CAD MODELING OF SOLAR VEHICLE STRUCTURE

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ABSTRACT

The main idea of the paper is to design a solar vehicle that aims to tackle the problems related to pollution, shortage of fuel and to monitor various parameters that improves the safety of the driver. The paper surveys a few existing systems and provides an overview of a solar vehicle that incorporates various safety features. A solar vehicle usually uses a battery which has been charged by solar panel. Photovoltaic cells are used to convert solar energy in to useful electrical energy. The objective of this paper is to construct a model of solar vehicle. This paper deals with features involved in a solar energy car which plays a vital role for the upcoming energy crisis. We aim at modeling of solar powered vehicle with the prime goal to support and promote renewable energy and bring into reality ensuring safety of vehicle against static failure. While doing this, we have tried our best to keep our vehicle chassis light weight.

1. INTRODUCTION

This paper provides us the sort description of the solar vehicle which is powered by solar energy and which produce zero emission. In this paper we see the model of the solar vehicle which is ready with the help of CATIA V5. Part modeling of solar vehicle is discussed later in this paper. This paper, followed by aims, objectives and scope of the research, sets the scene and scope of the dissertation. A solar vehicle is an electric vehicle powered completely or significantly by direct solar energy. Usually, photovoltaic (PV) cells contained in solar panels convert the sun's energy directly into electric energy. The term "solar vehicle" usually implies that solar energy is used to power all or part of a vehicle's propulsion. Solar power may be also used to provide power for communications or controls or other auxiliary functions. Solar vehicles are not sold as practical day-to-day transportation devices at present, but are primarily demonstration vehicles and engineering exercises, often sponsored by government agencies. However, indirectly solar-charged vehicles are widespread and solar boats are available commercially. Solar car is a solar vehicle used for land transport. Mini Solar cars combine technology typically used in the aerospace, bicycle, alternative energy and automotive industries. The design of a solar vehicle is severely limited by the amount of energy input into the car. Most solar cars have been built for the purpose of solar car races. Since 2011 also solar-powered cars for daily use on public roads are designed. Solar cars are often fitted with gauges as seen in conventional cars. To keep the car running smoothly, the driver must keep an eye on these gauges to spot possible problems. Cars without gauges almost always feature wireless telemetry, which allows the driver's team to monitor the car's energy consumption, solar energy capture and other parameters and free the driver to concentrate on driving. Solar cars depend on PV cells to convert sunlight into electricity. Unlike solar thermal energy which converts solar energy to heat for either household purposes, industrial purposes or to be

converted to electricity, PV cells directly convert sunlight into electricity. When sunlight (photons) strikes PV cells, they excite electrons and allow them to flow, creating an electrical current. PV cells are made of semiconductor materials such as silicon and alloys of indium, gallium and nitrogen. Silicon is the most common material used and has an efficiency rate of 15-20%. Nowadays, developed countries and big cities throughout the world are embarking on policies to encourage the research. Design software can be used to model or simulate almost every aspect of an structure or operation.CAD software were used to modeling the different parts of solar vehicle. A vehicle frame is the main supporting structure of a motor vehicle to which all other components are attached, comparable to the skeleton of an organism.

2. LITERATURE REVIEW

Anoop kumar et al. (2017) tells the history and future of electric and solar vehicles and provides and overview of a typical solar powered automobile. They discuss the working and their different component which is related to solar vehicle. *A. Karim and Z. Shahid (2018)* presents important details about the change of a conventional fossil fuel-based car into a solar-electric hybrid (SOLECT) car. Change of a conventional car into a SOLECT car can help people to protect environment and save on fuel costs. Study on vehicles are getting transformed from a one source of energy to multiple sources of energy due to environment-related issues and ever-increasing fuel problems. *Ankit Vijayvargiya et al. (2017)* focuses on an idea about solar car technology and its integration into society which solves the major problem of pollution and fuel in now days. A complete experiment of solar car has been prepared in this paper by using a car. It is clear that this paper is able to get acquainted with this new area of photovoltaic solar energy application. The aim of author is to implement the less polluting and most efficient vehicles. In this the solar vehicle combine with the batteries, LM317 voltage controlling IC, and BLDC motor of an electric vehicle resulting in twice the fuel economy of earlier vehicle. *Umang R. Agravat et al. (2017)* provide ease for the rider while riding a bicycle and also to save energy by all possible means. The Solar rays charge the battery through the solar panel when the solar electric bicycle is kept under sunlight placed above the carrier of the bicycle. The battery gives energy to the electric motor in the back wheel. It also help in to down the resistance in pedaling to make it helpful to go up hills. *T. Vignesh et al. (2017***)** proposed an improvement of the energy management system of a hybrid electric vehicle using an arduino processor. Hybrid power generation system is good and effective solution for power generation than conventional energy resources. It has greater efficiency. It can provide to remote places where government is unable to reach. So that the energy can be consume where it produced so that it will reduce the cost and transmission losses. Cost reduction can be done by increasing the production of the equipment. *Abhinya Chaturvedi et al (2015)* study of all previous works related to the electric and solar cars have been done. Solar powered vehicle is a three wheel drive and has been used for shorter distances. The main concentration was made on improving the design and making them cost effective. Energy from Sun is captured by the solar panels and is converted to electrical energy. Also, the rate of conversion of energy is not satisfactory (only 17%). But these disadvantages can be easily overcome by conducting further research in this area; like the problem of solar cells can be solved by using the ultra efficient solar cells that give about 30-35% efficiency. *Yasuji Shibahata et al. (2004)* talk about the chassis technology earlier to the 1980s had been progress as a technology of mechanical engineering field of that time. After the mid-eighties invention and practical application of four-wheel-steering system (4WS), especially the vehicle dynamics performance field out of chassis technology became a main stream of research and development for control technology. From then on, research and development of vehicle dynamics performance has been carried out as a collaborated technology of mechanical engineering and control engineering. *Pierluigi Pisu et al.(2001)* present fault detection and isolation is becoming one of the most important aspects in vehicle control system design. In order to achieve this FDI schemes, particular vehicle subsystems integrated with a controller have been proposed. This paper introduces a new Model-Based Fault Detection and Fault

Diagnosis method for monitoring the vehicle chassis performance. In this paper, a hierarchical model-based FDI scheme has been presented. The possibility of estimating the states of the vehicle has been demonstrated for a brake-by wire subsystem without mechanical backup. The validity of the proposed approach is examined by the extensive number of simulations performed. *Rafał Burdzik et al(2012)* provide a conversation on the studies comprising active experiments conducted on elected structural elements of vehicles, the aim of which was to evaluate the vibration propagation in vehicles construction. The vibration excitation was achieved by applying an engine working on idle gear. The studies were conducted on vibration propagation for different constant rotational velocity. The changes of the signals were observed in time, frequency and simultaneously in time frequency domains. *Chen Tang et al.(2018)* presents the design of an integrated suspension tilting mechanism for narrow tilting vehicles. The challenge in the design of such suspension tilting mechanisms is to permit large suspension travels to produce sufficient tilting angles to balance the vehicle in cornering, while at the same time remain as compact as possible to save the space for passengers and cargos. Existing solutions, which are frequently based on parallel mechanisms, are not space-friendly and add extra weight to the probable compact and light-weighted urban vehicles. *Gonzalo De La Torre (2018)* conclude that self-driving vehicles become increasingly popular, new generations of attackers will seek to exploit vulnerabilities introduced by the technologies that underpin such vehicles for a range of motivations (e.g. curiosity, criminally-motivated, financially-motivated and state-sponsored). For example, vulnerabilities in self-driving vehicles may be exploited to be used in terrorist attacks such as driving into places of mass gatherings (i.e. using driverless vehicles as weapons to cause death or serious bodily injury). *Krishan Kumar(2013)* paper describes computer aided finite element analysis of parabolic leaf spring. The present work is an improvement in design of EN45A parabolic leaf spring used by a light commercial automotive vehicle. Development of a leaf spring is a long process which requires lots of test to validate the design and manufacturing variables. A three-layer parabolic leaf spring of EN45A has been taken for this work. The thickness of leaves varies from center to the outer side following a parabolic pattern. These leaf springs are designed to become lighter, but also provide a much improved ride to the vehicle through a reduction on interleaf friction. The CAD modeling of parabolic leaf spring has been done in CATIA V5 and for analysis the model is imported in ANSYS-11 workbench. *Krishan Kumar(2015)* conclude that there are literally several studies accomplished to predict the fatigue life of leaf springs but estimation of fatigue life of a parabolic leaf spring by using CAE tools has not yet been executed in the past. Parabolic spring is an important component in a vehicle suspension system. It needs to have excellent fatigue life and in today's scenario manufacturers rely on constant loading fatigue analysis. The objective of this work is to perform the fatigue analysis of parabolic leaf spring by three different methods where CAE analysis is performed to observe the distribution of stress fatigue life and damage using Goodman approach. *Krishan Kumar(2016)* states that shot peening is a method of cold working in which compressive stresses are induced in the exposed surface layers of metallic parts by the impingement of a stream of shots directed at the metal surface at high velocity under controlled conditions. The shot peening can be applied to various materials and their weldment like steels, cast iron, copper alloys, aluminum alloys, Ti alloys and some plastics. Shot peening improves the fatigue and abrasion resistance of metal parts. *Ken Hashimoto(2014)* developed a highly reliable CAE analysis model of the mechanisms that cause loosening of bolt fasteners, which has been a bottleneck in automobile development and design, using a technical element model for highly accurate CAE that we had previously developed, and verified its validity. Specifically, drawing on knowledge gained from our clarification of the mechanisms that cause loosening of bolt fasteners using actual machine tests, we conducted an accelerated bench test consisting of a three-dimensional vibration load test of the loosening of bolt fasteners used in mounts and rear suspension arms, where interviews with personnel at an automaker indicated loosening was most pronounced, and reproduced actual machine tests with CAE analysis based on a technical element model for highly accurate CAE analysis. *Takashige Takahashi(2010)* the authors propose a model for a highly precise CAE analysis approach,

which is intended to contribute to the regeneration of development and design. This model has been applied with significant results in making proposals for bolt tightening behavior analysis, which continues to be an area of concern. *Thombare Shreyash Shripad(2017)* states that conventional combustion engine vehicles are very much responsible for various kinds of pollutions in current decade due to emission of Green-house gases. To control the problem of pollution occur by Combustion engines and also reduce the effect of Global warming, renewable energy sources are come in picture. Various kind of renewable energy sources are used for domestic as well as industrial applications. In Asian Countries Solar energy is accomplished in very large amount. *V. Sankaranarayanan(2008)* paper presents an adaptive semi-active control strategy to improve the stability and performance of a light commercial vehicle equipped with four continuously varying dampers. A choice between ride comfort or road holding of the vehicle is made automatically using a rule based adaptive algorithm based on various factors such as roll rate and yaw rate. The damping factor or the controller configuration of each damper is modified using a rule based adaptive algorithm and this technique is named Individual Damping Control (IDC) in this paper.

3. CAD MODELING OF SOLAR VEHICLE STRUCTURE

3.1 INTRODUCTION TO CAD MODELING

CAD Modeling of any project is one of the most time consuming process. One cannot shoot directly from the form sketches to Finite Element Model. CAD Modeling is the base of any project. Finite Element software will consider shapes, whatever is made in CAD model. Although most of the CAD Modeling software have capabilities of analysis to some extent and most of Finite Element software have capabilities of generating a CAD model directly for the purpose of analysis, but their off domain capabilities are not sufficient for large and complicated models which include many typical shapes of the product. CAD modeling software is dedicated for the specialized job of 3D-modeling. From the sketcher to the rendering skills, all is to do by the single specialized software. The model of the solar vehicle structures also includes many complicated parts, which are difficult to make by any of other CAD modeling as well as Finite Element software. CAD modeling of the complete solar vehicle structure is performed by using CATIA V5 R17 software. CATIA is having special tools in generating surface design to construct typical surfaces, which are later converted into solid models. Solid model of all parts of the structures are then assembled to make a complete structure. The process of assembly is very much analogous to general process of fabricating structures while real production. The CATIA design modulation software not only permits the CAD modeling but also the drafting feature which enables us to view the sectioned and oblique projections of the assembly. Drafting feature also enables to specify the different dimensioning technique on a 2D planer view. This feature shows the commercial application and advantage of CATIA as compared to other CAD modeling softwares.CAD model of our problem consist of different parts which are assembled together in assembly design to make a complete model of solar vehicle chassis out of all parts, some parts are similar in shape & size.

3.2 PART MODELING

Part modeling is the basic tool used by CAE Engineers in CATIA. Actually designing a part from scratch will require designing a sketch. Sketching profile is performed in the sketcher workbench, which is fully integrated in to part design. The sketcher workbench then provides a large number of tools allowing you to sketch the profile you need. Part modeling of anybody comprises of different techniques such as profile generation, padding, grooving, multi padding, pocketing, chamfering, filleting, shaft,

angular pattern and material addition including many more advanced tools for different requirements. Part model of a component used in the assembly of solar vehicle is shown in the Fig. 3.2.1 below.

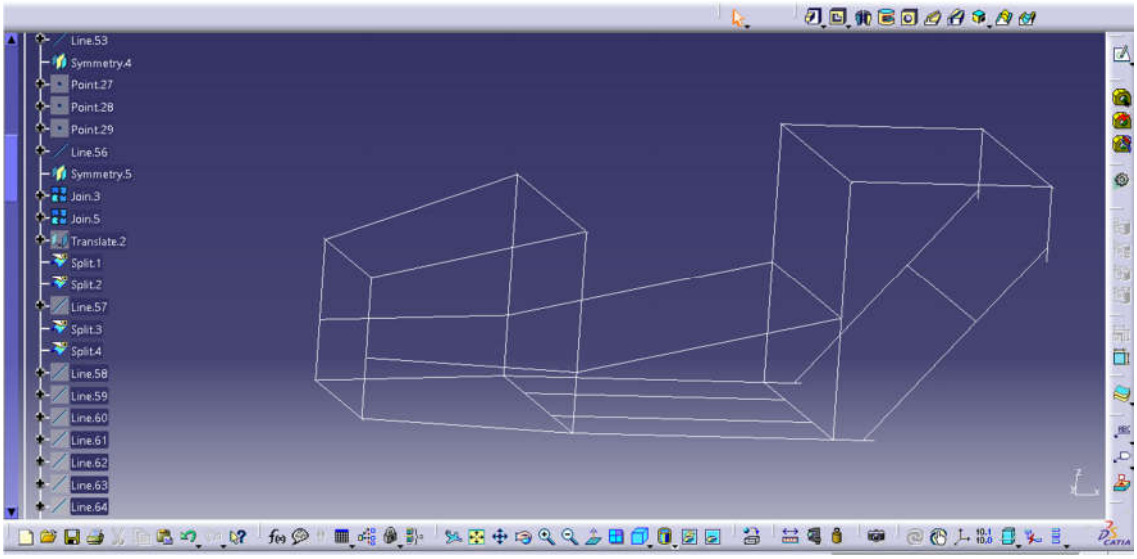

Fig:-3.2.1 Line view of chassis or roll cage

The next figure shows the padding of the base of the roll cage or solar car in which dimension mns are given in figure 3.2.2. The upcoming figure have padding of base and front part which is shown in figure 3.2.3. The figure 3.2.4 which shows padding of base and the back portion of the solar vehicle.

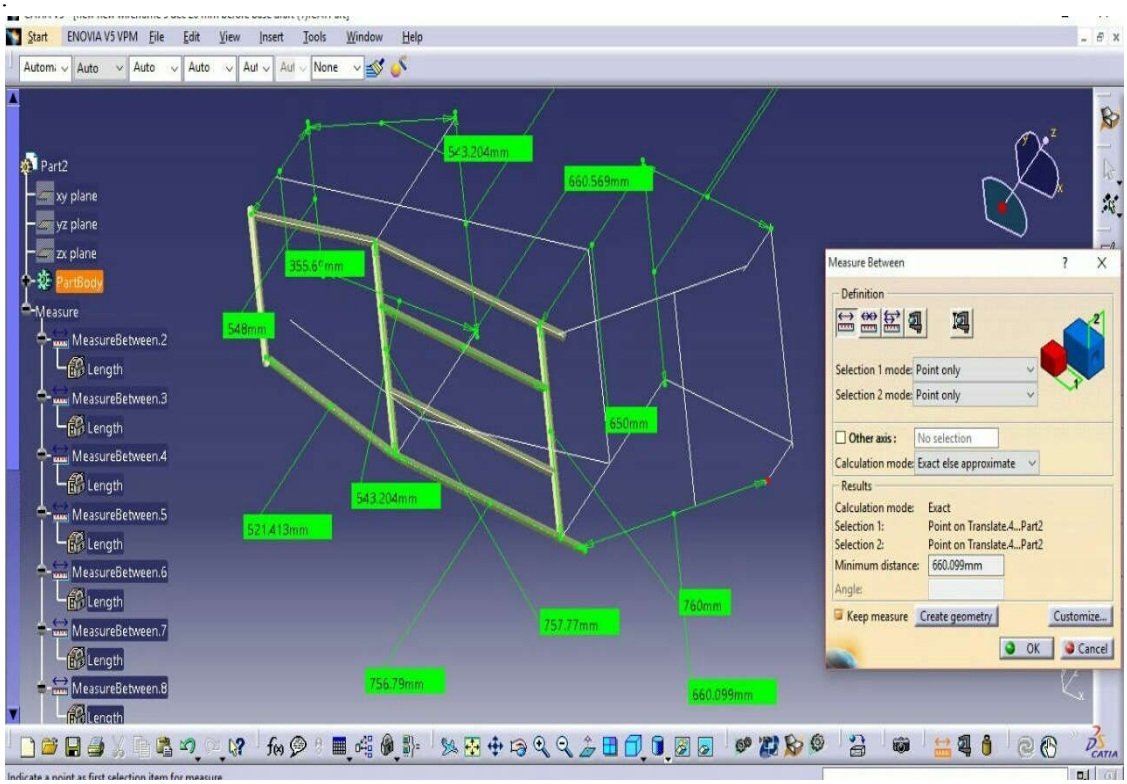

Fig:-3.2.2 Padding of base of the roll cage

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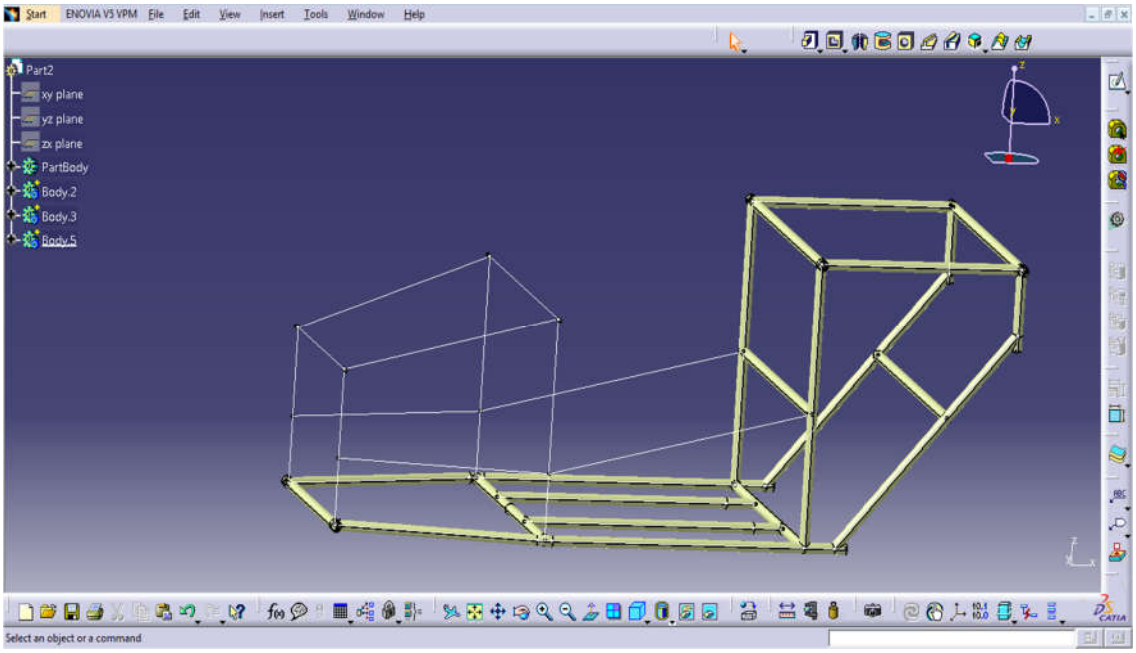

Fig:-3.2.3 Padding of base and back portion of the roll cage

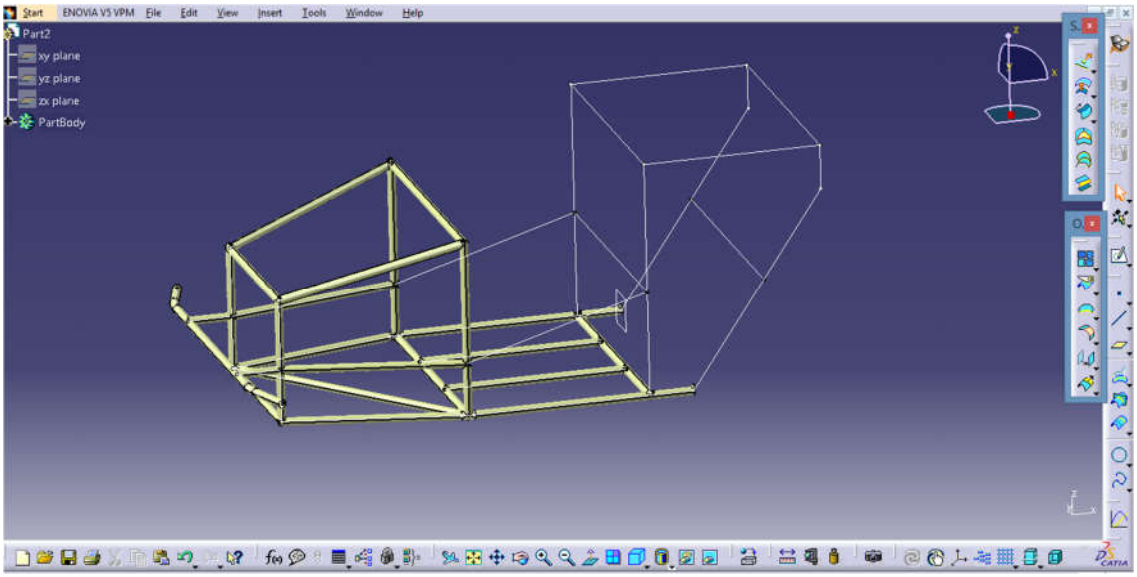

Fig:-3.2.4 Padding of base and front portion of the roll cage

Some parts of the model are created using part modeling, depending upon the thickness and shape of the component. Parts like clamps, rivets and shims are made by part modeling. Thickness of the component is applied during the sketcher stage. Component is made to pad, extrude or sweep with the thickness of the component already considered in the sketch.

3.3 ASSEMBLY DESIGN

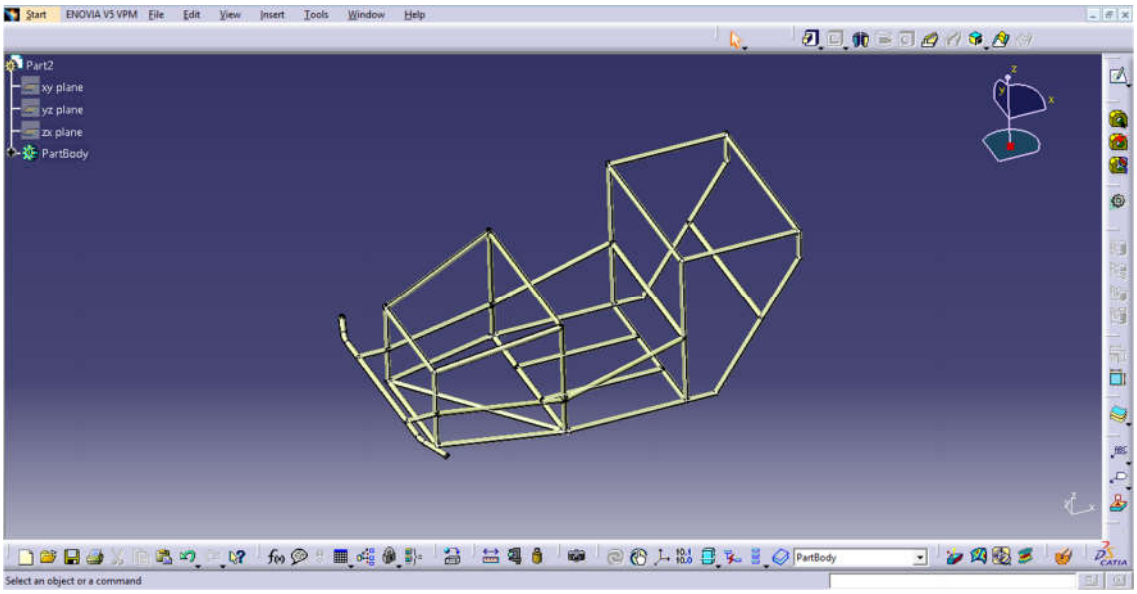

Fig:-3.3.1 wire frame model of roll cage or chassis

The Fig-3.3.1 shows the assembly of some parts of the solar vehicle. Assembly design provides us more convenient and more accurate way of positioning all the parts made by part modeling / Surface Modeling. Constraints allows to position mechanical components in relation to other components of assembly. It just needs to specify the type of constraint to be setup between two components and the system will plays the components exactly the way it is required. Constraint can also be used to indicate the mechanical relationship between the components. Assembling process is similar to the general manufacturing process any one part is made fixed as the base component and the other components are constrained with respect to the base components.

CONCLUSION AND FUTURE DIRECTIONS

In order to cope with the increasing demands for fuel and the disastrous environment pollution due to driving carbon-based vehicles, it is quite necessary to switch to a new source of energy, i.e. the solar power which would be a cheap, efficient, limitless and of course an eco-friendly alternative. Solar-powered electric vehicles are safe with no volatile fuel or hot exhaust systems. They are zero emission vehicles, odorless, smokeless and noiseless. They require minimal maintenance, are more reliable with little or no moving parts and can be efficiently charged nearly anywhere. Needless to say it is very much cost efficient. Since solar cars can easily incorporate future technology, we hope that it would not be long before the majority of the worlds' people would switch to driving this modern vehicle and thereby bring about a positive in their lives and the environment. This is just the beginning of a new technology and it is guaranteed that future developments will make solar cars the predominant mode of transportation over vehicles with internal combustion engines.

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