Design and Developement of Chassis for Solar Operated Vehicle

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***Abstract*-Chassis is a major component of a vehicle system. The automotive chassis is tasked with keeping all components together while driving and transferring vertical and lateral loads, caused by acceleration, on the chassis through suspension and the wheels. The key to good chassis design is that further the mass is away from the neutral axis the more rigid it is. In this project CAD software and ANSYS SOFTWARE is used for analysis (static, dynamic, thermal) using finite element method. Stress analysis is a key characteristic of a chassis. The design and analysis of chassis is done by identifying the location of high stress areas. The chassis design used in this project is the space frame chassis.**

Keywords—chassis, design, stress analysis, CAD software.

1. INTRODUCTION

1.1 Background

The solar energy is used as alternative energy to a fossil fuel. This energy is seen various domestic as well as commercial appliances. The energy directly captured from sun through photovoltaic panel and stored for various purpose. To have an efficient solar vehicle its frame (chassis) should sustain the all type of load stresses impact on it. As a common knowledge, the chassis is design to give shape for a car which will sustain the load of solar panel, actuators, the driver and also the suspension system.

1.2 objective

The main objective of this research is to create a preliminary study for possible design of solar car frame. As a common knowledge, frame body for solar car is created to give a shape of the solar car and also to withstand the load from the solar panel body, driver, actuator and also the suspension. The rigidity of frame body will greatly affected the solar car speed because the more rigid the frame body, more faster the solar car will go but they must have a accurate setup to make sure the car will get faster as it could be.

Also another objective is to determine the proper dimension of solar car to make sure the maximum performance of solar car can be achieved and also the maximum solar energy collected by the solar panel during race. The rigidity and the dimension will be the subject of this research..

1.3 Scope of the Research

There are some scopes that must be included in this research. One of the scopes is sketch and designs the body frame of solar car by using software. For example, draft sketching the chassis design by using ANSYS 14.5 or CAD software. Then next scopes is to compose the body frame analysis of solar car in term of static condition such as roll bar testing when collision or rollover during solar car operation.

Body frame is creating to support the upper body, engine, driver and also other Component which make up the vehicle. Rigidity and can lends the whole vehicle Support is the main factor that decides the structure of body frame. Body frame usually includes a multiple transverse cross members and a pair of longitudinally extending Channels. In order to allow for longitudinally extending storage space, the transverse frame body members have a reduced cross section.

The body frame has to base around a driver's cockpit to make sure the safety of the driver and also as a core of the vehicle. The safety of the chassis is a major aspect in the design, and should be considered through all stages. Generally, the basic body frame type consists of backbone, space frame, ladder frame, combination. This different type of frame design will result the different performance of each framework.

In this study, it is decided that tubular space frame chassis is used for the urban car. Since ladder chassis is not strong enough, motor racing engineers have developed a 3-dimensional design which known as tubular space frame. Tubular space frame chassis employs dozens of circular-section tubes (some may use square section tubes for easier connection to the body panels though circular section provides the maximum strength), position in different directions to provide mechanical strength against forces from anywhere. These tubes are welded together and form a complex structure. For higher strength required by high performance sports cars, tubular space frame chassis usually incorporate a strong structure under both doors. Tubular space frame chassis also very strong in any direction compared with ladder chassis and monologue chassis of the same weight.

2. MATERIAL SELECTION

Different chassis materials can reduce the weight of the vehicle, improving the vehicle power to weight ratio. Material selection can also provide advantages by reducing member deflection, increasing chassis strength and can determine the amount of reinforcement required.

AISI 1018 mild/low carbon steel has excellent weldability and produces a uniform and harder case and it is considered as the best steel for carburized parts. AISI 1018 mild/low carbon steel offers a good balance of toughness, strength and ductility. Provided with higher mechanical properties.

As material with the carbon percentage of 0.18% is required hence the 1018 material is selected.

Table 1 Chemical composition

CHEMICAL COMPOSITION	
Carbon, C	0.14 - 0.20 %
Iron, Fe	98.81 - 99.26 % (as remainder)
Manganese, Mn	0.60 - 0.90 %
Phosphorous, P	≤ 0.040 %

Table 2 Mechanical properties

Mechanical Properties	Metric	Imperial
Hardness, Brinell	126	126
Hardness, Knoop (Converted from Brinell hardness)	145	145
Hardness, Rockwell B (Converted from Brinell hardness)	71	71
Hardness, Vickers (Converted from Brinell hardness)	131	131
Tensile Strength, Ultimate	440 MPa	63800 psi
Tensile Strength, Yield	370 MPa	53700 psi
Elongation at Break (In 50 mm)	15.0 %	15.0 %
Reduction of Area	40.0 %	40.0 %
Modulus of Elasticity (Typical for steel)	205 GPa	29700 ksi
Bulk Modulus (Typical for steel)	140 GPa	20300 ksi
Poisson's Ratio (Typical For Steel)	0.290	0.290
Machinability (Based on AISI 1212 steel. as 100% machinability)	70 %	70 %
Shear Modulus (Typical for steel)	80.0 GPa	11600 ksi

3. THE DESIGN PROCESS

The 3-D object is created by catia software.

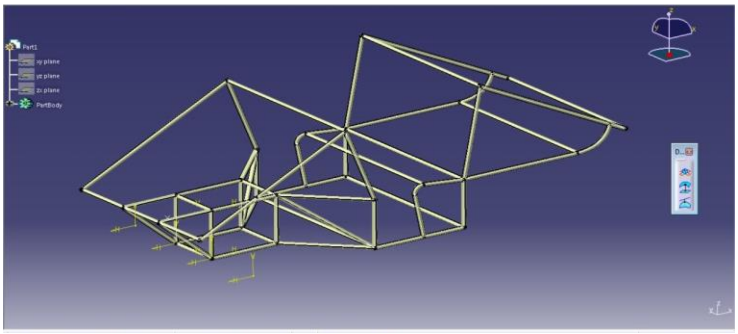

Fig. 1 3D Model of chassis using CATIA V5

4. SIMULATION WORK

The scenario which everyone tries to avoid is having an accident. During a car accident on a road there is more emphasis put on decelerating a vehicle through structural deformation absorbing the impact with crumble zones. An accident on the track is more concerned with having a very rigid enclosure with devices attached to dissipate the energy. A driver is also very securely connected to the chassis through multipoint harnesses and head restraints like the Hans Device. There is a difference in philosophy and the focus here will be on the latter.

A simulation works includes various necessary testing which are basics, such as:

- Frontal impact test.
- Side impact test
- Rear impact test

In following all the test we had taken two tests , those are –
Total deformation
Equivalent (von-mises) stress..

Frontal Impact Test

The frontal impacting force is calculated by Newton's second low.

For the frontal collision considering m as mass of the vehicle and u, v as the initial and final velocities respectively is taken as Collision time.

F = (m*(v-u))/t

In automotive industry, the impact time is of the range 0.15 to 0.2 s. Taking time of impact as

t = 0.18

F =250*(12.5-0)/0.18……..by taking velocity 45 kmph

F =17361.11 N

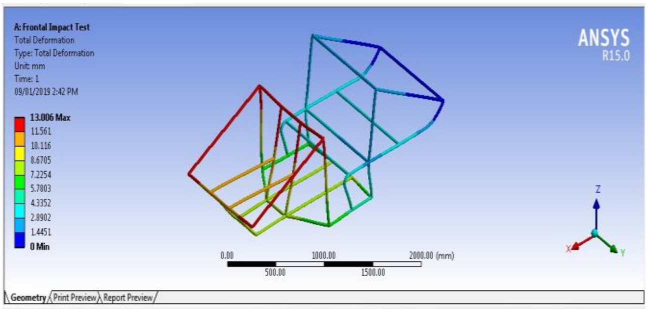

Fig. 2 Total deformation in Frontal impact test

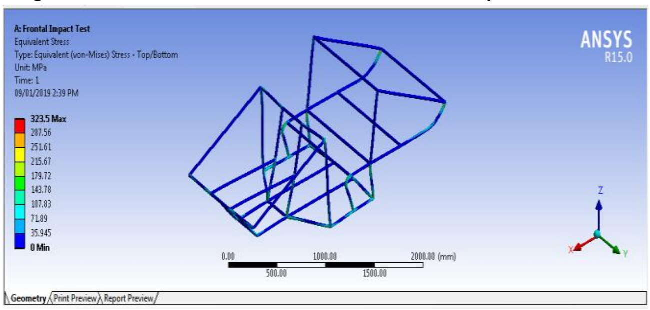

Fig. 3 Stress generation in Frontal impact test

Maximum deformation in case of frontal impact is seen as 13.006 mm & Maximum Stress is 32305 Mpa. So drivers cabin safe in case of frontal impact driver will be safe.

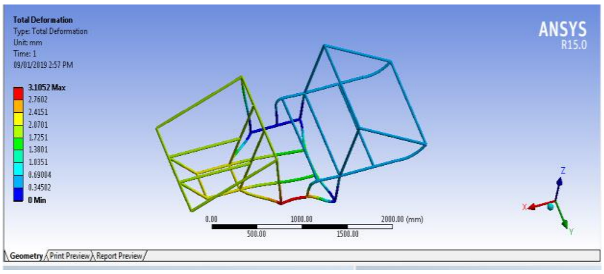

Fig. 4 Total deformation in Side impact test

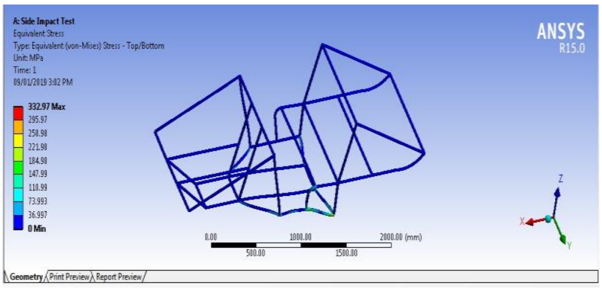

Fig. 5 Stress generation in Side impact test

In side impact, forces are considered as per Newton's second law. Deformation is seen 3.1052 mm and stress is 332.97 Mpa.

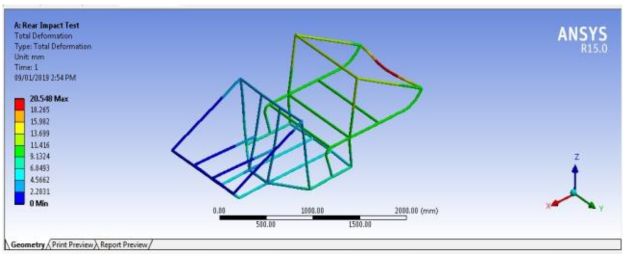

Fig. 6 Total deformation in Rear impact test

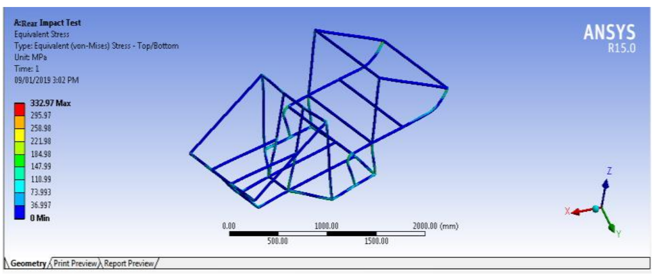

Fig. 7 Stress generation in Rear impact test

In rear impact, forces are considered as per Newton's second law. Deformation is seen 20.54 mm & 332.97 stress is Mpa

Table 3 Design Parameters

Required Parameters For Design	Values
Factor of Safety	1.1
Weight	30 Kg
Torsional Rigidity	78 Gpa
Wheelbase	59 Inch
Ground Clearance	10 Inch
Clearance between drivers seat & firewall	16 Inch
Clearance between battery & firewall	32 Inch
Chassis Material	AISI 1018
Wheel track	35Inch

CONCLUSION

From overall tests conducted on ANSYS software for total displacement and von-mises stress the chassis design selected is safe.

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