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Chassis Design for Solar Vehicle

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Abstract- A vehicle specifically working on the solar power has been designed and analyzed. This vehicle has been designed with sound engineering practice. This document describes the major aspects of the model of the car working on solar power. All engineering decisions were made with a focus on safety, manufacturability, durability and performance. This document even describes the various constraints and dimensions which were used to make this model and even gives suggestions for various changes which can be made in this model so as to change the structure and give it a new form as and when required regarding the changes meant to come in near future. This document is just an approach as to how the future solar vehicles can be made for single driver to go on a ride.

Keywords- solar vehicle, chassis design, analysis

1. Introduction

The chassis has been the back bone of the vehicle, all component such as transmission system, engine, fuel tank, steering system, suspension system etc are mounted on the chassis. There are different material which are used for the manufacturing of useful chassis. The material is selected according to their cost and properties required for the vehicle being manufactured. [1]

This event was organized by the ISIE a government body in which engineering aspirants had to fabricate a car which could run on solar energy and due to this feature, it would not cause any pollution. This advantage of this vehicle provided the event an important position as nowadays the environmental pollution is a big concern this pollution less vehicle is going to be very useful in the future as this vehicle reduces the use of non-renewable resources and uses the very little tapped unlimited potential that is the solar energy. The organized this challenge with a focus on safety, manufacturability, durability and performance. Economic and manufacturing constraints were large factors in the design process but ultimately sound engineering practice was used. All computer aided designs were done with Solid Works and analysis software such as ANSYS were used to verify these designs

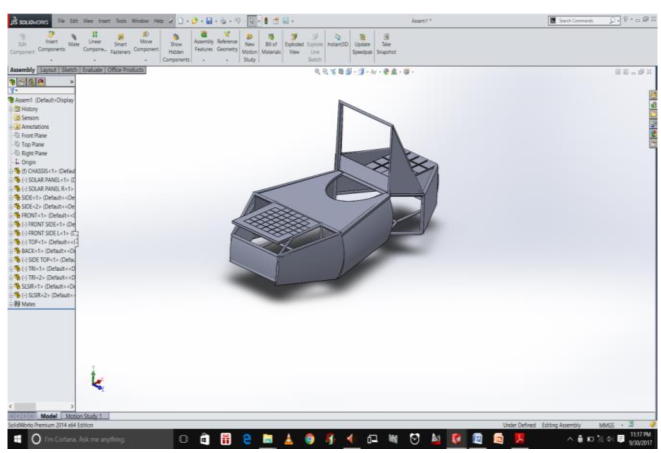

Fig.1 The Complete Vehicle As Seen From The Front

II. Bonnet

1.1 Objective

The front part Fig was designed according to streamlined structure which enables the body to move swiftly without experiencing any much obstruction from the wind or any other atmospheric fluid as the case may be .The streamlined structure enables the body to move by cutting the fluid as marine animals do for instance the fishes their bodies facilitate them to move freely within the liquid and they move speedily similarly the streamlined shape of this frame helps to move the chassis freely within the fluid air as in this case .It has been shown by the front edge coming down and meeting the pipe at lower end .A similar thing has been done on the sides where the sides converge and tend to meet in the beginning there by reducing the surface area hence the force acting on the front panel reduces.

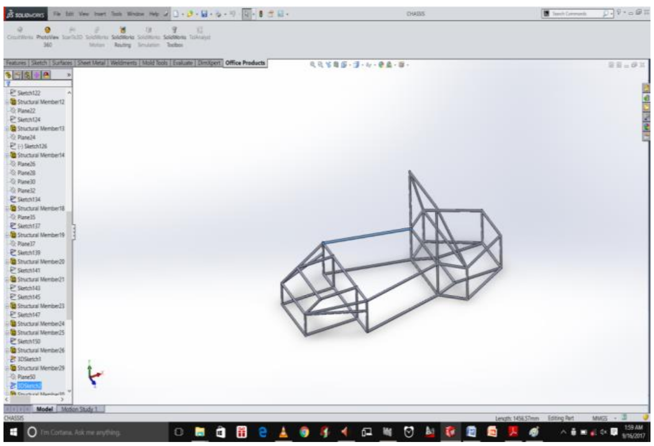

Fig. 2 Front Isometric View

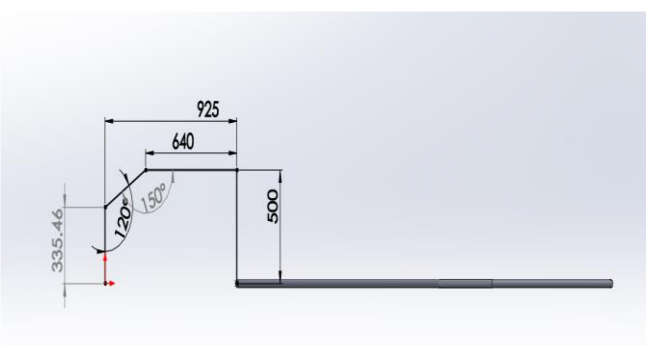

Fig.3 Side View with Measurements

III. Design

The stream lined structure was chosen so that not much energy is lost while the vehicle is moving against the direction of wind .The chassis has a bend in front of the bonnet from ground the vertical component rises by an angle of 120^{O} and then the next component rises by 150^{O} i.e. the next component becomes horizontal .Hence the complete structure becomes streamlined lined for instance when the component takes a turn of 3π/2 the vertical line makes an angle of 90 from ground the n rises by 120^{O} then 150^{O} that makes it to rise by 270^{O} hence $270^{O} + 90^{O}$ which makes it 0^{O} i.e. horizontal with respect to ground. The structure should be preferably made up of steel tubes.
The front end pipe has a length of 820 mm that is just half of the pipe behind it which is of 1640 mm length the height of this structure for bonnet is 500mm and decreases to 335mm in front.

IV. Body

The length of the body where the driver would be seated is 1796 mm and 1640 mm in length which decreases to 999mm at the rear end so as to allow the air to enter and serve as a coolant for the motor and the battery which would get heated due to usage. The height of the frame over here is 500mm. There would be no roof over this structure as it was prohibited in the rule book and this model was strictly made in accordance with the rules of the event.

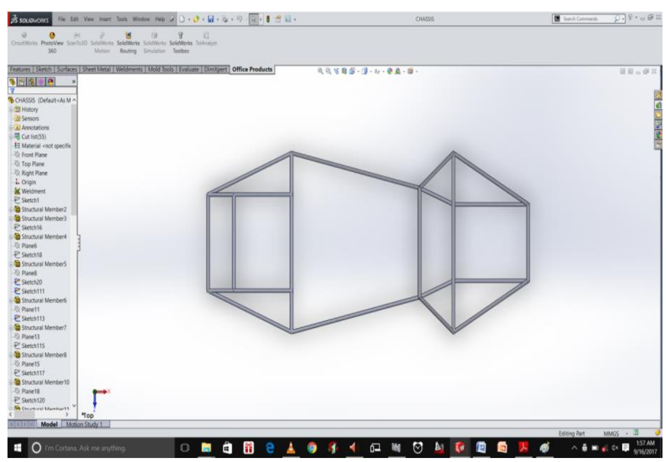

Fig. 4 Top View

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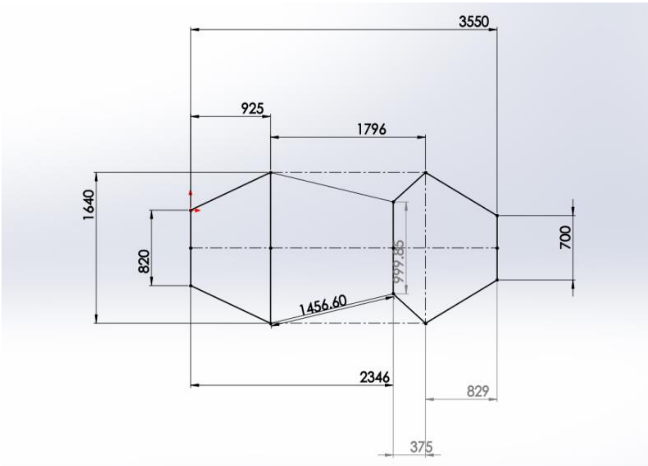

Fig.5 Top View With Measurements

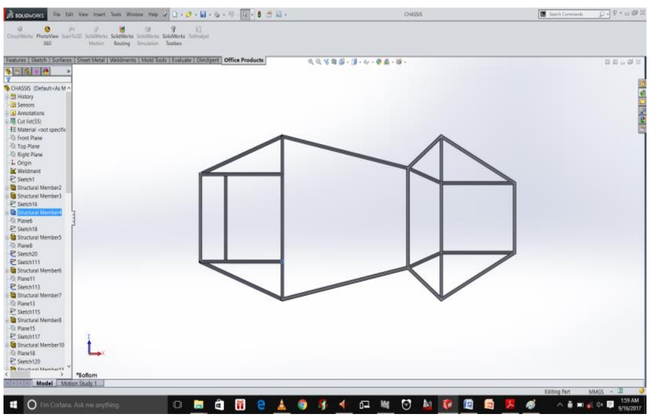

Fig. 6 Bottom View

V. Rear View

The rear structure is made according to encapsulate the motor which would be powered by the battery which in turn gets charged by the solar panels and there is an indentation in the structure so as to provide cooling through air to keep the drive train cool and so that it works efficiently with minimum losses. The rear structure begins with 999mm and then goes to become 1640mm this inclination allows the motor to get ventilation and then remain cool this structure ends with the dimensions of 700 mm.

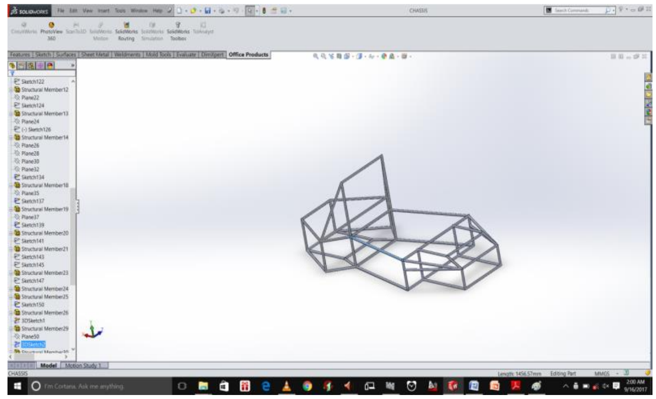

Fig.7 Isometric View For The Frame

VI. Top Frame

The frame is made to comply with the rule book hence the frame of top had to be in cooperated the height of the frame is kept 900mm and oblique pipe is installed at an angle of 30 of length 1026.36mm to support the base top frame.

VII. Analysis

The analysis was done taking the front, rear, side force to be 12kN,12kN and 4kN respectively.

7.1. Stress Analysis based on the impact stress

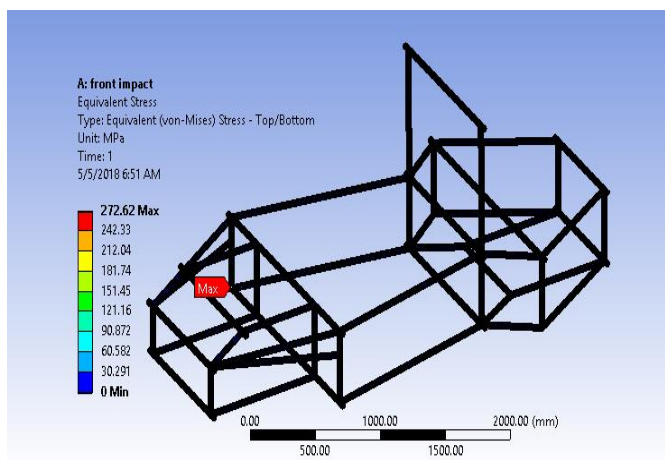

Fig.8 Stress Applied At Front Due To Impact

When the analysis was done of the Chassis from the point of view of front impact .The maximum stress applied on the chassis was 272.62 MPa which is less than the yield strength of the component 300MPa.

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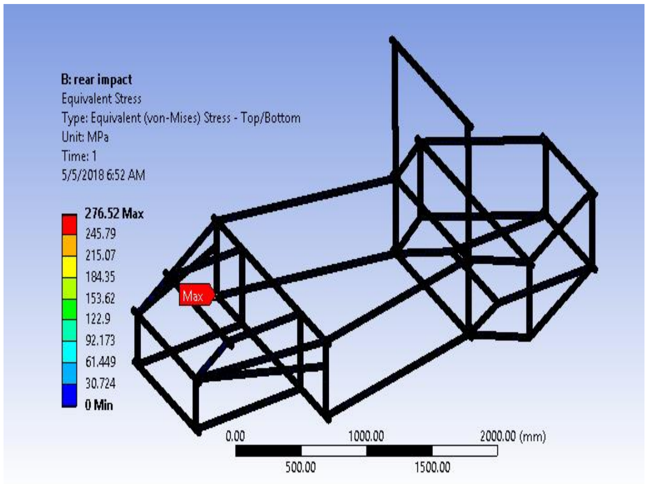

Fig.9 Stress Applied At Rear Due To Impact

When the analysis was done of the Chassis from the point of view of rear impact .The maximum stress applied on the chassis was 276.52 MPa which is less than the yield strength of the component 300MPa.

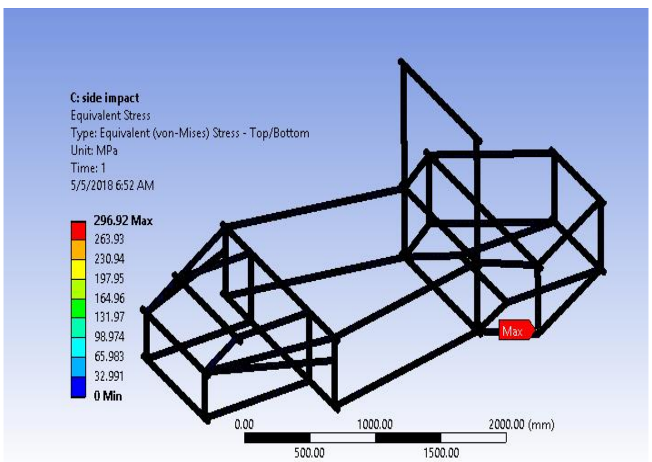

Fig.10 Stress Applied At Side Due To Impact

When the analysis was done of the Chassis from the point of view of side impact. The maximum stress applied on the chassis was 296.92 MPa which is less than the yield strength of the component 300MPa.

Table No. 01

IMPACT LOADING	
DIRECTION	STRESS / FORCE (MPa)
FRONT	272.62
REAR	276.52
SIDE	296.92

7.2. Stress Analysis Based on The Displacement Caused Due To Impact Stresses

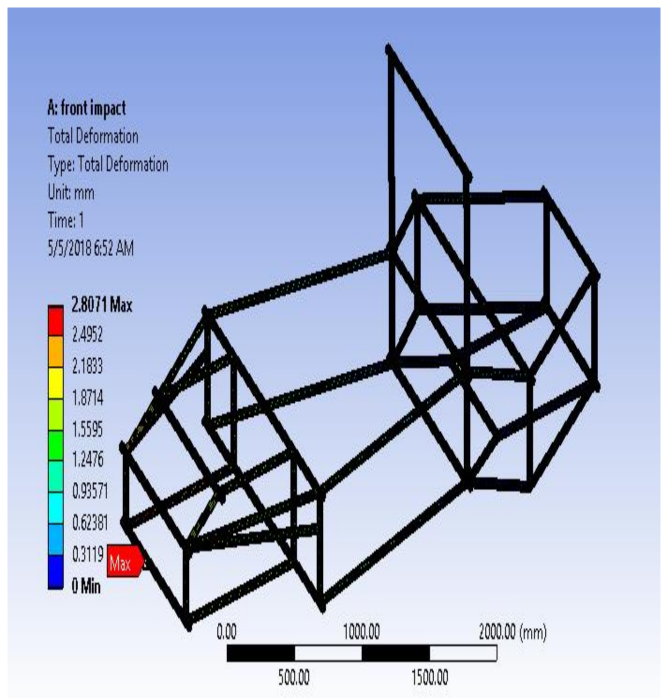

Fig.11 Displacement Front

When the analysis was done of the Chassis from the point of view of displacement caused due to the impact at the front end .The maximum displacement that took place was of 2.8071 mm indicated by red colour .

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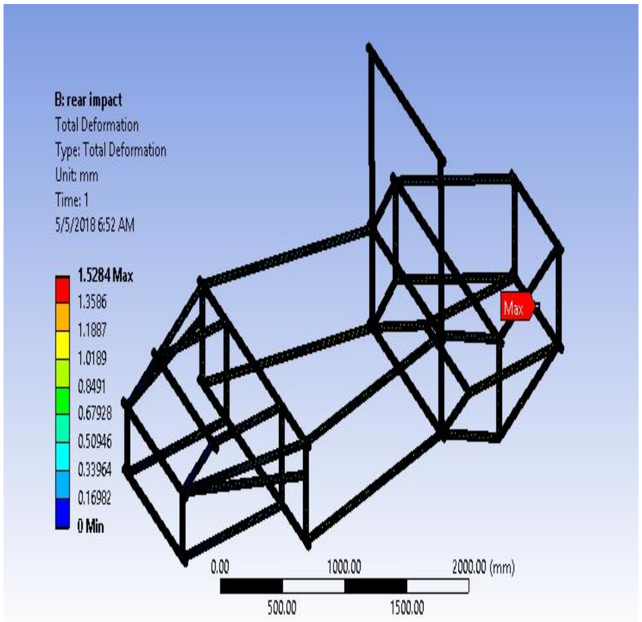

Fig.12 Displacement Rear

When the analysis was done of the Chassis from the point of view of displacement caused due to the impact at the front end .The maximum displacement that took place was of 1.5284 mm indicated by red colour .

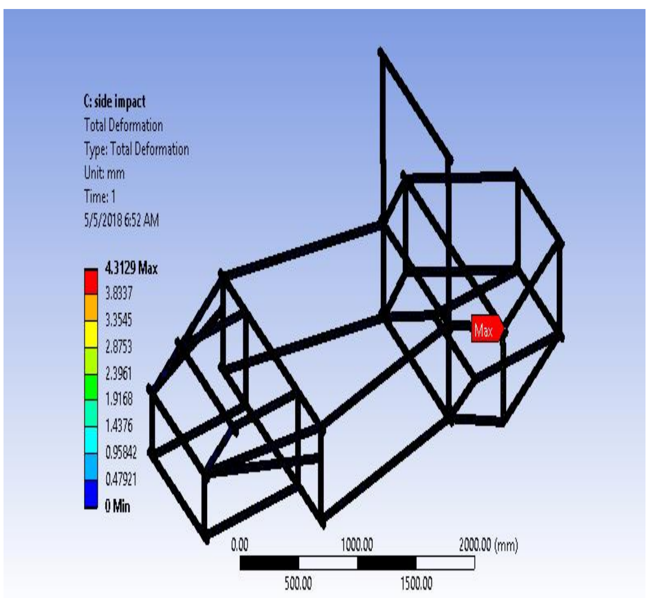

Fig.13 Displacement Side

When the analysis was done of the Chassis from the point of view of displacement caused to the impact at the front end .The maximum displacement that took place was of 4.3129 mm indicated by red colour.

Table No. 02

DEFORMATION IN TERMS OF	DISPLACEMENT
DIRECTION	DISPLACEMENT(mm)
FRONT	2.8071
REAR	1.5284
SIDE	4.3129

Inference: -
Based on the analysis results of the present work, the following conclusions can be drawn.

1) Part is safe under the given loading condition.
2) To improve performance, geometry has been modified which enables to reduce stress levels marginally well below yield limit.
3) The generated Von Mises Stress & Maximum Shear Stress is less than the permissible value so the design is safe for the materials.
4) Shear stresses were found minimum in Aluminum alloy 6063-T6 and maximum in ASTM A710 steel under given boundary conditions.
5) Von Mises stresses were found minimum in Aluminum alloy 6063-T6 and maximum in ASTM A710 Steel under given boundary conditions.
6) The Rectangular Box Cross-section Type of Ladder Chassis is having least deflection, Von Mises stress and Maximum Shear stress for Aluminum Alloy 6063-T6 in all the three types of materials of three different cross section type of Ladder Chassis. [3]

VIII. Conclusion

The team of this paper has designed and analyzed a chassis for the 2018 ESVC ISIE Competition. With a focus on safety, manufacturability, durability, and performance, this chassis has been engineered and validated to overcome the harshest conditions.

The paper has looked into the determination of the dynamic characteristic (the natural frequencies and the mode shapes) of the chassis, taking care of the mounting locations of components on the chassis and observing the response of the chassis under static loading conditions. The global vibrations of the chassis include torsion, lateral bending and vertical bending with 2 and 3 nodal points. The local bending vibration occurs at the top hat cross member where the gearbox is mounted on it. [2]

References

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