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PARAMETRIC ANALYSIS OF SPUR GEAR TO DETERMINE THE EFFECT OF VARIATION OF R.P.M. AND PRESSURE ANGLE ON STRESS PRODUCED

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ABSTRACT

Stress produced in gear is an important aspect which have strong impact on designing of gear for particular application. Stress produced in matting gears depends on geometry of gear and geometry depends on pressure angle of gear. So study of effect of pressure angle on stress is of great importance. Stress produced in gear is also effected by rotational velocity. In this paper the effect of varition of r.p.m and pressure angle on stress produced in spur gear is determined using finite element method. CAD model of spur gears is prepared using modelling tool solid works. Stress analysis at different r.p.m and pressure angle is carried by analysis tool ansys software.

KEYWORDS: Spur gear, CAD Model, FEA, stress, r.p.m, pressure angle

INTRODUCTION

In any machine component stress consideration is mojor cause of concern. In this paper stress behaviour in spur gear is analysed using finite element method. The effect of variation of r.p.m. and variation of pressure angle on stress produced in spur gear is also determined.

Gears are the most common means of transmitting motion and power in the modern mechanical engineering world. They form vital elements of mechanisms in many machines such as automobiles, metal cutting machine tools, rolling mills and transmitting machinery. Toothed gears are used to change the speed and power ratio as well as direction between an input and output shaft.

Gears are enclosed in gearbox. A gearbox as usually used in the transmission system is also called a speed reducer, gear head, gear reducer etc., which consists of a set of gears, shafts and bearings that are factory mounted in an enclosed lubricated housing. Speed reducers are available in a broad range of sizes, capacities and speed ratios. Their job is to convert the input provided by a prime mover into an output with lower speed and correspondingly higher torque.

When two gears are meshed with each other, a definite velocity ratio is obtained. Velocity ratio (or gear ratio) is the ratio between the angular velocity of driving gear and the angular velocity of driven gear.

In persent work stress analysis of spur gear is carried out using FEA.

The finite element analysis (FEA) is a computing technique that is used to obtain approximate solutions to the boundary value problems in engineering. It uses a numerical technique called the finite element method (FEM). The Basic concept in FEA is that the body or structure may be divided into a smaller elements of finite dimensions called "Finite Elements". The original body or the structure is then considered as an assemblage of these elements connected at a finite number of joints called "Nodes" or "Nodal Points.

For practical considerations the contact stress on involute spur gear can be better approximated using Finite Element Method. This Method can be used in approximating any kinds of stress, strains and deformations in single parts and assembly. This method originated for solving complex elastic and structural analysis problems. The first people to develop this method were Alexander Hrennikoff and Richard Courant . In 1947 Olgierd Zienkiewicz coined the term Finite element Analysis by gathering

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these methods. In 1952 Boeing made a great effort to analysis the aircraft structures using Finite element Methods and in 1964 NASA developed a software in Fortran language called Nastran to analysis the aircraft structures. In mid-1970 due to advancement in computer technology many software's capable of performing Finite element analysis were available.

MATERIALS AND METHODS

Methodology

- Spur gears with specifications of geometrical parameters and properties of material is selected.
- Model of spur gear with pressure angle 14.5º is prepared using solid works and mates are defined.
- Model of spur gear imported to ansys in parasolidx.t format.
- Analysis of stress is carried out on ansys at different r.p.m and pressure angle 14.5º.
- Another model of spur gear with pressure angle 20º is prepared using solid works.
- Results of stress at different r.p.m and pressure angle 20º are obtained using ansys.
- Results of stress produced at different r.p.m. at pressure angle 14.5º and pressure angle 20º are compared.

Mechanical properties of the material

Table 1. mechanical properties of material of gear and pinion [case hardened alloy steel (AISI9310)]

No.	Parameters	Specification
1.	Yielding strength(MPa)	1020
2.	Ultimate tensilestrength(MPa)	1265
3.	Young's modulus(MPa)	$203.9x10^3$
4.	Poisson's ratio	0.28

CAD models of spur gears prepared on solidworks

Table 2. Geometrical Parameters of first gear-pinion set

No.	Parameters	Pinion wheel	Gear wheel
1.	No. of teeth	17	32
2.	Module(mm)	2	2
3.	Pitch circle diameter(mm)	34	64
4.	Face width(mm)	10	10
5.	Pressure angle	14.5º	14.5º

Model with pressure angle 14.5º

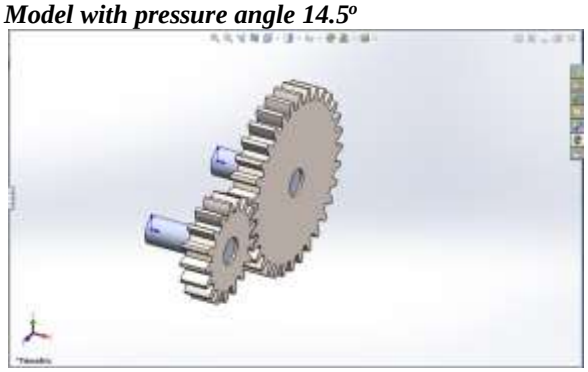
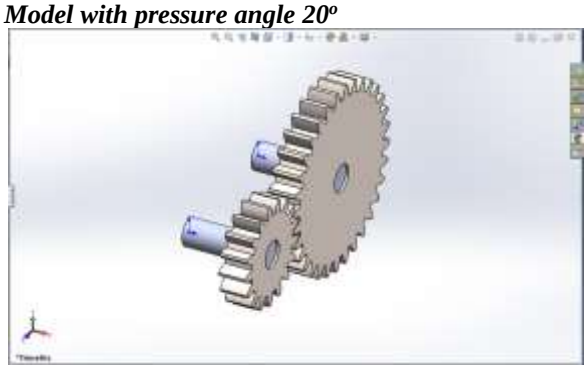


Table3. Geometrical Parameters of second gear-pinion set

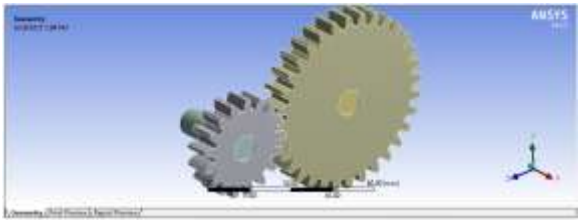
No.	Parameters	Pinion wheel	Gear wheel
1.	No. of teeth	17	32
2.	Module(mm)	2	2
3.	Pitch circle diameter(mm)	34	64
4.	Face width(mm)	10	10
5.	Pressure angle	20º	20º

Model with pressure angle 20º



Stress analysis on ansys software:

First model of spur gear imported to ansys



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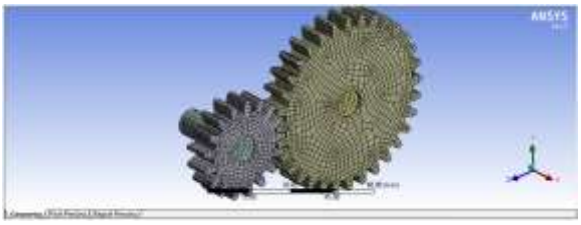
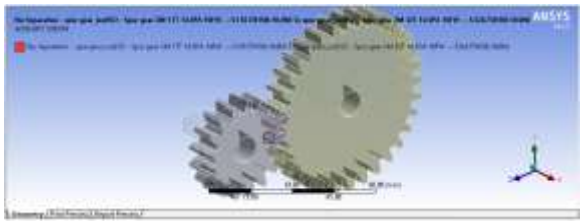
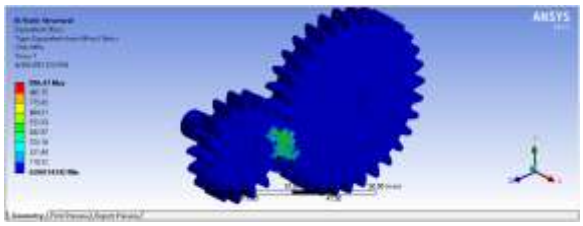
Meshing and Boundary Condition:



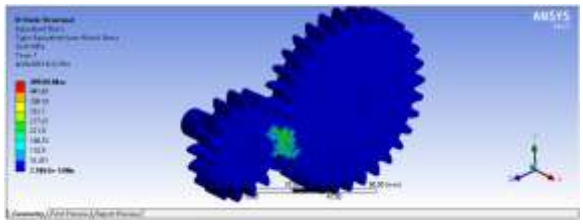


RESULTS AND DISCUSSION

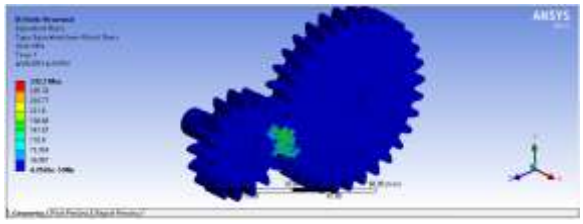
Results of stress produced at different r.p.m. at pressure angle 14.5º :



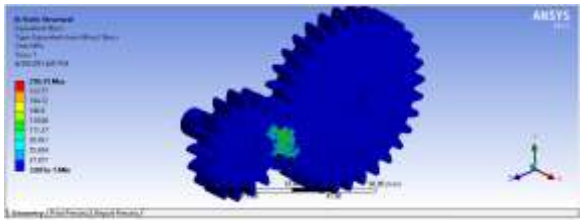
At 1000 r.p.m. max. stress is 996.4 MPa



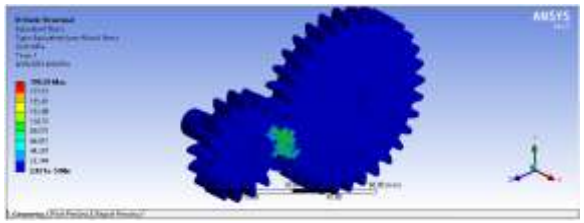
At 2000 r.p.m. max. stress is 499.06 MPa



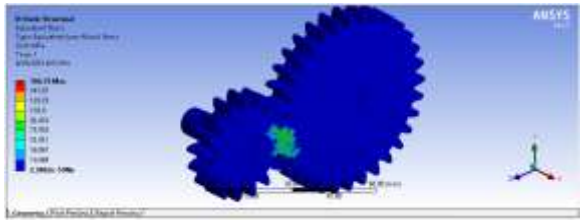
At 3000 r.p.m. max. stress is 332.7 MPa



At 4000 r.p.m. max. stress is 250.3 MPa



At 5000 r.p.m. max. stress is 199.2 MPa

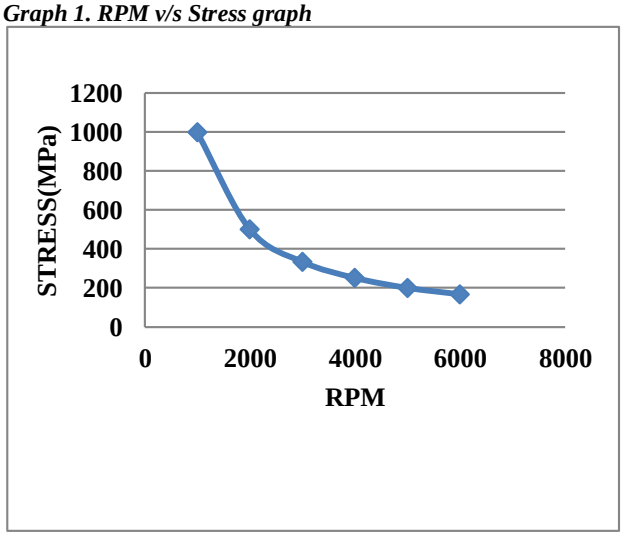


At 6000 r.p.m. max. stress is 166.3 MPa

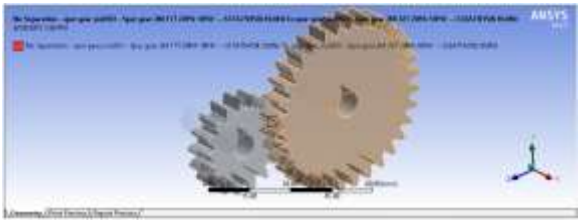
Table 4. stress at different r.p.m. at pressure angle 14.5º

RPM	STRESS(MPa)
1000	996.4
2000	499.06
3000	332.7
4000	250.3
5000	199.2
6000	166.3

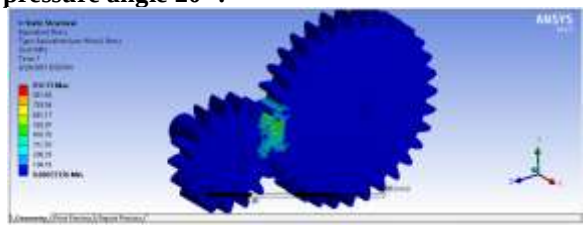
Graph 1. RPM v/s Stress graph



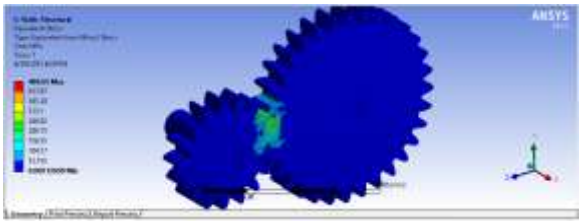
Second model of spur gear imported to ansys



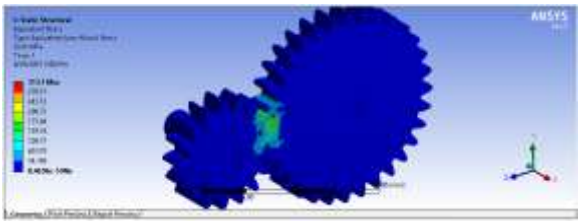
Results of stress produced at different r.p.m. at pressure angle 20º :



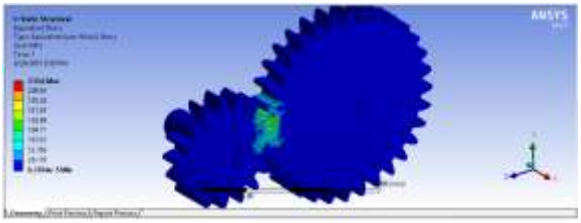
At 1000 r.p.m. max. stress is 937.7 MPa



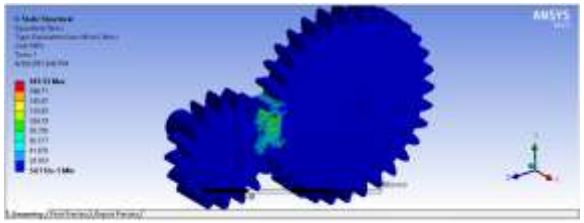
At 2000 r.p.m. max. stress is 469.6 MPa



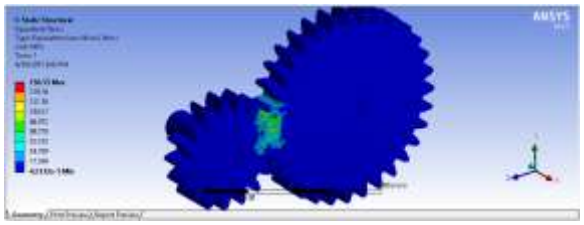
At 3000 r.p.m. max. stress is 313.1 MPa



At 4000 r.p.m. max. stress is 235.6 MPa



At 5000 r.p.m. max. stress is 187.5 MPa

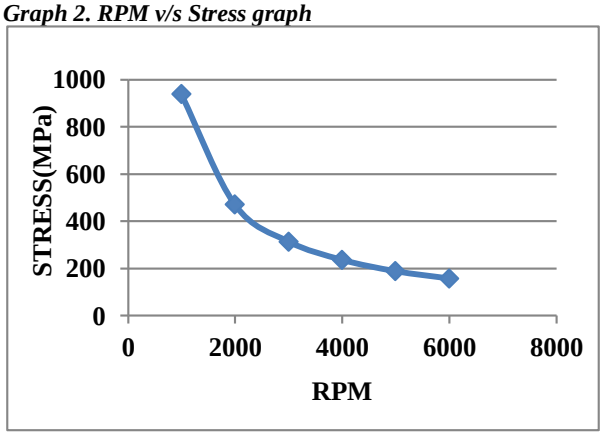


At 6000 r.p.m. max. stress is 156.5 MPa

Table 5. stress at different r.p.m. at pressure angle 20º

RPM	STRESS(MPa)
1000	937.7
2000	469.6
3000	313.1
4000	235.6
5000	187.5
6000	156.5

Graph 2. RPM v/s Stress graph

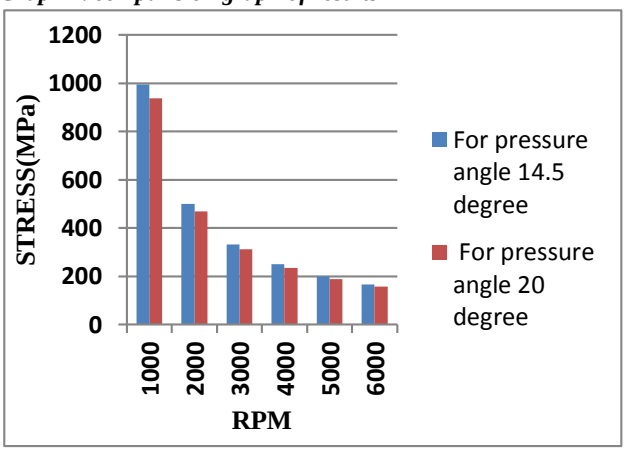


Comparision of results of stress at pressure angle 14.5º and 20º :

Table 5. comparision table of results

RPM	Stress at 14.5° pressure angle(MPa)	Stress at 20° pressure angle(MPa)
1000	996.4	937.7
2000	499.06	469.6
3000	332.7	313.1
4000	250.3	235.6
5000	199.2	187.5
6000	166.3	156.5

Graph 2. comparision graph of results



CONCLUSION

In this paper stress analysis of spur gear is conducted using FEA. The effect of variation of r.p.m and pressure angle on stress produced is determined. The results of variation of r.p.m. reveals that the value of stress at lower or starting rotational velocity is high, as the rotational velocity of matting gear increases the value of stress produced decreases. The maximum value of stress produced is 996.4 MPa which is less than the permissible working stress of gear material. The results of variation of pressure angle reveals that stress produced at 14.5° pressure angle is higher than stress produced at 20° pressure angle. Thus pressure angle 20 degree is favourable than 14.5 degree pressure angle.

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