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REVIEW ON DESIGN OF SUSPENSION SYSTEM FOR TWO SEATER ELECTRIC VEHICLE

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Abstract - *Suspension system is the necessary part in the automobile vehicle. Suspension system absorbs the unnecessary vibration which applied on the upward from road irregularities and provide comfort ride to passengers. Selection of spring and damper is one of the most important considerations when finalizing a car suspension design. The review paper is based on suspension system for an electric vehicle. The main objective for review paper is to find suspension ideally used in an electric vehicle application and find the flow to design on such system.*

Key Words: **suspension system, vehicle dynamics, Mcpherson suspension system, etc.**

INTRODUCTION

Therefore, in order to properly design a suspension system, one should consider its precise mathematical model. Since some of the behaviors of a suspension system, such as camber angle, depend on instantaneous geometry of the arms in the suspension system, to inquiring further details, researcher should use a model which includes all components of the system.

The suspension system of a vehicle refers to the group of mechanical components that connect the wheels to the frame or body. A great deal of engineering effort has gone into the design of suspensions systems because of an unending effort to improve vehicle ride and handling along with passenger safety and comfort. The primary functions of suspension system are providing vertical compliance and maintaining the wheels in the proper steer and camber attitudes to the road surface. This latter function, which is related to car handling, depends on the type of suspension system its geometry. Proper design of the suspension system plays an essential role in achieving optimal performance because ride and handling are compromising. In other words, one tends to be deteriorated as the other one is being improved.

Literature review

A.G.Thompson, [1] stated that for the optimum spring and damper rates in conventional car, formulas are developed. Frequency locus methods are used in the theory which is based on linear half-car model. Spring rates of suspension are tuned optimally in relation to tire radial rates and the optimal spring and damper rates are independent of speeds. The two dimensional half car model introduced in paper which represent an eight order linear system .If the wheel base, body center of gravity position, and the coupling ratio have already been fixed all that the suspension designer can do is to determine the front and rear spring and damper rates to minimize some arbitrarily chosen quadratic performance index. Polar plots of magnitude and phase, known as frequency locus plots, are employed in this paper. The use and construction of the frequency loci is simple, and leads to the derivation of approximate formulas for the spring and damper rates for optimum road holding.

Yong-Sub Yi, Joonhong Park, et al. [2] it is conventional to establish a set of goal for each kinematics and compliance characteristics in the early stage of vehicle development process, and try to find out design variables such as location of hard points and bushing stiffness. Author explained that the kinematic and compliance characteristics of the vehicle suspension are key parameters from which many aspects of ride and handling performances of vehicle can be estimated. He also stated that most of the engineers should rely on their own experience and intuitions, or repeat trial and error to design a new suspension and improve old one, and sometimes they fail to find the optimal set. Systematic and automatic process if exist which helps to find an optimal design which makes the process of suspension development much easier and more efficient.

A.Eskandari, et al. [3] discussed about the handling behavior of passenger car which has been optimized by altering suspension parameters. A virtual model of the car

is constructed by using Adams software for this purpose. Response surface method is used for the optimization. Author's objective in research paper is to find McPherson strut parameters of a typical vehicle suspension system and optimize the handling behavior of vehicle. Also he stated that the driver observes the direction and position of the vehicle, and corrects its input to achieve the desired motion. Design of experiment methods are used to choose the most important parameters among the suspension system. A complete model of the real vehicle has been constructed using ADAMS car software.

Pinhas barak, [4] highlighted that the design specifications for suspension of cars for handling and ride were amazingly associated with some magic numbers. This magic number is used to guide for evaluation of vehicle design for moderate driving conditions. Moreover, these numbers will continue to control design philosophy in the next decade regardless of high technology concepts. This magic numbers are timeless. These parameter values are needed for mathematical models which describe the motion of dynamic for a vehicle on the road, also helps the researchers to validate the overall performance of their simulations. Numbers are associated with bounce resonant frequency of the sprung mass, but also related to value for the dynamic index for quality ride and directional control. Paper demonstrates through some illustrative examples, computer simulation, road test results, that since the introduction of suspension in automobile industry, a series of specific numbers govern vehicle design for handling and riding.

M. S. Fallah, et al. [5] study mainly focused on the performance of Mac pherson suspension kinematic parameters. It is shown that although contribution of thesecontrollers on the improvement of ride quality of the vehicle is similar and they affect the performance of the man person suspension kinematic parameters significantly different. Simulation results are presented and discussed by author. Using a new model of the Mac person suspension system which facilitates evaluation of the suspension kinematic parameters, common hybrid control strategies based on different combination of the skyhook and ground hook controllers are explained.

Satoshi Suzuki, et al. [6] elucidates the specifications of the springs which minimize the side force. Then study the effect of the tilting angle of a spring seat and of the kinematic condition of the spring on the side force. In addition, these studies are done by using the finite elementcode. Author also investigated the specification of the spring which minimizes the side force to find out the solutions to compatibly satisfy the riding comfort and mass reduction. It was also found that the side force can be reduced when the lateral displacement of the spring seat coincides with the direction of the side force acting on it. Also the side force is reduced certainly by tilting the upper seat in a certain direction.

Keum-Shik Hong, et al. [7] investigated a new model and an optimal pole placement control for the Mac person suspension system. Author focus is on the rotational motion of unsprung mass in new modelling. It is also shown that the conventional model is a special case of this new model since the transfer function of new model coincides with that of conventional if lower support point of damper is located at mass center of unsprung mass. The control law was further applied to a suspension equipped with a continuous variable damper. When the active control law was applied to the damper, a small degradation in the vertical acceleration of the sprung masswas noticed. However, the overall performance was acceptable.

Ramesh Edara, et al. [8] performed multibody dynamics simulation analysis for the suspension systemoptimization. Four case studies presented to use effectively multi body dynamics simulation in suspension system development. Studies are also extended to predict suspension tuning components specifications. In the concept study, different suspension packaging options and kinematics concept are studied. The suspension system level performance studies various tests which are carried out using multibody dynamics simulation to optimize vehicle suspension system performance.

Sussumu Nohara, et al. [9] aims to denote the methodology used to optimize the knuckle for Macpherson to upgrade weight reduction and cost rumination the various engineering design standard that apply to component. Author also stated that the prime idea and righteous practice for evolution of any product always include a good definition of the objective. Objective includes stiffness goals, so it was chosen a functional volume covering the largest possible amount that the largest possible amount that the component could occupy in the vehicle environment.

Takashi Gotoh, et al. [10] explained the significant advances that have been made in resolve the issue of friction in mac person strut suspension for improving riding solace by optimizing the force action line through new spring design which entitles to control the reaction

force axis. For the design of spring author developed a calculation system which consist of the finite element code and mechanical system analysis program ADAMS.

J.P.Hastey, et al. [11] stated that the dilemma of friction in Macpherson strut type suspension can find its best solution through spring. The theoretical step which is flourished in the project enables to define accurately the setup of the spring. The purpose is to deal with the problem in suspension by describing some development method. A practical stage where author check the validity of calculation using measurement criteria linked to the frictions. Also the theoretical stage where determine the situation and form for the spring which are optimized by some calculation with proper software.

A.Purushotham, et al. [12] discussed about the mc person suspension system which has been modeled after studying dynamic equations to study vibration characteristics of sprung mass of the automobile system with the inclusion of various design parameters such as stiffness, damping masse, moment of inertia, etc. due to the complexity involve in the mathematical expression and executing them into the Simulink software, the model has been simplified with a two dimensional practical model of McPherson suspension. Result obtained from ansys model is compared with the mathematical model implemented on Simulink. It is perceive that the displacement and acceleration of the chassis of automobile obtained in ansys are close to the values of the mathematical model.

S.Dehbari, et al. [13] introduced the McPherson suspensionsystem which is frequently applied suspension system for compact and mid-sized cars. Suspension system of Dacia was two dimensionally modelled in full size. Model was capable of analyzing many suspension parameters such as castor angle and track which are related to the car handling. Author validates the model which was modelled in ADAMS car software. Two different tests were conducted on models and results were compared to each other.

Hee G. Lee, et al. [14] study shown on optimal design of McPherson strut suspension system. Sensitivity analysis for the kinematic static design factor and for reaction forces at linkage are carried out, from which the effects of each hard point on suspension factors can be found. Studies may be applicable effectively to adjudicate suspension system layout by predicting the variations of suspension factors required for vehicle characteristics at early design stages.

Dongchen Qin, et al. [15] reported that taking the front McPherson independent suspension as the object, the composition of the suspension is analyzed succinctly, and the dynamics model of the suspension combined with multi-body system dynamics theory is established in ADAMS. The curves of the vehicle performance are obtained, which include the toe angle, the camber angle, the kingpin inclination angle, the caster angle and the volume of lateral slip of the wheel. Results can provide data for improving the design of suspension.

Ian C. Faye, et al. [16] investigation demonstrates that significantly reducing vehicle weight intensifies the engineering tradeoffs associated with laying out suspension systems. Study show that an appropriate tire specification can clearly improve the steady state driving behavior of a lightweight vehicle.

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