Design and Analysis of Go-Kart Chassis

[1] Ujjal Kalita, [2] Yenduru Surya Teja, [3] Darisi Sri Veera Venkata Manikanta
[1] Assistant Professor, [2]Student, [3] Student
[1]Mechanical Engineering,
[1]Lovely Professional University, Jalandhar, Punjab, India

***Abstract*— Go-Kart is a self-propelled vehicle which is used as one of the motor sport vehicle. This is a four wheeled vehicle without any suspension and differential. The main objective of the design is to make a kart that is light weight, easily driven, durable as well cost friendly. The principle of triangulation has been extensively used to make sure that the chassis is extremely rigid and provides a safe cockpit for the driver in case of an accident. Aesthetical importance is also given to Kart. The main motive of our vehicle is driver safety. The vehicle has been designed in such a way that it can carry up to a 95th percentile male. Along with that vehicle reliability is not compromised in the pursuit of speed. Chassis is of a tubular cross section pipe, fabricated assembly of AISI 1020 grade and a few other grades. In this kart, we have used AISI 1020 class tube with 1 inch diameter and 2 mm wall thickness. A front and side impact test is also simulated for the design to ensure the safety of the driver. Frame gussets are also added in strategic locations in order to brace weak members or members that can experience high loading. Front and rear bumpers are also added to protect the vehicle in the event of front or rear impact**.

***Index Terms*— Go-kart, chassis, design, fabrication, impact test**

1. Introduction

Go-kart is a simple self-propelled, lightweight and compact vehicle easy for operation. Due to low ground clearance, this type of vehicles are specifically designed and fabricated for racing. Its main parts are the chassis, axle, steering, engine, wheel, bumpers and tyres. As it is one of the racing vehicle, its ground clearance is low due to which no suspension system is placed. Its engine could be either two-stroke or four stroke engine. Chassis in one of the main component of this vehicle as the total weight of the vehicle should be beard by it. Due to this, chassis should have strength and stability.

Go-karting is adventurous and great sporting vehicle for the people who are interested in racing because of its low cost, simple construction and safer way of racing. Its racing track could be indoor or outdoor. This project is aimed to be model and perform the dynamic analysis of the go-kart chassis which is constructed with the circular cross section beams. Modelling and analysis are performed on SOLIDWORKS software. The chassis is designed in such a way that it requires less pipes and ability to withstand optimum loads applied on it. They are usually raced on almost any plain tracks with no pits and speed breakers. This is considered as the first vehicle for starting a career in racing field. A driver could easily prepare for racing through this vehicle, wheel-to-wheel racing for high speed, precision control, impulsive racing skills and spontaneous decision-making skills. These vehicles, now called as "Go-Karts" had grown into a billions dollars industry in the USA and most of the developed countries in the world. They are made, sold, and used exclusively as recreational racers. However these vehicles are not designed for transportation and is considered illegal in most places to drive them on the road.

1.1 Uses of Go-kart

- Fun and Drifting
- Off Road Driving
- F-1 Racing
- Desert Racing
- Short Distance Travelling, etc.

1.2 Chassis

Chassis is a frame made of hollow pipes and different materials are used of various cross-section. It should have high torsional rigidity and high degree of flexibility because the vehicle should be stable and should have high strength. High degree of flexibility will give enough strength to withhold or grub the different load applied on the vehicle as well as its different accessories. While designing the chassis different criteria and factors that should be considered are its safe ride, structural strength due to applied load and ergonomics.

Selection of frame material

While designing any chassis, strength and light weight are the basic consideration. So material used in chassis is one of its important criteria. AISI 1020 is one of the suitable material for go-kart chassis and it is used for medium carbon steel and having its high tensile strength and high machinability and offers good balance of toughness and ductility. The design was made based on

Table 1 material properties of AISI 1020

SNO	PROPERTIES	VALUES
1	Tensile strength	440 MPa
2	Yield strength	370 MPa
3	Bulk modulus	140 GPa
4	Shear modulus	80 GPa
5	Young's modulus	205 GPa
6	Poisson ratio	0.209
7	Ultimate strength	394.72MPa
8	Thermal conductivity (100^0C)	51.9W/mk
9	Density	7.81g/cm^3
10	Melting point	2760^{0}C
11	Carbon content	0.17-0.230%

Table 2: Chassis dimension

Parameters	Values
Vehicle Length	78 inch
Vehicle wheel base	48 inch
Vehicle width	40 inch
Roll cage material	AISI 1020
Tube dimension	1 inch
Pipe thickness	2 mm

1.3 Engine and transmission

An engine of a go-kart vehicle is usually as small one. About 100-200cc. In this kart, we use a pulsar 134.6cc, 4-valve single cylinder petrol engine, air cooled, which produces about 13.3 BHP of power at 9000rpm, maximum torque is 11.4 N-m @7500rpm. We used 4-stroke engine because this is used for racing. Transmission means the whole of the mechanism that transmits the power from the engine crankshaft to the rear wheels. In this vehicle, the power from the engine is transmitted to the sprockets using chain, i.e. this is chain drive. The driver sprocket has 12 teeth and driven sprocket has 44 teeth.

The power from the engine is transmitted to the rear two wheels using chain drive. We use chain drive because it is capable of taking shock loads.

Engine specification

Table 3: Specification of a pulsar engine

Displacement	134.6cc
No. of cylinder	1
No. of gears	5
Maximum power	13.3 Bhp @ 9000 rpm
Maximum torque	11.4 N-m @ 7500 rpm
Engine description	134.6cc, 4-stroke, DTS-i, air cooled. 4-valve single cylinder, BSIV
Emission standard	BSIV
cooling	Air cooling
Bore	54mm
Stroke	58.8mm
Fuel type	Petrol
Clutch	Multi plate clutch

2. DESIGN AND METHODOLOGY

2.1 Introduction to design

Designing is one of the most important necessity considering the different factors such as its aesthetic, functional and economic dimensions. Research should be made before modelling any vehicle so that the vehicle meets the human needs. Meanwhile, the different kinds of objects may designed, including cloths, graphical user interfaces, skyscrapers, corporate identities, business processes, and method or processes of designing.The design was made based on the driver ergonomics. A

material of less weight without compensating the strength was taken into consideration to make the vehicle lesser in weight and optimizing the overall performance.

2.2 Methodology

2.3 Chassis design

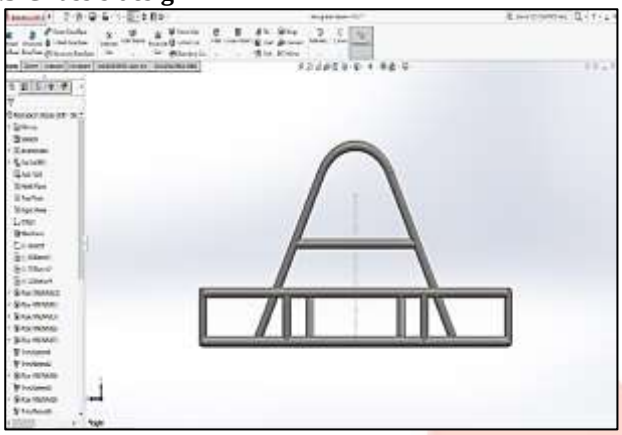

Figure 1: Front view

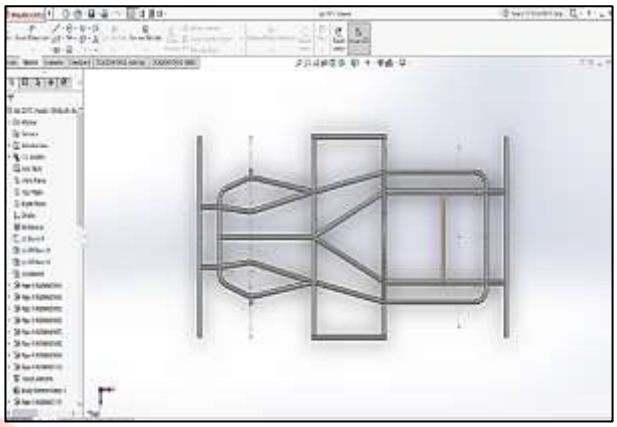

Figure 1 top view

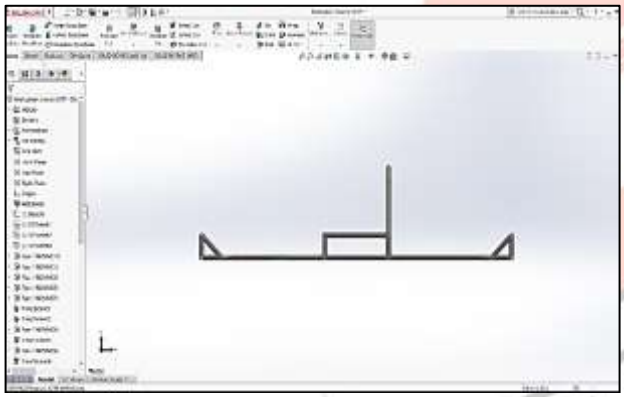

Figure 3: Side view

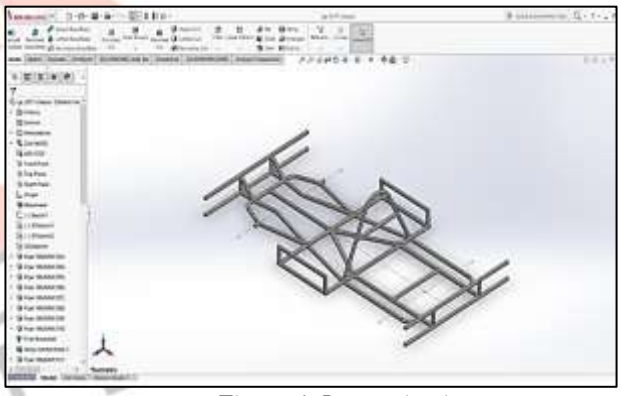

Figure 4: Isometric view

2.4 Cad model

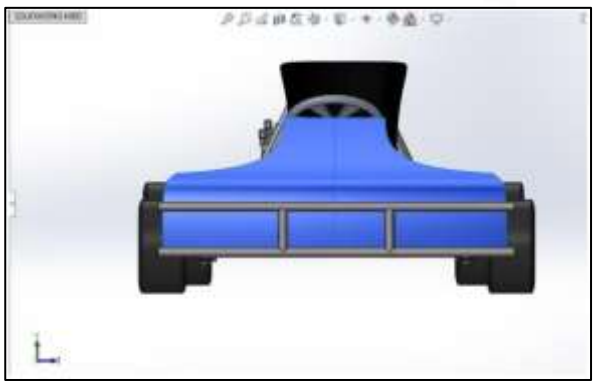

Figure 5: Front view of cad model

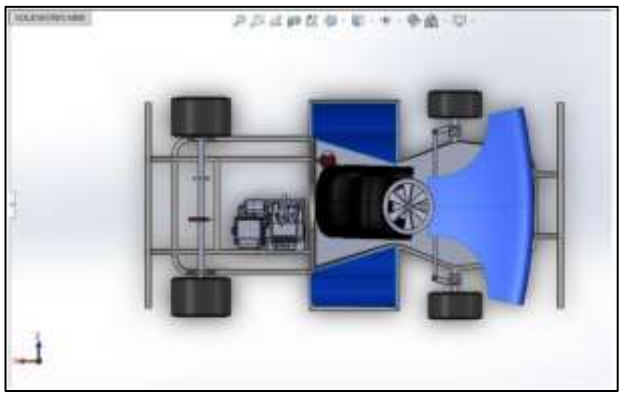

Figure 6: Top view of cad model

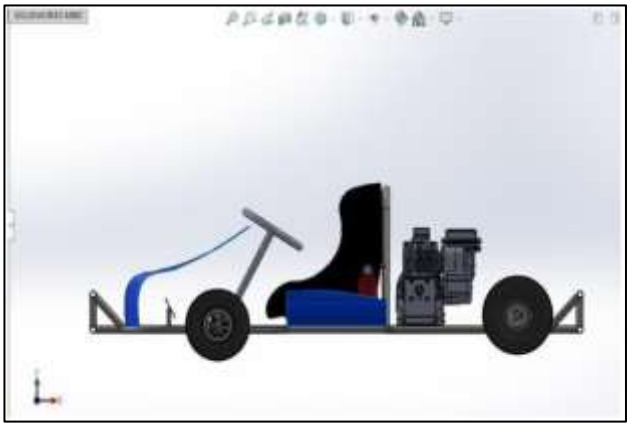

Figure 7: Side view of cad model

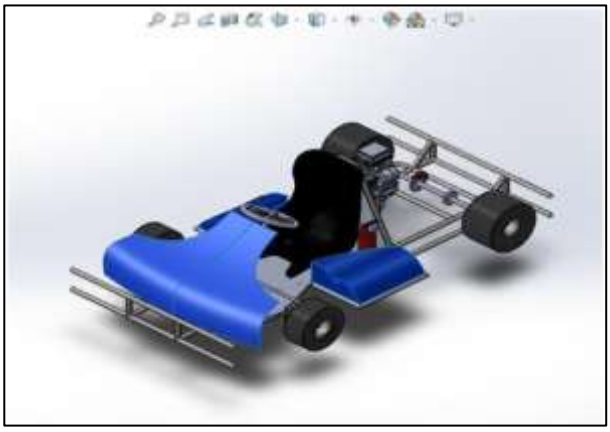

Figure 8 isometric view of cad model

3. Finite Element Analysis

Finite Element Analysis is a simulation technique for analyzing the different stress, deformation, vibration and other physical effects occurring on the structure on application of forces on it. Solidworks is one the simulation software. In this work Solidworks is used for the modelling as well as performing the different test.

1. Front impact 2. Rear Impact 3. Side Impact

3.1 Frame Design Consideration

The main criteria in analysis are the factor of safety, even stress distribution and the maximum stress induced. The energy rate is used as loads on the nodes.

3.1.1 Front Impact

For an ideal condition for testing the front impact force the acceleration is considered to be 2g. a=2g.F = ma Where F = impact force m = mass of vehicle F = 180 x 2x 9.8 = 3532 N

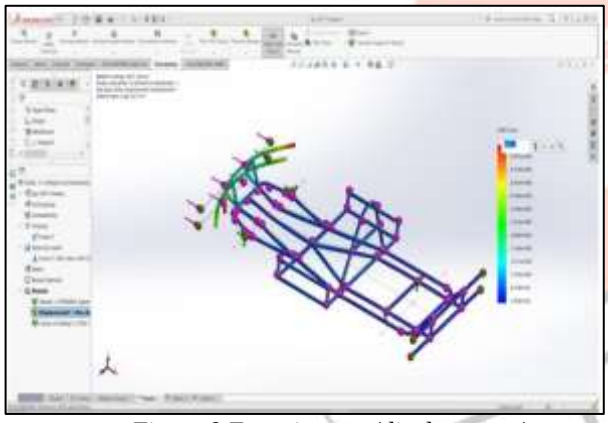

Figure 9 Front impact (displacement)

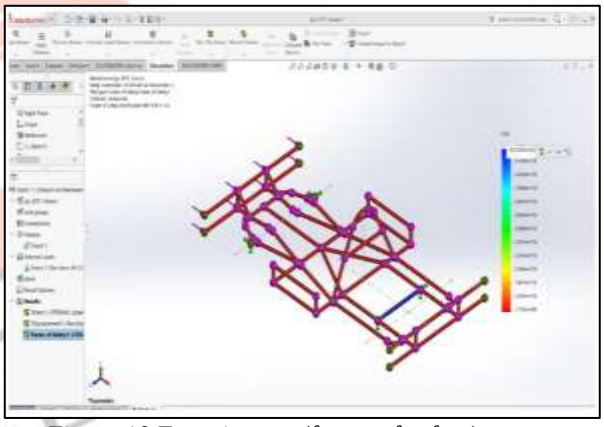

Figure 10 Front impact (factor of safety)

Front Impact	
Displacement	6.44 mm
Factor of safety	1.8

As go-kart is a small vehicle the acceleration can be taken as 2g. When the vehicle gets collided with a wall with front faced then the normal impact force will be absorbed by the front bumpers.

3.1.2 Rear Impact

The rear impact load is same as the front impact and the force is acting upon the nodes with the front completely constrained this time. The stress and displacement values are well within the permissible levels.

For an ideal condition for testing the rear impact force the acceleration is considered to be 2g. Rear impact F=3532N

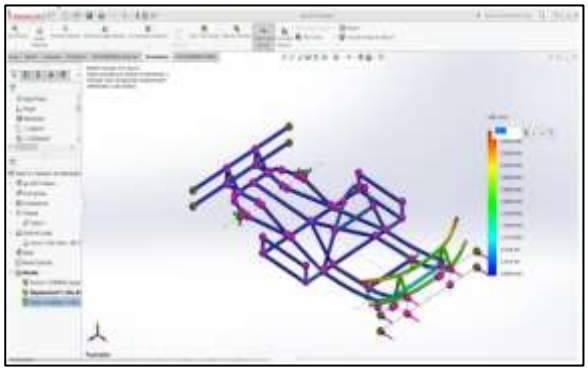

Figure 11: Rear impact (Displacement)

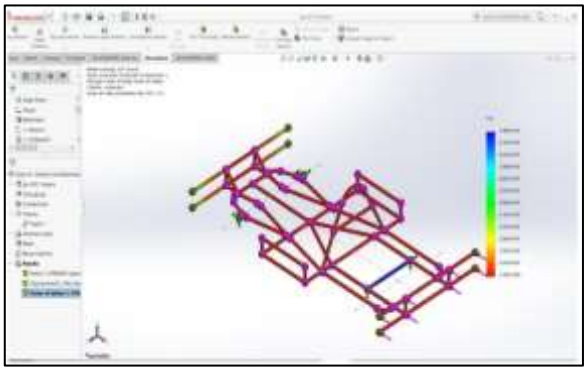

Figure 12: Rear impact (Factor of safety)

Rear Impact	
Displacement	5.1 mm
Factor of safety	2.3

3.1.3 Side impact

For the side impact the calculated present load is used for front impact and rear impact test. In this load is applied along the side bumpers of the frame and the other side wheels are constrained referring to the frame. For an ideal condition for testing the side impact force the acceleration is considered to be 2g. Side impact =3532 N

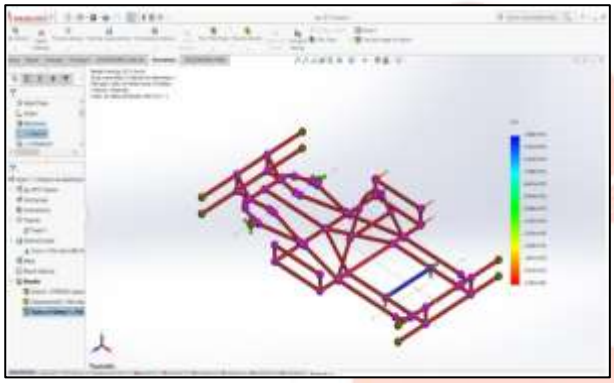

Figure 13: Side impact (Displacement)

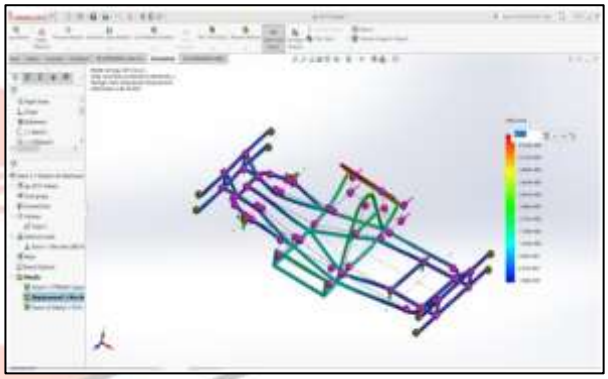

Figure 14: Side impact (Factor of safety)

Side Impact	
Displacement	5.1 mm
Factor of safety	2

4. Conclusions

The basic need of Go-kart vehicle is less weight to strength ratio and less clearance also satisfied by the roll cage. Keeping fabrication in the mind, we tried to make the design optimum and simple with high in strength and stability. Thus roll cage is demonstrate good strength against collisions from the front, rear as well as side.

From the above calculation we can conclude that AISI

1020 is one of the material that could be used for fabrication of go-kart chassis as it gives better performance. Static analysis is performed in Solidworks software using FEA technique on the chassis CAD model successfully. Maximum stress, deformation or displacement and factor of safety are calculated from it. The factor of safety is calculated and it is found to be greater than 1. Factor of safety is under the safe limit and can be used to make a Go- kart. Hence we can conclude that the chassis design is safe and stable.

The design of the chassis for Go-Kart helps to finding the strength and weakness of the design and fabrication. With the help of the analyses, it is easy to identify the chassis to rectify the weak points and the strength it with slight modifications.

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