



An Overview of Disarray in Ride Performance Analysis of Half Car Model Passive Vehicle Dynamic System Subjected to Different Road Profiles with Wheel Base Delay and Nonlinear Parameters

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Abstract: *Vibration of a vehicle is directly influenced by road roughness and suspension system. Apart from the road roughness, proper vehicle suspension system can play vital role to provide the driver and passenger comfort. Ride comfort is investigated by amplitude of vibration and ride comfort level. This paper tries to give an idea about the previous researches and their findings about the study of nonlinearity of the passive suspension system parameters by considering different car models. The modeling of vehicle with the analysis of dynamic response of the mathematical model have been examined in the large number of investigations.*

Keywords: *Suspension System, Half Car Model, MATLAB SIMULINK, Ride Comfort.*

I.INTRODUCTION

The suspension system on a vehicle has a myriad of purposes. The main objective is to isolate the vehicle from disturbances so that the driver can keep control on the vehicle, without endangering his and passengers well-being. The disturbances can be caused by irregularities on the road, or caused by loads inherent of the operation of the vehicle, such as acceleration, braking and turning, as well as aerodynamic loads.

Vehicle suspensions have been extensively adopted by ground vehicles to isolate ground vibrations and to provide passenger's ride comfort and safety. The vibration of vehicle and seat leads to driver fatigue and decreases driver safety and operation stability of vehicle. Hence development of improved suspension system to achieve high ride quality is one of the important ride challenges in automotive industry. Therefore the goal of vehicle suspension systems is to decrease the acceleration of car body as well as the passenger seat. In reality, some of the vehicle parameters are with uncertainties, so that it is an important issue to deal with vehicle suspension subjected to uncertain parameters in engineering application. The vehicle suspension system is responsible for driving comfort and safety as the suspension carries the vehicle-body and transmits all forces between body and road. It is well known that the ride characteristics of passenger vehicles can be characterized by considering the so-called "half-car" model. Physical models for the investigation of vertical dynamics of suspension systems are most commonly built on the half-car model.

The commercial vehicles use passive suspension system to control the dynamics of a vehicle's vertical motion as well as pitch and roll. Passive suspension system indicates that the suspension elements cannot supply energy to the suspension system. The passive suspension system controls the motion of the body and wheel by limiting their relative velocities to a rate that gives the desired ride characteristics. This is achieved by using some type of damping element placed between the body and wheels of vehicle, such as shock absorber.

Due to different road profiles in India, the focus towards the suspension system is very essential. The vibration of the vehicle leads to discomfort of passenger. Hence developing improved suspension system to achieve high ride comfort is one of the important challenges in automotive industry. Therefore the goal of vehicle suspension system is to decrease the acceleration of car body as well as the passenger seats. The vehicle suspension system is responsible for driving comfort and safety as the suspension carries the vehicle body and transmit all forces between body and road. The ride characteristics of passenger vehicle are well characterized by considering half car model.

The usual elements of a suspension system are an elastic spring, responsible for the stiffness of the system and acting as a transformer of kinetic energy into elastic potential energy, and a shock absorber (damper), responsible for dissipating energy from the vibrations. These are called passive elements, as they do not require an external power source and their characteristics are constant. Passive suspension systems are the most common in passenger vehicles. Different car models are used for analysis of the suspension system. They are full car model, half car model and quarter car model.

II.USE OF NONLINEAR ASYMMETRICAL SHOCK ABSORBER TO IMPROVE COMFORT ON PASSENGER VEHICLE

M.Silveira et al. published a paper on Use of Nonlinear Asymmetrical Shock Absorber to Improve Comfort on Passenger Vehicle. In this study the behavior of two different types of shock absorbers, symmetrical (linear) and asymmetrical (nonlinear) is compared for use on passenger vehicles. The analyses use different standard road inputs and include variation of the severity parameter. The asymmetry ratio and the velocity of the vehicle performance indices and acceleration values are used to assess the efficacy of the asymmetrical systems. The comparisons show that the asymmetrical system, with nonlinear characteristics, tends to have a smoother and more progressive performance, both for vertical and angular movements. The half-car front asymmetrical system was introduced, and the simulation results show that the use of the asymmetrical system only at the front of the vehicle can further diminish the angular oscillations. As lower levels of acceleration are essential for improved ride comfort, the use of asymmetrical systems for vibrations and impact absorption can be a more advantageous choice for passenger vehicles.

III.RIDE COMFORT OF A 4 DEGREE OF FREEDOM NONLINEAR HEAVY VEHICLE SUSPENSION

Md. Zahid Hossain et al. published a paper on Ride Comfort of a 4 degree of freedom Nonlinear Heavy Vehicle suspension. In this literature, a nonlinear mathematical model of 4 degree of freedom (DoF) heavy vehicle suspension is derived with half car model. Vibration characteristics due to parametric changes such as, pitch line excitation and damping coefficients are investigated for heavy vehicle suspension system. The model is simulated by MATLAB/ Simulink to observe the vibration phenomena. Ride comfort is investigated by amplitude of vibration and ride comfort level. A comparison between nonlinear and linear spring model has also been investigated briefly.

IV.MODELING AND VIBRATION ANALYSIS OF ROAD PROFILE MEASURING SYSTEM

C.B.Patel et al. published a paper on Modeling and Vibration Analysis of Road Profile Measuring System. The work contains the simulation of mentioned algorithm with half car model and studies the results in distance, time and frequency domain. This work hinges on the ability to accurately measure road profiles. The objective of the work is to develop an algorithm, using MATLAB/Simulink software, to convert the input signals into measured road profile. The algorithm is checked by the MATLAB/Simulink 4 degrees of freedom half car model. To make the whole Simulink model more realistic, accelerometer and laser sensor properties are introduced. The present work contains the simulation of the mentioned algorithm with a half car model and studies the results in distance, time, and the frequency domain.

V.SIMULATION AND ANALYSIS OF FULL CAR MODEL FOR VARIOUS ROAD PROFILE ON AN ANALYTICALLY VALIDATED MATLAB/SIMULINK MODEL

A. Mitra et al. published a paper on Simulation and Analysis of Full Car Model for Various Road Profile on an Analytically Validated MATLAB/Simulink Model. The objective of this paper is to develop a MATLAB/Simulink model of full car to analyze the ride comfort and vehicle handling. The detail study of mathematical modeling with step by step formation of state space matrix has developed and validation of Simulink model with analytical solution of state space matrix was elaborated in this paper. In this work the methodology was developed to design a passive suspension for a passenger car for satisfying the two conflicting criteria viz. Ride comfort and Road holding as per ISO-2631-1, 1997. Mathematical modeling has been also performed using a seven Degree of Freedom model of the full car for passive system. The solution of analytical method is validated with the Simulink model. This validated simulation model is used as a platform to analyze the performance of vehicle dynamics for different road profiles.

VI.PASSIVE SUSPENSION MODELING USING MATLAB, QUARTER CAR MODEL AND INPUT SIGNAL STEP TYPE

Andronic Florin et al. published a paper on Passive Suspension Modeling Using MATLAB, Quarter Car Model and Input Signal Step Type. As the purpose of a vehicle suspension system is to improve ride comfort and road handling. In this article handling and ride performance of a vehicle with passive suspension system quarter car model with two degree of freedom is simulated and analyzed. In this paper, there is simulation of a passive suspension system, a system that is most commonly used. To verify the accuracy of modeling were used State Space and Transfer Function. The parameters of a passive suspension system are generally fixed, being chosen to achieve a certain level of compromise between road holding, load carrying and ride comfort.



VII.OPTIMIZATION OF A PASSIVE VEHICLE SUSPENSION SYSTEM FOR RIDE COMFORT ENHANCEMENT WITH DIFFERENT SPEEDS BASED ON DESIGN OF EXPERIMENT (DOE) METHOD

Javad Marzbanrad et al. published a paper on Optimization of a Passive Vehicle Suspension System for Ride Comfort Enhancement with Different Speeds Based on Design of Experiment (DoE) Method. This paper reported on an investigation to determine the spring and damper settings that ensured optimal ride comfort of vehicle in different speeds using Design of Experiment (DoE) Method. Optimization was performed with the DoE method on a seven Degree of Freedom model in MATLAB software for speeds ranging from 60 to 90 km/h. Results indicated that optimization of suspension settings using the road and specified range of speed also improved the ride comfort on the same road at the different speeds.

VIII.EXPERIMENTAL VERIFICATION OF PASSIVE QUARTER CAR VEHICLE DYNAMIC SYSTEM SUBJECTED TO HARMONIC ROAD EXCITATION WITH NONLINEAR PARAMETERS

Prof.S. P. Chavan et al. published a paper on Experimental Verification of Passive Quarter Car Vehicle Dynamic System Subjected to Harmonic Road Excitation with Nonlinear Parameters. In the present study, nonlinearities of spring and damper are considered while preparing quarter car model. The sprung mass acceleration response obtained by FFT analyzer at sprung mass of quarter car model is compared with the results obtained by linear and nonlinear MATLAB/Simulink models. The simulation result showed considerable difference in linear and nonlinear passive sprung mass. It is necessary to consider the nonlinearities in suspension system for analysis of vehicle dynamic system.

IX.VIBRATION ANALYSIS OF QUARTER CAR VEHICLE DYNAMIC SYSTEM SUBJECTED TO HARMONIC EXCITATION BY ROAD SURFACE

S. H. Sawant et al. published a paper on Vibration Analysis of Quarter Car Vehicle Dynamic System Subjected to Harmonic Excitation by Road Surface. In this paper the stationary response of quarter car vehicle model moving with a constant velocity over a rough road is considered for the performance study. For this a simplified model and experimental set up is developed. The deterministic impulses due to road profile are given by an eccentric cam which gives input motion to front suspension acting as a follower of the cam. The displacements obtained by FFT analyzer at upper mount of shock absorber were compared with the analytical and MATLAB results. It shows that it is very much essential to consider the nonlinearities in suspension parameters at the time of modeling of vehicle dynamic system for its vibration analysis.

X. CONCLUSION

By the literature review importance of nonlinear analysis is seen. In earlier recherche linear parameters of suspensions were considered but in practice the suspension parameters behaves nonlinear characteristics. So it is important to consider the nonlinearities of the suspension system while designing the suspension system. This behavior of suspensions system is studied with the half car model for better understanding of nonlinearities of suspension parameter because it can elaborate more detail than that of the study quarter car model. As lower levels of acceleration are essential to ride comfort, asymmetrical damping systems for vibrations and impact absorption can be a superior choice over symmetrical systems for use on passenger vehicles under shock input.

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