Design of Transmission System for Go-Kart

Vishwajeet Vijay Raorane[1] Amit Gundopant Dhumal[2] Rushikesh Suresh Sapate[3] Shubham Shivajirao Patil[4] Prof. M.T. Sawant[5]
[1,2,3,4]Student [5]Professor
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]SSPM'S College of Engineering, Kankavli, India

Abstract— Transmission is the important part of a vehicle as it provides the means to get the vehicle in motion. In go-karts there is no use of differential in transmission system. Transmission system has to be perfectly designed to transmit the power from the engine to shaft. It is the connecting link between the engine and the shaft. Driver uses different gear positions according to the track conditions. The main aim behind this study is to develop and analyze light weight, efficient, low cost, less noisy transmission system.

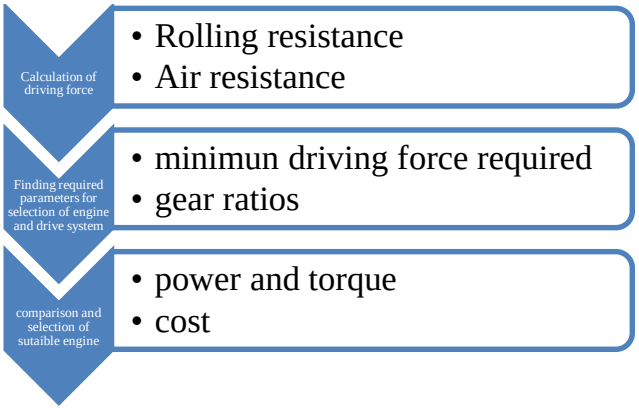
Key words: Gear Ratio, Pinion, Sprocket, Chain, Pitch, Pitch Circle Diameter, Rolling Resistance, Air Resistance

I. INTRODUCTION

A transmission is a device which consists of power source and power transmission system, which provides total control over the power generated by the source. Generally transmission in automobiles means device having different gear ratios providing different torque and rpm outputs. In India go-karts mainly uses two types of I.C.engines, geared and non gear engines. Velocity of vehicle plays a vital role on dynamics of the vehicle, at low speed acceleration is limited by the total mass inertia of the kart including driver; at high speeds air resistance is more effective than other resisting dynamic properties. The transmission system should be quite good enough to convert the available power from the source into driving force to overcome total resistance force and bring the kart in motion.

The go kart necessitates variable adjustments in speed and torque. Engine selection is also a very important aspect of the go kart design. Various 2 stroke and 4 stroke engines are easily available in India. Generally 4 stroke engines are preferred because of its fuel economy and less maintenance than 2 stroke engines. Major automobile industries that produce 4 stroke engines below 300cc in India are Bajaj, Hero, Honda, Yamaha, Mahindra, Tvs etc. (Table-1) they are available in 100, 110, 125, 135, 150, 180, 200, 220, 280cc's.

II. DESIGN METHODOLOGY



III. TRANSMISSION SYSTEM

A. *Objectives-*

- To achieve high torque at initial pickup
- To achieve max speed
- To select suitable components to reduce the power losses
- Low cost and light weight
- To get high efficiency

B. *Engine selection-*

Engine name	Displacement	Max torque	Max power
CB Shine 125	124.7 cc	10.30 Nm @ 5500rpm	10.16 Bhp @ 7500 rpm
Hero Glamour	125 cc	11 Nm @ 6500 rpm	11.4 BHP @ 7500 rpm
Bajaj V12	124.5 cc	10.98 Nm @ 5500 rpm	10.55 Bhp @ 7500 rpm
Yamaha Saluto	125 cc	10.1 Nm @ 4500 rpm	8.18 Bhp @ 7000 rpm
Bajaj Discover 125	124.6 cc	10.80 Nm @ 5500 rpm	10.9 Bhp @ 8000 rpm

Table 1:

As in go kart weight and efficiency is the main concerns , use of 100 to 150 cc 4 stroke engines is done. We use the Bajaj discover st 125cc appx. Petrol engine, which at 8000 rpm produces 10.9 Bhp . Using Bajaj 4 stroke engine because of its high mileage after comparing with other available engines.

Engine Specifications

1) Engine Type: 4 stroke single cylinder

- Cooling: Air cooled
- Displacement: 124.66 cc
- Max. Power10.9 Bhp @ 8000 rpm
- Max. Torque: 10.80 Nm @ 5500 rpm
- Ignition: Digital twin spark ignition system

2) Clutch and Transmission (gear ratios)

- Clutch Type: Wet multi plate
- Gear Box: 5 speed constant mesh
- 1st – 2.83
- 2nd – 1.82
- 3rd – 1.33
- 4th – 1.09
- 5th – 0.91
- Primary Reduction Ratio (P)- 3.57

3) Calculations

Maximum speed that kart will achieve is considered to be 75km/hr

Vehicle speed =75 km/hr
= 75 / 3.6
= 20.83m/s.

Required terms

V= r* W

W = V / r

r = radius of rear wheel

r = 5.5 inch.

r = 0.1397m.

W = 20.83 / 0.1397

W = 149.11 rad/sec.

W = 2*3.14*N/ 60

N = 149.11*60/ 2*(3.14)

N=149.11*60 / 2*3.14

N = 1423.89 rpm.

RPM required for 75 km/hr speed =1424 rpm.

8000 rpm by engine

1424 rpm required at wheels (rear axle)

8000/1424 = gear reduction ratio required.

N1 / N2 = 5.62

Gear ratio we have by engine at 5th gear is = 3.57 *0.91
= 3.25

Gear ratio required for driving and driven sprocket
= 5.62 / 3.25
= 1.73

Driving is a standard sprocket having specification:-

T2 /T1 = 1.73

T2 = 14*1.73

T2 = 25t

Overall gear ratio:-

For 1st gear = primary gear reduction ratio* 1st gear reduction ratio* transmission train gear reduction ratio
= 3.57* 2.83*1.73
= 17.47

Gear number	Overall gear ratio
1st gear	17.48
2nd gear	11.24
3rd gear	8.22
4th gear	6.73
5th gear	5.62

Table 2

Opposing forces:-

1. Rolling resistance (RR)

a) static condition

RR = Cr*W

Cr = 0.032(rolling coefficient for poor road condition)

W=170 (assumed weight of kart)

RR = 0.032*170*9.81

RR = 53.36 N.

b) dynamic condition

RR=(0.032+0.00016v) W

Gear position and speed:-

Rpm of 1st gear = speed of engine / gear ratio of 1st gear
= 8000 / 17.48
= 457.67 rpm.

Gear	Rolling resistance (n)
1	55.15
2	56.14
3	57.16
4	58.00
5	58.92

Table 3

Crank rpm	Rpm at shaft	Velocity (m/s)	Velocity (km/hr)
8000	457.67	6.70	24.12
8000	711.75	10.41	37.48
8000	973.24	14.24	51.26
8000	1188.71	17.39	62.60
8000	1423.49	20.83	74.99

Table 4

Hence the rolling resistance at various gear positions is as shown in table

2. Air resistance

AR= Cd*p*v^2*A/2

Cd = coefficient of drag

= 0.4 (consideration by body style)

p = 1.29 kg/m^3 (air density)

A = frontal area

= 0.569m^2

AR = 0.4 * (1.29)*(6.70)^2*(0.569 / 2)

AR = 6.59

Gear	Air resistance
1	6.59
2	15.91
3	29.77
4	44.39
5	63.69

Table 5

Force produced by engine:-

Torque= 10.8Nm.

Fr = T * overall gear ratio*efficiency of transmission / radius of wheel

Considering efficiency 75%

Radius of rear tyre =139.7mm

Gear	Force 'n' (engine)
1	1031.66
2	663.38
3	485.14
4	397.20
5	331.69

Table 6

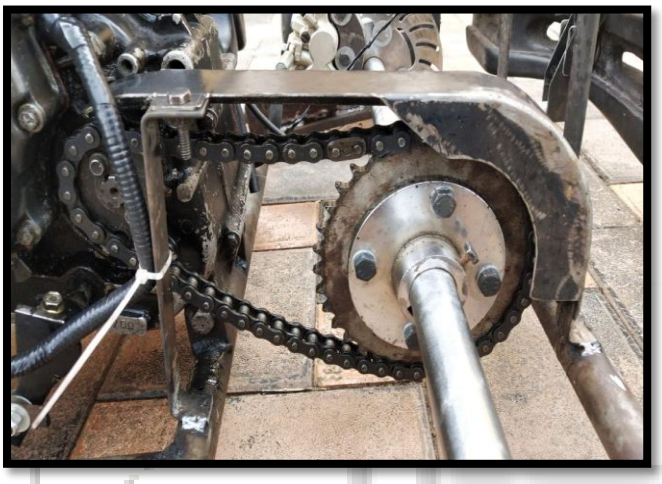
As the go kart comes under motor racing sports category. Kart is designed with minimum ground clearance to keep the C.G. as low as possible. No gradient resisting force is acting on kart because racing track is mostly horizontal. Hence total resisting force and the force produced by the engine at different gear positions are shown below. (Table -7)

Gear no.	1	2	3	4	5
Total gear ratio	17.48	11.24	8.22	6.73	5.62
Velocity (m/s)	6.70	10.41	14.24	17.39	20.83

Rolling resistance (n)	55.15	56.14	57.16	58.00	58.92
Air resistance (n)	6.59	15.91	29.77	44.39	63.69
Total road resistance(n)	61.74	72.05	86.93	102.39	122.69
Engine efforts (n)	1031.66	663.38	485.14	397.20	331.69

Table 7

As the power output from the gear box needs to be transmitted to the rear axle, chain drive mechanism is the efficient way. Belt drive is costly and has lesser efficiency than the chain drive due to sagging and slipping issues. Shaft drive system has the maximum efficiency with higher cost of production



(Photo-1: chain drive system)

- Calculations

– DESIGN OF PINION:

As per the consideration:-
Distance between engine driven Sprocket & Axle = 210mm. = 21cm.
Chain no: - 420
Specification of chain measured by Vernier caliper:-
1. Pitch =12.7mm.
2. Inner width = 7.9mm.
3. Roller Dia. = 8mm.
Diameter pitch of pinion:-
Driving sprocket=14 teeth
D = p*cosec*(180/14)
D = 12.7cosec (180/14)
D = 57.07mm (pitch circle diameter)
Outer diameter of pinion:-
d1= diameter of roller=8mm
Do = D + 0.8*d1
Do = 57.07 + 0.8*8
Do = 63.47mm.

– DESIGN OF SPROCKET:

Pitch Diameter of sprocket:-
Driven sprocket =25 teeth
D = p*cosec (180/25)
D = 12.7*cosec (180/25)
D = 101.32mm (PCD)
Outer diameter of sprocket:-
Do = D + 0.8*d1
Do =101.32 + 0.8*8
Do = 107.73mm.

– VELOCITY RATIO OF CHAIN

V.R= N1/N2 = T2/T1
V.R = 25/14
V.R = 1.78
Average velocity
V = 3.14*D*N/60
V = 3.14*0.10773*1424/60
V = 8.03m/s

– LENGTH OF CHAIN

Finding number of links (K):-
L= K*p
K= (T1+T2)/2+2*x/p+[T2-T1/2*3.14]^2 *p/x
T1= 14 & T2 = 25
x= 210 mm (centre distance)
P = 12.7mm.
K=(14+25)/2+2*(210)/12.7+[25
14/2*3.14]^2*12.7/210
K=52.75.
The value of 'K' is always kept as nearest even number.
We can take value of 'k' = 52

IV. WHEELS

Tires play a vital role because they take the total load of the vehicle and provide traction on the road. In market standard wet(wet weather)and dry tyres (slick)are available .as go kart racing events are rarely held in rainy seasons it better to go with the dry tyres .Basically the rear tyres are bigger in diameter as well as in radius than the front tyres. (Photo-2)

(Photo-2: left hand side -rear tyre and right hand side- front tyre)

A. Objectives of dry tyres

– To provide maximum grip at corners
– Maximum durability and strength

V. CONCLUSION

In this work, a detailed methodology of the virtual design of go kart transmission system has been presented. Also the defined path for the calculations and the assumptions those to be considered are described. Dynamic experimental test has to be carried out to test and validate the designs and

calculations. This will allow the modifications in the methodology. This work provides the basics for the developments and advancements in the transmission system.

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