GRD Journal for Engineering | Volume 2 | Issue 5 | April 2017
ISSN: 2455-5703

Fabrication and Analysis of Go-Kart Frame and Steering

K. Pasupathi
Assistant Professor
Department of Mechanical Engineering
Muthayammal Engineering College, Rasipuram, Tamil Nadu - 637408

S. Sakthivel
Assistant Professor
Department of Mechanical Engineering
Muthayammal Engineering College, Rasipuram, Tamil Nadu - 637408

R. Ramesh
Assistant Professor
Department of Mechanical Engineering
Muthayammal Engineering College, Rasipuram, Tamil Nadu - 637408

K. Sivanantham
Assistant Professor
Department of Mechanical Engineering
Muthayammal Engineering College, Rasipuram, Tamil Nadu - 637408

P. Ragupathi
Assistant Professor
Department of Mechanical Engineering
Muthayammal Engineering College, Rasipuram, Tamil Nadu - 637408

Abstract

The report covers all the aspects of the designing and analysis of the final go-kart chassis design. It also covers the material used and the reason of using the material in the go-kart chassis. Apart from this we will also look into the components integrated into the go-kart and the reasons behind it.
Keywords- Chromalloy Aisi 4130, Go-Kart, Chassis, Axle, Stress

I. INTRODUCTION

The Go-Kart is a small powered single occupancy racing vehicle, having a similar functioning as of a F1 vehicle but specifically meant for low powered engines. The Go-kart tracks are smaller when compared to F1 tracks but the door to F1 opens after being part of International Go-Kart Championships. The Go-Kart is very volatile as similar to F1 car chassis and special attention is needed even in the design and fabrication of the go-kart chassis and body works for its proper functioning.

II. DESIGN AND TESTING METHODOLOGY

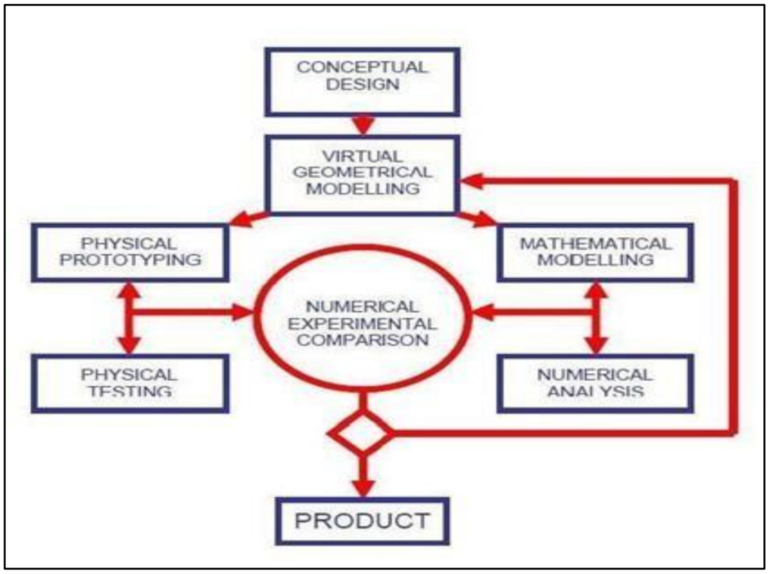


Fig. 1: Design and Testing Methodology

The research work, as previously said, foresee the definition of a planned methodology of virtual design and prototyping of go-kart vehicles, able to be applied both in the design process of an existing one.

The dynamic behavior of the vehicle is strongly influenced by the structural characteristics of the tubular frame; in fact, since the kart does not have a differential and suspension systems, its turning behavior is strongly influenced by the torsional deformation of the axle and stress levers when the speed of the kart will be very high and will be turning at high speeds.

We need to take all kinds of different phases of design and tuning process so that all the evaluation will be done on time. Thus, at the end, the methodology can be distinguished into 3 main systems:

- Purpose of Conducting
- Methodology of Conducting
- Tools of Aided Design

III. FINAL VIRTUAL DESIGN METHODOLOGY

We can easily define the workflow of the frame numerical design process, by the precise definitions of the main activities as shown in fig. below. The methodology is completely characterized by the Numerical processes of geometrical, structural and dynamic modelling. In this way, it can completely speed up the entire vehicle designing process, ensuring high flexibility and accuracy in the evaluation of virtual dynamic performances and sub-system correlation.

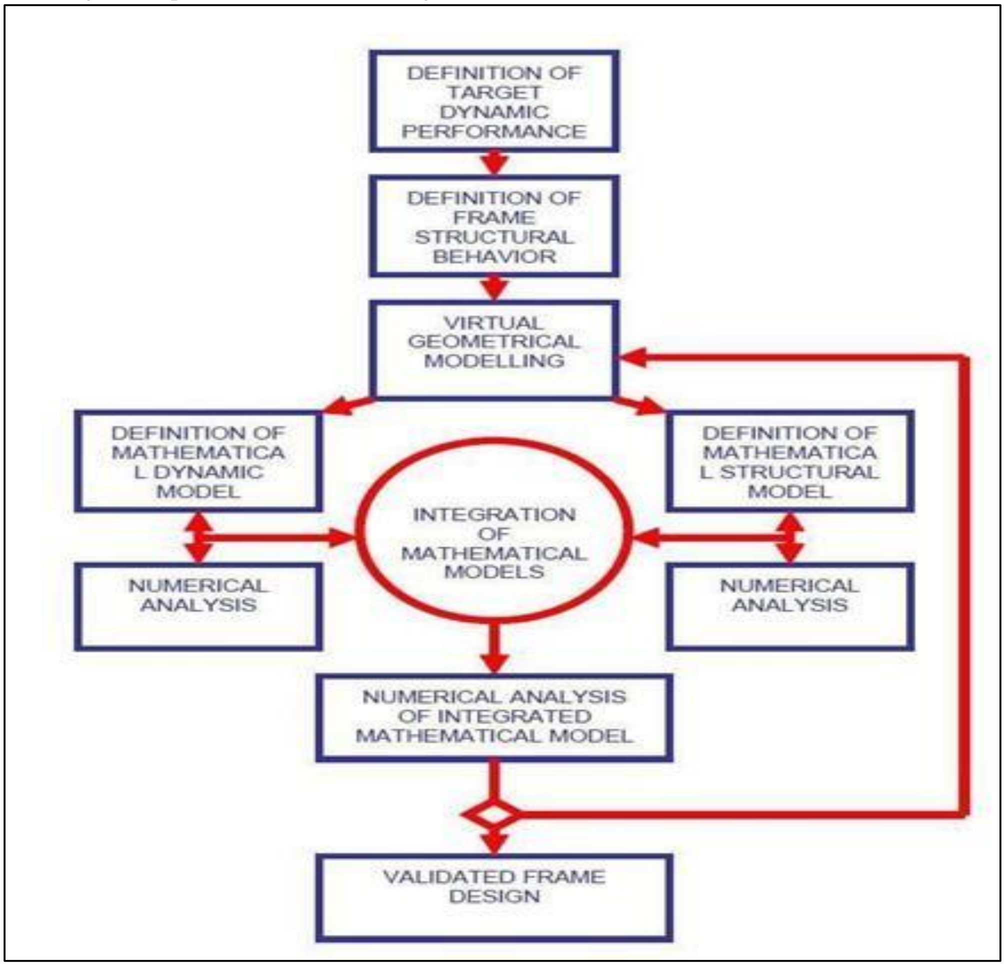


Fig. 2: Final Virtual Design Methodology

IV. MATERIAL USED FOR CHASSIS (AISI 4130)

AISI or SAE 4130 grade is a low- alloy steel containing chromium and molybdenum as strengthening agents. The steel has good strength and toughness, weld ability and machinability.

AISI/SAE 4130 grade is a versatile alloy with good atmospheric corrosion resistance and reasonable strength up to around 600º F (315º C). It shows good overall combinations of strength, toughness. And fatigue strength.

CHEMICAL ANALYSIS	
C	*Carbon* 0.28 – 0.33
Mn	*Manganese* 0.40 – 0.60 max
P	*Phosphorus* 0.035 max
S	*Sulphur* 0.040 max
Si	*Silicon* 0.20 – 0.35
Cr	*Chromium* 0.80 – 1.10
Mo	*Molybdenum* 0.15 – 0.25

This low-alloy steel finds many applications as forgings in the aerospace and oil and gas industries – as forged valve bodies and pumps, as well as in the automotive, agricultural and defence industries.

The alloy is readily machinable. Simple shapes might be machined following a normalizing treatment, whereas more complex shapes will require annealing. For optimum machinability a coarse pearlitic structure with minimum ferrite is normally recommended.

Weld ability of 4130 is good, and the alloy may be welded using any commercial method. The material may require a post-weld stress relief heat treatment in certain instances.

Low-hydrogen electrodes are recommended together with preheat at 300 – 500 º F (150 – 260 º C.) to be maintained during welding, Cool slowly and stress relieve where possible.

V. MATERIAL USED FOR AXLE (HARDENED STEEL)

The material used for the axle should have a comparatively high torsional value so that when the axle is rotating at high speed it should not bend because of the torsional forces applied to it. Plus, it should also have high tensile and compressive strength.

As per DVP report, the torsional strength of the hollow Axle Rod made of Hardened Steel is 180 MPa while the Fatigue strength is found to be 270 MPa.

VI. FINAL DESIGN MODEL

The Computer Aided Design of our go- kart vehicle is shown below

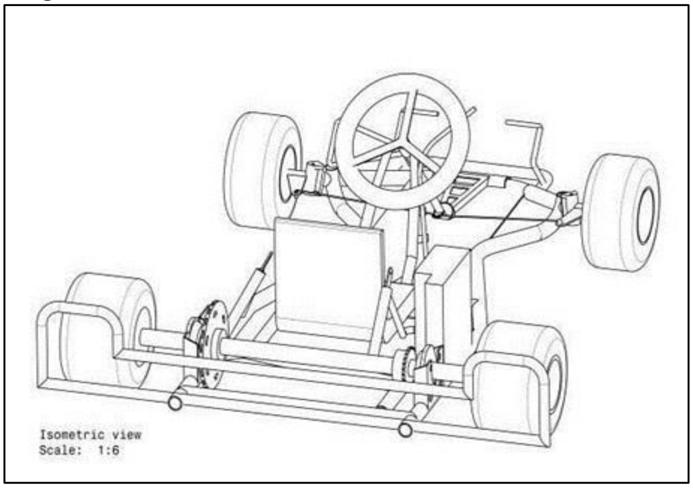
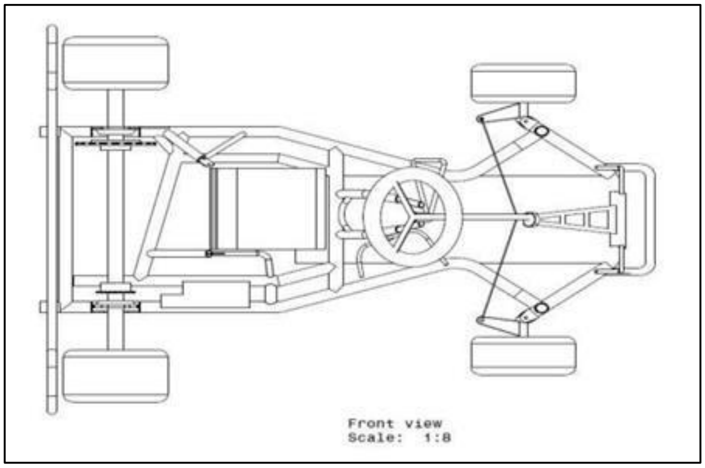
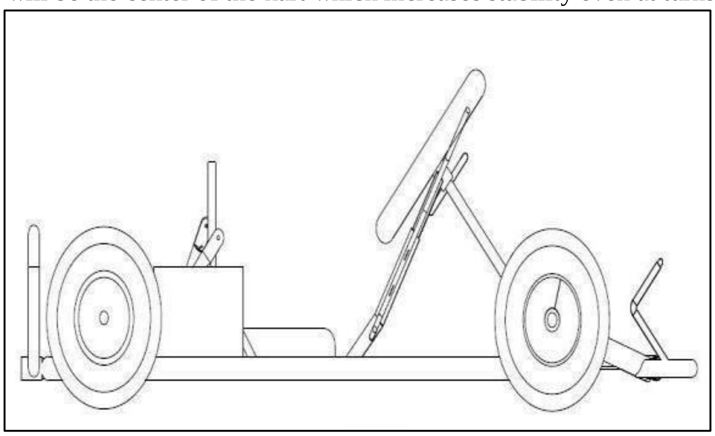


Fig. 3: Go- kart vehicle

The frame is composed of tubular elements and some other components welded to them, whose function is that of supporting the rear axle, the seat, the front wheels, the steering system, etc.



Plus, for perfect weight balance even at high speeds the COG (Center of Gravity) has been adjusted such that even when the weight of the driver is added, the COG will be the center of the kart which increases stability even at turns.



The Finite Element Method (FEM) Model of the Go-Kart design can be seen above (the meshed model of the Go-Kart). As can be seen, the design distributes the load equally and thus, the strength of the design is high and is effective for high speed driving.

VII. COMPUTER AIDED ANALYSIS

The Computer aided Engineering Design (CAD) of our go-kart is as follows,

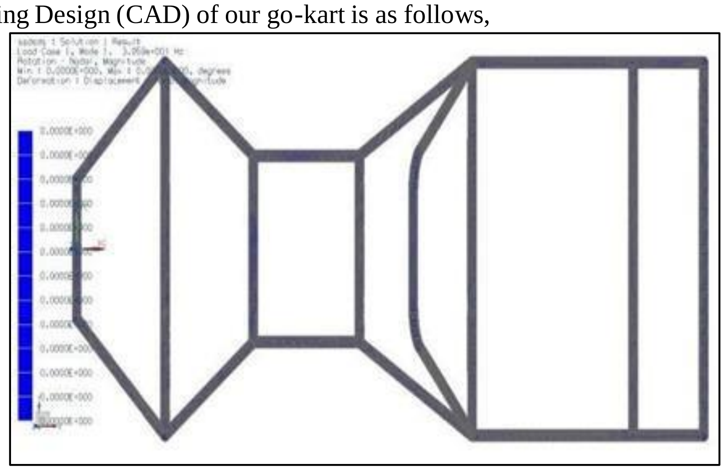
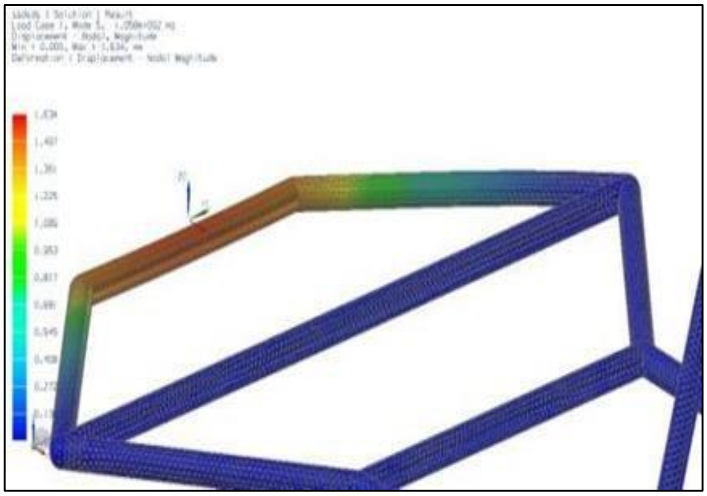
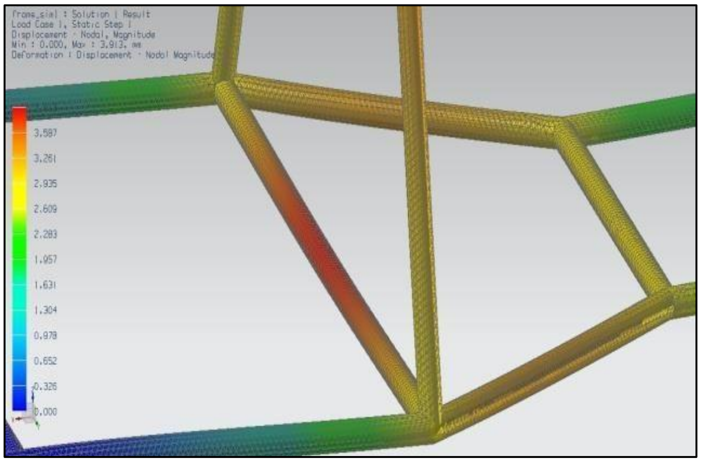


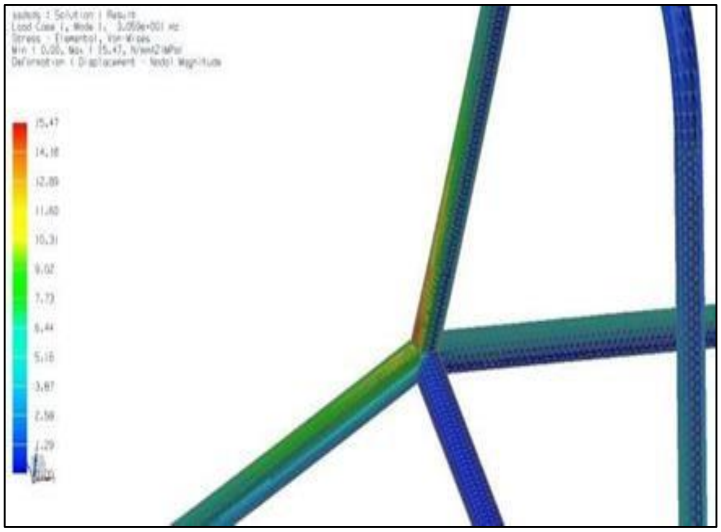
Fig. 4: CAD of Go-Kart

Also to reduce the weight of the go-kart, the side safeguards have been removed when compared with the design of the standard go kart.





As can be seen from the image above, the total deformation is maximum at red portion (in diagonal bar and Seat clamp) apart from that total deformation is minimum even at 150 Kg (including dead weight of the engine and an expandable load of the driver and fuel) of load on the design.



As can be seen from Equivalent Elastic Strain Test and Maximum Principal Stress test, the design has minimum stress points where the load is showing defects in design.

VIII. MULTI-BODY ANALYSIS

Multi body numerical analysis is a powerful tool to evaluate the global vehicle performance, a comparative virtual method of testing for performing various dynamic tests on various software analysis.

After the FEM model was correctly understood upon, it was possible to set up a software environment of torsional tests on the chassis and the following results were obtained for various constrains.

Modulus of Elasticity (MPa)	Displacement (mm)
190	2.4356
210	2.203
220	2.1027
250	1.8501

IX. INNOVATION

The Innovations that are to be placed in our go-kart vehicle is as follows,

Automatic Fire Extinguisher

Tilt Sensor

Impact Sensor

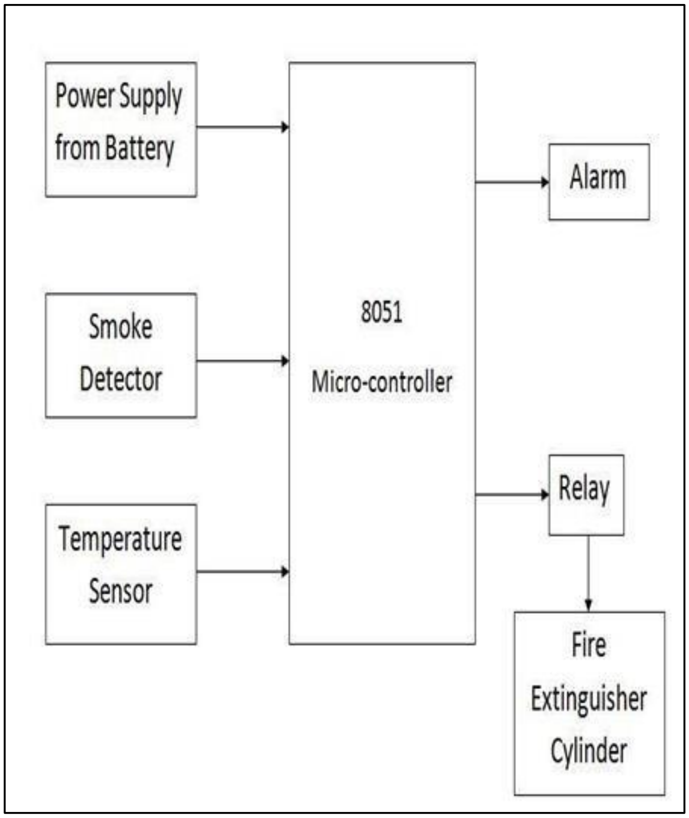


Fig. 5: Automatic Fire Extinguisher

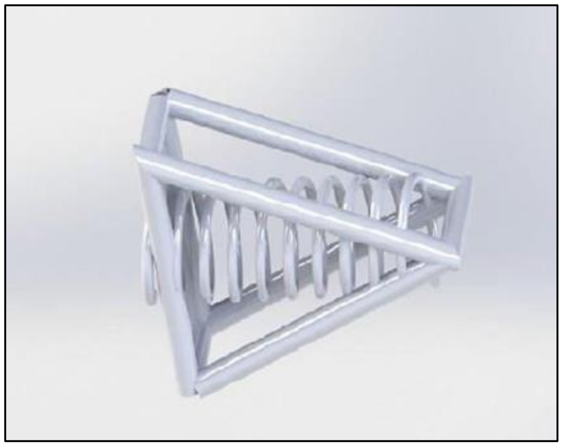


Fig. 6: Impact Zone (Crush Zone)

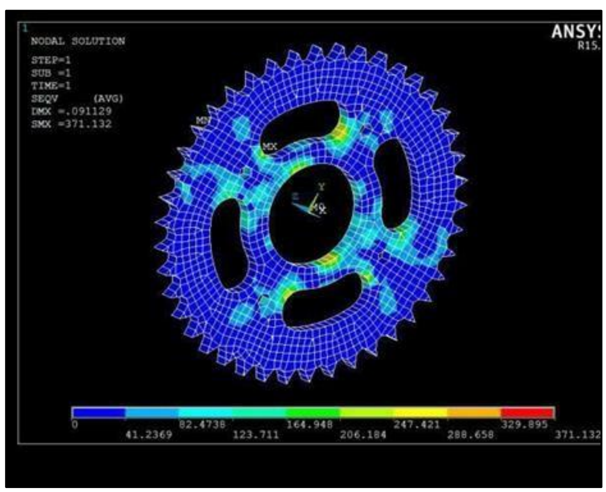
X. VEHICLE SPECIFICATIONS & SUBSYSTEM SELECTION

A. Engine

We shortlisted 3 125cc engines that would not only give a decent mileage but a good initial torque. After checking the specifications and dimensions, we came to the conclusion that the following engine is the best option.
HONDA Activa
Engine Displacement = 109 cc No. Of Cylinders = 1
Max Power = 8bhp Max Torque = 8.83Nm
Fuel Tank Capacity = 5.3 litre Fuel Tank Material = Fiber

B. Transmission

4-Speed,
Manual with sprocket & chain drive Axle Material Used = Hardened Mild Steel Length = 950 mm
Diameter = 40 mm



C. Steering System

The steering system for any Go-Kart is a simple Ackermann Steering System with Tie-rod.
Dia. of Spindle = 20 mm Material = Steel Rod
Diameter of Steering Wheel = 280 mm

D. Braking System

We planned on using the Disc braking system from a TATA Ace as it is most efficient. A single disc mounted on the rear axle is efficient and enough for the speeds that we would be attaining with the kart. We haven’t used single discs on each wheel as it would increase the kart weight unnecessarily and the braking force would be too high.
Location = Rear
Diameter = 210 mm
Type = Disc

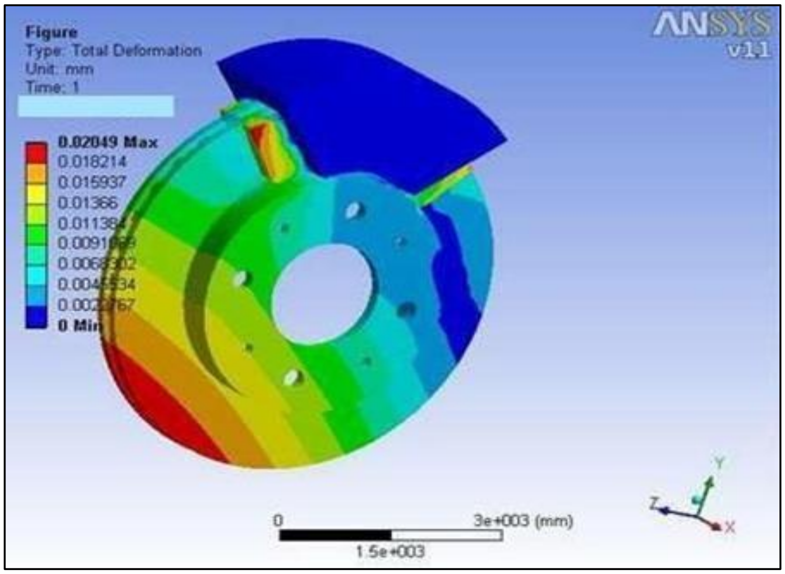


Fig. 7: Disc Braking System

E. Tyres & Wheels

For the kart, we planned on using specially made go-kart tyres for the rear and front respectively. These tyres are thinner, lighter and give good handling without compromising on the traction.

Front
Rim Diameter = 230mm
Tyre Size = 360mm x 80mm Rear
Rim Diameter = 240mm
Tyre Size = 410mm x 110mm

F. Body Works

Chassis Material = Chromally Quality = AISI 4130 Diameter = 30 mm
Side Bumper = Aluminium pipe 30mm Front Bumper = Aluminium pipe 30mm Rear Bumper = Aluminium pipe 30mm

G. Material Selection

Refer Section IV & V

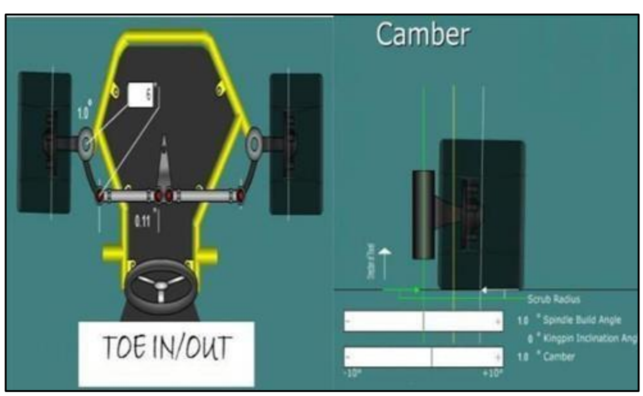
H. Basic Specification

Wheel Base = 1328 mm Track Width = 934.72 mm Base Clearance = 66 mm

XI. DYNAMIC CALCULATIONS

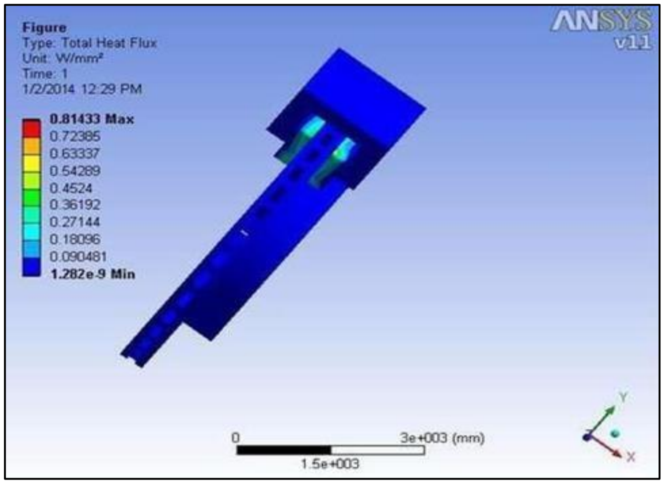
A. Steering

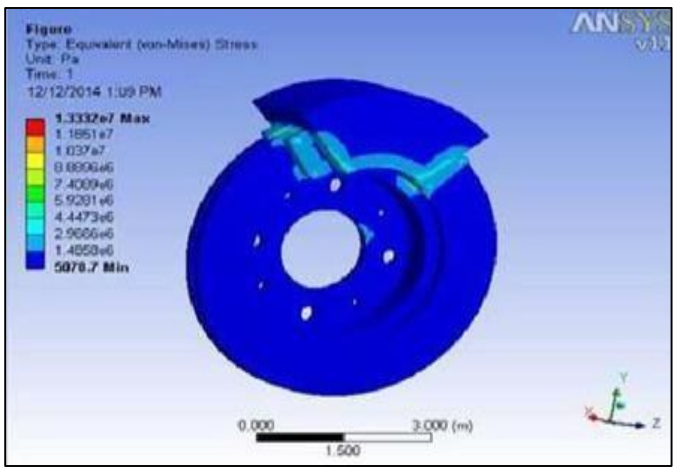
Steering Angle = $\cos^{(-1)}(a \div w) = 37^\circ$
Turning Radius $R = (w/\sin x) + (a \times \cos x)$
$= 2.69$ m
Camber = 1º positive Toe In = 1º



B. Braking

Stopping Distance, D = (mv^2)/(2AFu)
= 12.7 m
Stopping Time, T = 2D/V
= 1.4 sec Deceleration = (V^2)/2D
= 12.82 m/s.





XII. CONCLUSION

In this work, a detailed methodology of virtual design and testing has been presented including the reason of using the materials for fabrication of the chassis and axle.

Also, the reasoning of fabrication of new chassis design of go-kart which is different from the standard go-kart has been given and proven.

Even the entire process of design and testing proposed has shown interesting results but methodology must be still validated through dynamic experimental tests. This will allow the creation of mathematical model completely defined and Validated, giving the basis of future developments regarding the optimization process of Go-kart performance.

XIII. SOFTWARES USED

NX CAD
ANSYS v13

REFERENCES

[1] PTC Pro Wildfire 2.0 user's guide
[2] Design data handbook Vol I & Vol II, Prof. Lingaih, University College of Engg., Bengaluru.
[3] Design of Machine Elements – I , Prof. J. B. K. Das and Dr. P. L. Srinivasa Murthy

