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# Design and Analysis of Chassis for Solar Electric Vehicle

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**Abstract -** A solar car is a specialized type of car designed for race and powered by sun energy (solar). This is obtained from solar panels on the surface of the vehicle. Photovoltaic (PV) cells convert the sun's energy directly into electric energy. Solar vehicles are not sold as practical day-to-day transportation devices at present, but are primarily demonstration vehicles and engineering exercises. It have limited seating (usually one, sometimes two people), it have very little cargo capacity, and only be driven during the day. Chassis is one of the important parts and every car passenger has it. This structure was the biggest component in the car and car shape dependent on it. It has a considerable affected to the performance of the car. The primary challenge in developing an effective solar car chassis is to maximize the strength but minimize the weight. There are various types of chassis, each with its own advantages and disadvantages. Every extra pound requires more energy to move down the road.

In the present work a complete drawing and drafting of hybrid solar car have been prepared using **Solid Works** software. After complete analysis of this drawing by using **ANSYS R14.5** it is find out bear capability of load, stress, and strain of front & rear collision of car frame. A completed data are analyzed to examine the technical aspects of the hybrid car technology. Overall, hybrid technology has a lot of potential in the distant future, but as for right now they are not a significant applied over today's internal combustion engine.

*Key Words*: **Ergonomics, Percy, Analysis, Impact Analysis, Tubular space frame chassis.**

## 1. Introduction

A chassis consists of an internal framework that supports the complete vehicle, and gives a structural support to it. It is similar to an animal's skeleton. In recent few years ON- Road vehicles have changed drastically based on design and several other functional aspects. A chassis serves as the basic foundation which gives strength to the body and on which all the parts of a machine rest. Many composite materials offer a combination of strength and modulus that are either comparable to or better than any traditional metallic metals. Because of their low specific gravities, the strength to weight-ratio and modulus to weight-ratio of these composite materials are markedly superior to those of metallic materials. The fatigue strength weight ratio as well as fatigue damage tolerances of many composite laminates are excellent.

## 2. Types of Chassis Frames

The different types of chassis that are available in the market are: Ladder chassis.

1. Back bone chassis.
2. Monocoque chassis.

**2.1 Ladder Chassis:** The construction of this chassis is two longitudinal rail interconnected by many lateral braces. The rigidity to the structure is provided by the cross members and lateral. These types of space frames are not much used in the present day.

**2.2 Back Bone Chassis:** In this chassis tubular backbone which joins the front and rear axle and is responsible for most of the mechanical strength of the frame work. When the torsion stiffness of a chassis is derived from one large central tube running the length of the car, the resistance to twist depends mostly on the cross sectional area of that tube,.

**2.3 Monocoque chassis:** This type of chassis is used by most of the modern vehicles, as it is a single piece frame work which gives the perfect shape to the car. It is very much different from the ladder and the back bone type chassis.

| Properties | AISI 1018 | AISI4130 |
|---|---|---|
| Density (g/cc) | 7.8 | 7.8 |
| Young's Modulus (GPa) | 210 | 210 |
| Strength to weight ratio at Yield (kN-m/kg) | 38 | 100 |
| Yield Strength (MPa) | 360 | 480 |
| Ultimate Strength (MPa) | 420 | 590 |
| Thermal Conductivity: Ambient (W-m/K) | 50 | 42 |

**Table -1:** Material Properties

## 3. Design Considerations

### 3.1 Ergonomics:

The study of human-machine interfacing is important to vehicle design because the ultimate control of the vehicle belongs to the driver. When designing this 'interface' between person and machine, several aspects should be taken into account so that the best system of control is produced.

Ergonomics is the scientific and analytical discipline concerned with the design or arranging workspaces, systems and products, understanding of interactions among humans and other elements of a system so that it fits the humans who use them. It is the profession that applies theory, principles, analytics, data and methodology to design in order to optimize human well-being with respect to interaction with other systems and overall performance.
Problems related to the ergonomics determination were identified. These were: determination of seat inclination, pedal box position, dashboard controls and shifter location in consideration with team's drivers and SAE's body dimension for the 95th percentile male. The conclusion was agreed to be made based on a jigs setup that acts as a mock-up chassis.

Following are the dimensions coming from the ergonomic :

| | |
|---|---|
| Length of chassis | 2286.4mm |
| Height of main hoop | 1400mm |
| Height of front hoop | 750mm |

**Table -2:** Material Dimensions

### 3.2 Percy:

The 95th percentile male is represented by a two dimensional figure consisting of two circles of 200mm diameter (one representing the hips and buttocks and one representing the shoulder region) and one circle of 300mm (representing the head with helmet)Fig. 1

The two 200mm circles are connected by a straight line measuring 490mm. The 300mm circle is connected by a straight line measuring 280mm with the upper 200mm circle.

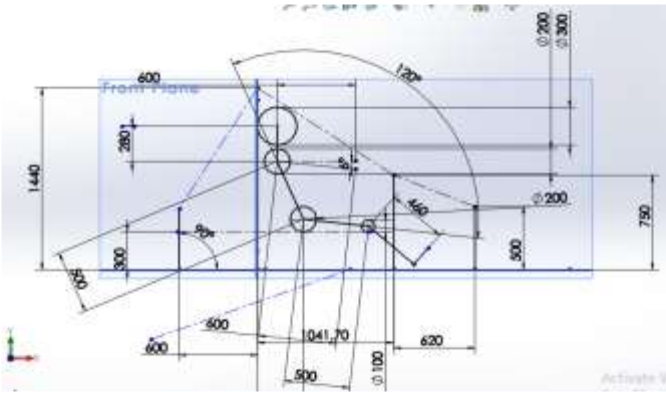


**Fig -1**: **Percy**

### 3.3 Triangulation:

Node-to-node triangulation - An arrangement of frame members projected onto a plane, where a co-planar load applied in any direction, at any node, results in only tensile or compressive forces in the frame members as shown in Figure 2.

All frame members, guides and supports that transfer load from the driver's restraint system into the above mentioned components of the primary structure. Triangulation can be used to increase the torsion stiffness of a frame, since a triangle is the simplest form which is always a structure and not a mechanism.

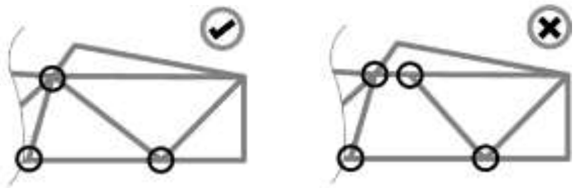

**Fig-2: Triangulation**

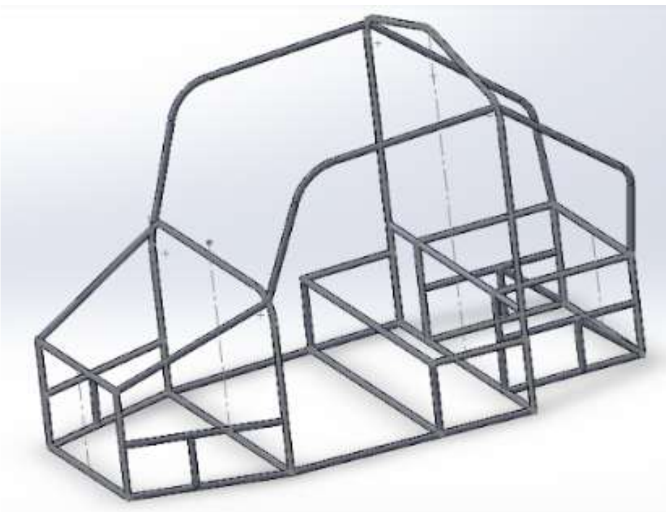

**Fig-3: CAD Model**

## 4. Analysis:

The analysis consists of bending test on the chassis frame. When the vehicle is negotiating the bump, there might be a case of alternating bumps on left and right wheels. The analysis had been carried out using ANSYS R14.5 software.

### 4.1 Front Impact:

For the front impact, motor and driver load were given at respective points on the chassis. All the four bearing positions were kept fixed. To properly model the impact force, the deceleration of the vehicle during impact needed to be found. The loads were applied only at front end of the chassis because application of forces at one end, while constraining the other, results in a more conservative approach of analysis.

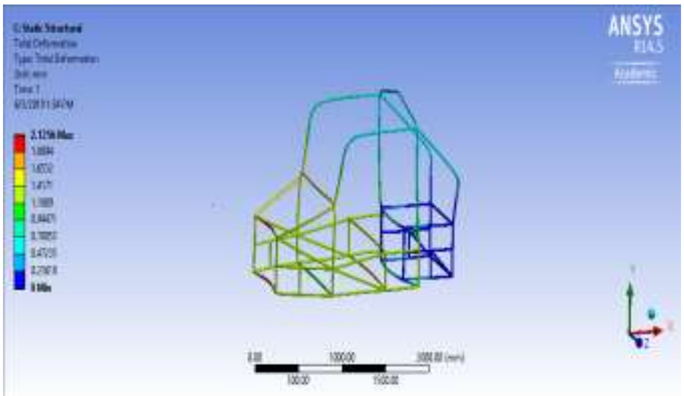


**Fig-4: Front Impact**

### 4.2 Side Impact:

For side impact analysis the vehicle was kept static for simplicity. Impact force was applied by constraining wheels bearing positions of chassis and applying load equivalent to the force on the right side.

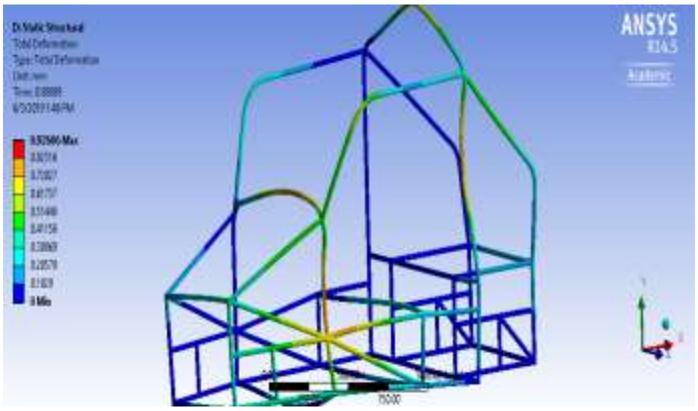


**Fig-5: Side Impact**

### 4.3 Rear Impact

Considering the worst case collision for rear impact. load was applied at rear end of the chassis while constraining wheels bearing positions of chassis.

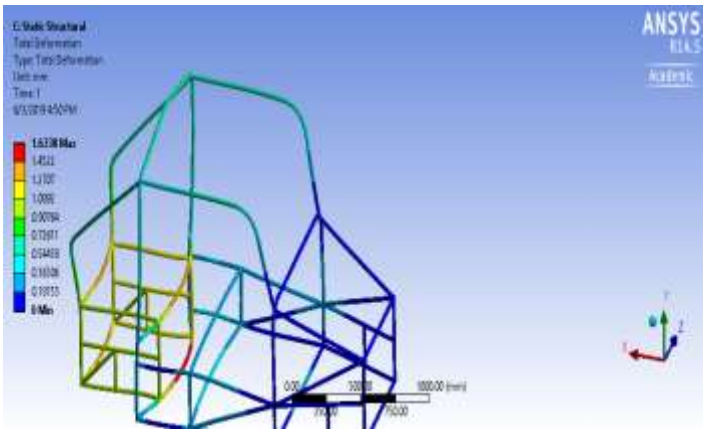


**Fig-6: Rear Impact**

### 4.4 Torsion Impact

It allows displacements of the suspension attachment points that modify suspension kinematics and it can trigger unwanted dynamic effects like resonance phenomena or vibrations.

Generalized equation for torsion is.

$$T = G\theta J/L$$

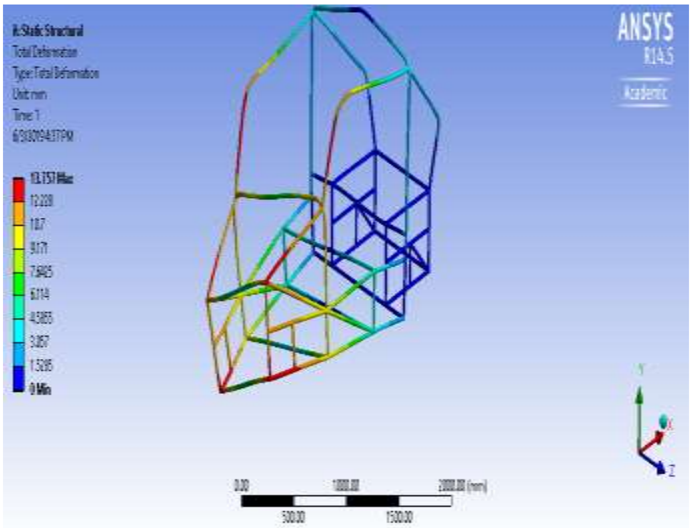


**Fig-7: Torsion**

**Fig-8: Prototype of Actual Model**

## 5. CONCLUSIONS

After performing the Front impact, side impact, and back impact and torsion analyses and making the necessary changes, the following design was finalized. The above designed chassis is much stiffer and stronger than the preliminary design. The chassis members were optimized by changing dimensions of the pipes in required positions.

We have studied about the design and analysis of Space frame chassis and learnt about the analyze process like the static analysis and modal analysis in ANSYS. Thus I would conclude by observing the above results and analyzation that the chassis space frame structure depend on the stiffness and stresses in that particular frame. The stresses obtained above are the well deserved in order to manufacture a chassis space frame as the stresses are very much lower as compared to that of the yield point of the material.

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