Optimum Design and Analysis of Electric Kart Chassis

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Abstract:- Go kart is the well-known concept in student racing car without suspension. Also it is manufactured professionally to sell it to big malls, resorts, etc. The concept of electric kart is new. The electric kart works on the battery power and motor. In the following paper, research is restricted to only chassis of the kart. The chassis is designed in the CREO parametric 2.0 and impact analysis is done by using ANSYS Workbench 14.0.

The chassis is designed to accommodate 95% of male and female of India. The analysis of chassis is carried out to validate the chassis design at maximum speed.

Keywords:- *Electric kart, Chassis, CREO Parametric, ANSYS Workbench 14.0.*

I. INTRODUCTION

A chassis consists of an internal vehicle frame that supports an artificial object in its construction and use, can also provide protection for some internal parts. An example of a chassis is the under part of a motor vehicle, consisting of the frame (on which the body is mounted). If the running gear such as wheels and transmission, and sometimes even the driver's seat, are included, then the assembly is described as a rolling chassis.

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

II. METHODOLOGY & OBJECTIVE

The design of any component follows three principles

- Safety
- Optimizations
- Comfort

The designed chassis of the kart should be act as safe guard to driver although it is comfortable for driver. The optimization is required to reduce the cost and weight of the chassis which will ultimately increases the performance. The following process is followed to design and analyses the chassis of kart.

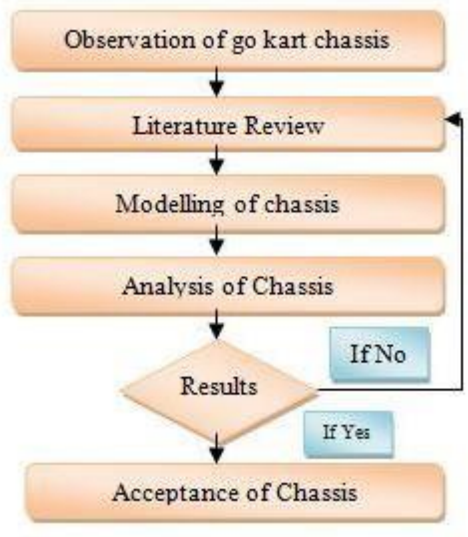

Fig 1:- Flowchart of Design process

The objectives of the study are:-

- To develop a geometrical model of electric kart chassis by using CAD software.
- To find out maximum stresses and deformation occur in impact analysis.
- To optimize the chassis design of kart.
- To find out material suitability for the kart chassis.

III. STEPS TO DESGIN THE CHASSIS

The steps involved in the designing of chassis are described below.

- Shape Design
- Dimension assumption
- Mass Distribution
- Calculating Centre of gravity
- CAD Modeling
- Analysis of Chassis
- Weight Reduction
- Consideration of Manufacturing Technique

IV. MODELLING OF THE CHASSIS

The modelling of the chassis is done by using CAD software. The software used for the modelling is CREO Parametric 2.0. The model is created by using various commands in the part environment.

The following figure shows the 3-D view of the chassis.

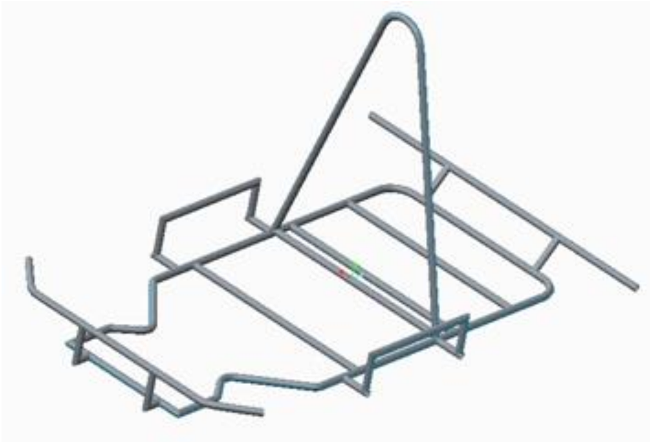

Fig 2:- D CAD Model

V. MATERIAL SELECTION

For the chassis of electric kart three materials are considered for the analysis i.e. AISI 1018, AISI 4130 and AISI 1026. After analysis it is found that the stresses generated in AISI 4130 are quite less than the material AISI 1018. On the other hand, the cost of AISI 4130 is 3 times more than the AISI 1018 and cost of AISI 1026 is 2 times more than AISI 1018.

The material selected for the electric kart chassis is AISI 1018 as it is cheaper than the other two materials discussed above and it is readily available in the market. Also it is best suitable for manufacturing processes.

Following are the properties of AISI 1018:

- Density = 7870 kg/mm^3
- Modulus of Elasticity = 205 GPa
- Bulk Modulus = 140 GPa
- Modulus of Rigidity = 80 GPa
- Poisson's Ratio = 0.290
- Yield Tensile Strength = 370 MPa
- Yield Compressive Strength= 370 MPa
- Ultimate Tensile Strength = 460 MPa

VI. ANALYSIS OF CHASSIS

The analyses of chassis are carried out in the ANSYS Workbench 14.0. The chassis is analyzed for the front impact, rear impact and side impact. The structural analysis is carried out to find out the maximum stresses developed and deformation occurs. The following procedure is followed to analyze the chassis in the ANSYS workbench 14.0.

A. Importing of geometry

The model created in the CREO Parametric 2.0 is saved as IGES file and imported in the ANSYS Workbench 14.0. The fig.3 shows the imported geometry of the chassis.

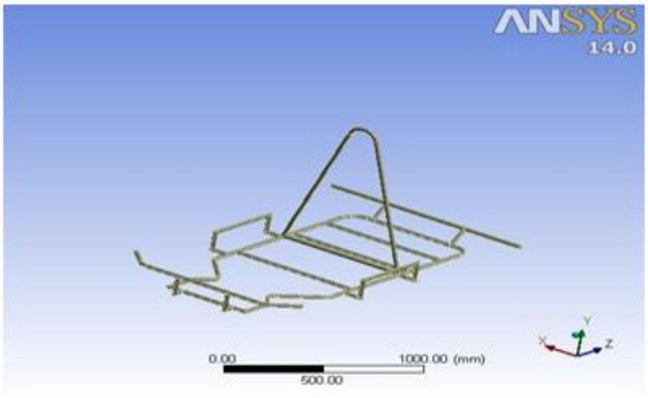

Fig 3:- Imported CAD geometry

B. Meshing

Meshing is the operation in which geometry is converted into small elements. Fig.4 shows the meshed view of the chassis. There are 40024 nodes and 17139 elements are formed in the chassis. The fine meshing is done to evaluate accurate reults.

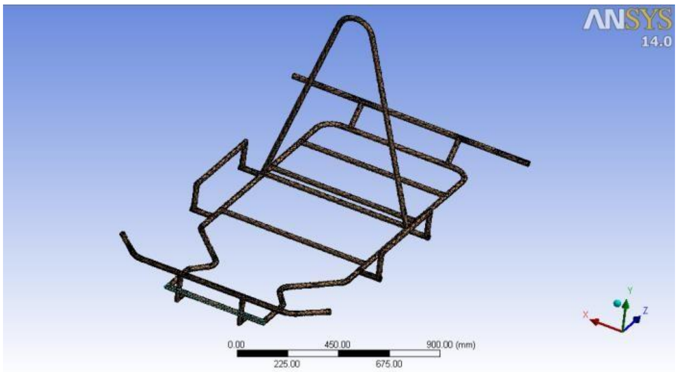

Fig 4:- Meshed view of chassis

C. Constraining

Constrains are used to fix the degrees of freedom. For the front impact analysis, load is applied at the front bumper and rear bumper is fixed; for rear impact analysis, front bumper is fixed and load is applied at the rear bumper and for side impact analysis, load is applied at the one side and another side is fixed. Fig.5 shows the constrained figure of front impact analysis.

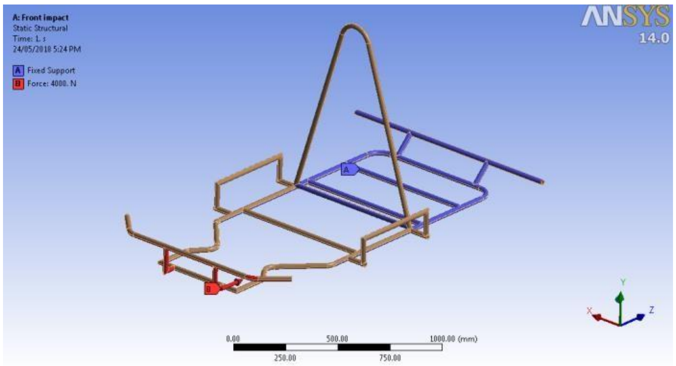

Fig 5:- Constrained view of chassis

D. *Results*

The last step of analysis is generating results. The results are taken is form of stress induced, deformation occur and strain induced. Fig.6. shows the equivalent stress contour in the chassis.

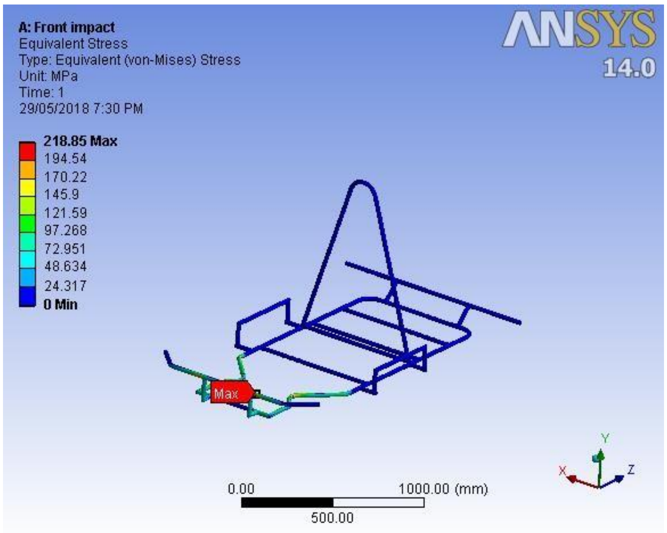

Fig 6:- Equivalent stress contour

➢ *Front Impact Analysis*

For the front impact analysis, the impact load is applied at the front bumper and the rear bumper and the tires points are fixed. The analysis is carried out for the speed of 90 km/h. The load applied is approximately 2.5G and the impact time is considered as 2 second according to standards.

$$\text{Force applied, } F = \frac{2 \times m \times v}{t}$$

Where,

m = mass of kart (vehicle)
v = velocity of the kart
t = impact time

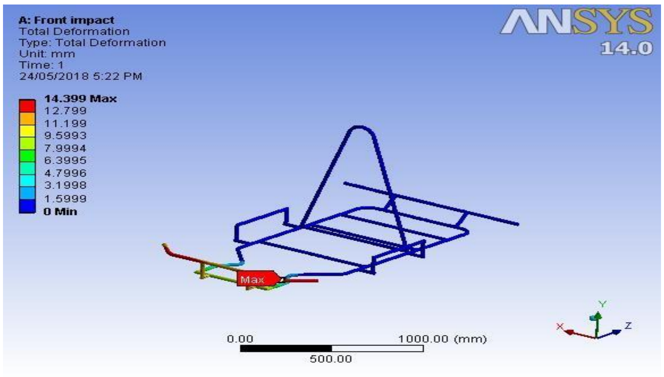

Fig 7:- Front impact stress contour

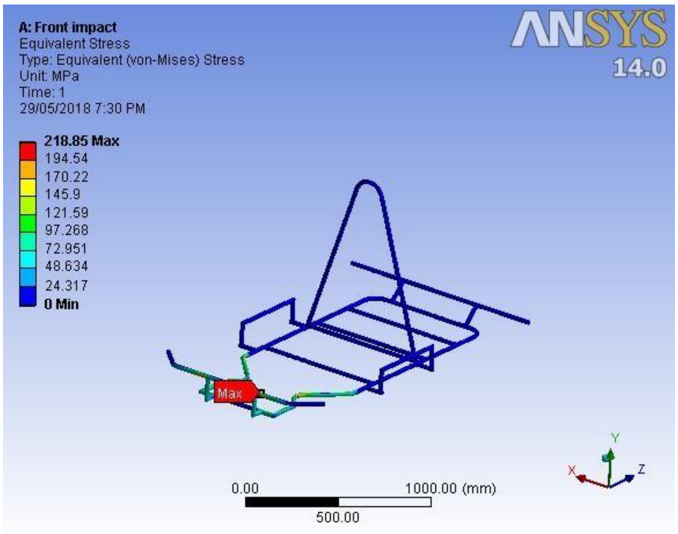

Fig 8:- Front impact deformation contour

Front Impact Analysis	
Load Applied (N)	4000
Velocity (km/h)	90
Impact time (second)	2
Gross weight (kg)	160
Maximum Force (G)	2.5
Maximum stress(MPa)	218.18
Maximum Deformation(mm)	14.39
Factor of Safety	2.10

Table 1. Result of front impact analysis

Fig.7 and fig.8 shows the equivalent stress contour and deformation contour of front impact respectively. Table 1 shows the result of front impact analysis.

➢ *Rear Impact Analysis*

For the rear impact analysis, the impact load is applied at the rear bumper and the front bumper and the tires points are fixed. The analysis is carried out for the speed of 90 km/h.

The load applied is approximately 2.5G and the impact time is considered as 2 second according to standards.

$$\text{Force applied, } F = \frac{2 \times m \times v}{t}$$

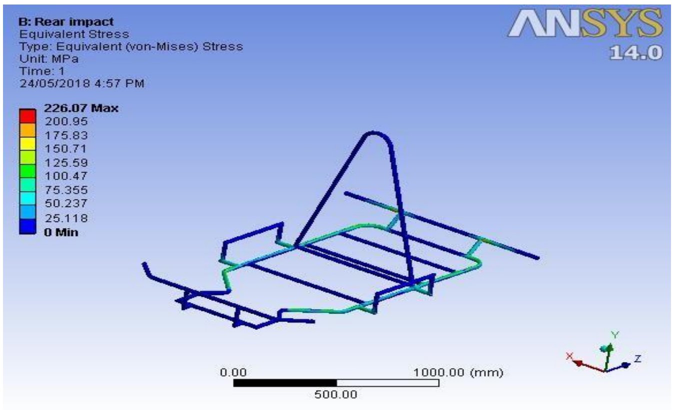

Fig 9:- Rear impact stress contour

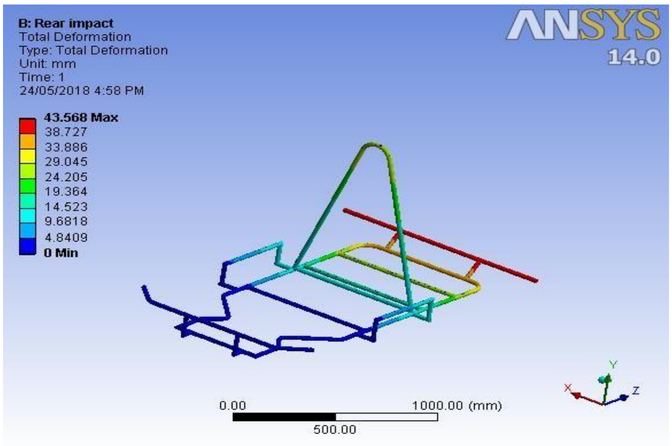

Fig 10:- Rear impact deformation contour

Rear Impact Analysis	
Load Applied (N)	4000
Velocity (kmph)	90
Impact time (second)	2
Gross weight (kg)	160
Maximum Force (G)	2.5
Maximum stress(MPa)	226.87
Maximum Deformation(mm)	43.58
Factor of Safety	2.02

Table 2. Result of rear impact analysis

Fig.9 and fig.10 shows the equivalent stress contour and deformation contour of rear impact respectively. Table 2 shows the result of rear impact analysis.

- *Side Impact Analysis*

For the side impact analysis, the impact load is applied at the side bumper and another side bumper is fixed. The analysis is carried out for the speed of 90 km/h. The load applied is approximately 2.5G and the impact time is considered as 2 second according to standards. As analysis is carried out for worst condition, side impact analysis also carried out at 90 km/h.

$$\text{Force applied, } F = \frac{2 \times m \times v}{t}$$

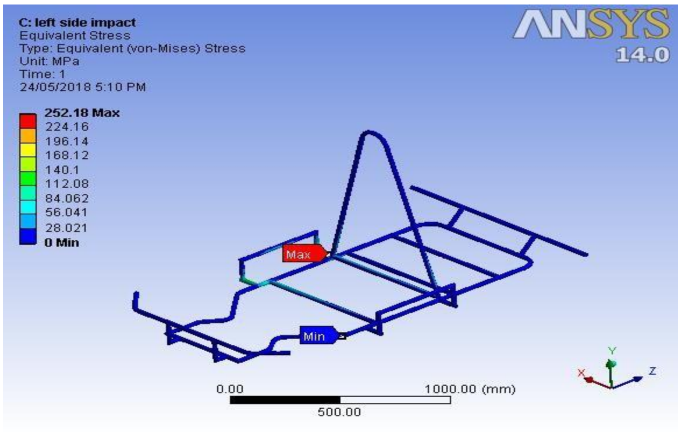

Fig 11:- Left side impact stress contour

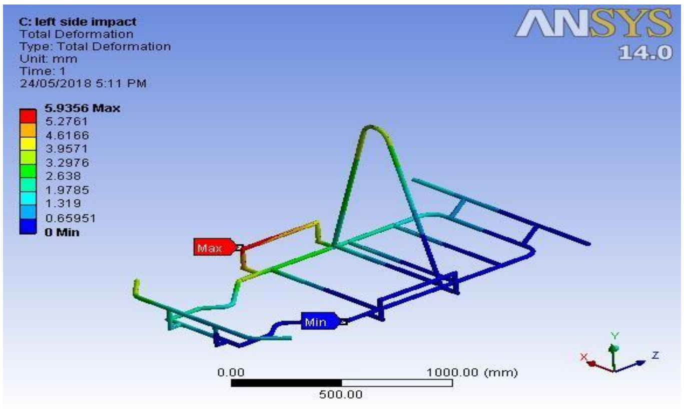

Fig 12:- Left side impact deformation contour

Left side Impact Analysis	
Load Applied (N)	4000
Velocity (kmph)	90
Impact time (second)	2
Gross weight (kg)	160
Maximum Force (G)	2.5
Maximum stress(MPa)	257.10
Maximum Deformation(mm)	5.93
Factor of Safety	1.78

Table 3:- Result of left side impact analysis

Fig.11 and fig.12 shows the equivalent stress contour and deformation contour of left side impact respectively. Table 3 shows the result of left side impact analysis.

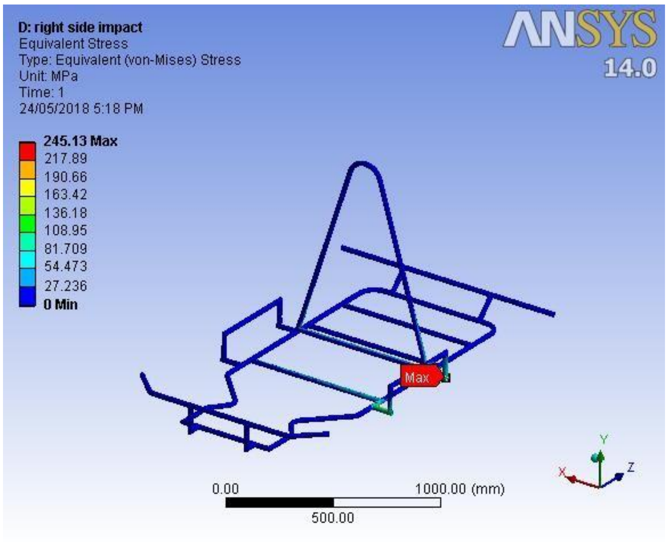

Fig 13:- Right side impact stress contour

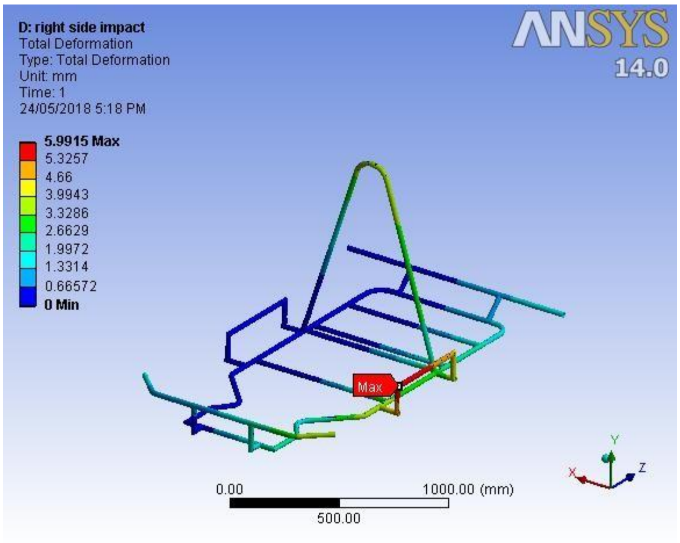

Fig 14:- Right side impact deformation contour

Right side Impact Analysis	
Load Applied (N)	4000
Velocity (kmph)	90
Impact time (second)	2
Gross weight (kg)	160
Maximum Force (G)	2.5
Maximum stress(MPa)	245.13
Maximum Deformation(mm)	5.99
Factor of Safety	1.87

Table 4. Result of right side impact analysis

Fig.13 and fig.14 shows the equivalent stress contour and deformation contour of left side impact respectively. Table 3 shows the result of left side impact analysis.

VII. RESULT AND CONCLUSION

The model of the chassis is created successfully using CREO Parametric 2.0. The analyses are carried out using ANSYS Workbench 14.0. The results are taken in the stress and deformation contour.

The stress induced in the chassis in front impact is……., in rear impact is 226.87 MPa and in side impact are 257.10 MPa & 245.13 MPa respectively. The stresses induced in the chassis are lesser than the ultimate tensile stress. Therefore the design of chassis is safe.

The material selected for the chassis is AISI 1018 as it is readily available in market and cost of material is less than the other two materials considered for the analysis. Also it is best suitable material for manufacturing.

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