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DESIGN AND DEVELOPMENT OF IC ENGINE GO-KART

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ABSTRACT

Go-kart (a simple racing car) is not a factory made product. It can be made by Mechanical and Automobile engineers for racing competitions.Team BVC dragsters aims at designing and fabricating GO-kart having high fuel economy and maximum driver comfort without compromising on kart performance. The goals of the team also include designing kart for the performance and serviceability. Compliance with the rulebook of INDIAN KARTING CHAMPIONSHIP-2018 is compulsory and governs a significant portion of the objectives. The aspects of ergonomics, safety, ease of manufacture, and reliability are incorporated into the design specifications. Analyses are conducted on all major components to optimize strength and rigidity, improve vehicle performance, and to reduce complexity and manufacturing cost. The design has been modeled in Solid works2015 and the analysis was done in ANSYS 14.5. The developed go-kart was participated in an event IKC2018 Season 2.

Index term:Go-Kart (Racing Car), Roll Cage, Power Train, Steering and Brakes Assembly, Finite Element Analysis.

I.INTRODUCTION

Go-Kart is a racing vehicle having very low ground clearance and can be work on only flat racing circuits. The design process of this single-person go-kart is iterative and based on several engineering processes.

The Go kart has been designed by team BVC dragsters consisting of under-graduate students from the Bharati vidyapeeth's college of Engineering affiliated to the Shivaji University. The Team BVC dragsters began the task of designing by conducting extensive research of each main assembly and components of the kart. The entire kart is designed by keeping in mind that it should be able to withstand the racing conditions without failure. Each component has been considered to be significant, so the kart could be designed as a whole trying to optimize each component while constantly considering how other components would be affected. Taking cost as a major parameter, the entire vehicle is designed to integrate the usage of standard parts reducing manufacturing cost. Combining this design methodology with the standard engineering design process enabled us to achieve a perfect match of aesthetics, performance, and ease of operation.

II.METHODOLOGY

2.1 Assumptions used in design

- Length and width of chassis must be around 70” and 50” respectively as per rulebook.
- Weight of vehicle around 100 kg.
- Engine of 100-200cc and 4.5 bhp.
- No differential is required.
- Ground clearance minimum 2”.
- Gear ratio approx. 1:2.5 to get initial torque.
- Steering ratio 1:1.
- To accommodate a driver of height 110cm.

III. DESIGN ELEMENTS OF GO-KART

3.1 Chassis

Chassis is an extremely important element of the kart. Generally it is made of circular steel tubes of different grades. It was decided to keep roll cage for the kart after long and deep thinking to have a driver safety. Size of the chasis is 65*38.The development of Design is explained below in this section.

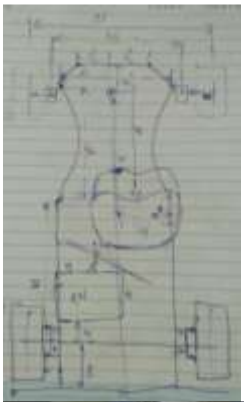




Fig1- Hand sketch Fig2- Floor plan Fig3- Final design Fig4- PVC Prototype Fig5;Developed chassis

Step by step development of chasis.

Following components are mounted on chassis –

- Engine having 190cc developing 4.5bhp.
- Transmission system consisting of chain, sprocket and rear axle with axle hangers.
- Tiers.
- Brakes.
- Steering assembly.

3.2 Steering system

The steering system for the vehicle has to be designed to provide maximum control of the vehicle. Along with controlling the vehicle, the steering system has to provide good ergonomics and be easy to operate. After researching multiple steering systems, the tripod steering mechanism type was selected which provides easy operation, requires low maintenance, provide excellent feedback and is cost effective.

STEERING CHARACTERISTICS	
Steering linkage with 1:1 ratio	
Mechanism	Tie rod
Tie rod length	13 inch
No of tie rod	2
Inner turning radius	1.7m
Outer turning radius	2.7m
Max. Inner turning angle	47 deg
Max. Outer turning angle	56deg

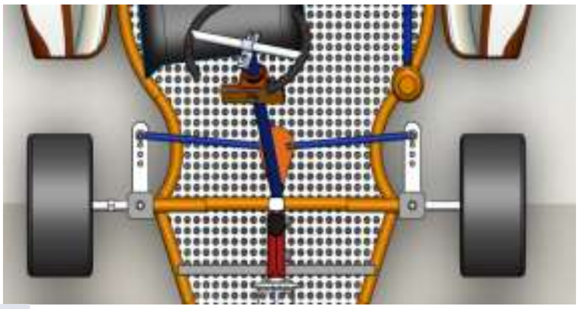


Fig 6- Steering Geometry Fig 7-Stub axle Design

3.3 Brake system

According to rule book of IKC the vehicle travelling at 40kmph should stop when you apply the brake. A hydraulic disc brake has been chosen as a suitableway to accomplish these requirements. The discs of diameter 200mm, which is operated by single piston caliper hydraulic braking system, has been selected according to vehicle design demands. The discs are mounted on the rear axle. Master cylinder is placed front side of the vehicle besides the steering column for easy maintenance.

BRAKES	
Hydraulic rear disc brakes	
Disc diameter	200 mm
Disc thickness	4 mm
TMC piston diameter	19.05 mm
Pedal ratio	5:1
Pedal force	100N
Frictional force	1254N
Braking torque	398Nm


Fig 8- TMC CADFig 9- Caliper CAD

1 Weight transfer= $\frac{C.G.height \times deceleration \ \times massonrearaxle}{wheelbase}$

W.T =$\frac{6\times.0254\times.69\times9.81\times99}{45\times.0254}$ = 89.34 N

Dynamic load on rear axle = static load on rear axle−weight transfer

Dynamic load on rear axle =

(99 ×9.81)-89.34 = 881.85 N

2 Weight transfer= $\frac{C.G.height \times deceleration \ \times massonfrontaxle}{wheelbase}$

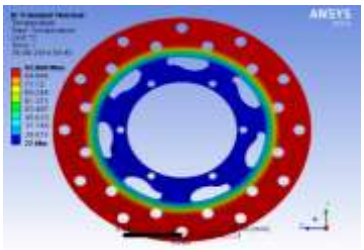


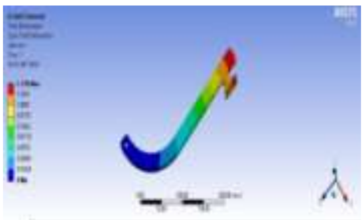
Fig 10- Disc analysis

W.T. =$\frac{6\times.0254\times.69\times9.81\times81}{45\times9.81}$ = 73.10N

Dynamic load front axle = static load on front axle + weight transfer

Dynamic load front axle =

(99×9.81)-73.10 = 898.09 N



3.4 Transmission system:

3.4.1 Axle design-Fig 11- Pedal analysis

Rear axle is used to transmit the power from engine to the rear tire through chain drive. It is the hollow shaft of inner diameter25mm and thickness of 5mm and length of 4inch according to design calculations. The material used is EN8 which is in British designation which is also known as AISI1040.

Transmission	
Parameters	Values
Max. speed @ lowest ratio	80km/hr
Max. torque @highest ratio	11Nm@7000rpm
Final reduction	2.929
Gearbox type	Manaul
Sprocket	

Driving teeth	14
Driven teeth	28

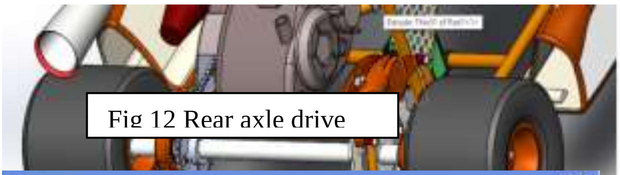


Fig 12 Rear axle drive

Reduction Ratio Chart

Primary reduction	1st	2nd	3rd	4th	Final reduction
3.35	3.17	2.00	1.35	1.038	2.929

Wheels	
Front (inch)	10*4.5
Rear (inch)	11*7.5

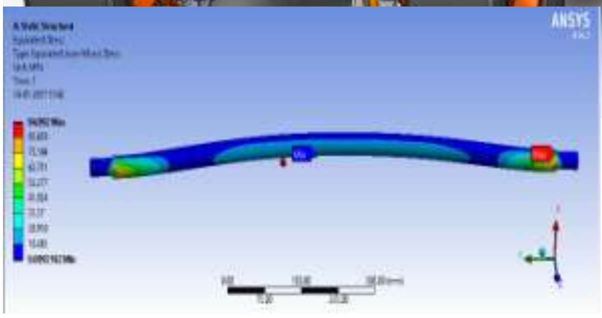


Fig 13 Analysis OF SHAFT

3.5 Engine

As per IKC rulebook, single cylinder four stroke 125 cc chain. Engine has to be selected. So there had number of options for the selection of engine such as Honda shine, Bajaj discover, TVS Flame and TVS Phoenix etc. After long research work and survey we left with two engines to be selected. They have been compared on the following basis. Bajaj Discover 125 ST engine is selected as its performance is better than phoenix

Parameter	Discover	Phoenix
Max. torque	11.8 Nm	10 Nm
Max. power	12.8 kw	11kw
Fuel economy	68 kmpl	70kmpl
Weight	22kg	18kg
Overall	16.5*12.5*100	15.8*12.1*10
Price	25000/-	36000/-
Gearbox	5 speed	4 speed

Engine Comparison Chart Fig 14-Engine CAD

IV.FINITE ELEMENT ANALYSIS

4.1 Analysis of chassis

Case	Total force applied	Max stress (MPa)	F.O.S	Max deformation (MPa)
Front impact	4000 N	326.83	1.13	1.6972
Rear impact	1500 N	274.94	1.35	1.4
Side impact	3200 N	301.45	1.22	0.87116

Calculations for chassis analysis

1) Front impact force (F) = m a

$= \text{mass of vehicle} \times \text{acceleration} = 180 \times \frac{80}{0.6} \times \frac{5}{18}$

=3897N

2) Side impact force= 2× mass of vehicle × gravity force

= 2× 160 × 9.81

= 3139.2 N

3) Rear impact force (F) =1.5 × mass of vehicle × gravity **Stress Analysis Chart**

= 1.5 × 160 × 9.81

= 1560 N

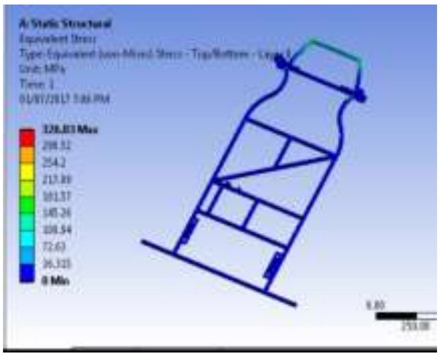
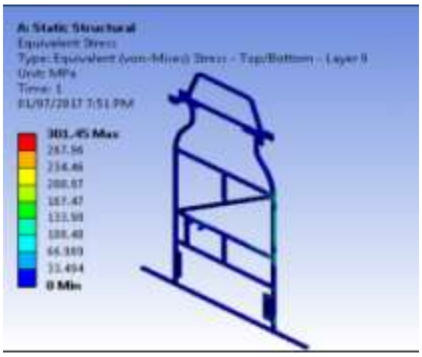
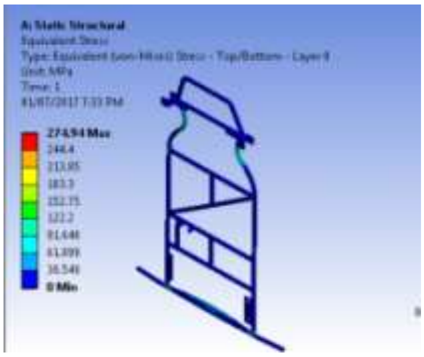




Fig 15- Front impact Fig 16- Side impact Fig 17-Rear impact

4.2 Analysis of knuckle

The knuckle undergoes many stresses during braking, bump, droop, side impact and front impact. However, the greatest loading that it undergoes is during landing, where the entire load of the vehicle will fall on the knuckle. The knuckle was first loaded with a simple vertical force throughthe spindle similar to the vehicle landing from a jump. The resulting Von-Mises stress plot for the knuckle is shown in Fig. The maximum stress was found to be approximately 275.5 N/mm2, which is well below the yield strength of 370N/mm2 for TN8 steel. This shows that the design of the knuckle is safe, and will withstand heavy forces that are acting on it at all times.

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Material	Steel EN8
Stub Axle Dia. (mm)	20
Stub Axle Length (mm)	126
Von-Mises Stress N/mm2	275.11
Max. Deformation (mm)	0.8
FOS	1.5

Knuckle Specification Chart

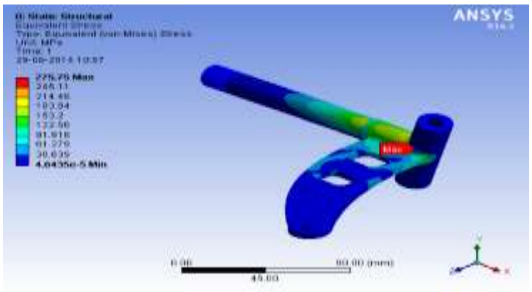

Fig 18- FEA of knuckle

V. CONCLUSION

The objective of designing and developing Go-kart with high safety and low production costs seems to be accomplished. The design process included using Solid Works and ANSYS software packages to model, simulate, and assist in the analysis of the completed vehicle.

The various experimental runs has been conducted on the developed go-kart and following results are obtained

- The vehicle runs at a speed of 40-80 kmph.
- The vehicle stops within a range of 3 meter after apply-ing the brakes.
- It is a light weight and compact vehicle.

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3D VIEWS

MANUFACTURED KART