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VARIABLE DAMPING USING ADJUSTABLE FLUID FLOW

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ABSTRACT

Function of the suspension system is reducing the deviation of the vehicle body from the mean line of travel to a minimum, and the same time, thereby giving the passengers the best possible ride and making best use of contact with ground via tires to provide good adhesion during cornering, acceleration and braking.

The development of faster vehicles and also the requirements of smoother and more comfortable rides have led to the fitment of dampers on almost on all present day vehicles. Shock absorbers have a significant influence on handling performance and riding comfort. Shock absorber plays an important role not only for comfort of the riders of the vehicle but also in the performance and life of the vehicle. However, no further reduction of vehicle vibration can be expected for using the optimum values of damping coefficient and spring stiffness for the shock absorber. Thus it is necessary to make modification to improve the functions of shock absorber.

This paper is concerned with mathematical modeling and experimental validation of shock absorber, goal of this research is to create damper model to predict accurately damping force, experimental analysis done by varying the various parameters, such as flow area in bleed(A_b), mass (M) and operating frequency(ω). Here in this, input is given in the form of sinusoidal excitation and the output is received as a numerical data of the displacement transmissibility.

1. INTRODUCTION

The analysis and prediction of response and stresses in dynamic systems are inherently more difficult than of stresses in static systems. The effects of vibrations are excessive stresses, undesirable noise, loosening of parts and partial or complete failure of parts. Hence as engineers our foremost task must be to reduce or if possible totally eliminate these undesirable effects. Although various methods are available for the same, at a stage where no changes in design are possible, anticipation of trouble in original planning and design can make possible, avoidance of vibration problem at a little cost. An automotive suspension system is meant to provide both safety and comfort for the occupants. When a vehicle encounters a road surface irregularity, the tire deforms and the suspension displaces. Some of the energy caused by the disturbance is dissipated in the tire; some energy is dissicipated in the damper, and the remainder of the energy in the spring. The spring then releases this energy as a damped oscillation.

Criteria traditionally used to describe the damping properties of shock absorbers depends on experimental measurement and various parameters which is used to measure it. Here in our project we have analyzed a spring –mass-damper system (two wheeler automotive shock absorber: rear wheel), a practical case of which is a vehicle travelling on a rough road. It is a well-known fact that engineers and scientists generally are never absolutely sure that any prediction of theory is correct until it has been tested and verified in practice, hence the importance of experimental and practical work besides theory and analysis. Measurements of analogous systems, mechanical as well as electrical and electronics, may suggest modifications which will enable the performance of n actual system to be predicted. In our dissertation work the experimental analysis is carried out in following ways:

We have shock absorber and scotch-yoke mechanism with electronic sub-system and have made an attempt to perform experimental analysis of it.

During experimentation various combinations of mass (m), bleed flow area (A_b) are used, so that various possible driving conditions can be achieved. The output which is the displacement form is then used to calculate transmissibility, which is also analyzed to make conclusion.

2. MATHEMATICAL MODELING OF THE DAMPER

Mono-tube racing dampers were the basis for the damper model. In this case external oil flow adjustment system was attached (shown in figure 1) to the mono-tube shock absorber (Apache) for changing the oil flow through orifice to adjust the damping to get good ride comfort.

In that external flow adjustment system there were two circular plates with circular slot (arc) as shown in figure (2). Lower circular plate was fixed and upper circular plate was rotated by rod to get variable damping. By rotating the upper circular plate opening and closing area for oil flow increases and decreases depending upon position of upper circular plate, so we got different damping values.

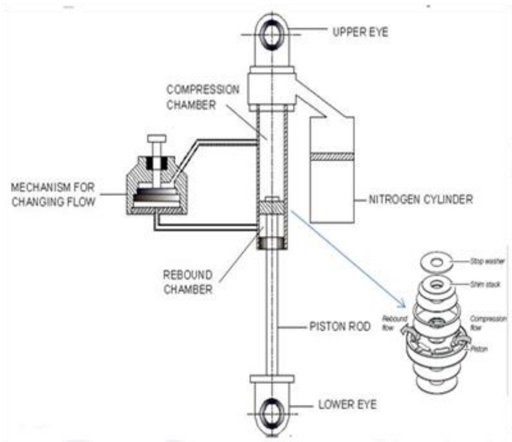

Figure 1: External adjustable shock absorber

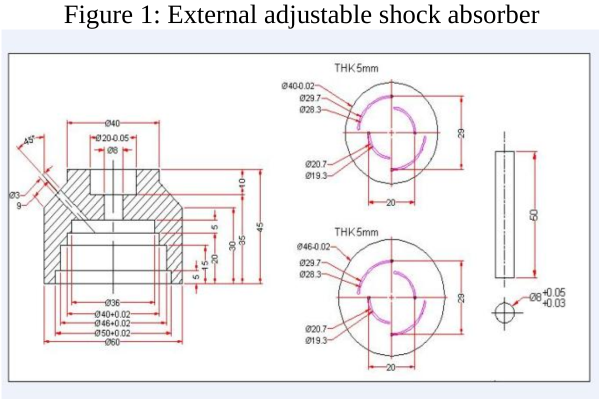

Figure 2: variable flow passage for adjusting flow area between compression and rebound chamber.

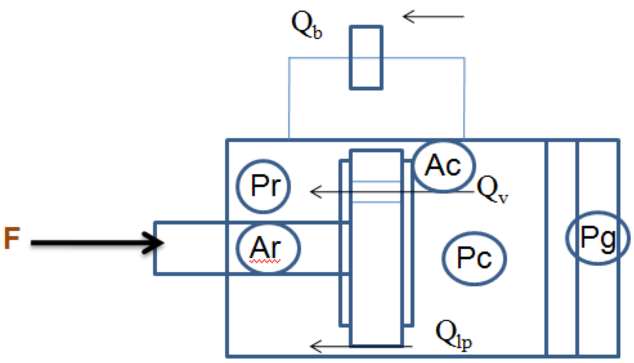

Figure 3: Damper Compression Flow Diagram

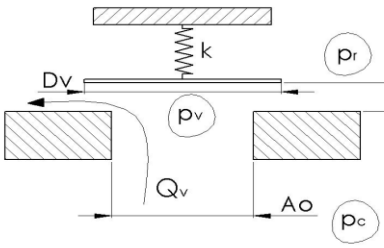

Figure 4: Simplified Compression Stroke Valve Model

The pressure drops across the piston orifice and the valves can be visualized. The shim stiffness, k, must also be determined. The method for finding k will be explained in the Shim Stiffness Modeling section.

In essence, the model show in Figure 4 treats the shim as a linear spring to determine shim deflection, y, and the relation between deflection and force, k×y. A force balance on the valve relates the forces; this is shown in Figure 5

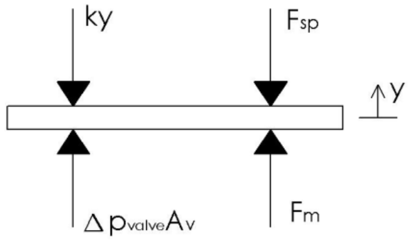

Figure 5: Free Body Diagram of Valve

In a mono-tube damper, the gas chamber accounts for the increase of volume caused by the insertion of the piston rod. Assumed the damper oil was incompressible, which makes the gas pressure a function of the piston displacement. Figure 6 shows the forces acting on the gas piston. [5]

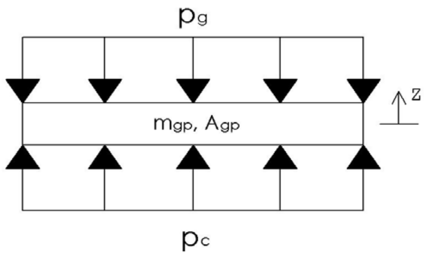

Figure 6: Free Body Diagram of Gas Piston

3. DAMPER FORCE MODELING

After the chamber pressures are calculated, the damper force can be found. Summing the forces on the piston assembly yields a relation for the damping force based on the other acting forces. Figure 4.7 shows the free body diagram of the piston assembly.

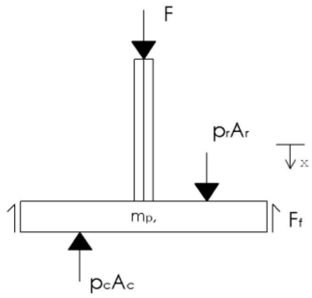

Figure 4.7: Free Body Diagram of Piston Assembly

Applying Newton's second law, the sum of the forces in the x direction gives equation

$$F = \quad + \quad - \quad +$$

F is the damper shaft force and F_f is the friction force acting on the piston. The acceleration is calculated from the known sinusoidal input from the damper dynamometer and the pressures are calculated from the model above. The mass of the piston assembly, mp, includes the piston, the rod, the needle valve and the rod end/spherical bearings and can be measured directly. The areas are also measured parameters.

4. CONCLUSIONS

It can be seen that for larger bleed area transmibility reduces, due to increase in the oil flow because of higher friction losses. The mathematical model using fluid flow equation and FEA analysis could accurately calculate damping force for given damper parameters. It is better to have low transmibility (larger bleed area), for lower suspension velocity, which leads to lesser acceleration being transmitted to the occupants. However for higher suspension velocity, bleed area should be low (higher transmibility) to reduce displacement of tyre from road.

REFERENCES

1. **Emanuele,Tudor and stammers** '*Semi-active suspension control'*, Springer publication,2008
2. **John c. Dixon** '*The shock absorber Handbook'*, Professional Engineering Publishing Ltd, Second Edition, 2007
3. **Douglas Thorby** '*Structural Dynamics and Vibration in Practice'*, Butterworth Heinemann Publications first edition, 2008
4. **Rajesh Rajamani** '*Vehicle Dynamics and Control'*, Springer publication,2006
5. **Eyres, Champneys, and Lieven,** '*Modelling and Dynamic Response of a Damper wit Relief Valve'*, non-linear dynamics, 2004, vol.40, Pp.119-147
6. **Renxue and Limin** '*Research on Co-Simulation and Test of Semi-Active'*, Suspension Second International Conference on Computer Modeling and Simulation, 2010
7. **Shi Ying and Tian Xiangtao** '*Model of the 1 / 4 of a Simple Suspension Model Simulation and Analysis',* ICEIT, 2010
8. **Michael S. Talbott and John Starkey** '*An Experimentally Validated Physical Model of a High-Performance Mono-Tube Damper*', Motor sports Engineering Conference & Exhibition Indianapolis, Indiana, 2002
9. **Bofu jiang**, United state patent application, publication no. US 2006/0278483, 2006