Optimization of Displacement Sensitive Twin Tube Shock Absorber

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ABSTRACT

Abstract **Shock absorber is one of important component in a vehicle suspension system. The shock control spring motion by damping energy from the spring. This paper was focused on the dynamic characteristics of an automotive shock absorber. The design of interchangeable shock absorber test rig was developed and fabricated for the dynamics measurement system. This test rig integrated with the computer systems to record the signal. An experiment was conducted to optimize the stiffness and damping coefficient for 850 cc and 1600 cc shock absorber of splendor bike. Simulation study was performed utilizing the COSMOS Motion software. It can be seen from the results that there is a good agreement between the experimental and simulated results in terms of stiffness and damping value except few discrepancy. The acquired results show that the range of discrepancy within 10%. The good range of stiffness of the passenger vehicle shock absorber is 20 N/mm to 60 N/mm while the damping of passenger vehicle shock absorber is 1 Ns/mm to 6 Ns/mm.**

Keywords: Shock absorber; stiffness; damping coefficient

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1. Introduction

The shock absorber absorbs and dissipates energy. One design consideration, when designing or choosing a shock absorber, is where that energy will go. In most dashpots, energy is converted to heat inside the viscous fluid. In a vehicle, shock absorbers reduce the effect of travelling over rough ground, leading to improved ride quality and vehicle handling. While shock absorbers serve the purpose of limiting excessive suspension movement, their intended sole purpose is to damp spring oscillations. Spring rates are chosen by the manufacturer based on the weight of the vehicle, loaded and unloaded. Some people use shocks to modify spring rates but this is not the correct use. Along with hysteresis in the tire itself, they damp the energy stored in the motion of the unsprung weight up and down. Effective wheel bounce damping may require tuning shocks to an optimal resistance. The characteristics of the shock absorber plays important role in its performance. Therefore for good human ride and comfort vehicle suspension needs to be optimized. Therefore this paper mainly deals with optimization of two wheeler suspension of Hero Honda Splendor bike.

The two wheeler shock absorber specifically Hero-Honda Splendor which is displacement sensitive twin tube shock absorber, is taken for study. Vibration characteristics can be find out by using various springs having different stiffness on shock absorber test rig. The force verses displacement curves and force verses velocity curves can be find out for various speeds and can be compared with each other to study the nonlinear behaviour of the suspension. From these characteristics optimum spring stiffness and damping coefficient can be find out for better human ride and comfort.

1.1 METHOD OF OPTIMZATION OF SHOCK ABSORBER

1.1.1 Objectives

1. To study the behaviour of the selected spring stiffness and the effect of various speeds and loads on the performance of displacement sensitive shock absorber.

2. To find the optimum spring stiffness and damping coefficient for better human ride and comfort.

1.1.2 System Development

1. Design of Experiment: It is the methodology based on statistics and other discipline for arriving at an efficient and effective planning of experiments with a view to obtain valid conclusion from the analysis of experimental data. Design of experiments determines the pattern of observations to be made with a minimum of experimental efforts. To be specific Design of experiments

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(DOE) offers a systematic approach to study the effects of multiple variables / factors on products / process performance by providing a structural set of analysis in a design matrix. In this experimental work, there are following two parameters having three levels for each parameter.

1. Spring stiffness- 41.11 N/mm,73.43 N/mm, 44.53 N/mm.
2. Damping coefficient- 1273 Ns/mm; 1485 Ns/mm; 1697 Ns/mm

Experiment	Spring stiffness	Damping Coefficient
1	41.11 N/mm	1273 Ns/mm
2	41.11 N/mm	1485 Ns/mm
3	41.11 N/mm	1697 Ns/mm
4	73.43 N/mm	1273 Ns/mm
5	73.43 N/mm	1485 Ns/mm
6	73.43 N/mm	1697 Ns/mm
7	44.53 N/mm	1273 Ns/mm
8	44.53 N/mm	1485 Ns/mm
9	44.53 N/mm	1697 Ns/mm

Table-1: Set of Experiments

1.1.3 Experimental Setup:

Figure 1: CAD Model of Experimental Setup

1.2 Experimental Procedure:

Displacement sensitive shock absorber is actuated with the help of D.C.Motor. The apparatus and experimental strategy are shown in Fig.I. Control unit is connected to D.C motor to control its rpm. D.C. motor is coupled to Gear Box. The output shaft of the gear box is rotating about vertical axis at same speed as that of the D.C motor. The Optimization of Displacement Sensitive Twin Tube Shock Absorber 25 output shaft of the gearbox is coupled with cam disc on which cam profile is welded. The lower mount of the shock absorber is placed on the cam profile with the help of ball bearing. The shock absorber is constrained to move in only one direction in order to justify the assumption of single degree-of-freedom (SDOF) behaviour. The top of the absorber is attached to a load cell so that the internal force could be measured directly (it was found that inertial forces were negligible). S-type of load cell is used having 500kg capacity. Accelerometer is also connected at the top. The displacement transducer is connected at lower mount of shock absorber. Data Acquisition system records the data from load cell, accelerometer and displacement transducer.

2: Observations:

1.Transmissibility : By plotting the curve of displacement as shown in Figure III. we can plot the transmissibility curve for different values of speed.

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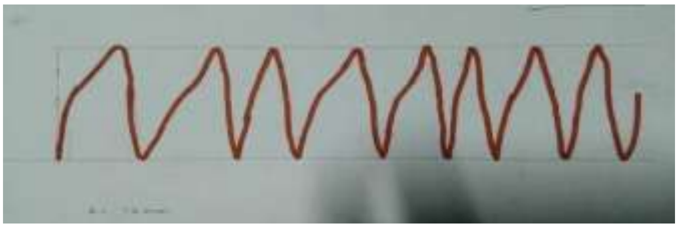

Figure-II: Displacement vs time plot at 70 rpm

Transmissibility curve

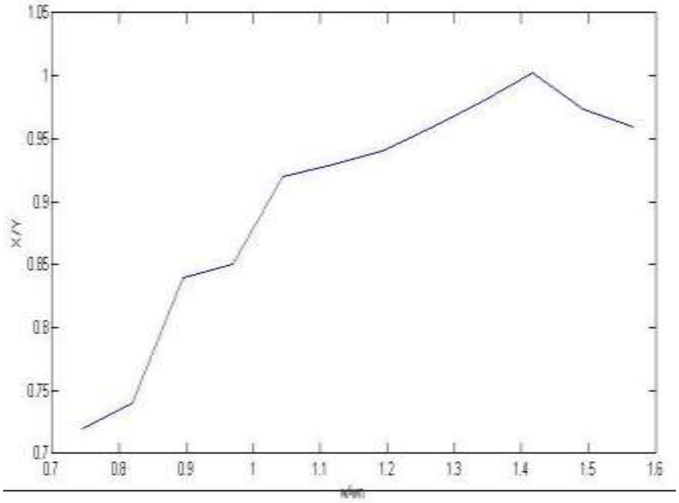

Figure-III: Transmissibility Curve

The above graph is plotted against the ratio of ω/ωn to the transmissibility ratio i.e.x/y. From the above curve we get to know that at ω/ωn equal to √2 or 1.41.

3. CONCLUSION

After conducting the experiments following conclusions are drawn:

1. From the experimental study of shock absorber, as frequency of excitation changes, there is change in the performance behaviour of the suspension. The area of hysteresis loop increases with the increase in excitation frequency. The force transmitted increases by 3% for each subsequent rise in frequency. Therefore Shock absorber is frequency dependant.

2. Shock absorber absorbs energy during compression stroke and releases during expansion stroke. The force transmitted and velocity increases in compression stroke and decreases in expansion stroke. Therefore shock absorber is stroke dependant.

3. Displacement sensitive shock absorber shows strictly nonlinear behaviour.

4. Among four tested suspension spring the optimum spring stiffness is k=44.53 N/mm

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And finally this day has come. I am presenting the paper with great pride. There are too much efforts of gardener to yield the beautiful flowers. So we should not forget him while praising flower. It is a matter of gratification for me to pay my respects and acknowledgements to all those who have imparted knowledge and helped me to complete my report. I would first like to acknowledge the great contribution and support I have received in this endeavor from Guide Prof.S.B.Belkar . His in depth guidance and inspiration for me will be of great help to tackle any kind of problems likely to be met in the future. I expressed my sincere thanks to Head of Dept. Prof. Dr. A.B. Ubale & Principal Dr. Ajit M. Kate for his valuable guidance.

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