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Design and Analysis of a GO-KART

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Abstract—*This paper describes the process and methodology to produce a low cost go-kart which is comfortable, vulnerable, durable and complete in all aspects by modelling it in SolidWorks Rx2014 and analysing it in Ansys 15.0 software. The feasibility of the go-kart design was examined through FMEA, cost report. The team focuses on a technically sound vehicle which is backed by a profound design and good manufacturing practices.*

The report explains approach, reasons, selecting criteria and expected working of the vehicle parameters. The procedural way of explanation is used for different parts of the vehicle, which starts from approach with the help of known facts, then the design and calculation procedure has been explained. The best way known had been use to go on to the final result of all parameters.

Due to the resemblance to properties like high yield stress (27-400MPa) and high amount of iron content (98.81-99.26%), the material was chosen to be Steel AISI 1018 for manufacturing the chassis. On performing analysis of the kart chassis following results based on impact testing were encountered:-

1. *Front impact 5.05mm (8600N force)*
2. *Rear impact 3.62mm (5300 N force)*
3. *Side impact 0.63mm (5600 N force)*

1. INTRODUCTION

GO-KART is a simple racing car. It consist of four-wheels, small engine and place for only one person. It is a car very commonly used in United States. They were manufactured by Airmen in early 1950s as a way to pass spare time. The father of karting Art Ingles built the first kart in 1956 in Southern California. From that period of time it became very popular in all over America and Europe. A GO-KART is an automobile which has neither suspension nor differential. They are not track oriented but also sometimes used as entertainment or hobby. Karting is the first step towards racing the expensive cars on track. Till date it is considered as the most economic motor sports. Karting is the most useful and safe way of introducing a driver to motor sports. We initiated our design by considering all the aspects and requirements by modelling in CAD Software like Solidworks Rx2014 and then further analysing it in the analysing software like Ansys 15.0.By performing the various analysis tests we modified our stock designs. And hence a final design was fixed. The designing process mainly depends on the safety, ergonomics, market availability, cost of components and safe and secure engineering practices.

1.1 GO-KART in India

MRF bought GO-KARTS in India in 2003 which had a 250cc, 2-stroke engine producing 15 BHP power. It costed them around 3 Lakhs. INDUS motors are providing karts within range of 1- 3 Lakhs. There are a number of racing tracks in Nagpur, hence being considered as the home of GO-KARTS in India.

2. PARTS OF A GO-KART

A GO-KART mainly comprises of 6 major parts:-

1. Chassis
2. Engine
3. Steering
4. Power train
5. Wheels
6. Brakes

3. PART DESCRIPTION

3.1 Chassis

The chassis has been designed by taking factors like dimensional limits (width, height, length, and weight), operational restrictions, regulatory issues, contractual requirements, financial constraints and human ergonomics as a priority. A basic chassis frame of circular pipes of 1.25 inch diameter and 2mm thickness was designed and selected by taking the points of strength, availability and cost into consideration

3.1.1 Chassis Material Selection

The most commonly used materials are:-

AISI 1018 has excellent weldability and produces a uniform and harder case and it is considered as best steel for carburizing parts. The 1018 carbon steel offers a good balance of toughness, strength and ductility. Considering the above factors we choose AISI 1018 for our chassis material.

Table no. 3.1

Material	Yield Strength (MPa)	% Elongation at braking	Cost in Rs. Per m
AISI 1026	260-440	17-27%	345
AISI 4130	435-979	18-26%	735
AISI 1020	230-370	18-28%	315
AISI 1018	270-400	18-29%	300

3.1.2. Material Composition of AISI 1018

Table No. 3.2

Element	Content
Carbon (C)	0.11-0.2 %
Sulphur (S)	<=0.050%
Iron (Fe)	98.81-99.26%
Manganese (Mn)	0.60-0.90%
Phosphorous (P)	<=0.040%

3.1.3 Physical Properties

Table No. 3.3

Properties	Value
Density	7.87g/cc
Yield Tensile strength	370 MPa
Elongation at break (in 50mm)	15%
Poisons Ratio	0.29
Modulus of Elasticity	200GPa

3.1.4 Chassis Analysis

The kart chassis was subjected to various loads and forces from various sides. The analysis report is as follows;-

Table No. 3.4

Side	Force (N)	Deformation (mm)	FS*
Front	8600	5.053	2.6
Rear	5300	3.626	2.1
Right	5600	1.415	2.5
Left	5600	0.630	2.5

*-Factor of Safety

Front Impact Testing

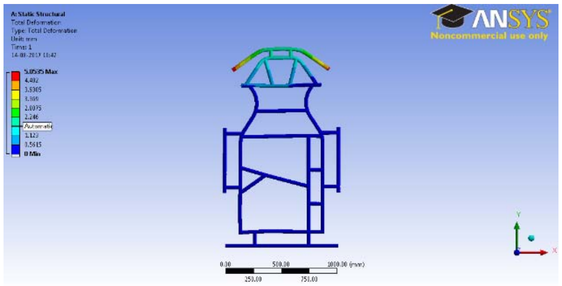
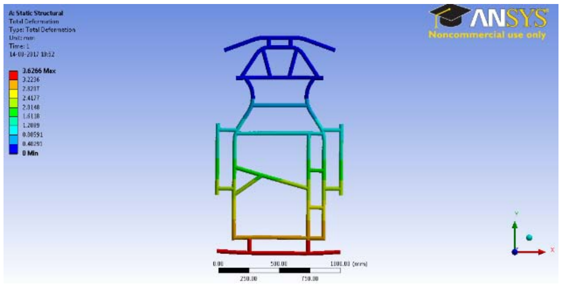


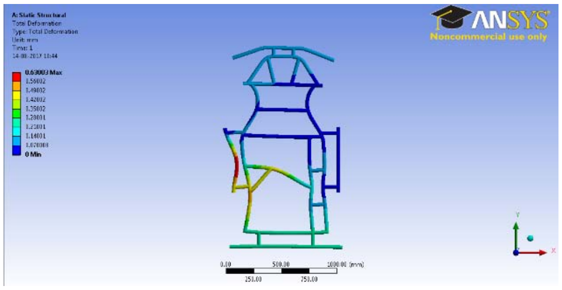
Fig. No. 3.1

Rear Impact Testing



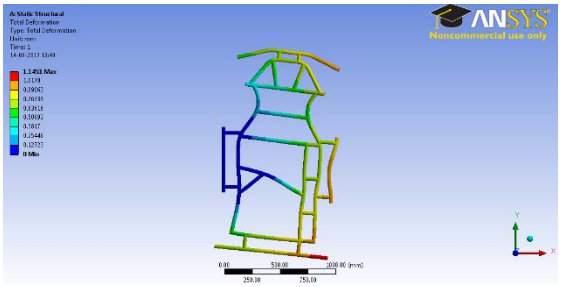
-Fig. No. 3.2

Left Side Impact Testing



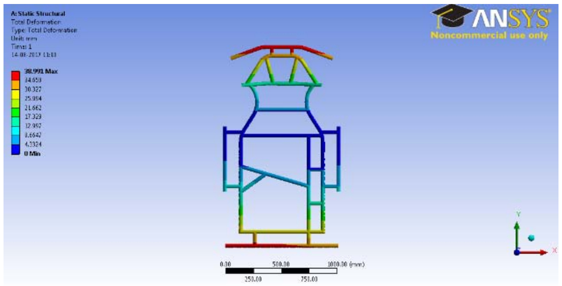
-Fig No. 3.3

Right Side Impact Testing



-Fig. No. 3.4

Torsional Impact Testing



-Fig. No. 3.5

3.2 Engine Selection

According to our need we selected the BAJAJ DISCOVER 125 engine.

3.2.1 Engine Specifications

Table No. 3.5

Engine Displacement	125cc
No. of Strokes	4
No. of Cylinder	1
Max. Power	11BHP @8000rpm
Max. Torque	10.8 N-m @5500 rpm
Type of Cooling	Air Cooled
No. of Valves	2
No. of Gears	5

3.3 Steering System

Due to the simple mechanism and easy operation. The mechanical steering system was used. So by using mechanical arrangements we used Ackerman's Steering System. By using such system we obtained the steering ratio of 1:1.

Significant measures of the system:-

1. Caster Angle = 5 Degree
2. Camber Angle = 5 Degree
3. King Pin Inclination = 10 Degree
4. Min. Turning Radius = 1.84 Meter
5. Max. Turning Radius = 2.99 Meter
6. No. of turns of steering wheel lock to lock = 0.18
7. Wheel Track = 36inches
8. Wheel Base = 36 inches

3.3.1 Calculations:-

1. **Inner Lock Angle (θ)**

$= \frac{\text{Total steering wheel rotation}}{\text{steering ratio X 360}}$

$=\theta = 32.4^0$

2. **Outer Lock Angle (Ø)**

= Cot Ø – CotΘ

$= \frac{W}{L} = \frac{Wheel\ track}{Wheel\ base}$

$= Ø = 22.98^0$

3. **Ackerman Steering angle (a)**

$\text{Tan}(\theta^1) = \frac{(\sin Ø - \sin \theta)}{(\cos Ø + \cos \theta - 2)}$

$\theta^1 = 31.74$

4. **King Pin Inclination**

ρinside = Tan-1 {l/ (l/tan Ø)-w} - Ø

ρinside = 9.42 °

5. **Turning Radius Calculation**

Rmin

$\text{Rmin} = \frac{1}{\tan\theta}$

=116.84/tan32.4

Rmin=1.84m

Rmax

$\text{Rmax} = (\text{Rmin}+w)^2 + L^2$

Rmax =2.99m

3.4 Breaking 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. As the GO-KART has only a single rear live axel. The brake disc is also mounted directly on the rear axle so that when the brakes are applied the kart stops immediately and vehicle comes to rest within less time and less distance. But there are some complex parts cannot be manufactured like brake disc, brake callipers, master cylinder and some of the fluid lines.

Significant measures of braking system:-

Brake Disc Diameter = 150mm

Calliper = Double acting Double piston semi float type.

Master Cylinder = 16.5 mm (ID)

3.5 Wheels and tyres

Wheels and tyres used are of standard dimensions.

1. Front = 11*5 inches
2. Rear = 11*7.5 inches

Fig. No. 3.6

3.6 KartSpecifications

1. Wheel base = 46 inches
2. Wheel track (front) = 36 inches
3. Wheel track (rear) = 43 inches

3.6.1 Vehicle Calculation

1. **Tractive Effort (at static condition)**
   FT = μ*m*g
   FT= 500.31 N

2. **Starting Torque**
   T = FT*R
   T=69.89 Nm
   Where,
   R= radius of wheel
   FT= Total tractive force (at static condition)
3. **Max. speed**
   Max speed = $\frac{C*T1*RPM}{T2*1056}$

   Where,
   C=circumference of the wheel
   T1=teeth on engine sprocket
   T2=teeth on axle sprocket
   1056=conversion factor to convert inches per minute to miles per hour

   Max Speed = 77.33kmph

4. **Sprocket Calculation**
   Teeth on driver sprocket = 13
   Driver sprocket outside dia. =6 cm
   Driver sprocket inner dia. =4.8 cm
   Driver sprocket pitch inner dia. =1.6 cm
   Driver sprocket pitch arbour=2 cm
   Teeth on axle sprocket = 44
   Axle sprocket pitch=6 cm
   Axle sprocket outside diameter =18.080cm
   Axle sprocket calliper diameter =17.516cm
   Sprocket gear ratio: 3.38

4. FUTURE SCOPE

In future GO-KART can be made to run on the bio – fuel instead of petrol. Even using a bigger engine (in terms of power) would be a good idea. Solar panels can also be installed above the kart hence running on solar energy reducing pollution and being economic. Suspension system can also be introduced for a comfortable ride. Aerodynamics can be improved hence increasing the speed and reducing the drag.

5. CONCLUSION

The 125cc GO-KART was finally designed and analysed. I considered all the possible factors for designing and analysing. By some calculation we found the maximum speed to be 77.34kmph. But it can be significantly increased. By reducing the kart weight or else by increasing the engine power. I found the various deformation results by analysing the chassis on Ansys. The paper above gives the outline for a small scale industries. This paper gives proper information while designing the chassis.

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