Study on Design and Analysis of a Go-kart Chassis

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Abstract:

A Go-Kart is a small four wheeled vehicles without suspension or differential. It is a light powered vehicle which is generally used for racing. This paper is aimed to model and perform the dynamic analysis of the go-kart chassis which is of constructed with circular beams. Modelling and analysis are performed in SOLIDWORKS and ANSYS respectively. The go-kart chassis is different from ordinary car chassis. The chassis is designed in such a way that it requires less materials and ability to withstand loads applied on it. The design and Simulation aspects of designing go-kart the report explains objectives, assumptions and calculations made in designing a go kart. The objective is to design a safe and functional vehicle based on rigid and torsion free frame Strength and light weight are the basic consideration for choosing the chassis material. AISI 1018 is the suitable material to be used for the go-kart chassis which is a medium carbon steel having high tensile strength, high machinability and offers good balance of toughness and ductility.

Keywords: Chassis, Go-Kart, AISI 1080, Wheelbase, Track width, Frame Analysis.

1.0 Introduction:

Racing is an enormously complicated activity at the higher level of sport and significantly so at any level. At the very heart of this activity is the problem of achieving a performance from the driver-vehicle entry which, in the particular race environment, exceeds the competition. This is the challenge. It is the dynamic behavior of the combination of high tech machines and infinitely complex human beings that makes the sport so intriguing for participants and spectators alike.

The objective of go kart vehicle is to develop a frame with an optimum combination of stiffness, strength and weight. Components and parts used in our vehicle are being designed carefully with full attention given to the optimization based on results obtained from analysis of various subsystems. The aim is to create an industrial level database of part models and drawings in order to emulate the process of industrial design and mass production best in our capability.

Go-Kart is a great outlet for those interested in racing because of its simplicity, cost and safer way to race. The tracks go-kart is similar to F1 racing track. A go-kart is powered by 125cc engine in most of the countries. In some countries, go-karts can be licensed for use on public roads. Typically, there are some restrictions, e.g. in the European Union a go-kart on the road needs head light (high/low beam), tail lights, a horn, indicators and a maximum of 20 HP.

2.0. CHASSIS DESIGN CRITERIA

The chassis has been designed by taking factors like dimensional limits, operational restrictions, regulatory issues, contractual requirements and human ergonomics as a priority. A basic chassis frame of circular pipes was designed and selected by taking the points of strengths into consideration. The chassis of go-kart is a skeleton frame made up of hollow pipes and other materials of different cross sections. The chassis of go-kart must be stable with high torsional rigidity, as well as it should have relatively high degree of flexibility as there is no suspension. So that it can give enough strength to withstand with grub load as well as with other accessories. The chassis is designed by taking ergonomics as main factor. The chassis is designed in such a way that it should ride safe and the load that applies does not change the structural strength of the chassis. The chassis is the backbone of the kart as it has to be flexible so that it must be equal enough to the suspension. Chassis construction is normally of a tubular construction, typically GI with different grades. In this kart, we use AISI 1080 material. The chassis supports the power unit, power train, the running system etc. The design of Chassis was done in CATIA V5 software. The chassis has the ability to carry and support the power train, power unit, running system, etc. the go-kart chassis has been classified into different types such as open, caged, straight, and offset.

- Open karts do not have chassis.
- Caged kart chassis surrounds the driver and have a roll cage which is mostly used in dirt tracks.

2.1. DESIGN METHODOLOGY:

1. The wheelbase and track width was finalized for vehicle
2. Extra members were introduced in the chassis for the mounting, but keeping in mind the weight factor.
3. Components were placed in accordance with the weight balance of vehicle
4. Ground clearance is taken in account
5. Engine position was finalized for optimum weight balance
6. Ergonomics of vehicle was kept in mind, pencil sketches were made and design is checked and changes were made with driver comfort ability.
7. Analysis was done to check the impact resistance of the frame and to determine the factor of safety
8. After approximation weight and acceleration of the kart was known, cross-section of chassis pipes was determined by using bending moment formula.

3.0. MATERIAL SELECTION:

The frame material has the appropriate values of bending stiffness and bending strength that have to be calculated about the axix that given the lowes value. Bending stiffness is given by EI product and bending strength is given by the value of SyI/c.

Alloy steels are designed by AISI four - digit number. They are more responsive to mechanical and heat treatments than carbon steels. They comprise different types of steels with components which exceed the limitations of B, C, Mo, Ni, Mn, si, cr and Va in the carbon steels.

AISI 4130 alloy steel is a medium carbon, low alloy steel in ASTM A29 standard. ASTM 4140 steel is also commonly referred to as chromo steel, or chrome molly steel, containing nominally 0.28-0.33% Carbon, 0.8-1.1% Chromium and 0.15-0.25% Molybdenum. It is similar to 4140 steel which has a higher carbon level (0.28-0.33%), giving 4130 material improved weld ability, at the expense of through thickness strength. With the proper heat treatment it is also readily machined. Annealing ASTM 4130 alloy steel offers excellent ductility. AISI 4130 steel is usually supplied as round bar commonly in the hardened and tempered condition.

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

Table 3.0: Chemical Composition, Characteristics, and Properties

CHEMICAL ANALYSIS

Steel designation	Chemical composition								
Simbolic	C	Mn	Si	P max	S max	Cr	Mo	V	Al
AISI 4130	0,28 ÷ 0,33	0,40 ÷ 0,60	0,15 ÷ 0,35	0,035	0,040	0,60 ÷ 1,10	0,15 ÷ 0,25	-	-

Concentration limits of the elements that are not indicated in the table can be deduced in the en 10020 regulation.

MECHANICAL CHARACTERISTICS

Steel		d ≤ 16mm				16mm < d ≤ 40mm				40mm < d ≤ 100mm				100mm < d ≤ 160mm			
Symbolic	Numeric	R_e min	R_m	A min	KCU min	R_e min	R_m	A min	KCU min	R_e min	R_m	A min	KCU min	R_e min	R_m	A min	KCU min
		N/mm²		%	J	N/mm²		%	J	N/mm²		%	J	N/mm²		%	J
AISI 4130	1,7218	685	880 ÷ 1080	12	32,5	635	830 ÷ 1030	12	32,5	520	740 ÷ 880	13	30	420	690 ÷ 830	15	30

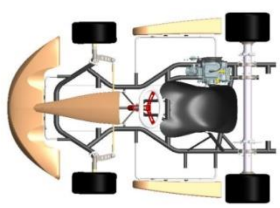
JOMINY HARDENABILITY

Steel designation		Range limits	HRC hardness measured from the quenched end of the test tube (mm)												
Symbolic	Numeric		1,5	3	5	7	9	11	13	15	20	25	30	35	40
AISI 4130	1,7218	max	56	55	53	51	49	47	45	42	39	37	35	33	32
		min	46	45	42	38	35	30	28	26	24	23	21	20	-

- **VEHICLE VIEWS**

FRONT VIEW

BACK VIEW



TOP VIEW

ISOMETRIC VIEW 01

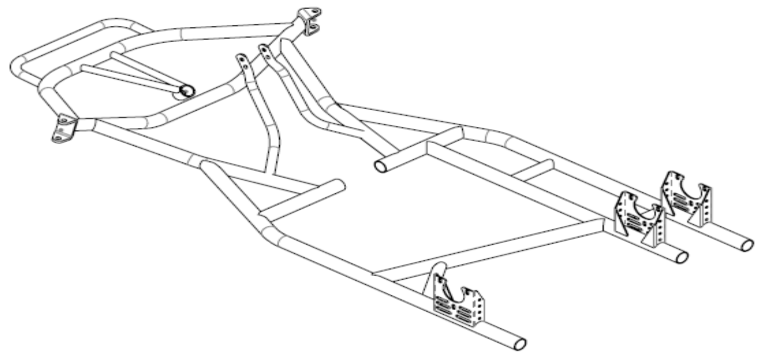
SIDE VIEW

ISOMETRIC VIEW 02

4.0. FRAME ANALYSIS:

Finite element analysis (FEA) is a computerized method for predicting how a product reacts to real world forces, vibration and other physical effects. Finite element analysis whether a product will break, wears out, or work the way it was designed. Here we divide the roller cage into small sizes known as element and collection of elements on model form a mesh.

The computer analysis the elements and shows us a collective result. The computer solves by the computational method provided. The material and structure of roll cage has been finalized and the FEA was performed on it. It is tested whether the roll cage will be able to withstand torsion, impact. To get the chassis of better strength, little iteration were done in the Design. And on the basis of FEA results better chassis was chosen.



3D ISOMETRIC

5.0ANALYSIS OF CHASSIS:

The analysis of the chassis designed in SOLIDWORKS is analyzed using ANSYS software. With help of analysis, One can know the strength of the design and the load carrying capacity, stresses induced in the structure, torsional Rigidity and also overall dynamic loads applied. Different loads are applied on each side of the chassis i.e. on the Front bumper, rear bumper and side bumper.

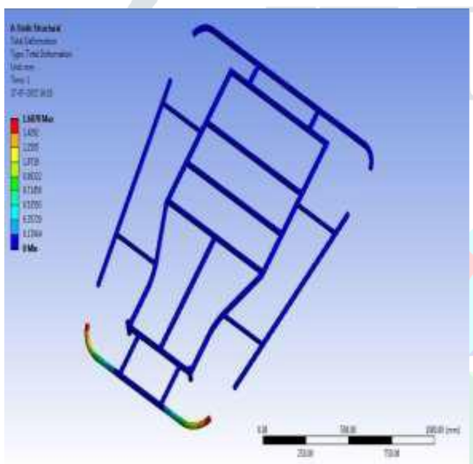


Fig.3 Front load displacement in ANSYS

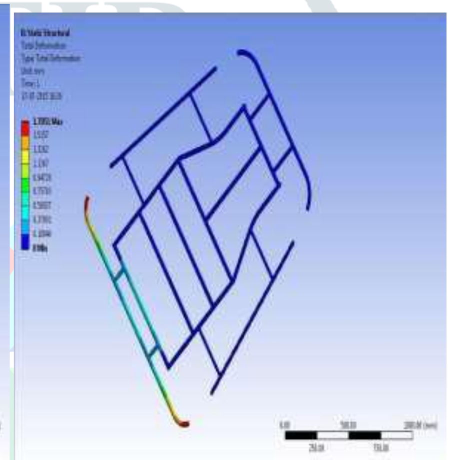


Fig.4 Rear load displacement in ANSYS

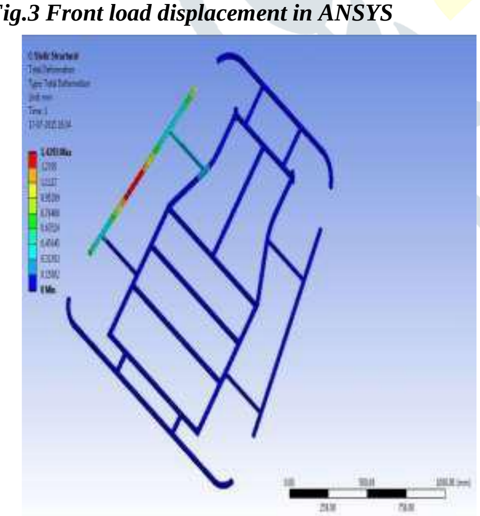


Fig.5 Side load displacement in ANSYS

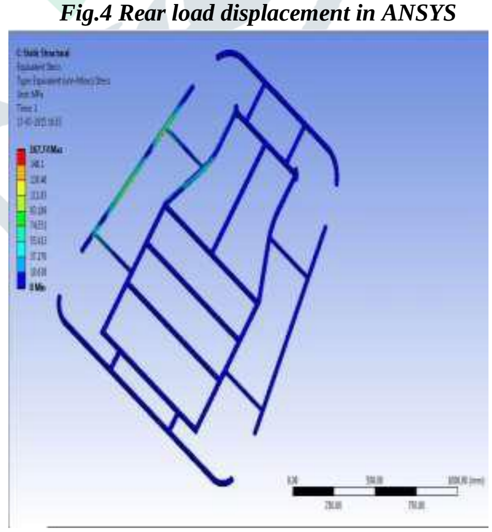


Fig.6 Side load von mises stress in ANSYS

6.0 CALCULATION:

- Total vehicle weight : 140 Kg (with driver)
- Maximum speed : 80 Kmph
- Frame is fixed from the front and rear axles.

6.1 Front Impact Analysis:

- In front collision test, the go kart collides with a stationary rigid wall and comes to rest. Using the projected vehicle/driver mass of 140kg, the impact force was calculated based on a G-load of 4.
  F=ma ...(1)
  =140*4*9.81
  =5949 N
  Impulse time = weight*(velocity/load)....(2)
  = 140*(22.22/5494)
  =0.57 seconds

  We apply 5494 N from the front for the test of front impact of roll cage structure of vehicle for determining strength at the time of front collision.

6.2. Rear Impact Test

- Using the projected vehicle/driver mass of 140 kg, the impact force was calculated based on a G-load of 4.
  - F=ma ...(1)
    =140*4*9.81
    =5949 N
  Impulse time = weight*(velocity/load)....(2)
  = 140*(22.22/5494)
  =0.57 seconds

  We apply 5494 N from the front for the test of rear impact of roll cage structure of vehicle for determining strength at the time of rear collision.

6.*3 SIDE IMPACT TEST:*

- Using the projected vehicle/driver mass of 140 kg, the impact force was calculated based on a G-load of 4.
  - F=ma ...(1)
    =140*2*9.81
    =2797 N

  - Impulse time = weight*(velocity/load)....(2)
    = 170*(22.22/2797)
    =1.11 seconds
- We apply 2797 N from the side for the test of side impact of roll cage structure of vehicle for determining strength at the time of side collision.

7.0. Torsion Test:

- Int this test the flexibility of frame has been tested using finite element methods. The test has been carried out by fixing the rear axle and a load on the front axle has been applied.

Front impact analysis

Figure: Boundary conditions

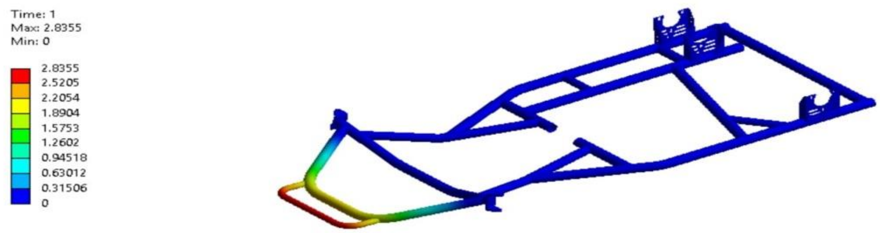


Figure: deformation

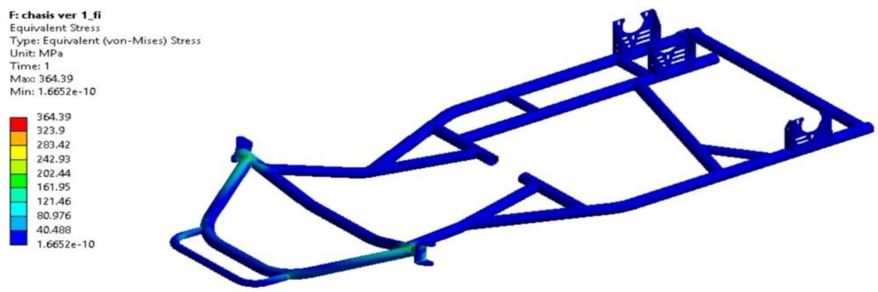
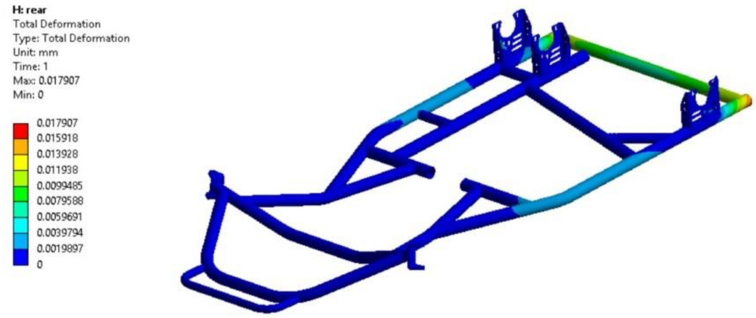


Figure: Stresses

Rear impact analysis

Figure: Boundary conditions



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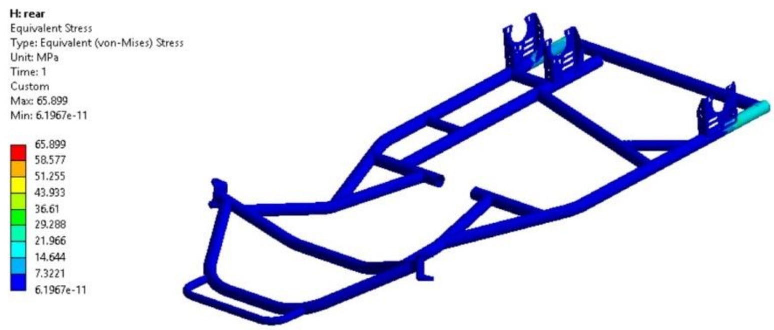
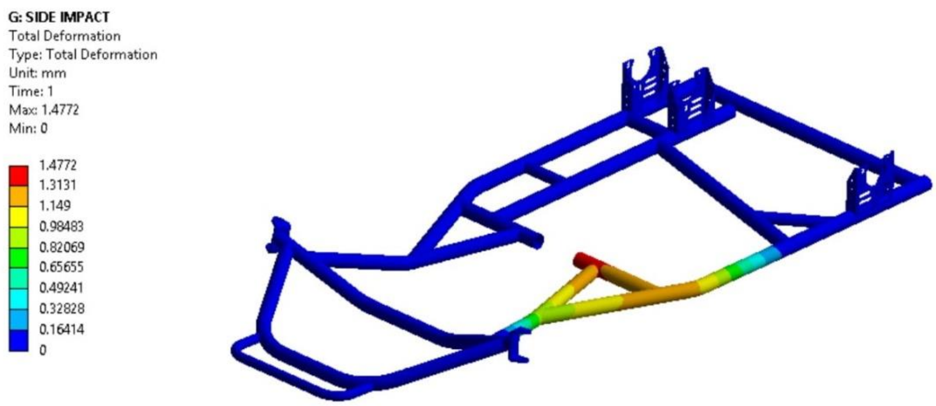


Figure: Stresses

Side impact analysis

Figure: Boundary conditions



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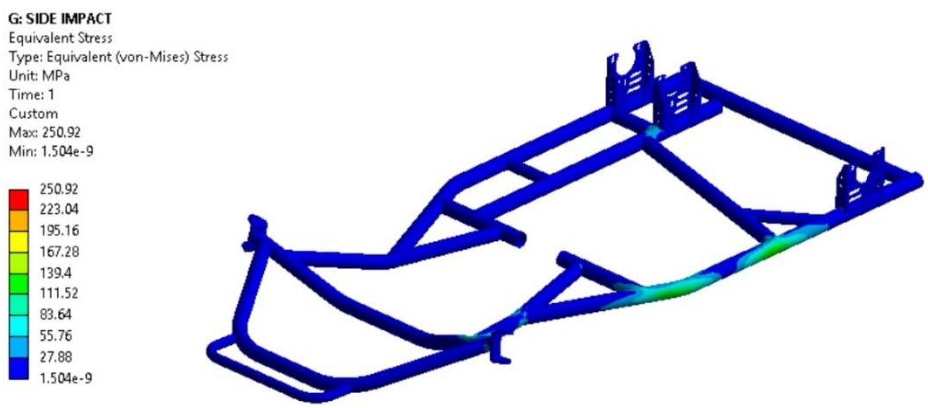

Figure: Stresses

Torsion test

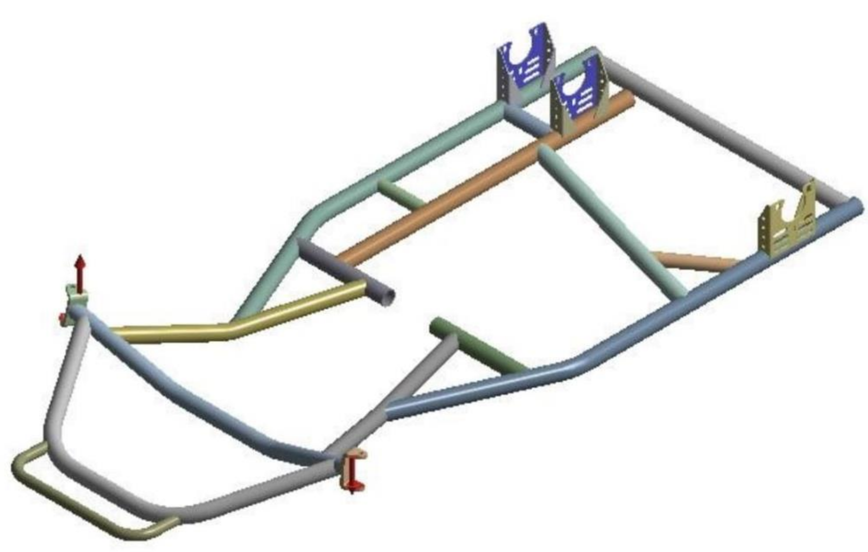

Figure: Boundary conditions

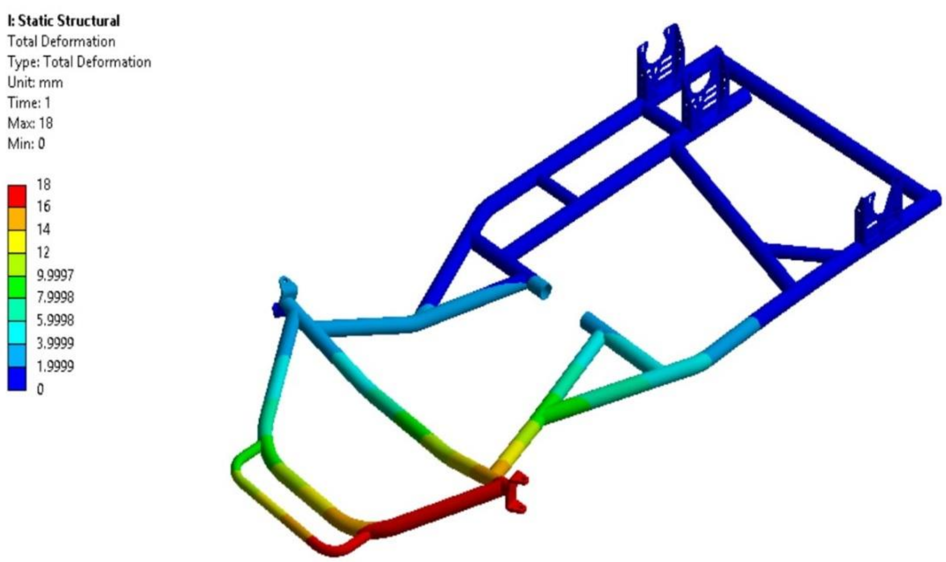

Figure: deformation

8.0. CONCLUSION:

The designing of the chassis for Go-Kart helps in identifying the strength and weakness of the build and design. With the help of the analyses, it will be easy to modify the chassis to rectify the weak points and to strengthen it with slight modifications. It will be able to carry all the components such as power train, power unit, wheels, tires and also it must have the capacity to carry a human weighing more than 70kg. On adding all the weights, it crosses more than 120kgs

9.0 REFERENCES:

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