

Modification of Final Drive Mechanism in Toyota Innova Car (Diesel)

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Abstract— in the past 20 years, rapid development in the automotive industry have been accompanied by increase in speed, loads and engine power. This paper is reports on review of modification of final drive mechanism in Toyota In nova car (diesel engine).Final drive mechanism is used in rear wheel drive engines. With the help of propeller shaft and differential, engine power is transmitted from engine to the rear wheels of the car. Now-a-days, Toyota In nova car makes too much noise and comparatively high RPM at high speed of engine (in running condition). The study shows that in today's In nova car engine makes above 2500 rpm on reaching 100kph in 5th gear and makes loud noise in cockpit. Driving at 60 kph in 4th gear the engine is at 2000 rpm and changing up to 5th gear drops the revolution to more quite 1500 rpm. Driving at 50 kph in a fourth gear result in the same engine speed but the engine doesn't like being driven like that, it labours a bit. At 80 kph in the 5th gear the engine is doing 2000 rpm and taking the Innova 100 kph in the 5th gear result in engine speed of above 2500 rpm. Thus at highway speed the loud engine noise makes one feels that an additional gear would have been handy. The core agenda of the project is to modify final drive mechanism of Toyota Innova to reduce RPM and noise of engine with the help of changing crown-pinion ratio, when car is in running condition. We have gathered a final and concurrent conclusion to this problem with use of the AUTOCAD and SOLID WORKS analysis.

Key words: Final drive unit, Differential unit, Crown-pinion teeth ratio, Wheel hub

I. INTRODUCTION

The Toyota Innova is a compact MPV manufactured by Toyota. It is produced in Indonesia under supervision by Toyota Astra Motor since 2004. As with Toyota Kijang, which it replaced, the Innova is produced and first marketed in 2004 in Indonesia. The Innova is part of Toyota's IMV program together with the Toyota Hilux pickup truck and the Fortuner SUV. Its official name in Indonesia is Toyota Kijang Innova, while in India, it is Innova. In current automobile market, Toyota Innova is very popular car. There are so many users of Innova car. It is successful model. Toyota Innova has 2.5 liter diesel engine which produces maximum torque of 200 Nm at 3600 rpm. But there are some problems faced by Innova users like high engine noise in cockpit at higher speed (above 100 kph), less fuel efficiency etc. Some problems are defined as follow:

- 1) At highway speed loud engine noise makes driver feel that additional gear would have been handy.
- 2) Innova(diesel) has 2.5 liter engine and if compare to the 3.0 liter in the Toyota Fortuner, there is non-proportional difference in power. The Fortuner gets 70% more horsepower for just 20% more displacement.
- 3) Comparatively high RPM above 100kmph speed. (Compare with Mahindra M-hawk engine.)

So we want to develop a system where user may not suffer from above problems while driving a car. So we decide to make some modification to overcome above problems.

II. SOLUTION OF THE PROBLEM

The problem defined above can be solved by many alternative ways but according to our survey, we have found two alternative ways to solve above problem.

Firstly by making changes in gear box and secondly by doing modification in final drive.

But changes in gear box is more difficult and require very accurate machining process which increases its cost. Due to the compact size of its gear box assembly it very difficult to make changes in gear box.

Thus above changes in gear box is very difficult, so we decided to make modification in final drive mechanism to reduce noise and RPM. For that we will change crown-pinion teeth ratio from 11:43 to 12:43 and also diameter of the crown should be changed according to requirement. But change in crown-pinion teeth ratio require very precise machining process and it is quite difficult to make single work piece. So that we decide to replace whole differential unit of Toyota Innova car by Totoya Fortuner's differential unit. Because crown-pinion ratio of Fortuner's differential is 12:43, which we have to require. But there is another problem faced that wheel drum of Toyota Fortuner is larger than Toyota Innova car. So that 15 inch diameter alloy wheel cannot attach on the Fortuner's drum.

After long time thinking of above problem, we made design of one type of converter plate to solve above problem. Design of converter plate is shown below.



Fig. 1: Crown wheel and pinion

III. DESIGN OF CONVERTER PLATE

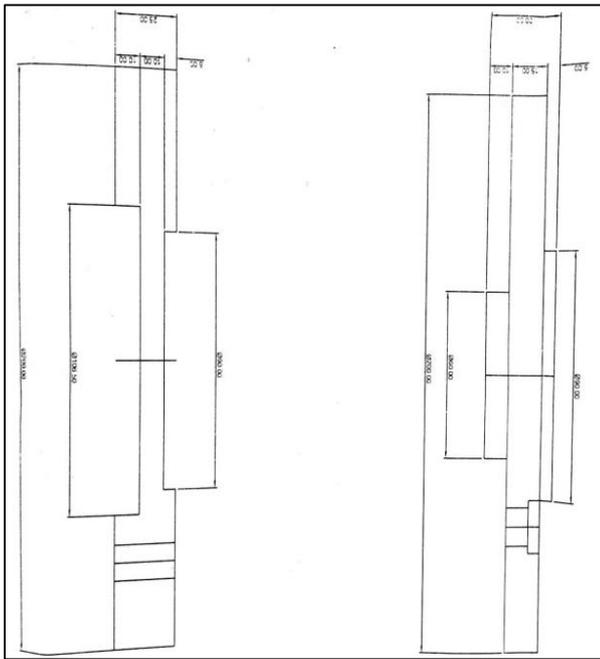


Fig. 2: D Design (AutoCAD 2011)

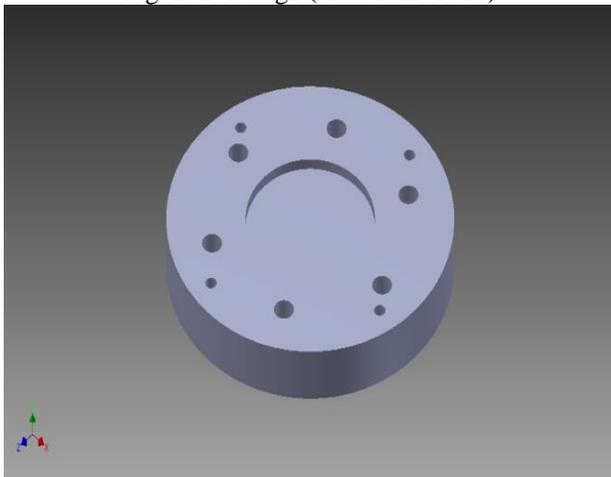


Fig. 3: Converter Plate (Solid Works)



Fig. 4: Wheel Hub (Solid Works)



Fig. 5: Assembly of Converter Plate and Wheel hub

IV. MATERIAL USED

Here EN-31 steel is used for making converter plate and wheel hub assembly. EN-31 is a high quality carbon alloy steel which offers a high degree of hardness with compressive strength.

Here is some analysis of EN-31 steel:

- Carbon 0.90-1.20%
- Chromium 1.00-1.60%
- Silicon 0.10-0.35%
- Manganese 0.30-0.75%
- Sulphur 0.050% max
- Phosphorous 0.050% max



Fig. 6: EN-31 Steel

V. ADVANTAGES AND COMPARISON

By doing above modification, the following achievements is done:

- Rpm reduction in all gears.
- Reduction in noise of engine.
- Increase in efficiency(12.5%).
- Better performance.
- Increase in displacement of vehicle in all gear per revolution of crown wheel.
- Successfully achievement of 100 km/h speed around 2100 rpm.
- Increment in initial pick-up compared to conventional Innova.

A. Comparison

	Conventional Unit	Modified Unit
Achievement of 100km/h speed	Around 2600 RPM.	Around 2100 RPM.
Engine Noise	More	Less compared to conventional unit.
Performance at high speed	Lower	Better performance
Efficiency	Lesser compared to modified unit	Better efficiency

Table 1: Comparison Table

[13] <http://www.team-bhp.com/forum/indian-car-scene/9378-innova-diesel-problem.html>

VI. CONCLUSIONS

Paper discuss about modification of final drive mechanism in Innova car. The result confirm that problems arrived before modification is easily overcome with the help of this new modified unit. Thus reduction in engine noise at higher speed, increment in performance and also increment in efficiency is done properly.

REFERENCES

- [1] V Morankar, Prof. M. R. Khodke, "Noise reduction of diesel engine", Research Paper published by International Journal of Research and Technology (IJERT), vol.3
- [2] Ranbir Singh and Yogender, "A Brief Review of Transmission System in Automobile", International Journal of Latest Research in Science and Technology Vol.1, Issue 2 :Page No.D222-D226 ,July-August(2012)
- [3] Veeranjanyelu, U. Haribabu, "Design and Structural Analysis of Differential Gearbox", International Journal of Research and Technology, vol.3
- [4] K.V.N. Parvathi, C.H. Prabhakara Rao, "Structural Design of Composite Drive Shaft for Rear Wheel Drive Engine", International Journal of Advanced Engineering Research and Studies E-ISSN2249-8974
- [5] A Bensely, S. Stephen Jayakumar, D. Mohanlal, G. Nagarajan, A. Rajadurai, "Failure Investigation of Crown Wheel and Pinion", Science Direct Engineering Failure Analysis 13 (2006) 1285-1292
- [6] Piyush C. Chaudhary, Vimal D. Sonara, Dr. Praveen R. Rathod, "Analysis and Design of Rear Axle using Finite Element Analysis", International Journal of Advance Engineering and Research, Volume 2 Issue 3, March-2015
- [7] Mr. Anant Shivaji Kolelar, "Lubrication and Efficiency of Rear Wheel Drive Axle in Road Vehicles"
- [8] Nick Cristello, Young Kim, "Design and Optimization of an automobile Universal Joint", Proceedings of 17th IASTED International Conference Modelling and Simulation, May 24-26, 2006, Montreal, QC, Canada
- [9] Prof.HariBabu, C. Veeranjanyelu, "RPM Reduction of Diesel Engine", Science Direct Engineering Analysis

Websites

- [10] <http://www.westyorkssteel.com/alloy-steel/engineering-steel/en31/>
- [11] www.teambhp.com
- [12] <http://www.carwale.com/toyota-cars/innova-2013-2014/userreviews/25296.html>