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DESIGN AND PROTOTYPING OF TWO SPEED GEAR BOX FOR GO-KART VEHICLE

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Abstract – *This paper deals with the overall design procedure for manufacturing & prototyping of two speed gear box for Go Kart vehicles. The mechanism that transmits the power developed by the engine of automobile to the engine to the driving wheels is called the TRANSMISSION SYSTEM (or POWER TRAIN). Torque is not directly changed but it can be transferred in the form of power using suitable device. It is a very useful method that we adopt, and it is also easily affordable. Many other alternative, even though more elegant and appear to be more effective are not feasible when it comes to transmission this project mainly focuses on the design and prototyping of gear box that can transmit torque to the maximum and also helps to do some useful work in automobile where power transmission is a major factor. The transmission of power is done in two speed in this project the setup uses two shafts and four sprocket arranged in suitable distance to achieve the desired torque and speed.*

This paper describes in detail the parameters included in the entire design and considerations made for zeroing those parameters. Validation of the design is done by conducting theoretical calculations, simulations and known facts. Analyses are conducted on all major components to optimize strength and rigidity, improve vehicle performance, and to reduce complexity and manufacturing cost.

Key words - *Gearbox, transmission system, gear train, torque, all-terrain, constant mesh, automobile, go-kart*

I. INTRODUCTION

Like every automobile, go-karts also have various systems. Mainly there are 4 systems in this kart like Chassis, Steering, Engine & Power train and Braking. The standard Go karts are usually powered by either 2-stroke or 4-stroke petrol engines. These engines are generally air cooled with or without gear box. Go-karts are equipped with disc or drum brakes. The vehicle has been designed conducting extensive research of each main assembly and components of the kart.

In a vehicle, the mechanism that transmits the power developed by the engine to the wheels is called the power train. In a simple application, a set of gears or a chain and sprocket could perform this task. However, automobiles are not designed for such simple operating conditions. A gearbox that converts a high speed input into single output called a single stage gearbox it usually has two gears and shafts. A gearbox that converts a high speed input into a number of different speeds output it is called a multispeed gearbox. Multispeed gearbox has more than two gears and shafts. A multispeed gearbox reduces the speed in different stages. Gears are wheel-like machine elements that have teeth uniformly spaced around the outer surface. To shift gears in this transmission, you move a clutch plate sideways so that it locks together with one or the other of the two gears on the output shaft. The gears can spin freely on the output shaft: they do not transmit any power directly. But the clutch plate slides on a square section of the output shaft, so when it is coupled to one of the output gears, it transmits power from the gear to the output shaft.

1.1 Objectives & Methodology

This project is strives to produce a low cost go-kart two speed gear box by designing with CAD and prototype is manufactured by using locally available materials. Former designs of transmission of go karts allow higher speed only if the throttle is increased but these projects allows the go kart to utilize torque variations by variations in the combinations of gears. In that way this project utilize the both constant mesh type gearbox arrangements also the chain drive power transmission.

Various concepts of the gear should be studied. This includes the types of gear boxes, its working principles and various concepts related to the design & assembly of gear boxes. Different types of transmissions should also be studied along with the various underlying defects. And also, theoretical calculations should be carried out for given gear box design which includes design of all its component-parts. A CAD model should also be created In order to get a perspective view of the two speed gear box system in virtual environment. Accordingly, proper conclusions should be drawn out for the effective working of the gear box.

II. DESIGN CALCULATIONS FOR TRANSMISSION SYSTEM

2.1 Calculation of RPM

2.1.1Calculation of rpm from linear velocity

Speed of the Vehicle = 55kmph

Speed of the vehicle = 30Kmph

Engine power in KW = 4777.5

Diameter of the wheel in meters = 0.279

The Speed of the vehicle 55 kmph

$\mathbf{V = (\pi * D * N) \div 60 \text{ in m/s}}$ V = 15.27 m/s

N = 1046 RPM

The speed of the vehicle 30 kmph

V = 15.27 m/s

N = 570 RPM

It is assumed that there is no power loss during the transmission. By that the output shaft rotation as of to attain the 55 Kmph and 30 Kmph is 1046 RPM and 570 RPM.

2.2 Calculation of number of teeth

The speed ratio of pair 1

Z_2= 3 Z1
** The standard speed ratio for the pair 1 from PSGDB P.NO. 7.74 is 3.15

The speed ratio of pair 2

Z_3= 5.5 Z4
**The next standard value from the PSGDB P.NO7.74 FOR pair 2 is 5.6
**The minimum teeth value is assumed as 23 teeth for first pair
Z_4 =72teeth
**The minimum teeth value is assumed as 17 teeth for the second pair
Z_4 =95 teeth

2.3 Design of chain and sprocket

From American National Standards Institute the standard chain values are taken. Since the values of pitch and braking loads are taken from it.

ANSI Chain #	Pitch P	Max Roller Dia. D_r	Width W	Pin Dia. D_p	Link Plate Thick LPT	Roller Plate Height H_r	Link Plate Height H_p
25*	¼”	0.130**	1/8”	0.0905”	0.030”	0.95 x P	0.82 x P
35*	3/8”	0.200**	3/16”	0.141”	0.050”	0.95 x P	0.82 x P

Table - 2.1 ANSI Chain Table

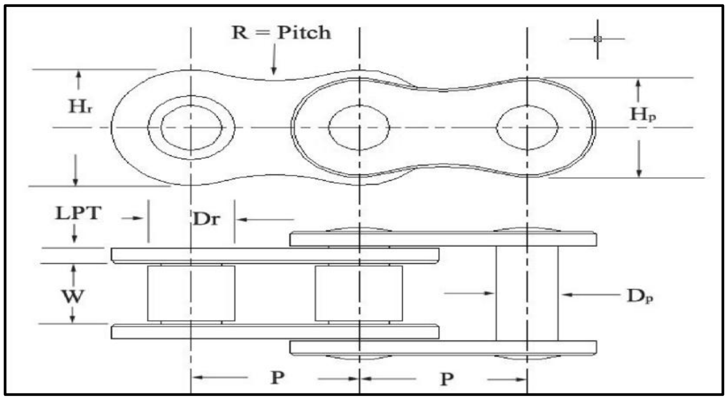

Figure- 2.1Nomenclature of Chain

Specifications

Pitch **(P)**	= ¼" = 0.250"
PR	= Pitch Diameter
Drive Sprocket (**n**)	= 23 Teeth
Driven Sprocket (**N**)	= 72 Teeth
Center Distance (**C**)	= 6" / 0.250 = 24 (expressed in pitch units
The chain length	= 2 (Tangent line length BE + arc ME + arc BK)

2.4 Calculate the pitch circle radius for the drive sprocket

DE = P / (sin (180º / N))
DE = 0.250 / (sin (180º / 23)
DE = 0.250 / (sin (7.82º)
DE = 0.250 / (0.1361616)
DE = 1.8360
DE = 0.9180

2.5 Calculate the pitch circle radius for the driven sprocket.

DE = P / (sin (180º / N))

DE = 0.250 / (sin (180º / 72))

DE = 0.250 / (sin (2.5º))

DE = 0.250 / (0.04361938)

DE = 5.7313

DE = 2.8656

2.6 Calculate the length of side DF

a) Line AF is parallel to line BE and perpendicular to AB and DE

b) Line BE is tangent to circles K and M

c) Line DF = DE-AB

Line DF = 2.8656 - 0.9180 =1.9476

2.7 Calculate angle *a*.

Sin a = opposite side / hypotenuse

Sin a = DF / AD

Sin a = 1.9476 / 6" * 25.4 = 0.3246

To find the measure of angle a with a sine of 0.3246 we take the inverse $\sin^{-1}$

$<a = \sin^{-1} 0.3246 = 18.94$ deg

2.8 Calculate the length of the chain between the pitch circle tangent points, BE.

Since,

Angle *a* =18.94 deg

Then we can use a calculator to find the cosine of 18.91^{o} = 0.946.

Sin a = adjacent side / hypotenuse

Sin a = AF / AD

Sin a = 148 / 6" = 0.946

Sin a = AF / 6" = 0.946

AF = 0.946 *6" / 0.250

AF = 22.70

Here are the relationships we determined in the exercise above.

BE = AF = AD cosine a = C cosine a = 22.70 pitch units

2.9 Find the pitch lengths of chain wrapped around each of the sprockets.

Half the chain wrapped around the large sprocket is represented by arc ME. Measured in pitch units (teeth) we find

ME =MH + HE = N / 4 + (N (a / 360)) = 21.78 pitch unit

Half the chain wrapped around the small sprocket is computed in a similar way, except, the arc length of angle "a" is subtracted from the 90 degree arc KG. Note that the chain does not wrap the small sprocket in as many degrees of arc as it does

The large sprocket. Prudent chain drive designs dictate that the angle formed by the arc of the chain around a sprocket should be equal to or greater than 120 degrees.

KB = KG – BG = N / 4 - (N (a / 360)) = 4.53

Using the information from the 6 preceding steps, we can find the chain length (In pitch units) for these 2 sprockets. Let L represent the chain length in pitches.

L = 2 [BE + ME + KB]

L = 2[21.78 + 4.53 +22.70]

= 2[37.472] = 98.02 Pitch units

We can combine all the calculations above into a single more elegant expression of the chain length (In pitch units) between any 2 sprockets;

L = 2[C cos a + (N + n / 4) + a / 360 (N-n)]

Solving for L we find

L= 2 [22.70 + ((72+23) / 4) + (18.94 / 360 (72-23))]

L = 98.05 Pitch units

2.10 Calculating Center Distance from a Known Chain Length

This requires that we rewrite the formula C (The required center distance). The desired chain length is 68 links or pitch units. This formula can be used to find the center distance for any given chain length and sprocket set.

C = Center Distance in Pitch Units

L = Chain Length in Links or Pitch Units

N = Number of Teeth of the Large Sprocket

N = Number of Teeth of the Small Sprocket

C = L – n ((90-a) / 180) – N ((90-a) + (180)) / (2 cos a)

C = L - 23((90-18.94) / 180) – 72 ((90 + 18.94) / (180)) / (2 cos 18.94)

C= L – 9.079 – 7843.68 / 95.15

C = 98.05 – 9.079- 7843.68 / 95.15

C = 0.8526 Pitch units

2.11 Calculating the Overall Dimensions of a Chain and Sprocket

Drive it is often necessary to integrate chain and sprocket drives systems into mechanisms where space is at a premium. Small form factors and necessity to reduce weight demand close fitting tolerances. Designers must be able to accurately calculate the specific and overall dimensions of the drive systems they create in order to ensure that they will integrate with an existing mechanism without interference. In order to generate a successful design it is necessary to calculate the following**:**

Minimum Center Distance

The arc of the chain engagement on the smallest sprocket should not be less than 120 degrees. For drive ratios greater than 3:1, the center distance of the sprockets should be equal to or greater than the difference of the 2 sprocket diameters. This will ensure 120 degrees of chain wrap around the smaller sprocket.

Maximum Center Distances

The American Chain Association suggests that center distances between sprockets should not exceed 80 Pitch Units (For unsupported chain drives). Excessively long center distances create catenary tensions that act to increase chain wear and result in unnecessary chain vibration. Consider supporting the chain on guides or rollers where long center distances are required.

Outside Sprocket Diameters (OD)

In order to accurately calculate the clearances for a given chain and sprocket drive, it is necessary to determine the outside diameters of the sprockets. This dimension can be approximated using the following formula

OD = P (0.6 + cot (180 / N)

OD = 0.250+ cot (180 / 23)

OD = 0.250 + cot 7.82

OD = 0.250 + 7.27

OD = 7.52 mm

III. BILL OF MATERIALS

S.NO.	DESCRIPTION	QTY
1	Shaft (30mm)	Required
2	Sprockets	4
3	Bearings	6
4	Steel plates (430 x 160 x 10)mm	3

Table - 2.2 Bill of Materials

IV. 2D MODELLING AND DRAFTING

2D Modelling Of Chain Drive

2D Modeling of Dog and Catch Plate

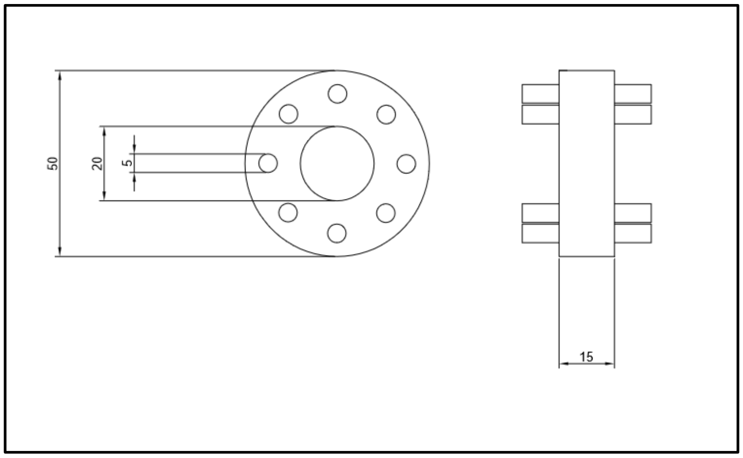

Figure 4.1 Dog and Catch Plate setup

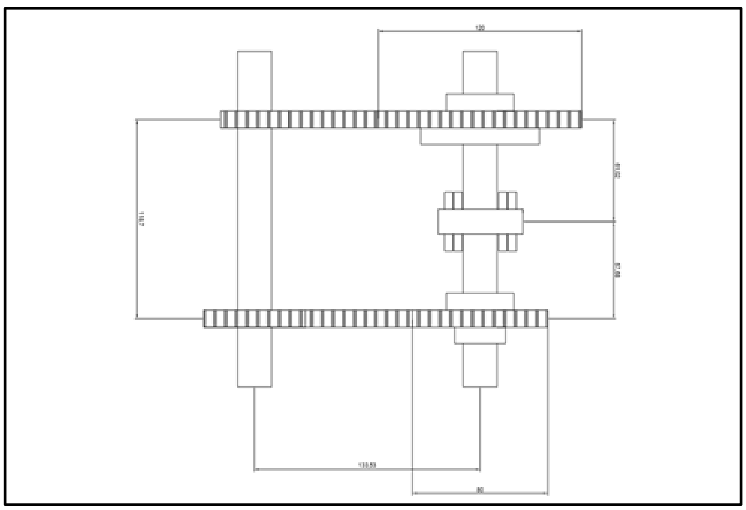

Figure 4.1 2D modeling of complete setup of gearbox

V. RESULT & CONCLUSION

By this project we have concluded that the two speed gearbox was made by as per the requirements of a typical go-kart vehicle. We have made a system with chain drive transmission also with the principle of a constant mesh gearbox. The chain drives are always running through a bearing on a shaft like a constant mesh gearbox does. An arrangement called dog and catch plate clutch were used to shift the gears in-between 1 and 2. The system kept always in neutral position if it is not required to move the vehicle. Fork like structures used in dog plates and holes were used in catch plate they were used to move the two shafts that are in a same axis of rotation.

The system exhibits a higher power transmission also it exhibits an easy installation. The chain drive is one flexible system that has shown a higher efficiency on a high shock and intermitted loads. It is very necessary for a go kart vehicle. Lubrication can be easily donned.

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