International Journal of Research in Engineering, Science and Management
Volume-2, Issue-10, October-2019
www.ijresm.com | ISSN (Online): 2581-5792

A Review on Design and Manufacturing a Go-Kart Chassis

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***Abstract*: Chassis is a major part of any automotive design. It is responsible for supporting all functional systems of a vehicle and also accommodates the driver in the driver compartment. A Go-Kart is a small four wheeled vehicles without suspension and differential and is generally used for racing having low CC Engines. This paper is aimed to model and perform the dynamic analysis of the go-kart chassis having a circular cross sectional area and also manufacture a safe and comfort chassis for the driver. The objective of this report is to document and represent the chassis designed by TEAM PISTON HEART to compete in Go-kart Design Challenge 2020.**

***Keywords*: Go-kart chassis, Analysis, Manufacturing, driver safety and comfort.**

1. Introduction

The go-Kart is a vehicle which is simple, lightweight, compact and easy to operate. The go-kart is designed for racing purpose and has very low ground clearance while compared to the other vehicles. The common parts of go-kart are engine, wheels, steering, tires, axle and chassis. No suspension can be mounted to go-kart due to its low ground clearance.

The chassis of go-kart is a skeleton frame made up of hollow pipes. The chassis must be stable with high torsional rigidity and also relatively high degree of flexibility as there is no suspension. So that it can give enough strength to withstand engine vibration and dynamic loads acting on vehicle. The chassis is designed in such a way that it provides safety for the driver and the dynamic conditions does not change the structural strength of the chassis, ergonomics are mainly considered.

Fig. 1. Chassis Frame

2. Design procedure

The frame is designed for rear mounted engine in which the driver and engine are inline. To maintain the competition rules, rulebook of 7th GKDC is followed to design the Go-kart. Once the designing of the kart is completed, the next important task is to carefully select material for the chassis. Strength, Weight to Strength ratio, cost of the material and other parameters are considered while selecting the material. Comparative chart of the properties of few available materials is shown below.

Table 1
Comparison of material properties

Material name	Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Mass density (kg/m^2)	Shear modulus (GPa)	Cost (Rs/kg)
AISI1018	440	370	7870	80	150
AISI1020	420.5	351.5	7900	80	200
AISI4130	731	460	7850	80	500

After the comparison of above material and the market survey, AISI 1018 is considered as the structural member for manufacturing the chassis. Chromoly 4130 have better properties but it is too costly hence the second best material AISI1018 is used which does not differ more from AISI4130 and is also available at a cheaper rate. The Dimensions of 1-inch outer diameter and wall thickness of 1.6 mm for tubing was selected. Thinner wall requires being welded using TIG (Tungsten inert gas) welding process which also makes it stronger and efficient to weld.

Chemical composition:

Table 2
Chemical composition of AISI 1018

S. no.	Chemical composition	Percentage(%)
1	Fe	97.76
2	C	0.35
3	Si	0.20
4	Mo	0.012
5	P	0.016
6	Ni	0.058
7	S	0.007

3. Technical specification

Overall Length- 85 inch
Overall width- 30 inch
Front track width- 35 inch
Rear track width- 39 inch

Wheel Base- 45 inch
Cross section area of pipe- 1 inch
Chassis material- AISI 1018 Seamless
Weight of chassis- 15kg
Ground Clearance- 2 inch

4. 3D modeling and analysis on CAD model

Once the design is final the cad model on solid works is made of the same which includes all the mounting such as engine mounts, seat mounts, axle bearing mounts steering and bodywork mounts etc. After the chassis is ready total assembly of the vehicle is done which half to fix the position of every individual component to be installed in the kart.

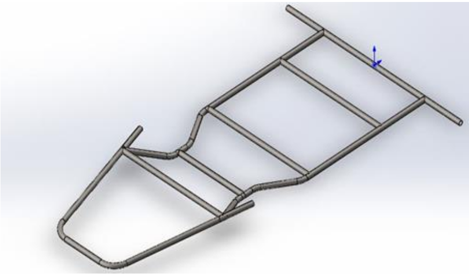

Fig. 1. CAD Model of Chassis

When the cad model is ready chassis is tested which ensures the safety of the driver in dynamic condition. Chassis is tested on Finite Element Analysis (FEM). Finite element analysis is a computerized method for predicting how a product reacts to real-world forces, vibration, and other physical effects. Finite element analysis shows whether a product will break, wear out, or work the way it was designed. The computer analyses the elements and shows us a collective result. The computer solves by the computational method provided. The material and structure of chassis was finalized and implemented, then FEA was performed on it.

Two types of analysis are performed on the chassis.

Front impact: For the front impact, engine and driver load was given at respective points. The kingpin mounting point stand rear wheels position kept fixed. Front impact was calculated for an optimum speed of 60 kmph. The loads were applied only at front end of the chassis because application of forces at one end, while constraining the other, results in a more conservative approach of analysis.

mass of the vehicle = 170 kg
speed of vehicle, V= 60 kmph = 60 x 0.277 m/s = 16.66 m/s
momentum gain = m x V = 160 x 16.66 = 2832.2 kg m/s
Force applied in ANSYS= 3000 N (using ceiling function to round off)

The total deformation of the front member is shown in the fig below.

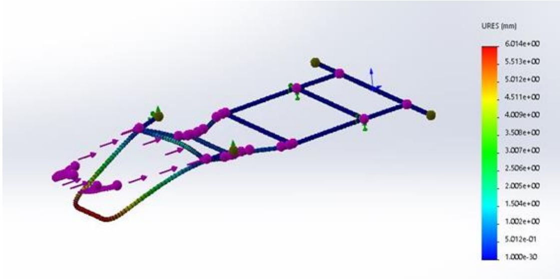

Fig. 3. Front impact

Rear impact: Considering the worst case collision for rear impact, force is calculated as similar to front impact for speed of 80 kmph. Load was applied at rear end of the chassis while constraining front end and king pin mounting points.

mass of the vehicle = 170 kg
speed of vehicle, V= 60 kmph = 60 x 0.277 m/s = 16.66 m/s
momentum gain = m x V = 160 x 16.66 = 2832.2 kg m/s
Force applied in ANSYS= 3000 N (using ceiling function to round off).

The total deformation of rear member is shown in the fig below.

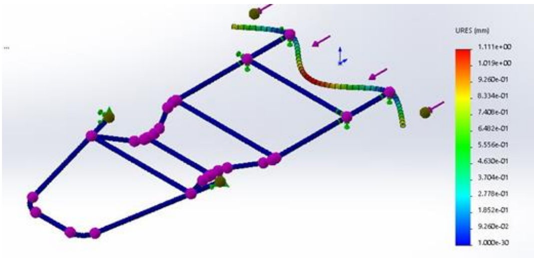

Fig. 4. Rear impact

Hence from the above analysis it is concluded that the chassis designed is safe for the driver.

5. Manufacturing of chassis

First step involved in manufacturing is to purchase the material at a cheapest rate available in the market. AISI 1018 hollow pipes of cross section are 1 inch and 1.2 mm wall thickness were purchased at rate of 150 Rs/Kg. Which costs a total amount of Rs. 3500/- for the material.

Fig. 5. Purchased pipes

After purchasing the material, the members are cut into the desired lengths which can be obtained from the cad model.

Fig. 6. Pipes cut in length

Next step is bending process which was done. The front member, side members, bodyworks supporting members were bend using CNC machine. The cost for CNC machining was Rs.3000/-

Fig. 7. Bending operation on CNC

Fig. 8. Bend pipes

After bending, for proper joining of two members the ends of the pipe should be cut in the desired shape. This step is known as profiling. It is also known as Fish mouth or Notching. The notch radius is kept 1/3rd of the diameter of the pipe.

D = 1 inch = 25.4 mm
Notching radius = 25.4 x 0.33 = 8.382 mm.

Fig. 9. Profiled pipes

The last step is the welding process. To get a strong joint and the norms of competition Tungsten Inert Gas (TIG) welding is used for welding of chassis and it is also better the Arc welding.

6. Conclusion

It is observed that selection of material plays an important role in chassis stability and its behavior during dynamic loading conditions. Factor of safety should be considered for proper designing of a go-kart chassis. In this paper, analysis were carried which concludes that the made chassis is totally safe for the driver and also gives comfort.

Acknowledgement

The authors have taken this opportunity and are highly delighted to thank Mr. T. Z. Quazi, Professor and HOD, Department of Automobile Engineering, Saraswati College of Engineering, Kharghar, for his valuable guidance and support.

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