ISSN: 0971-1260
Vol-22-Issue-2-April-June-2019

# Design Of Convertible Differential Gearbox

EZHIL PSM[1], MADESHWARAN P[2], GOWTHAM P[3], AGASTIN P[4]

*Department of Mechanical Engineering*

*Sri Sairam Engineering College, West Tambaram, Chennai, Tamil Nadu, India*

*ezhilpsm@gmail.com*[1]

*madeshfury@gmail.com*[2]

*gowthamkaran@gmail.com*[3]

*agastin@gmail.com*[4]

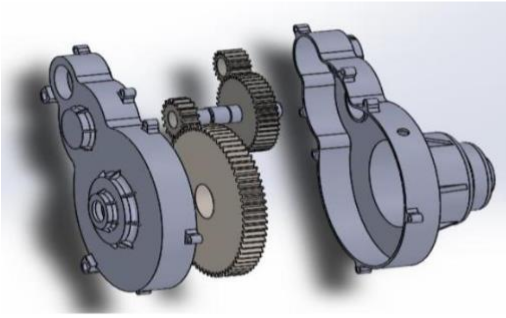
***Abstract***— **we are planning to make a design of gear box which will comprise both locking and open differential mechanism. It will reduce design cost and production cost during mass production. Since those mechanism acquires separate gearboxes it will increase time of production. Our design will reduce the time of production by acquiring a single gearbox setup for both mechanisms. This will reduce the cost and usage of raw materials. It increases the user's comfort. The design comprises both open and locking differential, so the user can effectively relocate it based upon their usage. The users do not have to afford for both gear box, instead they can afford for a single gear box which comprise both open and locking differential. Since normal vehicles (daily usage) are working under differential mechanism, some vehicles use locking differential while driving along off-roads. The automotive differential is designed to drive a pair of wheels while allowing them to rotate at different speeds. A locking differential is designed to overcome the chief limitation of a standard open differential by essentially "locking" both wheels on an axle together as if on a common shaft. This forces both wheels to turn, regardless of the traction (or lack thereof) available to either wheel individually.**

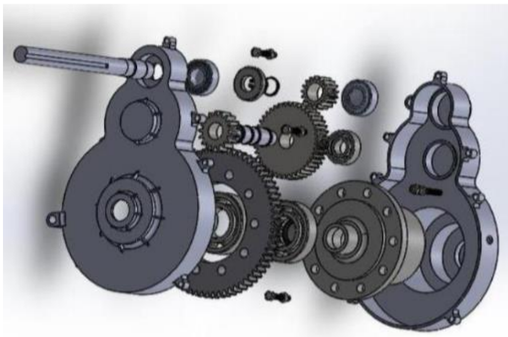
***Keywords—open differential, locking differential***

INTRODUCTION

A differential is a gear train with three shafts that has the property that the angular velocity of the one shaft is the average of the angular velocities of the others or a fixed multiple of that average. A gearbox provides speed and torque conversions from a rotating power source to another device using gear ratios. In automobiles and other wheeled vehicles, the differential allows the outer drive wheel to rotate faster than the inner drive wheel during a turn. This is necessary when the vehicle turns, making the wheels that is travelling around the outside of the turning curve roll farther and faster than the other. The average of the rotational speed of the two driving wheels equals the input rotational speed of the drive shaft. An increase in the speed of one wheel is balanced by a decrease in the speed of the other. When used in this way, a differential couples the input shaft (or prop shaft) to the pinion, which in turn runs on the ring gear of the differential. This also works as reduction gearing. Front wheel drive vehicles tend to have the pinion on the end of the main shaft of the gearbox and the differential enclosed in the same housing as the gearbox. There are individual drive shafts to each other.

Since normal vehicles (daily usage) are working under differential mechanism, some vehicles use locking differential while driving along off-roads. The automotive differential is designed to drive a pair of wheels while allowing them to rotate at different speeds. A locking differential is designed to overcome the chief limitation of standard open differential by essential "locking" both wheels on an axle together as if on a common shaft. This forces both wheels to turn, regardless of the traction available to either wheel individually.





ISSN: 0971-1260
Vol-22-Issue-2-April-June-2019

LITERATURE REVIEW

Prof. Utkarsh.A.Patil, Recent advances in differential drive systems for automobile propulsion, Differential is used to eliminate all the limitations.

Prof.Sanjoy Bisvas, Validation of rear axle with differential lock for off-road

Prof. Jan Furch, Identify technical condition of the gearbox, examines the technical conditions of rotating parts using acoustic diagnosis.

Prof.D.A.Crola, Off-road vehicle dynamics(vol-7/2013), Detailed study about the off-road vehicles.
Prof.S.E.Chocholek, Differential for the improvement of traction control (1988), Study about differential used in heavy vehicle.

II. FACTORS DETERMINING THE CHOICE OF MATERIALS

A. MANUFACTURING OF CASING

Sometimes the demand for lowest possible manufacturing cost or surface qualities obtainable by the application of suitable machining techniques may demand the use of special materials.

B. AVAILABILITY OF MATERIAL

Some materials may be scarce or in short supply, it then becomes obligatory for the designer to use some other material which though may not be a perfect substitute for the material designed. The delivery of materials and the delivery date of product should also be kept in mind.

C. COST

As in any other problem, in selection of gears, bearing, shaft the cost of material plays an important part and should not be ignored. Machining cost is the major type of section where cost of labor and machining are added.

D. QUALITY REQUIRED

This generally affects the manufacturing process and ultimately the material For example it will be more desirable to go for casting in case of casing manufacture than costly CNC machining.

III.CALCULATION

**Material**: EN24
Pressure angle Ø: 20°
Max Torque:19 Nm (Engine)
Min rpm:1900 (100 additional)
Module:2
Face Width:3-5mm
Fillet radius r: r/d =0.02-0.06=0.04
Gear ratio =2.5
Max power, $P=2\pi NT/60$
$= 2\pi*3800*19\backslash 60$
$= 3780.38316$w.
Max power in hp=5.067537hp=P(w)/746

**Gear 1&2:**

$m=d1/z1$
For 20°, full depth involute profile, $z\geq17$, $z=17$
$z2=iz1$
$z2=2.5\times17=43$
$m=d1/z1$, $d1=mz1$
$=2\times17=34$mm
$d2=mz2=2\times43=86$mm

Addendum, $a=1/P_d=1\times m$
$=1\times2$
$=2$mm

Dedendum, $d=1.25m$
$=1.25\times2$
$=2.5$mm

Diametral pitch, $Pd=1/m=1/2=0.5$mm

Circular pitch $Pc=\pi m$
$=\pi(2)$
$=6.2831285$mm

Tip diameter $d_{a1}=d_1+2m=34+2(2)$
$=38$mm
$d_{a2}=d_2+2m=86+2(2)$
$=90$mm

Root diameter,$d_{f1}=d_1\times2.5m$
$=34\times2.5\times2$
$=29$mm
$d_{f2}=d_2(2.5m)$
$=86(2.5)2$
$=81$mm

Centre distance, $C=(d_1+d_2)/2$
$=(34+86)/2$
$=60$mm

Base circle diameter,$d_{b1}=d_1\cos Ø$
$=34\cos 20°$
$=31.949549$mm
$r_{b1}=15.9747$mm
$d_{b2}=d_2\cos Ø=86\cos 20°$
$=80.813565$mm
$r_{b2}=40.406782$mm

Tooth depth, $h=2.25m$
$=2.25\times2$
$=4.5$mm

Tip and root clearance= 2.25m-1m
$=1.25$mm

Face width, $b=3\pi m$
$=18.85$mm

Addendum circle radius, $r_{a1}=a+(d_1/2)$
$=2+(34/2)$
$=19$mm
$r_{a2}=a+(d_2/2)$
$=(86/2)+2$
$=45$mm

Fillet radius, $r_f=r_f/d=0.04$
For pinion $r_{f1}=0.04\times d_1=0.04\times34$
$=1.36$mm
$r_f=lp/8$
$=\pi m/8$
$=0.785398=0.8$mm

For gear, $r_{f2}=0.04\times d2=0.04\times86$
$=3.44$mm

Tooth thickness, $t=\pi m/2=3.14\times2/2$
$=3.141592$mm

Form factor, $y_1=0.154-(0.912/z_1)$
$z_1=17$
$=0.100352$
$Y_1=\pi y_1=0.315268$
$y_2=0.154-(0.912/43)$

ISSN: 0971-1260
Vol-22-Issue-2-April-June-2019

=0.417174

Velocity, v=πdN/60

$N_1$=Engine speed/cvt ratio

= 1900/(3.1×0.85)

=721.062618rpm

$N_2=N_1/i$

=721.062618/2.5

=288425047rpm

pitch line velocity, v=πdN/60

= $\pi \times d_1 \times N_1/60 \times 1000$

= π ×34 ×721.062618/(60 ×1000) $v_1$=1.283661m/s

$V_2$= πd2N2/60

= π*86 *288.4250/ (60 *1000) =1.298763m/s

Tangential load $W_t$ = Max power/Pitch line velocity

$w_{t1}$=3780.38316/1.283661

=2945.00118N

$w_{t2}$=3780.38316/1.298763

=2910.756743N

Fatigue stress concentration factor,

$k_f$=H+(t/r) ^L+(t/l) ^M

Shigley's pg.743

H=0.34-0.438366 *2Ø

=0.34-0.458366*2*π*20/180=0.02

L=0.316-0.458366×2×π*20/180

=-0.003999

M=0.290+0.458×2× π×20/180

=0.609999

$r_1$=(d-$r_f$) ^2/ ($d_1$/2) +d-$r_f$

= (2.5-0.8) ^2/ (34/2) +2.5-0.8 =0.154545

$r_2$= (2.5-0.8) ^2/(86/2)+2.5-0.8

=0.064653

l= addendum + dedendum

=2+2.5

=4.5mm

IV.PROCESS CARRIED

A. CUTTING

By cutting, the required material with dimensions of the components of the mechanism has been obtained.

B. DRILLING

Drilling is used to produce holes in objects. In this project the holes made in the alloy steel plate to connect metal pin with steel plate. These holes are done by conventional vertical type drilling machine. C. FINE GRINDING

It is nothing but the grinding process, which is done as smooth with fine grains. This is done to the entire roller for good surface finish. It is done by conventional cylindrical grinding machine D.BORING

It is the operation of expanding the hole that has already been drilled by means of single point cutting tool.

E. GEAR HOBBING

It is the machining process for gear cutting and cutting splines on a hobbing machine.

F. CLEANING

It is the operation to clean the all machined parts without burrs, dust and chip formals. By meaning the parts they are brightened and good-looking. G. ASSEMBLING

It is the operation, which deals with the assembling of various parts produced by above operations.

CONCLUSION

The suggested gear box design will comprise both locking and open differential mechanism, so it will reduce design cost and production cost during mass production. Since those mechanism acquires separate gearboxes it will increase time of production. This design will reduce the time of production by acquiring a single gearbox setup for both mechanisms. This will reduce the cost and usage of raw materials. It increases the user's comfort. The design comprises both open and locking differential, so the user can effectively relocate it based upon their usage. The users don't have to afford for both gear box, instead they can afford for a single gear box which comprise both open and locking differential.

REFERENCES

1. Design Data Book, PSG COLLEGE OF TECHNOLOGY .
2. Design of Machine Elements, Rao T. Krishna.
3. Theory of Machines, R.S. Khurmi.
4. Theory of Machines: Kinematics and Dynamics, Sadhu Singh
5. Theory of Machines, Bansal R K,Brar J S
6. Machine Design by R.S.KHURMI & J.K.GUPTA
7. Mechanics of Materials , R. C. Hibbeler