International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 08 | Aug 2018 www.irjet.net p-ISSN: 2395-0072

Design and FEA of Portal Axle for SUV Vehicles

Vidhya D.Shinde [1], Dr.K.K.Dhande[2]

[1] PG Student, Dept. of Mechanical Engg.DYPIET, Pimpri, Pune-18.
[2] HOD Dept. of Mechanical Engg.DYPIET, Pimpri, Pune-18.

Abstract – *Portal axle is gearbox designed to increase ground clearance of the vehicle for off road driving conditions. The higher ground clearance depends on the arrangement of gear train of portal axle in which the input shaft of portal axle is used to receive the power from differential and sends it to portal axle gear train and the output shaft of portal axle transfer the power from portal axle gear train to road wheels. The main objective of this project is design and analysis of portal axle for Scorpio S2(SUV) having helical gear train with two idler gear. The portal axle gear train is modeled in SOLIDWORKS and analyzed using ANSYS 16.0 software. The experimentation is done to calculate the total torque transmission capacity of portal axle.*

Key Words: **Differential unit, Gearbox, Helical gear train, Portal axle.**

1. INTRODUCTION

Portal axles (or portal gear train) are an off-road technology where the axle tube is above the center of the wheel hub and where there is reduction gearbox in the hub. Portal axle in vehicle gives two advantages, firstly ground clearance is increased and secondly axle shaft drive with same power but reduced torque. This reduces load on axle crown wheel and differential. The Portal Axle is a gearbox unit at least two gears (input and output gear) combined to give greater off-set between the input gear and output gear.

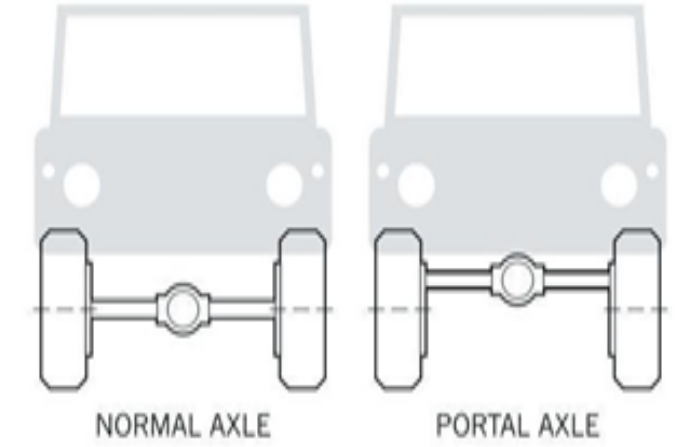

Fig -1: Difference between vehicle with normal axle and portal axle.

Fig.1 shows the difference between a normal vehicle without portal axle and normal vehicle with portal axle. Portal axles are commonly installed on four wheel-drive (4WD) vehicles for driving on off-road conditions and to gain additional ground clearance to protect underneath components from damage. In actual mounting of shaft in vehicle the input shaft of portal axle is used to receive the power from differential unit and sends it to portal axle unit and the output shaft transfer the power from portal axle unit to road wheels.

1.2. PROBLEM STATEMENT

Normal cars other than off-road vehicles its suspension gets damage due to low ground clearance which decreases the life of vehicle. SUV like Scorpio S2 which are having low ground clearance gets damage in off road condition. So, we are design Portal axle or gear box which are mount on wheel hub which increase the ground clearance.

1.3. OBJECTIVES

The main objective of this project is to increase the ground clearance of SUV by using portal axle having helical gear train and to find torque.

2. METHODOLOGY

- Problem identification.
- Project literature study.
- Methodology.
- Selection of design parameters for design stage.
- Create system model by using CAD.
- Finite element analysis by using ANASYS 16.
- Material procurement for gear.
- Manufacturing stage.
- Results and discussion.

3. DESIGN AND CALCULATION

Input Parameters: Power = 55 kW
N2 = 2800 rpm

Gear Ratio = 1.5

Design of Gear:

Gear dimensions are: D1 = 96mm T1 = 24

D2 =144mm T2 = 36

D3= 72mm T3 = 18

Centre distance= 150mm

Design of shaft:

Diameter of output shaft= 15mm

Diameter of input shaft= 15mm

4. CAD MODEL AND ANALYSIS OF PORTAL AXLE

The gears are modelled in SOLIDWORKS on the basis of design parameter.

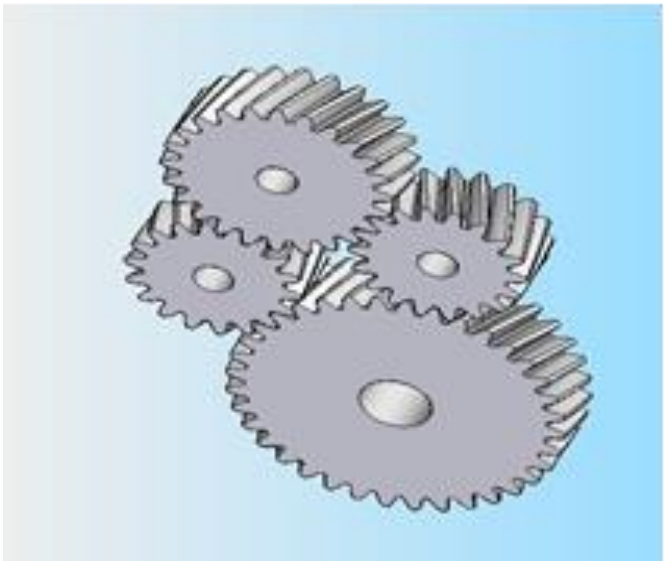

Fig -2: Cad model of helical gear train

In stress analysis, the gears are modelled on the basis design parameter. Analysis done on ANSYS 16.0 SOFTWARE. Material properties, gear parts are assigned and followed with pre-processing gear meshing, load on the gear train. The moment of 68000Nmm along z-direction. The tooth root is the weakest point of gear, hence tooth root area subjected to high density mesh.

4.1. PROPERTIES OF CAST STEEL

Table -1: Properties of Cast steel

Properties of Cast Steel	
Youngs modulus	$2X10^5$ Mpa
Poissons ratio	0.29
Density	$7.85X10^{-6}$Kg/mm^3
Tensile strength	518.8Mpa
Yield tensile strength	415Mpa
Ultimate Tensile strength	540Mpa

4.2. MESHING OF GEAR TRAIN

Number of nodes= 123077
Number of elements= 46248

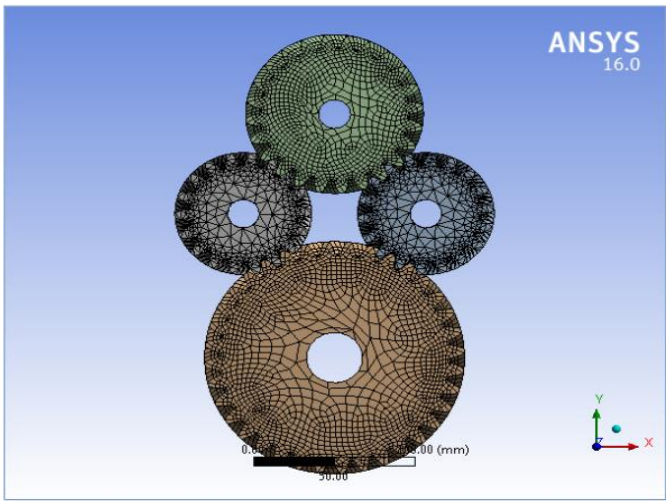

Fig -3: total deformation of helical gear train

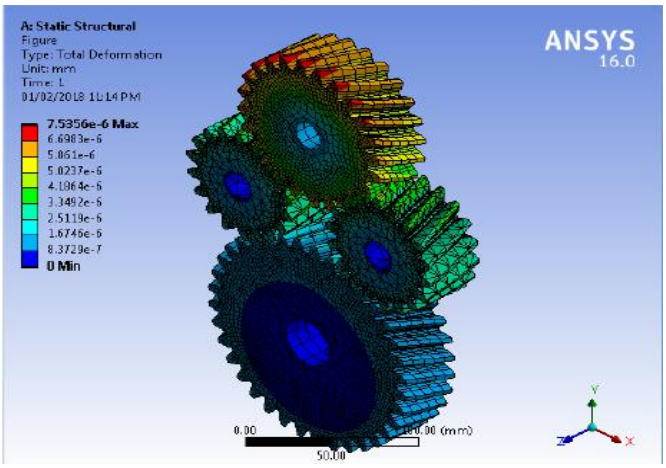

Fig -4: Cad model of helical gear train

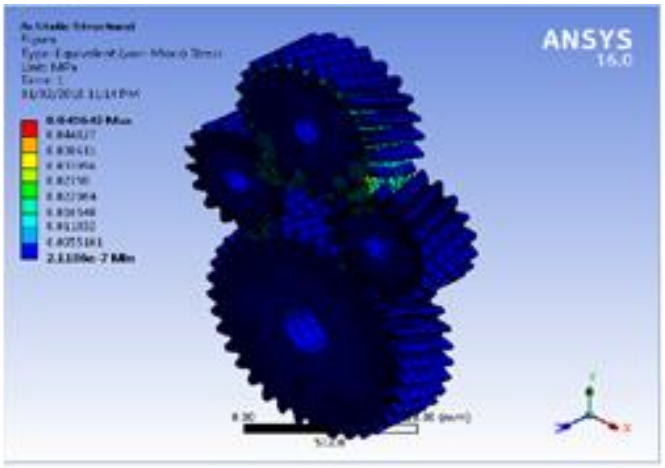

Fig -5: Equivalent (von-misses) stress

Table -2: Analysis result values

	Deformation (mm)	Von-misses stress (MPa)
Maximum	7.535	0.049

5. EXPERIMENTAL ANALYSIS SET UP

Gear is manufactured by using hobbing process.
The main parts of experimental set up is motor, gear train, tachometer, rope brake dynamometer.
The input speed to the input shaft is provided by using motor and the load is varying by using rope belt dynamometer then output speed is measured by using tachometer.

Fig -6: Experimental set up for analysis without load condition

Experimental Result:

1 HP= 0.746 kW power motor is used.

CASE 1: WITHOUT LOAD CONDITION
Input shaft speed= N1= 1501
Output shaft speed= N2= 1420
By using P= (2πNT)/ 60000 kW
gives, T1=4.7484 Nm & T2= 5.01928 Nm
T2>T1

CASE 2: WITH LOAD CONDITION= LOAD OF 15Kg
N3=1150
Gives, T3=6.1977 Nm
WITH LOAD CONDITION= LOAD OF 20Kg
N4=1050
Gives, T4=6.78 Nm
SO, T4>T3>T2>T1

Fig -7: Experimental set up for analysis with load condition

Table -3: Experimental result Analysis

Sr. No.	Load(Kg)	Output shaft speed(rpm)	Torque (Nm)
1	0	1420	5.01
2	15	1150	6.197
3	20	1050	6.78

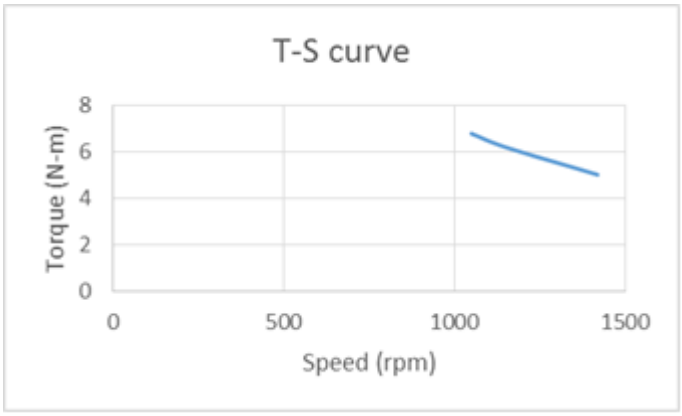

Chart -1: Torque vs Speed Graph for Portal Axle

Chart -1: Name of the chart

IRJET sample template format ,Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

6. CONCLUSION

Portal axle is designed using helical gear train for Scorpio, modelled in Solid Works and analysed by using ansys. After experimental analysis, it was concluded that torque transmission increases of the vehicle by using helical gear train of portal axle in off road condition. The ground clearance increases upto 150mm.

ACKNOWLEDGEMENT

I am thankful to Prof. N. I. Jamadar (ME Co-ordinator) for his timely help to complete this work.I wish to express my special thanks to Dr. S. N. Mali (Principal) for his encouragement and providing required facility to complete this project work.

REFERENCES

[1] JongBoon Ooi, Xin Wang, ChingSeong Tan, Jee-Hou Ho et. Al., "Modal and stress analysis of gear train design in portal axle using finite element modeling and simulation, Journal of Mechanical Science and Technology" Oct. 24, 2011.

[2] Manikandan, Prof. S. Parimala murugaveni, " Analysis of spur and helical gear in portal axle gear box using fem", IJSRD, Vol. 4, Issue 03, 2016.

[3] Mr. Niket N. Lachake, Prof. A. B. Gaikwad, Experimental and FEA assessment of modification in portal axle shaft, IOSR Journal of mechanical and civil engineering, volume 13, issue 5, Ver I (Sep- Oct 2016), PP6979.

[4] Mali Lakhan B., Supekar Dattatray Dilip, Sayyad Arshad Jabbad, Sartape S.L., Taware Akshay Dnyandeo, "Design and Manufacturing of portal axle gear box", IRJET Volume:04 Issue: 04.

[5] Anand Dhere,et.al. "Design and analysis of portal axle of vehicle",International Journal of Current Engineering and technology, June- 2017.

[6] Umesh Shinde, Deepak C Patil, "Finite Element Analysis of portal axle gear train using Metallic and Composite Spur Gears", IRJET, Volume: 03 Issue: 04, April- 2016.

[7] Manjunatha B., Malthesha P. J., Someshkhar Hiremath, "Design and analysis of input shaft of a portal axle", International Journal of Science and Technoledge (ISSN 2321-919X).

[8] E. Jayaram, M. Rambabu, Structural Analysis of gear train design in portal axle using Finite Element Modeling, IJRMET Vol.3, Issue 1, Nov-April 2013.

[9] Tawanda Mushiri, "Analysis of a gear train using finite element modelling", International conference on operation Exellence and service Engineering, Sept 10-11, 2015.

[10] R. S. Khurmi, J. K. Gupta "Spur gears", "Helical gears", *Machine design* 14th Edition, New Delhi.