.8625mm	7.8625
Tip radius	3.926mm	3.926

As per specifications given in Table-I the spur Gear is modeled as shown in figures below individual models for 1) Main gear only 2) Pinion gear only 3) gear pair with shaft have been created and used.

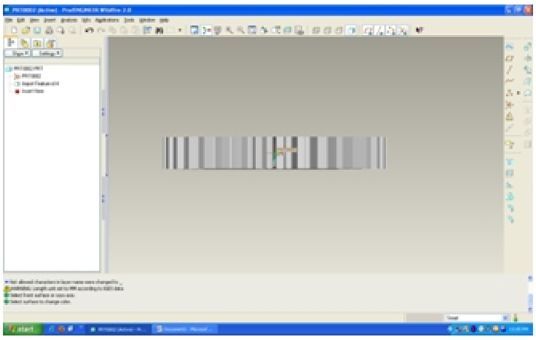


Main gear geometric model isometric view

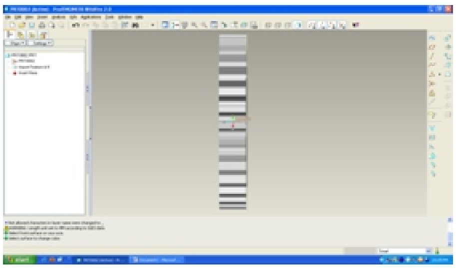
ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Monthly Peer Reviewed Open Access International e-Journal



Front view

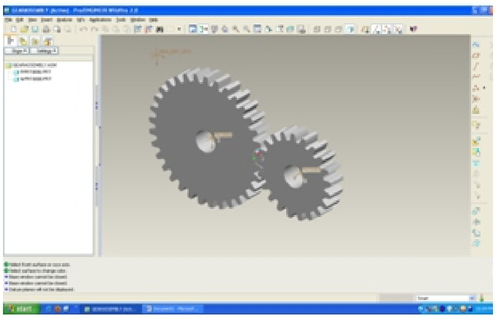


Top view

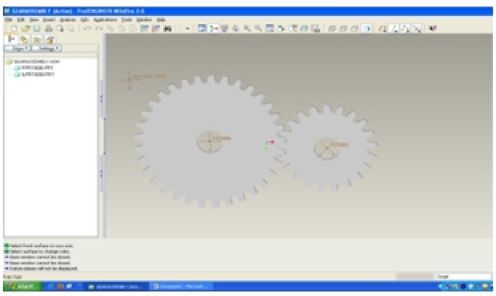


Side view

ASSEMBLY GEAR GEOMETRIC MODEL:

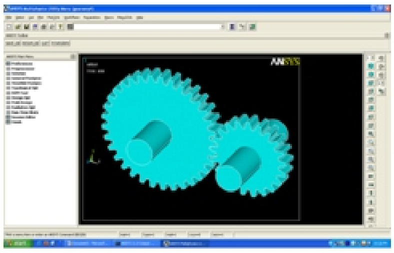


Isometric view



Front view

ASSEMBLY GEAR WITH SHAFT GEOMETRIC MODEL:



Isometric view

SOLUTION OF SIMULTANEOUS EQUATIONS :

All the equations required for the solution of the problem is now developed. In the displacement method, the unknowns are the nodal displacement. The Gauss elimination and Chalky's factorization are most commonly used methods.

CALCULATION OF STRESSES OR STRESS RESULTANTS :

The nodal displacement values are utilized for calculation of stresses. This may be done for all elements of the continuum or may be limited only to some predetermined elements.

LIMITATIONS OF FEM:

Due to the requirement of large computer memory and time, computer program based on FEM can be run only in high speed digital computers.

For some problems, there may be considerable amount of input data. Errors may creep up in their preparation and the results thus obtained may also appear to be acceptable which indicates deceptive state of affairs.

FINITE ELEMENT ANALYSIS OF GEAR PAIR:

The dimensions of the gear and pinion are given earlier section 3.3 and the major parameters are repeated below.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Monthly Peer Reviewed Open Access International e-Journal

PROPERTIES	MAIN GEAR	PINION GEAR
Module	10mm,	10
Pitch diameter	330mm	210
Addendum circle	350mm	230
deddundum circle	309.05mm	188.51
Base circle	310.06mm	197.3

The loading is determined from the torque being applied on the main gear and pinion gear and assemble of both gears. An early level can has a power of around 70HP and speed around 7000rpm.

For a speed N of rpm torque is obtained from the formula HP= 2πNT/4500.
Torque =7160N
This torques is acting over a perimeter of the shaft.
This load is applied as a tangential load at 4 nodes distributed at 90deg interval.
The pinion shaft is constrained to have zero displacement, which is the boundary condition.

The material properties used as:

E = 2E5 N/mm2
Poisons ratio = 0.3

THE ANALYSIS IS CARRIED OUT BY 4STAGES:

1. Main gear separately.
2. Pinion gear separately.
3. Assemble of main gear and pinion and,
4. Analysis of gear pair mounted in gear box.

ANYLISIS OF DRIVEN AND DRIVING GEAR:

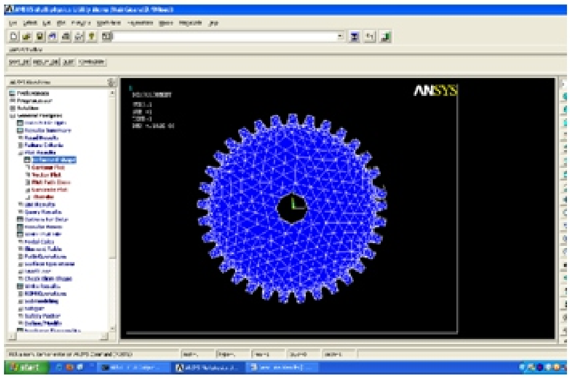
Analysis of main gear only:

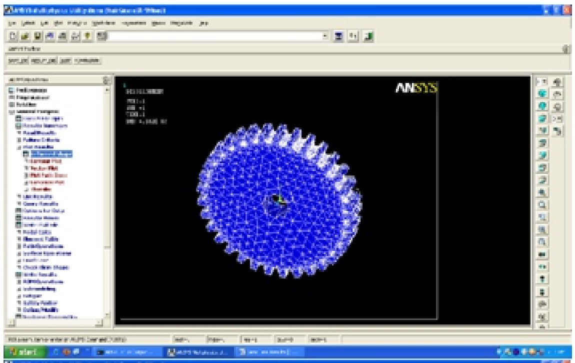
The meshed main gear model is applied boundary conditions of no linear displacement at centre and only rotation allowed. The line load 2.2N/mm2 is applied on a tooth end.

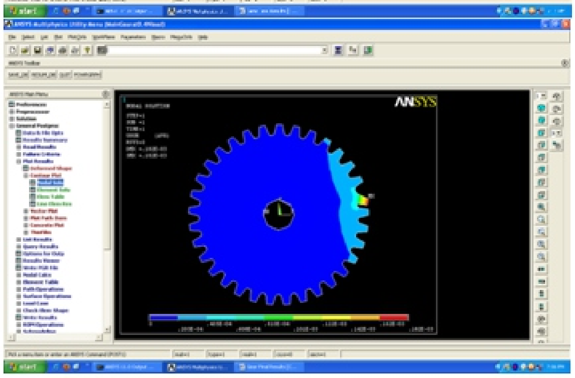
MAIN GEAR:

At Load 2.2N/mm2:

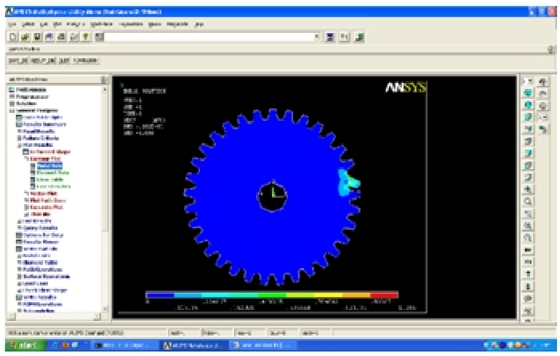
DEFLECTION:





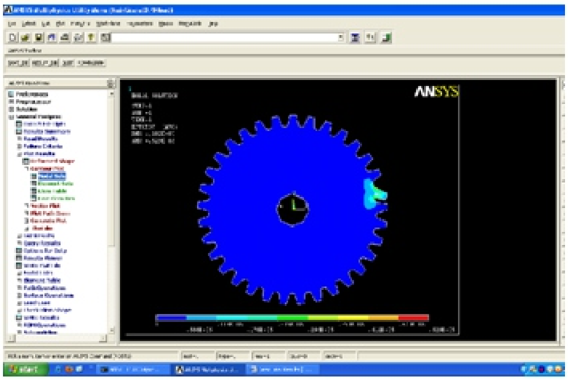


Von misses stress:

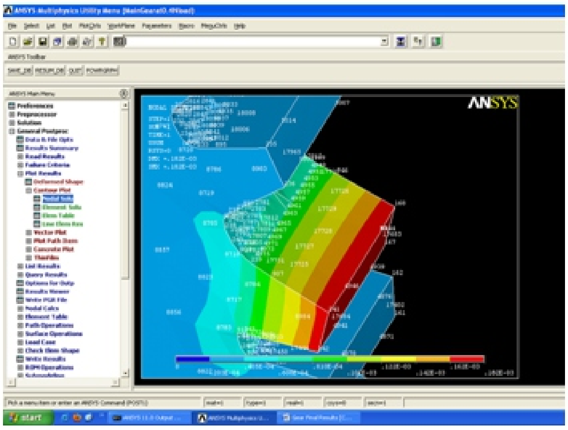


Von misses Strain:

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Monthly Peer Reviewed Open Access International e-Journal



DEFLECTION WITH NODE NUMBER:



MAXIMUM ABSOLUTE VALUES

NODE 4945 4940 740 4945
VALUE 0.64122E-04-0.18051E-03-0.14709E-04 0.18353E-03

CONCLUSION:

The primary aim of the thesis was to examine the effect of mounting bracket or (gear box) for a spur gear assembly for this purpose a finite element analysis was carried out for following cases,

1)Analysis of main gear only,

2)Analysis of sub gear only,

3)Analysis main gear and sub gear without the gear box ,

4)Analysis of the gear assembly inside the gearbox.

It can be concluded that the analysis of individual gears does not provided much information regarding the deflection and the stress in the practical configuration also the analysis of the spur gear assembly a lone gives a little more realistic assessment of stress and deflection.However the analysis of the gear assembly inside the gear box shows clearly that much more the stress and deflection in the gear portion is transformed to the supporting shafts.

SCOPE FOR FUTURE WORK:

Contact stress analysis can be carried out by using contact element in finite element analysis.Analysis can be carried out by giving the load in practical manner at the end of the pinion shaft, like in the case of a vehicle or machinery.This also the effect of casing on loss of stress.

RESULTS:

The results are shown in following table.
For torque of 7190Nmm, the value of deflection and von Mises stress and strain are detailed below.

Case	Deflection(mm)	Vonmisses stress N/mm²	Vonmise strain
Big gear (only)	$0.182x10^{-3}$	31.41	$0.59x10^{-5}$(low since totally fixed)
Sub gear (only)	$0.190x10^{-3}$	36.59	$0.620x10^{-5}$(low since totally fixed)
Assembly gear (torque analysis)	$0.22x10^{-3}$	41.49	$0.261x10^{-3}$
Gear assembly inside the gear box	$0.471x10^{-4}$(on gear) $0.424x10^{-4}$(on shaft)	83.60(on shaft) 9.3(on gear)	$0.554x10^{-3}$(on shaft) $0.615x10^{-4}$(0n gear)

It can be concluded that the analysis of individual gear s does not provided much information regarding the deflection and the stress in the practical configuration also the analysis of the spur gear assembly a lone gives a little more realistic assessment of stress and deflection.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Monthly Peer Reviewed Open Access International e-Journal

However the analysis of the gear assembly inside the gear box shows clearly that much more the stress and deflection in the gear portion is transformed to the supporting shafts.

This is the very important observation since when one designs a gear pair,

The following two aspects are to be consider namely,

1)The gear stress analysis especially at the contact zone to overcome plasticity effect and,

2)The analysis of the shaft system which takes up more stress & deflection when the gear is assembled in the gearbox.

BIBILOGRAPHY:

1)Ram lingam germane, Subramanian shanmugam "modeling and contact analysis of crowned spur gear teeth".

2)Kristina marković – Marina franulović "contact stresses in gear teeth due To tip relief profile modification".
3)Ali Raad Hassan "Contact Stress Analysis of Spur Gear Teeth Pair".

4) J.R. Koisha, H.P. Doshi"Influence of Friction on Contact Stress for Small Power Transmission Planetary Gear Box".

5)Chia-Chang Liu, Yi-Cheng Chen, and Shih-Hao Lin "Contact Stress Analysis of Straight Concave Conical Involute Gear Pairs with Small Intersected Angles".

6)JongBoon Ooi1, Xin Wang, ChingSeong Tan, Jee-Hou Ho and Ying Pio Lim "Modal and stress analysis of gear train design in portal axle using finite element modeling and simulation". ent analysis of stresses in involute spur & helical gear".

7)IvanaAtanasovska, Vera Nikolić-Stanojević"3d spur gear fem model for the numerical calculation of face load factor".

8)SorinCănănău "3d contact stress analysis for spur gears".

9)Alexander L. Kapelevich, Thomas M. McNamara "Direct Gear Design for Automotive Applications".

10)Vera Nikolić-Stanojević, Ivana (Atanasovska) Cvejić"The analysis of contact stress on meshed teeth's flanks along the path of contact for a tooth pair".

11)Shreyash Patel "finite elem1.

2)James Kuria* John Kihiu"Effect of Gear Design Variables on the Dynamic Stress of Multistage Gears".

13)Saul Herscovici "improving the gear box durability".

14)Dr.raghu Kumar ,NirajTiwari,Devendra Kumar ,R.R Veralakshmi ,Mohan Chhetri"transmission error on spur gear".

15)S. H. Chang and R. L. Huston, J.J.Coy "Finite Element Stress Analysis Of Spur Gears Including Fillet Radii and Rim Thickness Effects".

16)ManojHariharan"spur gear tooth stress analysis and stress reduction using stress reducing geometrical features".

17)Miguel Amezketa, Xavier Iriarte, Javier Ros and Jesús Ma Pintor"dynamic model of a helical gear pair with backlash and angle-varying mesh stiffness".

18)Zeping Wei "stresses and deformations in involute spur gears by finite element method".