International Journal for Modern Trends in Science and Technology
Volume: 03, Issue No: 08, August 2017
ISSN: 2455-3778
http://www.ijmtst.com

Simulation of 3 DOF Quarter Car suspension system due to road excitation

T Lalit Vidyasagar[1] | PaidimallaVenkat [1] | Kotipalli Pavan Kalyan[1] | M.Issacu[1]

[1]Automobile Engineering, Godavari Institute of Engineering & Technology, Rajahmundry, Andhra Pradesh, India

*Corresponding Author Email ID: lalitvidyasagar@giet.ac.in

ABSTRACT

The suspension system acts like a comfort framework which is given to every moving vehicles. In this research we are going to study the pattern of passive suspension system when the road excitation is given to the quarter car suspension system. The study of patterns is done with different speeds and a graphical representation has been plotted to take inference from it. The study was done on MATLAB software and graphs also plotted using MATLAB software.

KEYWORDS: *Passive suspension system, 3DOF Quarter car, MATLAB*

I. INTRODUCTION

This suspensionframework is the most least difficult one, as it is a straightforward spring mass damper framework. The damper are likewise the other name of shock absorber.The passive damping can be, best case scenario if the safeguard is solid and wehave to relax the springs. The uninvolved suspension framework works contrastinglyin various types of road prole. This undertaking will give total clarificationon inactive and active suspension frameworks and for what reason to utilize activesuspensions. In passive suspension frameworks, we found that when we attemptto diminish the vertical movement, we see that the taking care of execution getsruined.There is consistently an adjustment in equipment part of the detached suspensionframeworks which is hectic, because of which numerous car organizations are dismissingthe passive method of controlling the vibration.Components in passive suspension systems:

Springs
Dampers or shock absorber

Springs

The essential suspension segments are steel springs. The spring is a looped substancewhich is of a flexible nature. The springs have a steady solidness whichis otherwise called spring firmness. The steel springs have certain limitations theoption in contrast to this elastic bushing, gas spring, and air suspension, otherwisecalled hydropneumatic suspensions. Types of springs are:

Leaf spring: A leaf spring is a straightforwardtype of spring ordinarilyutilized for the suspension in heavy wheeled vehicles. Initially called a laminatedor carriage spring, and here and there alluded to as a semi-circularspring, curved spring, or truck spring, it is probably the most established type of springing.

Torsion bar springs: A torsion bar suspension, otherwise called a torsionspring suspension, is any vehicle suspension that utilizes a suspension baras its principle weight-bearing spring. One furnish of a long metal bar is appendedsolidly to the vehicle frame; the furthest edge ends in a switch, thetorsion key, mounted opposite to the bar, that is connected to a suspension arm, an axle, or the pivot.

Dampers or Shock absorbers

A safeguard or damper is a mechanical or hydraulic device used to retain andcontrol the shock driving forces. It does this by changing over the kinetic energyof the shock into another type of energy particularly heat which is then dispersed.

Types of shock absorbers:

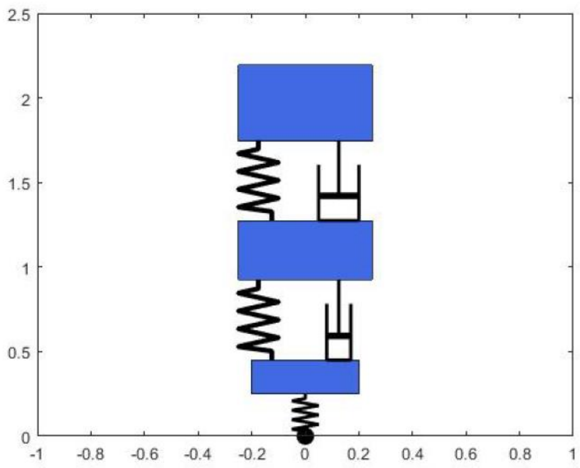
Twin-tube: Basic twin-tube, Otherwise called a "two-tube" safeguard, thisgadget comprises of two settled tube-shaped cylinders, an inward cylinderthat is known as the working cylinder or the pressure tube, and an externalcylinder called the save tube. At the base of the gadget within is a pressurevalve or base valve.

Mono-Tube: The chief design option in contrast to the twin-tube structurehas been the mono-tube safeguard which was viewed as a progressiveheadway when it showed up during the 1950s. As its name suggests, themono-tube stun, which is additionally a gas-pressurized stun and furthermorearrives in a coilover design, comprises of just one cylinder, the weighttube, however it has two cylinders. These cylinders are known as the workingcylinder and the separating or drifting cylinder, and they move in relativesynchrony inside the constrain tube in light of changes in street perfection.The two cylinders additionally totally separate the stun's liquid and gas segments.

II. MATHEMATICAL AND MATLAB/SIMULINK MODELS

The mathematical model is taken from MATLAB/Simulink software.

Passive suspension system



3 DOF passive suspension system

The accompanying 3 DOF suspension frameworkexperiences uninvolved suspension,which is a basic spring-damper suspension framework. In result segment,the yield of this suspension framework is appeared with different speed and differentdamping coefficient, the stroke, stroke speed are calculated which will helpus in finding the suspension limit of this detached suspension.

The numerical conditions for this passive suspension framework are:

By applying Newton's Second Law of movement to the seat, sprung mass and unsprung mass as independently, the condition of movement of the framework can be gotten.

Condition of movement for seat mass is given as:[7]

$$M_{sp}\ddot{y}_{sp} + K_{sp}(y_{sp} - y_s) + C_{sp}(\dot{y}_{sp} - \dot{y}_s) = 0 \quad (1)$$

Equation of motion for mass of sprung is given as:

$$M_s\ddot{y}_s + K_s(y_s - y_u) + C_s(\dot{y}_s - \dot{y}_u) - K_{sp}(y_{sp} - y_s) - C_{sp}(\dot{y}_{sp} - \dot{y}_s) = 0 \quad (2)$$

Similarly Equation of motion for mass of unsprung is given as:

$$M_u\ddot{y}_u + K_t(y_u - q_1) - K_s(Y_s - Y_u) - C_s(\dot{y}_s - \dot{y}_u) = 0 \quad (3)$$

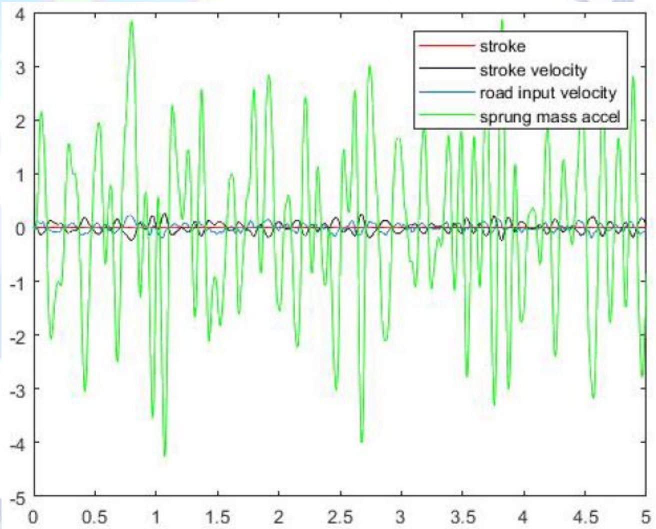
where q(t) is road profile index which is taken by array of data containing roaddisturbances. The simulation of this passive suspension systems are done in MATLAB/Simulink.

III. RESULTS AND DISCUSSIONS

Passivesuspension system at different speeds

The passive suspension system is observed at various speed such as 20km/hr,40km/hr, 60km/hr.

4.1.1 Vehicle at 20km/hr

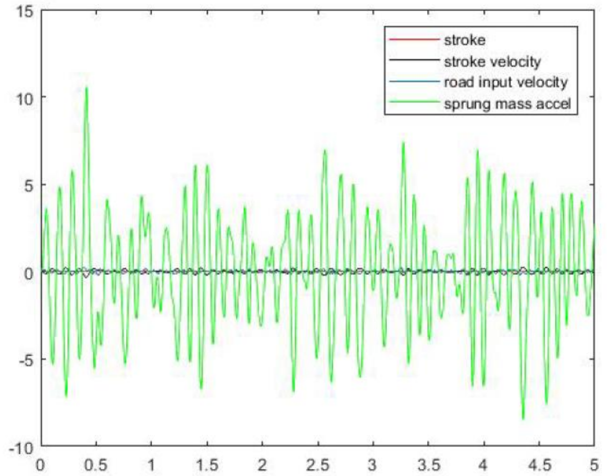


Response at 20km/hr x-axis-time y axis-disturbance

At moderate speed of 20 km/hr the sprung mass quickening is low howeverthe stroke and stroke speed the climb is seen which is undesirable. In this settingstroke is only a diversion of springs and its speed is additionally calculated.It is discovered that at low speed the street speed has more noticeable qualitywhich is unwanted for any rider.

The solace of a rider is been undermined andmay get uncomfort while riding.

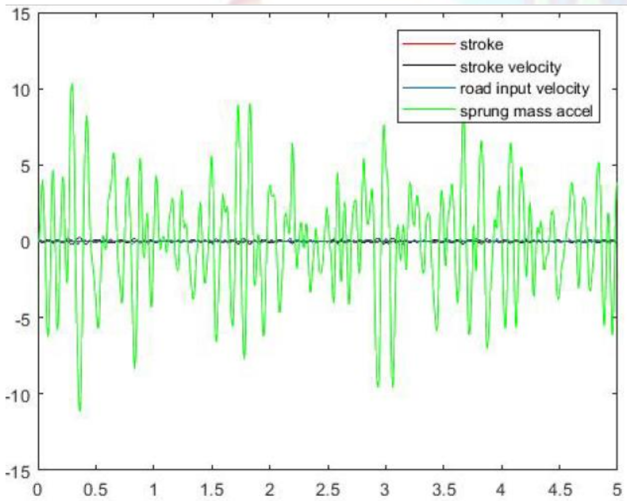
Vehicle at 40km/hr



Response at 40km/hr x-axis-time y axisdisturbance

The speed of a vehicle is appear to be high about 40km/hr. We saw that thesprung mass quickening has went excessively high when contrasted with the vehicleat 20km/hr. The stroke and stroke speed is contrasted with be exceptionally littlewhen identified with the sprung mass increasing speed. This gave little focal points over the 20km/hr vehicle, yet it is viewed that the aggravation is as excessivelyhigh when contrasted with the 20kn/hr vehicle.

Vehicle at 60km/hr



Response at 60km/hr (x-axis-time y axis-disturbance)

IV. Conclusion

We have seen the vehicle at various rates shows diverse reaction diagram, fromthose charts we can infer that, in passive suspension framework the final productof any suspension procedure are affected by speed of the vehicle.

It is discovered that after certain measure of speed the working of suspensiongets same, this is probably the greatest disadvantage of passive suspensionframework. The working of suspension framework relies upon the speed of vehicle.

References

[1] KazimaSosthene, Musabyimana Josee, Xiong Hui (2018),"Fuzzy logic controllerfor semi active suspension based on magneto-rheological damper", International Journal of Automotive Engineering and Technologies, e-ISSN: 21469067

[2] Naman Garg and Bharat Bhushan (2017),"A 3 Degree of Freedom Quarter CarActive Suspension System Model Design Approach using PID, FuzzyLogic andFuzzy Tuned PID", InternationalJournal of Engineering Technology,Management and Applied Sciences,Volume 5, Issue 6, ISSN 2349-4476

[3] Ankita R. Bhise, Rutuja G. Desai, Mr. R. N. Yerrawar, Dr. A.C. Mitra, Dr.R. R. Arakerimath (2016),"Comparison Between Passive And SemiActive SuspensionSystem UsingMatlab/Simulink", IOSR Journal of Mechanicaland CivilEngineering (IOSR-JMCE) Volume 13, Issue 4 Ver. I, PP 01-06

[4] R. Kalaivani, K. Sudhagar and P. Lakshmi (2016),"Neural Network based Vibration Control for Vehicle Active Suspension System",Indian Journal of Scienceand Technology, Vol 9(1)

[5] Mahesh P. Nagarkar, Gahininath J. Vikhe Patil, Rahul N. Zaware Patil(2016),"Optimization of nonlinear quarter car suspension{ seat{driver model",Journal of Advanced Research, 7, 991{1007}

[6] Galal Ali Hassaan (2015),"Car Dynamics using Quarter Model and PassiveSuspension, Part VI: Sprung-mass Step Response", IOSR Journal of ComputerEngineering (IOSR-JCE) e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 17, Issue 2, Ver. 1 PP 65-74

[7] TinnavelliRamamohan Rao, Punjala Anusha (2013),"Active Suspension Systemof a 3 DOF Quarter Car Using Fuzzy Logic Control for Ride Comfort", International Conference on Control, Automation, Robotics & Embedded systems(CARE)