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Design of Two Stage Reduction Gearbox with Integrated Constant Velocity Cup

Dr. Rahul Sherekar[1], Abhishek Sonone[2], Harshal Jambhure[2]

[1]Professor, Department of Mechanical Engineering, J.D.I.E.T. Yavatmal Maharashtra, India
[2]Department of Mechanical Engineering, J.D.I.E.T. Yavatmal Maharashtra, India

ABSTRACT

Engineering design is an iterative process that requires to deal with all feasible design solutions in order to arrive at desired objectives. An All-terrain vehicle is an OFF road vehicle that has the ability to drive on any terrain without any difficulty. These vehicle are designed to sustain any sort of extreme loads that act during OFF-road driving. It is used to provide required torque and velocity of the vehicle according to variation of terrain and load condition. The main aim of this project is to design a gearbox that compact light weight and Coupled Constant Velocity Cup(CV). The two stage compound reduction gearbox has design which consist of an input shaft ,idler or jack shaft and output shaft which finally transmits power to the wheels through CV joints which design integrated with gear which also works as output shaft. The reduction Ratio of gear box is design by considering the all terrain Vehicle. The result of the report to deals with designing and analysis of a lighter and a more compact gearbox with integrated constant velocity cups or joints which reduces the transmission area.

Keywords : Cup(CV), selector gearboxes, steering boxes and power takeoffs, ATV, CVT

I. INTRODUCTION

In order to propel the Vehicle, a particular type of speed & power changing device is required to transfer the power developed by the Engine to the driving wheel due to constantly changing requirement demanded on the Engine & its inherent limitation. These devices are known as Transmission. It includes all the components between the Engine & the Road wheels used for transmission like Clutch, Gearbox, Propeller shaft, Differential & Axles. All vehicles, aircraft and watercraft included, require transmissions in order to Convert torque and engine speed. Transmissions are distinguished in accordance with their function and purpose – e.g. selector gearboxes, steering boxes and power takeoffs. This Project deals exclusively with transmissions for off-road vehicles.

The main goal when designing a vehicle transmission is an optimal conversion of the traction available from the engine into the traction force of the vehicle as efficiently as possible over a wide range of road speeds. This must be done such that there is a favourable compromise between the number of speeds, climbing performance, acceleration performance & fuel consumption of the vehicle. Technical & technological developments should be considered- reliability & service life as well. The task of transmission is to convert the traction available from the drive unit, satisfying requirements placed on it by the vehicle, the road, the driver & the environment. Technical & economic competitiveness are essential here. In addition to the driving &

transport performance, transmissions are of central importance with respect to reliability, fuel consumption, ease of operation & road safety.

II. LITERATURE REVIEW

Gisbert Lechner, Harald Naunheimer (1999) have given full account of the development process for automotive transmission, detailed study of driving resistances, Design and Manufacturing of 2-Stage Speed Reducer for a Baja allTerrain Vehicle various characteristics for transmission variables and drive train power losses. Selection of optimum gearbox ratio considering maximum acceleration and gradability is also analyzed.

III. DESIGN DESCRIPTION

The gear reduction concept generation and from the gear housing designs. The input gear receives the power from the CVT via the input shaft. The input gear then meshes with the first intermediate gear creating the first reduction. A shared shaft supports both intermediate gears; therefore, the motion from the first intermediate gear is transferred to the second intermediate gear without the 20 need of additional meshing gears or added weight. The second intermediate gear then meshes with the output gear, creating the second and final gear reduction. The output gear's rotation turns the output shaft which transfers mechanical energy to the rear wheels as well as a brake rotor the completed alpha design model. Also considered using aluminium hubs for the gears to help reduce the weight and moment of inertia of the system, without sacrificing the wear or strength benefits of steel for the gear teeth. In addition, expects that all of the shafts will have splines or polygons to ensure that gears and shafts rotate together and will be supported by the gear housing. The gear housing will require bearings fitted in bearing carriers that will support the shafts and reduce friction. There will also be finger guards made out of carbon fiber or another, readily available, lightweight composite or plastic, which will help with sealing and follow all SAE Baja rules. The use of liquid sealant will ensure the system is leak proof.

IV. METHODS AND MATERIAL

- For decreasing the weight without compromising with the strength, material selection plays a critical role.
- For gears, a case hardened material with high tensile strength as well as high endurance strength is used to withstand static as well as dynamic loads.
- For shafts, a through hardened material with high torsional strength is selected which can withstand bending loads and can transfer the torque at higher rpm.
- For gearbox casing, material with high strength to weight ratio is needed which can withstand radial loads coming from gears.

Table 1. Materials

PART NAME	GEARS	SHAFTS	CASING
MATERIAL	20mnCr5	20mnCr5	7075-T6

SPECIFICATION

Max. Torque = 19.6 Nm @ 2600 rpm
Max. Power= 10 hp @ 3600 rpm

Engine Capacity= 305 cc
Max speed selected = 60 km/h
CVT lower Ratio= 3:1 CVT
Higher Ratio= 0.5:1
D= Tire diameter = 23 inch =
N= engine rpm = 3600 rpm (max)
Gear ratio = 11.25:1
Total reduction = gear ratio * CVT ratio
=7.1*3.5 = 24.85

CALCULATIONS FOR MODULE AND DIAMETER OF GEARS

A. Ratio according traction required:

fr =rolling resistance coefficient=0.236≈0.25

Mass of vehicle=200kg

Gradient angle $\alpha_{st}=7^{\circ}$

Gravity g=9.81m/sec^2

Fr=fr*mf*g*cosα

=0.25*200*9.81*cos7

=486.843N

B. Air resistance

$F_l=1/2*\zeta*c_w*A*v^2$

=0.5*1.204*0.7*0.800*16

=93.56N

$F_{l(Tyre)}=1/2*\zeta*0.09*r^2$

$=0.5*1.204*0.09*0.197*16.66^2$

=5.53N

Total F_l=99.29N

C . Gradient resistance

f_{st} =mg*sinα_{st}

where=$\alpha_{st}=40^{\circ}$

f_{st}=200*9.81*sin40

=1261.15N

Total tractive effort

T_{total}= $F_r+F_l+F_{st}$

=1847.283N

I_{max}=total reduction

T_{max}*imax*ηtotal*1/$r_{dyn}=T_{total}$

19.66*i_{max}*0.75*1/0.2865=1847.2

i_{max}=35.0932

Reduction for gear box

i_{max}=35.09/3

=11.96

Take total reduction of gearbox

First stage reduction is

$i_1=0.76*i_t^{0.65}$

=3.81

Second stage reduction

i_2=11.96/3.81

=3.13

Final reduction is

=3.78*3.11=11.75

Gearbox Ratio=11.75

MODELING

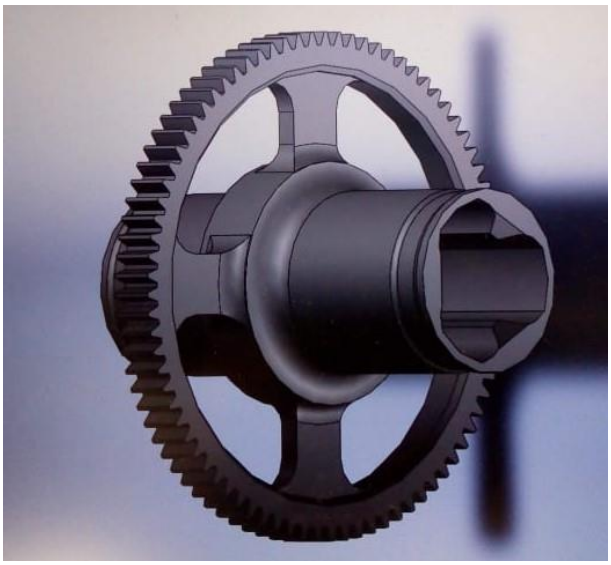

Figure 1: Gear with integrated CV Cup

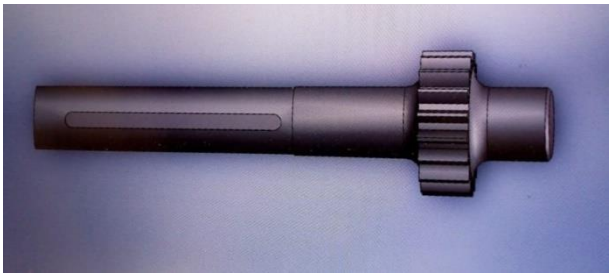

Figure 2 : Input Shaft

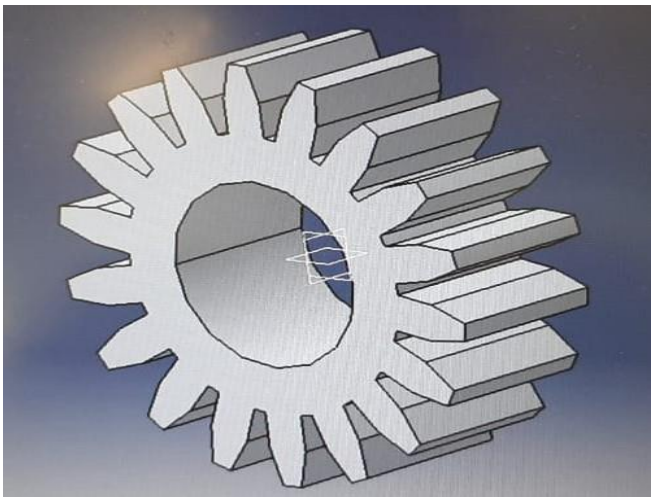

Figure 3 : Pinion

Figure 4: Gear

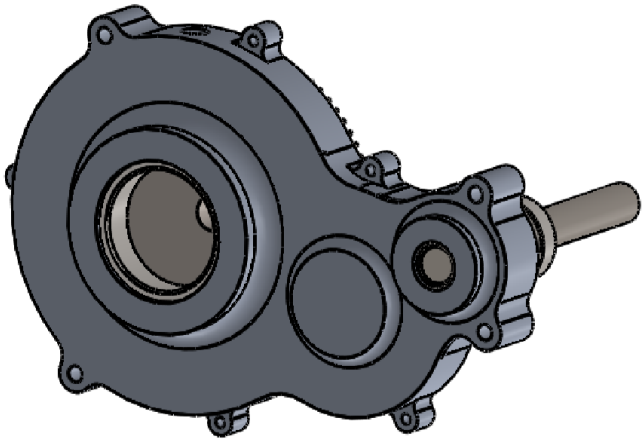

Figure 5: gearbox casing

Tripod joint

Tripod joint is used at the inboard vehicle drive shaft it unable the power transmission even in case of angle shifting between the gearbox and wheel assemble it supports the gearbox and wheel assemble to work in angular position. tripod joint has needle bearing or barrel shape rollers mounted on a spider bearing or spider tower hence it is also called three pointed yoke instead of ball bearings. This fit into a cup of having three matching grooves respectively which attached to the gearbox as well as wheel assemble. Thegroove is design at 120 degree to one another and slide back or fourth in tracks in an outer “tulip” housing.

This three ball bearing assemble with spider tower as only limited operating angle but it is also able to plunge in and out with a longer distance as suspension travel. The general type of tripod joint Has 26 degree of articulation.

V. CONCLUSION

Nowadays the popularity of ATVs is increasing day by day so the companies can implement this design in future to decrease the overall weight and cost of the ATV. Furthermore, vehicle with a CVT based transmission connected to a gearbox.

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