A REVIEW PAPER ON DESIGNING OF SUSPENSIONLESS VEHICLE

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ABSTRACT

This paper concentrates on explaining the design and engineering aspects of making a Go Kart.Go-Kart racing is a constantly growing concept all over the world. Go-Kart is four wheeled vehicle designed for racing and in some countriesfor enjoyment purpose too.it is not a factory made product and not for the mass production it is for the competition of designing and manufacturing in small workshop itself.This paper explains objectives, assumptions and calculations made in designing a Go-Kart. The primary objective is to design a safe and functional vehicle based on rigid and torsion free frame. The design is chosen such that the Kart is easy to fabricate in every possible aspect.

1. INTRODUCTION

There are many motor sports in the world. Bikes, cars, formula one are the example of them. The drivers in these are very professionals and accurate. They drive them very fast. But there is also motor sport which does not need professional driver and no need of such grate speed. Such a motor is called as Go-kart.The Go-kart is a vehicle which is compact, simple, lightweight and easy to operate. The go-kart is designed for flat track racing so, its ground clearance is very small as compare to other vehicle hence it skips the suspension. Roll Cage can be called as skeleton of a vehicle Chassis usually refers to the lower body of the vehicle including the tires, engine, frame, driveline and suspension. Out of these, the frame provides necessary support to the vehicle components placed on it. First a proper design of the frame or the roll cage is carriedout. The pipes are cut in the required lengths. If required, bending of the pipes are also done. Then notching is done of these pipes. These pipes are then joined or connected by welding them together.

We approached our design by considering all possible alternatives for a system and modeling them in CAD software SOLIDWORKS and subjected to analysis using ANSYS based on analysis result, the model was modified and retested and a final design was fixed. The design process of the vehicle is based on various engineering aspects depending upon

We have to set up some parameters of our design.

2. DESIGN OF KART

The following design methodology was used during design:

- Requirements
- Design calculations and Analysis
- Considerations
- Testing

3. DESIGN

The main part in the designing is the design of frame OR chassis.

➢ CHASSIS

Weight and operator ergonomics. The number one priority in the chassis design was driver safety and Finite Element Analysis (FEA), the design assured.

Frame design is divided into the two major parts:

1. The front block (cockpit) for steering and seat position, etc.

2. Rear block (engine compartment) for transmission and brake assembly.

Both the blocks are separated by the firewall. The frame model can be viewed as shown below.

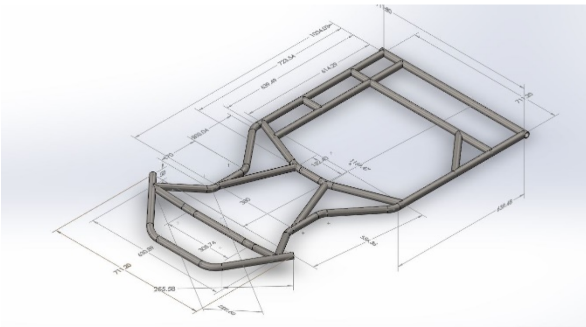

Fig:- Chassis structure

➢ DESIGN PARAMETERS

WHEELBASE: The distance between the centre of front and rare wheels is known as wheel base. 1066.8

OVERALL LENGTH OF VEHICLE: The length of the vehicle with bumpers and bodywork. 1676.4 mm

TRACK WIDTH:- Distance between the left and right tyres is called track width.

Front :-965.2mm

Rear :-990.6mm

➢ MATERIAL 0F FRAME

The material may be of circular or rectangular section.The material which is used in the frame design should have good weld ability relatively soft and strengthens as well as good machine ability. A good strength material is selected while designing the roll cage in order to absorb as much energy as possible to prevent it from fracturing at the time of high impact.

Like AISI-1018 can be choose for the chassis because it has structural properties to provide the low weight to strength ratio.1-inch diameter tube with a wall of thickness of 2mm is used.

These above mentionproperties satisfy the technical requirements of material which is to be used in a frame.

➢ JUSTIFICATION

Round hollow tubes are light in weight and can sustain more load and impact under the static and dynamic condition.

➢ DESIGNING AND ANALYSIS

We had done designing of the chassis on CREO,CATIA,AUTO-CAD, software and analysis using ANSYS software by applying 1tonload on front ,rear and both sides of chassis. This gives safe result for chassis.

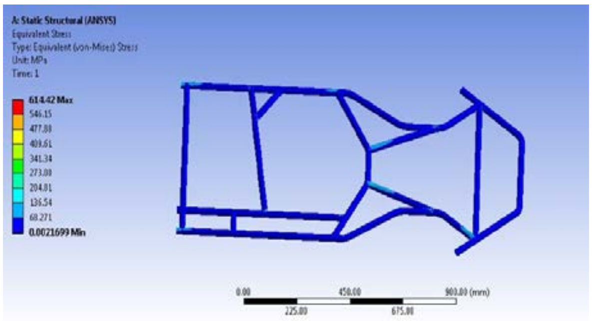

FIG:-ANSYS MODELOF GO-KART CHASSIS

4. ENGINE AND TRANSMISSION

Engine can be select according to our requirement and necessity.

➢ ENGINE SPECIFICATIONS

Configuration	Value
Engine Technology	single cylinder , 4stroke,air cooled , OHV(Over Head Valve)
Maximum Power	11 hP
Gross Torque	11N-m
Bore*Stroke	52.4*57.8
Displacement	124.7cc
Dry Weight	28.5
Fuel Capacity	5 lit.

Assuming transmission efficiency = 80%

Gross weight of the Kart = 170kgs

Number of teeth on CVT output = 54

Number of teeth on rear shaft sprocket =36Ratio = 0.5:1

SPEED (RPM)	Gear Ratios	SPROCKET RATIO	FINAL RATIO
6500	3.076	0.5	1.538
6500	1.994	0.5	0.997
6500	1.473	0.5	0.736
6500	1.19	0.5	0.595
6500	1.038	0.5	0.519

➢ CALCULATIONS

Speed = (circumference of the wheel * rear shaft rpm) / (60*1000) m/s

= (∏*11*25.4*852.27)/(60*1000)

= 12.468 m/s

= 44.86 km/hr.

Drive torque = engine 1torque * reduction * efficiency

=7.5*16*0.66*0.8

= 63.36 Nm
Drive force = drive torque/radius of wheel
= 63.36*1000/5.5*25.4
= 453.54N
Acceleration = Drive Force/mass
= 453.54/160
= 2.83 m/s2

5. STEERING SYSTEM

There are following types of steering systems like Rack and pinion, recirculating ball and nut, worm and sector and power steering.
Mechanical arrangement is planned to be used this type of steering system was selected because of its simple working mechanism and a steering ratio of 1:1 so to simple we have used mechanical type linkage.
This steering geometry is having 99% Ackerman and also gives 60degree lock to lock turn of steering wheel which is very suitable for the race track as it allows quick turns with a small input and being more precise at the same time. We also attain a perspective turning radius about 2.8meter.

➢ COMPONENTS DIMENSIONS

COMPONENTS	DIMENSIONS
Tie Rod	14 inch x 0.5 inch ϕ
King-Pin	3 inch x 1.5 inch x 11mm ϕ
Bracket	3.5inch x 2.5inch x 0.5 inch 1inch x 2inch x 10 mm ϕ
Pit-man arm Bolt	10 mm ϕ
Steering shaft	20 inch x 1 inch ϕ
Steering wheel	10 inch ϕ

According to the Ackermann geometry the front tyres will rotate about the mean point as a result the entire force will act on the outer front tyre on a corner.Thusthe cornering traction will be primarily governed by the outer tyre.
We have chosen the mechanical linkage because it is cheap, light in weight and easy to design and manufacture.

➢ CONSIDERATION FOR STEERING

- Amount of steering wheel travelling is decreased.
- It is simple and cheap

GEOMETRY	VALUES
Caster Angle	12 degrees
Camber Angle	0 degrees
King pin Inclination	10 degrees
Combined Angle	10 degrees
Toe-in	5 mm
Scrub Radius	9 mm
Minimum Turning Radius	1.12 m
Maximum Turning Radius	2.59m

➢ CALCULATIONS

Inner lock angle (θ) = (total steering wheel rotation * 360) / steering ratio
= 37.9 degrees
Outer lock angle(ϕ)= cot ϕ – cot θ
= w / l = 24.54 degrees
Ackerman angle calculation: Tan α = (sin ϕ – sin θ) / (cos ϕ + cos θ – 2) = 33.43 degrees
Ackerman inside angle: Ψ = tan-1 (WB / (WB / tan ϕ – TW)) – ϕ = 13.33 degrees
Ackerman percentage: %Ackerman = ((inside angle - outside angle) / (Inside 100% Ackerman)) * 100% = 99.97%
Turning Radius(R max) Calculation
R min = length of wheel base / tan θ = 1.3m
R max 2= [R min + Wheel track width] 2 +Length of wheel base 2] = 2.8 m

6. BRAKING SYSTEM

As we are having the many other option to select the braking system in vehicle but we get the optimize result in using hydraulic disc brake system.
The braking system has to provide enough braking force to completely lock the wheels at the end of a specified acceleration run, it also proved to be cost effective. The braking system was designed by determining parameters necessary to produce a given deceleration.
Considerations for braking system selection:
You can choose the different disk and caliper according to requirement of ground clearance and the deacceleration you need to stop the vehicle.
After making a market survey we have selected the disk of Active 125 , and caliper of Apache Rtr 180

Reasons for selection for Activa 125 disc

- Thickness (4mm) is not too high.
- Outer diameter is 190mm which is in accordance with our required design.

➢ CALCULATIONS

1. Gross weight of the vehicle
W = weight of the vehicle (with load conditions) in kgs * 9.81
= 170*9.81
=1667.7N

2. Brake line pressure:
p = force on the brakes / area of master cylinders (as pedal ratio is 4:1) (Assume the normal force applied on the pedal: 350n)
= pedal ratio *force on the pedal / area of master cylinder
= 4*350/(π/4)*(0.01)2
= 17.8343Mpa

3. Clamping force (CF):
CF = brake line pressure *(area of caliper piston*2)
= 17.8343*((π / 4) * (25.4 * 10-3) 2 * 2)
= 18064.6825N

4. Rotating force: RF = CF* number of caliper pistons * coefficient friction of brake pads =18064.6825*0.3*2 =10838.80N

5. Braking torque (tn) = rotating force* effective disc radius 08=10838.80*0.095 =1029.68 N-m (torque available at the two tires of the rear shaft)

6. Braking force=(braking torque /tyreradius)*0.8
=(1029.68 / 0.1367)*0.8
=6025.51N

7. Deceralation:
f=-ma(-ve sign indicates force in opposite direction)
a=-B.f/m
=5586.0820/170
=-35.44m/s

8. Stopping distance:
v2 – u2 = 2*a*ds
(v=0,u=12.5m/s)
Stopping Distance =2.26meters

7. THE FINITE ELEMENT ANALYSIS

The aim is to carry out a design check of the given Go-kart chassis under estimated loading conditions and to minimize the weight of the frame keeping Highest Possible Safety Factor.
Material of the tubes is to be assumed as AISI 1018, Hot Rolled with properties:
Syt = 610 MPa
Sut = 664 MPa

The following tests were used to check the design by using ANSYS 15.0

1) Front impact test
2) Side impact test
3) Rear impact test

1. Front impact test: In this test chassis is tested, when it strikes from Front.
   Consideration :-
   - Mass of the vehicle with driver 120 Kg
   - Velocity of vehicle is 16m/s
   - Consider impact time is 0.13 sec.

   $WD = ½ mv^2$
   $^{=}1/2 *120*16^2$
   WD = 15360 J
   Calculating front impact force:

   WD = (F* Displacement)
   = F *(t*v)
   15360 = F*0.13*16
   F=7384.61 N

2. Side Impact Test:-In this test chassis is tested, when it strikes from Side.
Consider impact time is 0.3 sec
Calculating side impact force:

WD = (F* Displacement)
=F *(t*v)
$15360 = F*0.3*16^2$
F=3200 N

3.Rear impact test :- : In this test chassis is tested, when it strikes from Rear.
Consider impact time is 0.13 sec
Calculating front impact force:
WD = (F* Displacement)
= F *(t*v)
15360 = F*0.13*16
F=7384.61 N

4.Rear impact test :- In this test chassis is tested, when it strikes from Rear.
Consider impact time is 0.13 sec
Calculating front impact force:

$$WD = (F^* \text{ Displacement})$$
$$= F *(t*v)$$
$$15360 = F*0.13*16$$
$$F=7384.61 \text{ N}$$

Test	Total applied Force (N)	Max. Deformation (mm)	Safety Factor Min.
Front Impact	7384.61	3.889	1.87
Side Impact	3200	2	1.9
Rear Impact	7384.61	17.53	1.82

8. SAFETY AND ERGONOMICS

➢ SEAT

The seat used in this kart is very light. It is made of plastic material and is attached to the chassis by four points only and can be adjusted in an angle of back rest according to requirement of the drivers comfort the back side the angle of the seat is at 17 degrees which is the good position of drivers body rest according to the ergonomics point of view and is kept almost parallel to the firewall. The seat implemented in our go kart provides a good combination of weight reduction and ergonomics.

SPECIFICATIONS	VALUES
KNEE ANGLE	130 degrees
ELBOW ANGLE	108degrees

➢ KILL SWITCH:

Kill switch provided in our vehicle as a safety to our driver in case of emergency. If driver wants to kill the engine or stop the engine in case of emergency so he pushes the kill switch gently and our engine would stop. The electronics are designed so that when the kill switch is depressed power is disabled on primary ignition coil of engine. Because the kill switch function is achieved by using a pair of diodes to simultaneously ground out the engines primary coil current. One diode prevents the engine from grounding through the relay and the other diode prevents battery current from flowing back into ignition coil.

9. CONCLUSION

In this way we design our Go kart chassis, steering, braking system and the other components of the kart.
The kart is designed according to the requirement, need and the purpose of the kart. So a detailed study of various automotive system is taken as per our approach. Thus, this design provides a clear insight in design and analysis of our vehicle.

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