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# Design and Simulation of Eco-kart Chassis Frame

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***Abstract:-***This Paper aims to design, modal, stimulate and perform the static analysis of a Eco-kart Chassis made up of Circular cross section pipes. Modeling and Analysis are performed using Software i.e Creo2.0 and ANSYS 14.0 respectively according to the rulebook provided. The maximum deflection is determined by performing static Analysis with consideration to position of motor and battery position , braking System, steering system, seat position and many more. The FEA results are verified by comparing with analytical calculations. Considering these results modal is modified.

***Keywords*:-**FEA, Model, Optimization, Analysis, ANSYS14.0, Chassis.

*****

## I. INTRODUCTION

Now-a-days there is increase in Pollution all over the world and the main factor responsible for this is the harmful gases leaving from the Automobiles. Also there is a growing demand for fossil fuel like petrol and diesel to power the automotive and other needs of human. Due to excessive use fossil fuels, the level of pollution from vehicle is increasing day by day. All these factors are responsible for various problems in human such as Headache, stress, reduced performances.

To minimize all these Problems there is a need to explore alternative in place of fossil fuel powered vehicle. Battery powered vehicles are not so popular in India as they need frequent charging, small range of distance travelled in single charging, small range of speed and short battery life. To explore these ideas to students and to increase the focus on this research, the Society of Automotive Engineering started competitions in which students have to design and Fabricate the Kart which will be powered electric Battery.

## II. DESIGN METHODOLOGY:

- Enhance driver safety
- Resist static and dynamic loads
- Should be small in size
- Light in weight
- Low cost
- Provision of sufficient space for mounting of components
- Abiding Ergonomics and Aesthetics.

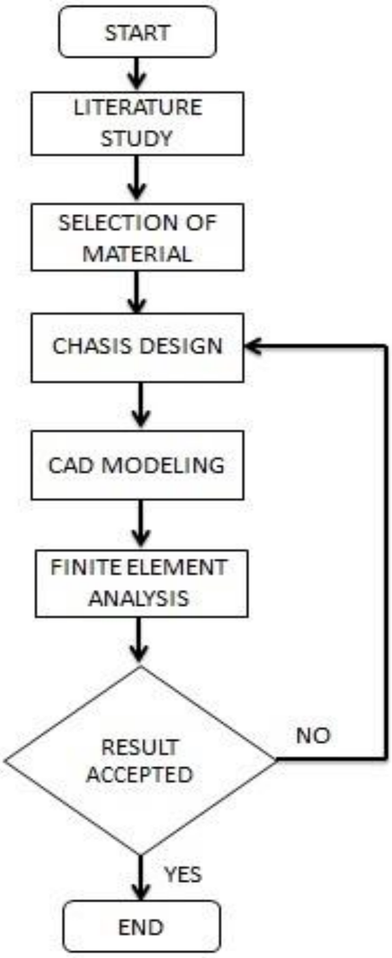


FIG.1 FLOW CHART : PROCESS METHODOLOGY

### *2.1. Selection of Material:*

The material selection is a key factor while determining the strength of vehicle. According to the constraints of event the material should not be mild steel. Thus we had to look for alternative material. The materials considered are AISI 4130,Stainless Steel 202,Stainless steel 304,Aluminum 6063.

| Properties | AL6063 | AISI4130 | SS202 | SS304 |
|---|---|---|---|---|
| Density of Material | 2.7 gm/cm³ | 7.85gm/cm³ | 7.8gm/cm³ | 7.85gm/cm³ |
| Chemical Composition | Al → Max 97.5% | Fe → 97.03% - 98.22% | Fe → 68% | C 0.08% |
| | Cr → Max 0.1% | Cr → 0.80% - 1.10% | Cr → 17% - 19% | Mn 2% |
| | Cu → Max 0.1% | Mn → 0.40% - 0.60% | Mn → 7.5% - 10% | P 0.045% |
| | Fe → Max 0.35% | C → 0.280% – 0.330% | Ni → 4% - 6% | S 0.03% |
| | Mg→0.45 % - 0.9% | Si → 0.15% - 0.30% | C → ≤0.15 % | Si 0.75% |
| | Mn → Max 0.1% | Mo→ 0.15% - 0.30% | Si → ≤1% | Cr 18-20% |
| | Si → 0.2% - 0.6% | | N→ ≤0.25% | Ni 8-12 % |
| | | | | N 0.1% |
| | | | | Fe 65% |
| Ultimate Tensile Strength (Sut) | 241 MPa | 560 MPa | 515MPa | 510 MPa |
| Yield Tensile Strength (Syt) | 214 MPa | 460 MPa | 275MPa | 210 MPa |
| Modulus of Elasticity | 68.9 GPa | 190-210GPa | 190-210GPa | 190 GPa |
| Poisson's | 0.33 | 0.28 | 0.28 | 0.265 |
| Machinability | Easily Machined | Easily Machined | Easily Machined | Easily Machined |
| Welding | Any Commercial Method | Any Commercial Method | Any Commercial Method | Any Commercial Method |
| Availability | Easily Available | Not Easily Available | Easily Available | Easily Available |

FIG.2 MATERIAL PROPERTIES

Aluminum 6063 has an advantage of being light in weight but it has less ultimate strength and yield strength. AISI 4130 has the best possible properties but it is not easily available and is costly. Thus SS 202 and SS 304 were thealternatives remaining. SS 202 has Mn content in place of Ni as compared to SS 304 which resultsin improved properties. Thus SS 202 is selected.

### *2.2. Chassis Design:*

The chassis can be called as skeleton of a vehicle besides its purpose being seating the driver, providing safety and incorporating other sub systems of the vehicle. Thus while designing we had to consider the driver and batteriesweight as the major load acting on the chassis thus to support this load we have equipped a structure by two cross members. To achieve greater stability we maintained the weight distribution of front: rear = 45:55 and left: right = 50:50. The kart is also equipped with front, side and rear bumpers to enhance driver safety. Hollow circular members are used throughout the chassis frame as they have higher bending stiffness as compared to solid circular members. The outer diameter of the members is 1 inch and its thickness is 2 mm which is sufficient to sustain the static and dynamic loads.

### *2.3. CAD Modeling:*

Initial sketches were drawn considering the static load, dynamic load, load due to motor torque and braking torque.The new design was then modeled on CREO 2.0 and later analyzed on ANSYS 14.0.

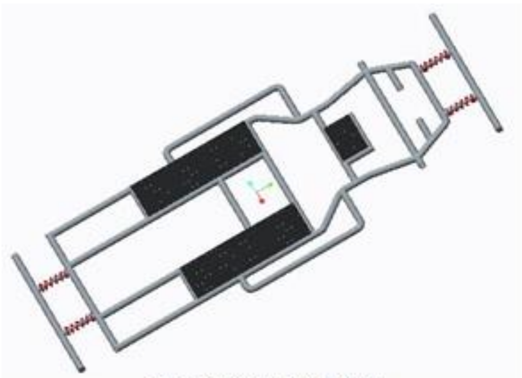

FIG.3 CHASSIS DESIGN

## III. FINITE ELEMENT ANALYSIS

The finite element analysis (FEA) used numerical method or often known as finite element method (FEM) that can be applied to approximate solution for an engineering problem. The approximate solution is obtained by idealized a product model by splitting it into as many small discrete pieces called finite elements or more commonlyknown aselements, which are connected by nodes. This dividing process is known as mesh generation. Each of the generated elements has exact equations that define how it reacts to certain load. Hence, accuracy of the solution can be increased by refining the mesh generation.

The main criteria in analysis are factor of safety, even stress distribution and the maximum stress induced. Loads are placed on wireframe model of the frame at the critical points to simulate the amount of force that the Vehicle would undergo from its own weight and the Driver in the Event of Collision. Analysis is conducted by use of Finite Element Analysis FEA on ANSYS Software. A 4-node quadrilateral (Quad4) shell type element is used while developing the mesh to model the hollow tubing.

### *3.1. Meshing:*

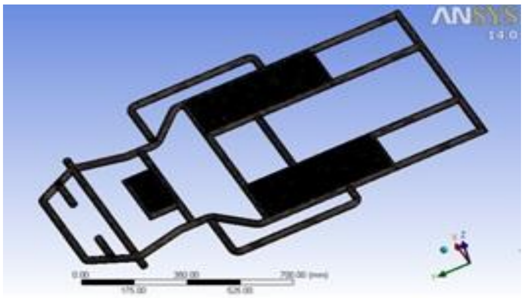


FIG.4 MESHING OF CHASSIS

### *3.2. Analysis:*

3.2.1. Dead weight Analysis**:**

Boundary Conditions selected are area of fixed point, in which Front nodes and rear nodes are fixed. The Driver weight, Battery and Motor weight is Considered on the various nodes oronmembers of Chassis while own weight of chassis is neglected.

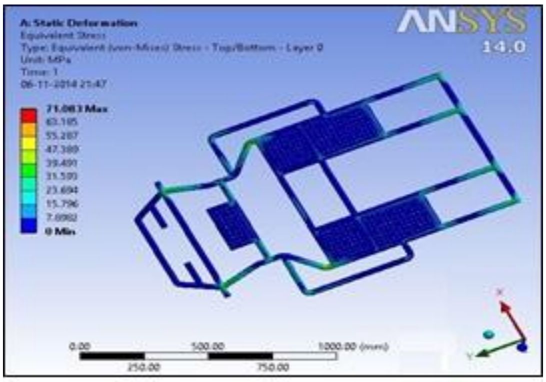


FIG.5 DEAD WEIGHT ANALYSIS

3.2.2 Crash Analysis:

To insure the safety of Passenger and vehicle, crash test are performed using simulated models.

A. Front Crash Analysis:
Generally in case of pure elastic collision in frontal impact the linear velocity remains at 40kmph.Hence the value of force is calculated by Mass Moment equation that is$F = P/\Delta T$

$$F = (m \times v)/\Delta T$$

$$F = (160 \times 11.11)/0.667$$

$$F = 2665\,N$$

This load is applied to the chassis from the front end and the rear endis held as fixed support. The result obtained is as below.

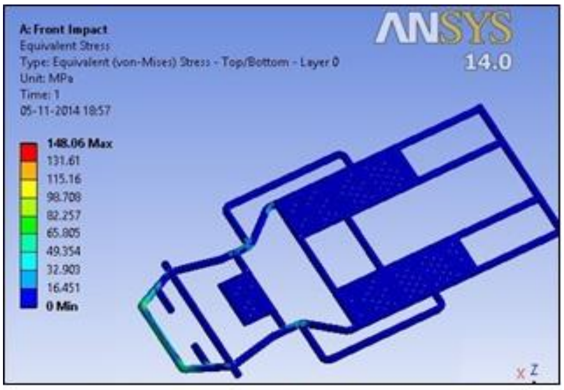


FIG.6 FRONT CRASH ANALYSIS

B. Rear Crash Analysis:
The rear impact load is calculated by same method as the front impactconsidering a vehicle at 12.5 m/s speed and is applied to the nodeswith thefront completely constrained this time.

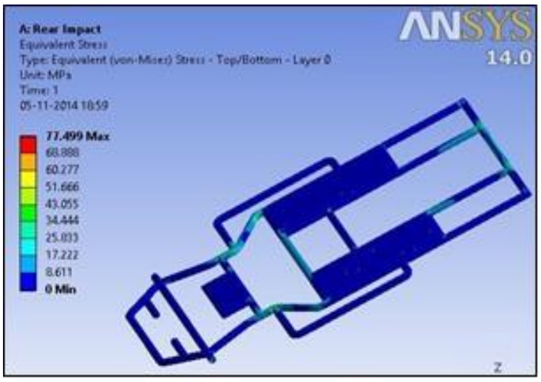


FIG.7 REAR CRASH ANALYSIS

C. Side Crash Analysis:
The side impact load is calculated by same method as the front impact considering a vehicle at 10 m/s speed and is applied to the nodes with the front and rear completely constrained this time.

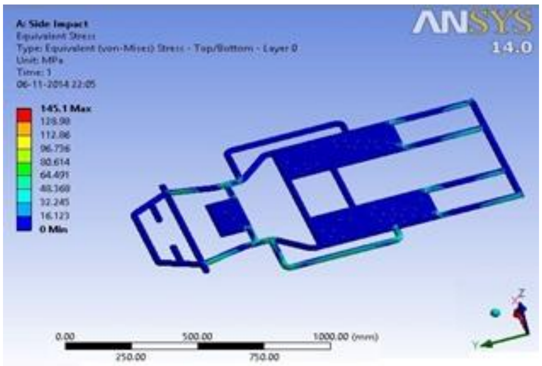


FIG.8 SIDE CRASH ANALYSIS

### 3.2.3. Modal Analysis:

Modal analysis is the study of dynamic properties of structure under vibrational excitation.

As a Kart travels along the road, the kart chassis is excited by dynamic forces induced by the road roughness, motor, transmission and more. Under such various dynamic excitations, the Kart chassis tends to vibrate. Whenever the natural frequency of vibration of a machine or structure coincides with the frequency of the external excitation, there occurs a phenomenon known as resonance, which leads to excessive deflections and failure. To avoid the resonance phenomenon, Modal analysis has been done.

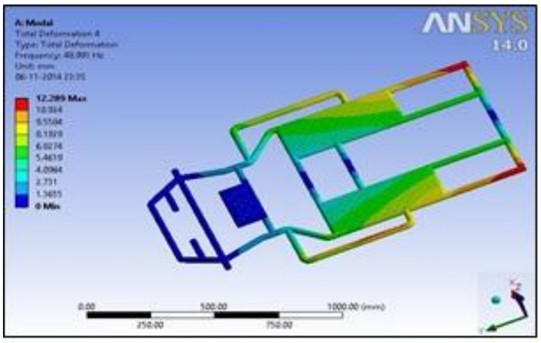


FIG.9 MODAL ANALYSIS

From the above fig. it is observed that the maximum deflection i.e. 12.2 mm occurs at48Hz. Hence itcan be said that the natural frequency of Kart is 48Hz.

## IV. RESULT AND TABLE:

$$Factor\ of\ Safety = \frac{Yield\ Stress}{Stress\ Generated}$$

| Factors | Dead Weight Analysis | Front Crash Analysis | Rear Crash Analysis | Side crash Analysis |
|---|---|---|---|---|
| Impact Force | Uniformly Distributed at Various Position | 2665 | 2998 | 2398 |
| Total Deformation(mm) | 0.885 | 0.4926 | 0.239 | 0.97885 |
| Stress Generated(MPa) | 71.083 | 148.06 | 77.499 | 145.1 |
| Factor of Safety | 3.86 | 1.85 | 3.54 | 1.89 |

FIG. 10 RESULT

Above table shows that the stress and the displacement values are within the permissible values also the Factor of Safety is maintained throughout the chassis Design.

## V. CONCLUSION

Design and Simulation of Eco-kart Chassis is carried out using Finite Element Method in which the maximum deflection, maximum stress developed and its location is determined on the Chassis Structure. And from the Factor of Safety it can be concluded that the designed Chassis is Safe and can be used in the Championship.

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