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DESIGN AND FABRICATION OF CHASSIS FRAME FOR SOLAR ELECTRICAL VEHICLE

[1]Dr. Rajesh Gurani, [2]Dr. B J Patil, [3]Ravindra Bhadkumbe, [4]Laxminarayan Yadgiri, [5]Nikhil Kamble, [6]Aboli Awad

[1]Associate Professsor& Head, [2]Principal, [3,4,5,6]Student
[1,3,4,5,6] Department of Mechanical Engineering
[1,2,3,4,5,6] KSGBS's Bharat-Ratna Indira Gandhi College of Engineering, Solapur, Maharashtra. – 413255. India
Email – rajeshgurani91@gmail.com,

Abstract :Chassis, also known as 'Frame', is the foundation structure of any car that supports it from underneath. The purpose of the chassis is to bear the weight of the car in its idle and dynamic states. And another aspect regarding the power supply to an automobile engine is scarcity and pollution from Fossil fuels. Hence everyone is doing more research on alternatives like Solar, Electric or hybrid driven systems. Through the process of designing, testing and building the ladder type cross bar section chassis is very much suitable light weight solar powered electric vehicles.These chassis provide high level of strength and stiffness performance and relatively easily constructed without the need of specialize machinery and tooling.This type of chassis manufacturing techniques are also less prone to manufacturing defects as compared to other methods as the cross section bars use for making chassis is a standard part and comes directly from supplier.

So this paper is mainly focuses on the design and fabricationof chassis for the solar powered electric vehicle. A CAED model is build using the design software and analyzed with the analytical theories. Then the final model of chassis is fabricated and tested for suitability. Also a small modification in Ackerman steering is carried out to cut the radius of curvature of vehicle while turning.

***IndexTerms*–Hybrid Electric Vehicle, Ackerman Steering, Photo-Voltaic Cell.**

I. INTRODUCTION

Today's sector accounts for 23% of CO2 emissions, 72% of which is being emitted by road transport. The CO2 emission regulation for new cars has come as a response to set emission performance limits for new passenger cars with the goal of establishing a road map change for automotive sector. Many researchers are jointly working on future energy challenges, both in terms of security and sustainability, in that achieving a sustainable transportation system will be the critical component. Electrification of the transportation system seems to be the most promising alternatives in terms of increasing the security of supply and promoting a sustainable transportation through less pollutant resulting from conventional transportation. Electric Vehicle deployment may be considered as sustainable emission only when powered by the considerable amount of Renewable Energy Sources (RES). From power supply point of view, there is a limitation of accommodating an increasing level of RES sources under load demand from Electric Vehicle users both at peak and off peak time. On the other hand, an efficient penetration of RES depends on the ability to inject the maximum power within the stability of the electricity networks. The EV potential in demand side management enhancement.

According to a report released by the Society of Indian Automobile Manufacturers (SIAM), electric vehicles are considered a positive step to decarbonise the automobile transportation sector. Battery electric vehicles have improved transmission efficiency and less pollution such as air, land and water. The electric potential stored in power batteries is utilised to actuate the drive system i.e. electric motor of electric vehicles. The electric machine employed in the electric vehicle has the efficiency up to 95% while the efficiency of a gasoline engine is up to 35%. Therefore, the overall efficiency from the tank to the wheel of the electric vehicle is two times more as compared to ICE vehicle. The work discussed above suggests that battery electric vehicles are conceived as "the vehicles of future" in the queue of conventional ones.

A zero-emission vehicle is powered by Solar energy by means of solar photovoltaic panels through storage batteries and the traction is obtained by an electric motor. But, solar energy for electric Vehicle is not an issue, because several critical points also need to be analyzedexample, the efficiency and costs of solar photovoltaic panels, how to maximize the solar irradiation, and the control and energy management.

A hybrid system for an electric Vehicle is proposed, including solar photovoltaic, storage battery and super capacitor, with the system configuration and different control strategy. The vehicle involving battery powered and charged by photovoltaic panels is used for agricultural activities in remote hilly areas, with the aim to produce the cleaner power hence the usage of diesel is reduced in agriculture. Other hand, many solar vehicles are built to participate in different solar vehicle championship around the world to test and examine the new technological advancements and its potential to design the zero-emission vehicles.

The objective of the proposed design is, the energy drawn from the solar panel should be used to charge a battery which runs the motor of the vehicle. A simple DC Converter acts as interface between the solar panel and the battery to obtain the required constant voltage and it will extract maximum power from solar photovoltaic panel. The geometrical analysis of the steering mechanism is successfully done. According to Steering geometry, the outer wheels moves faster than the inner wheels, therefore, the equation for correct steering.

The frame is the leading structure of the electric vehicle that supports the steering system, suspension system, traction system, braking system, battery system and auxiliary loads. The performance of chassis depends on rigidity resistance during bending and torsion, load absorbing effectiveness and overall weight of chassis. Lightweight design such as space structure, pressed aluminium and monocoque type frames are primary concerns for EVs. The space lattice structure with circular or square beam cross-section is mostly employed in the racing car due to higher rigidity. Pressed aluminium type frame is constructed intensive welding process. Monocoque chassis in which members are joined by welding together are extensively used in lightweight vehicles and cars.

II. LITERATURE SURVEY

The emergent concerns over the ecological disgrace have amended thedemand of energy efficient and non-polluting electric vehicles [1]. The interests on the development of non-polluting vehicles haveimproved the progression of fuel cell vehicles, hybrid electric vehicles and nonconventionalenergy sources based automobiles [2].The Hybrid Electric Vehicle (HEV) designed with the combination of two ormore energy sources gives more advantages by reducing the emission of CO_2[3]. The electricvehicle uses the mechanical energy obtained from the drive motor as asupplement for the drive power obtained from the Internal Combustion (IC)engine during the acceleration period. The restoration of the electrical energy iscarried out during the deceleration or braking period of the Electric Vehicle (EV)and HEV.

Ghani et al. have presented a study on the retrofit conversion ofhybrid electric vehicles to plug-in HEVs [4]. The simulation and experiments wereperformed by using the powertrain system analysis toolkit are presented. At thebeginning, a rule-based fuzzy controller has been developed for the batteryenergy-management unit. Followed by this, model of the conversion PHEV hasbeen presented.Parten et al. have described a power management strategy tounderstand the real-time optimal torque distribution between the electric motor ofparallel hybrid electric vehicles and internal combustion (IC) engine [5].

III. METHODOLOGY

An electric-solar car is an electric vehicle powered completely or significantly by direct solar energy using the photovoltaic cell. The analysis and understanding of electrical and photovoltaic systems seems to be highly intuitive for fabrication of successful design of prototype. The main aim and focus of our project is to design and analysis an effective steering system for electric-solar vehicle. Ackerman steering principle is taken as the consideration of steering mechanism. The steering effort is applied to steering wheel to rotate rack shaft that is attached with pinion gear which convert rotary motion into linear motion through rack and pinion steering mechanism helps in smooth steering of vehicle.

We are using rack and pinion steering system for our solar vehicle. Because it is simple and most common in cars, small trucks, suvs.A rack and pinion gearbox is enclosed in metal tube. A rod, called tie rod connects to each end of rack. The pinion gear is attached to steering shaft. When you turn steering wheel, gear spins, moving the rack The tie rod at each end of rack connects to steering arm on spindle.

The physical model of the DC-DC boost converter is designed in the Simscape library tool to boost up the output power of the PV module. For each incident irradiance level, duty cycles 65%, 70%, 75% and 80% are considered for the DC-DC boost converter. The design value of the capacitor and inductor are computed at these duty cycles and assigned to the DC-DC converter model. Further, simulations have been performed for these duty cycles at irradiance levels of 1000, 800, 600, 400, and 200 W/m2. The results show that 80% duty cycle of controlled PWM voltage is more efficient at 1000 W/m2 irradiance.The post-processing of results shows that 75% duty cycle of the DC-DC boost converter is most efficient considering all the incident irradiance levels together.

IV. CAED MODEL AND ASSEMBLY

In the present chapter, the physical vehicle model of the three-wheeled electric vehicle is designed in the Simscape environment of MATLAB tool. The physical signal of the torque is transferred to the left and right wheel with the help of “ideal torque source” and “differential” blocks. Thereafter, determine the appropriate mechanical parameters and coefficients from the literature survey. Simulations have been carried out for the three- wheeled vehicle physical model for different road gradient. The value of applied torque, the dynamic load acting on the front and rear wheel are computed. Finally, to crosscheck the Simscape physical vehicle model results, longitudinal vehicle dynamic (LVD) is developed. Figure 4.1 shows the SolidWorks model structure of the proposed solar electric vehicle.

The frame of the electric vehicle is a primary element as it supports internal as well as external load. Chassis is the leading base of solar powered electric vehicle that supports the steering system, suspension system, drives system, braking system, battery system and loads of passengers. Performance of the chassis depends on the rigidity resistance during bending and torsion, load absorbing effectiveness and overall weight of chassis. In India, delta type chassis are commonly used in the three-wheeled vehicles including both auto-rickshaw and electric rickshaw due to the advantages of less turning curvature and rear wheels drive architecture as compare to tadpole type configuration. Delta type configuration has one front wheel and two rear wheels while tadpole type configuration having two front wheels and one rear wheel.

Chassis of the solar powered electric vehicle is an unconstrained structure. Hence, the static analysis can't apply directly to analyse the internal stresses and strain due to vertical and longitudinal loading of vehicle structure because stiffness matrix becomes singular due to the inflexible body movement of structure. The design phase is consisting of the need for design, detailed specifications and collection of other relevant information followed by a feasibility study of the conceptual design. The second phase which is analysis phase includes stress calculation based on predefined boundary & loading conditions and if required basedon all calculations the optimized model can be produced. These two phases come under the umbrella of CAD i.e. computer aided design.

SolidWorks software is used for modelling the existing and modified chassis of the electric vehicle. After that, AISI 1033 steel is considered the material for solar powered e-vehicle and meshing CAD models of existing and modified chassis are created. Vertical and longitudinal loads are computed for these chassis. Thereafter, CAD models of chassis are analysed to compute force reaction, moment reaction, equivalent stresses, inertial relief translational and rotational acceleration to counterbalanced the applied external loads. Finally, undertaken a comparison between existing and modified chassis results.

In the field of Computer Aided Design (CAD) modelling are the foundation of any project and most time-consuming process. It has been considered as the backbone of any of the CAE projects by the designing professionals and researchers. It is the process of elaborating computerizes models of the component before they will physically produce. The user can visualize their design and deal with problems before the resources invested to convert them into physical form. Double type monocoque chassis are extensively used in the existing three-wheeled "battery" vehicles. Single type monocoque chassis is the modified version of double type chassis. Double and single type chassis is constructed in the Weldments module of SolidWorks tool. Rectangular hollow cross-section profiles having dimensions 56x38x2 mm, 56x28x2 mm, and 30x30 mm are employed for modelling the frame structure. The selection criteria of the rectangular profile are based on higher torsional strength and bending moments over other profiles. Figure 4.1 show the 3D chassis models of existing (double type) and modified (single type) three-wheeled "battery" vehicle prepared in SolidWorksWeldments module. The dimensions of the structure model are based on the existing dimensions of leading battery vehicles.

Figure 4.1 CAED model of the chassis frame

4.1 How to Make Solar electric vehicle Steering: Assembly

Building a solar electric vehicle steering system is really easy with the above model. Just by following the step-by-step instructions and diagrams in the plans, drill and cut out the steel and weld it up steering models can be built.

4.1.1 Steering Hoop:

Cut out and weld the steering hoop on a flat surface. The angles were cut on 51° read from a protractor (reads as 39° from an abrasive chop saw). You should also cut out and drill holes for the kill switch plate. Weld the kill switch plate onto the steering hoop. When tacking the steering hoop to the frame, you should shoot for about a 55° slant.

Once the hoop and column are complete, it is time to permanently attach them to the solar EV. Again, the hoop should be about at a 55 degree angle from the horizontal frame. Make sure the 3/4″ID spacer on the steering shaft has some wiggle room, then tack it. If it is a tight fit, welding will make it warp and bind to the shaft. I ground down part of the steering column so it would have enough wiggle room before welding.

Figure 4.2 fabrication and assembly of Steering Hoop

Tack weld the lower bracket first, then check the steering angle. Make sure that the pitman arm travel is limited so that the go karts steering angle turns no more than 45 in either direction from straight up. 'Straight up' is when the pitman arm points straight up, and the wheels are both pointing forward. I used my angle finder to determine how high to tack the lower bracket that holds the steering column. The angle iron should contact the frame and prevent you from over steering.

4.1.2 Steering Shaft:

Drill holes in the steering wheel hub, and weld it flush with the steering shaft (make sure you have the steering wheel symmetrical on this step). Slide the two spacers onto the shaft, drill a 3/4″ hole in the lower bracket that will be welded to the kart. Weld the angle iron (steering stop) and pitman arm (with 3/8″ hole) onto the shaft as well. The lower bracket should have just enough play between the spacer and steering stop to spin freely on the steering shaft without binding.

Figure 4.3 Assembly of Steering Shaft and Brackets

4.1.3 Spindle Brackets for Front Axle:

The spindle brackets that came in the go kart parts kit should be tack welded near 90°, roughly centered on the go kart's front axle. There is minimal room for error here, so please attach the tie rods and spindles just to make sure they (the tie rods) don't contact the bumper before you fully weld the spindle brackets to the axle.

Figure4.4 Assembly of Spindle brackets and Tie rods to front axle.

The tie rods in the above picture and spindles should be bolted onto the kart. Tighten the kingpin bolts (the bolts that hold on the spindles) just tight enough that they don't bind to the spindles.Building a Solar Electric Vehicle steering system is easy with the design I used. This system includes the wheel, column, steering stops and brackets, which then attach to the pitman arm, tie rods, spindles, and spindle brackets. This reliable design has stood the test of time and needs minimal servicing. This kart is functional, simple, and heavy duty. You will get many years of enjoyment out of it.

V. CONCLUSION

In this paper the chassis for the solar driven electric vehicle is designed and tested. The model is designed in the design software and compared analytically with theoretical values. After analyzing in the software it is concluded that deformation produced will be negligible and it can sustain at above the nominal stress.Therefore it is commonly used in light vehicles.

The steering system has altered slightly as it is made rear wheel movable by the help of steering system and due to that we have also connected both these by the help of link that are further connected to steering wheel. A linkage is used to provide turning of the vehicle in an effective manner.

Use of L-type link to play the mechanism made free to turn more and effective. The proposed steering is arranged to exhibit maximum torque over the link to move the Mechanism. The presented methodology of chassis design is very much suitable light weight solar powered electric vehicles.These chassis provide high level of strength and stiffness performance and relatively easily constructed without the need of specialise machinery and tooling. Also it is better quality with economically low budget.

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