Experimental Validation of Two Wheeler Damper Using With MATLAB

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Abstract— For the implementation of a parametric model of an automotive damper this research was to create a damper model to predict accurately damping forces to be used as a design tool for the damper design team. The model accounts for each individual flow path in the damper, and employs a flow resistance model for each flow path. The deflection of the shim stack was calculated from a force balance and linked to the flow resistance. These equations yield a system of nonlinear equations that was solved using Newton's iterative method. this model was to generate accurately force vs. velocity and force vs. displacement plots for examination. The dynamic model and analysis is used to correlate the model to real damper data for verification of accuracy. With a working model, components including the bleed orifice, piston orifice, and compression and rebound shims which were varied to gain an understanding of effects on the damping force.

I. INTRODUCTION

In any design endeavor with limited time for research and development, tools that increase productivity or decrease necessary testing are crucial for success. This gives rise to a need for development tools such as computer models of suspension, chassis, and engine systems. Because of schedule constraints, the suspension design of most automobile two wheeler is based primarily on steady state analysis.

There are many types of automotive suspension dampers, which are commonly referred to as shock absorbers. This is a misnomer because the damper does not actually absorb the shock. That is the function of the suspension springs. As is well known, a spring/mass system without energy dissipation exhibits perpetual harmonic motion with the spring and the mass exchanging potential and kinetic energy, respectively. For the purpose of this paper, the term damper will be used. The function of the damper is to remove the kinetic energy from the system and to convert it into thermal energy. The methodology for the damping force analysis of an automobile shock absorber using a mathematical model is proposed. [1]

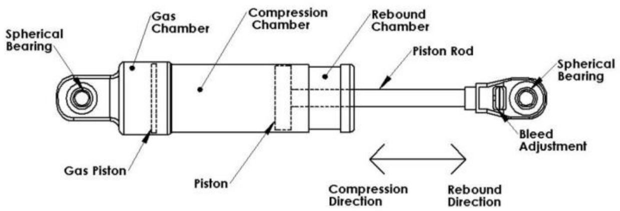

Fig 1: Components of Mono tube Adjustable Damper

The damper consists of several main parts. The tube of the damper houses all of the internal components. Once assembled, the tube is divided into three chambers: gas, rebound, and compression. The gas chamber is at the top of the tube; it is separated from the compression chamber by a floating piston. This piston separates the gas in the gas chamber, typically nitrogen, from the oil in the compression chamber. The compression chamber sits between the floating piston of the gas chamber and the piston. The rebound chamber is opposite the compression chamber on the other side of the piston and at the bottom end of the tube. Both the compression chamber and rebound chamber are completely filled with high-quality mineral or synthetic oil. The piston of the damper is connected to the rod that goes through the rebound chamber and out the bottom of the tube. The rod passes through a special seal designed to keep the oil in, dirt out and to minimize friction between the rod and seal. The damper is attached to the vehicle through two eyelets. The damper operates in two modes, compression (positive velocity) and rebound (negative velocity). During the compression stroke the rod is pushed into the tube and fluid flows through the piston from the compression chamber to the rebound chamber. The rebound stroke is the reverse process in which the rod is drawn out of the tube and fluid flows from the rebound chamber to the compression chamber.[2]

II. EXPERIMENTAL WORK

According to experiment to produce actual damping condition of shock absorber in room it is necessary to construct a device which can produce up and down movement of shock absorber. Shock absorber tester was developed for this purpose.[3]

Fig 2: Shock absorber test rig.

Shock absorber test rig consist of mainly 3 phase motor, Piston crank mechanism with connecting road, two cylindrical rods and three plats. 3 phase motor and piston crank mechanism is attached with base frame and two cylindrical rod also attached with base frame.3 phase motor shaft is connected with piston crank mechanism. Piston crank mechanism connected with outer connecting rod and connecting road is connecting with two cylindrical plats. On the upper end plate load cell is attached that could be measure force and load cell output single can be recorded on digital indicator.

When power was come from starter to variable frequency drive which would be control the electrical motor speed. From different speed we can measure different velocities, forces and displacement. On that measuring data we can plots FD and FV.

III. Development Of Damper Model Using Matlab

MATLAB® is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB, you can analyze data, develop algorithms, and create models and applications. The language, tools, and built-in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java®. You can use MATLAB for a range of applications, including signal processing and communications, image and video processing, control systems, test and measurement, computational finance, and computational biology. More than a million engineers and scientists in industry and academia use MATLAB, the language of technical computing. [4]

A. Key Features of MATLAB

– High-level language for numerical computation, visualization, and application development
– Interactive environment for iterative exploration, design, and problem solving
– Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration, and solving ordinary differential equations
– Built-in graphics for visualizing data and tools for creating custom plots
– Development tools for improving code quality and maintainability and maximizing performance
– Tools for building applications with custom graphical interfaces
– Functions for integrating MATLAB based algorithms with external applications and languages such as C, Java, .NET, and Microsoft® Excel® [5]

IV. Comparision Of Results And Discussion

A. Experimental results

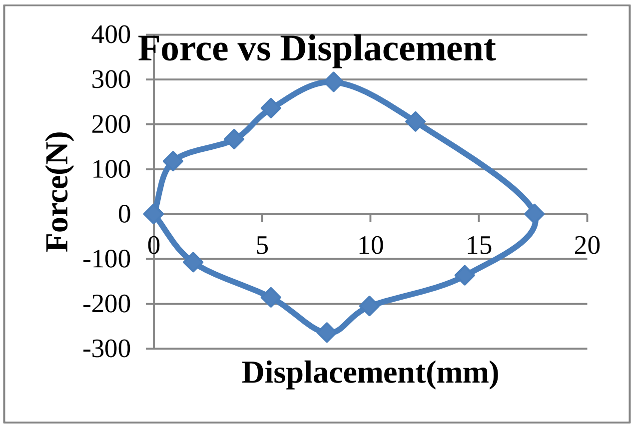

Fig. 3: Damper Force Vs displacement curve

Fig 3. shows Damper Force Vs displacement curve which indicates full cycle of compression and indicates rebound stroke. In this graph positive value of force is compression and negative value of force is rebound. Velocity taking as positive values only.

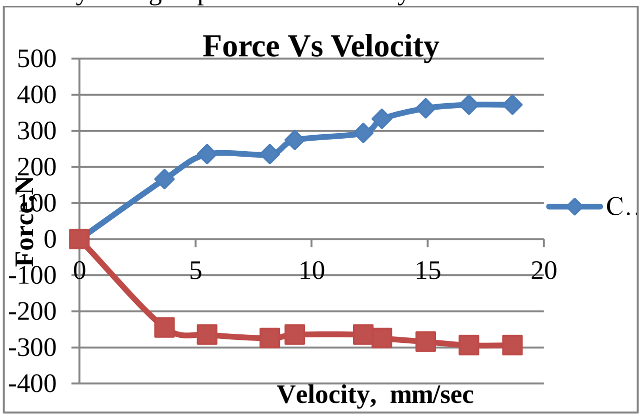

Fig 4: Damper Force Vs Velocity

Fig 4. Force vs. Velocity Graph. It indicates when increasing velocity as well as compression and rebound force also increasing.

B. MATLAB programming results

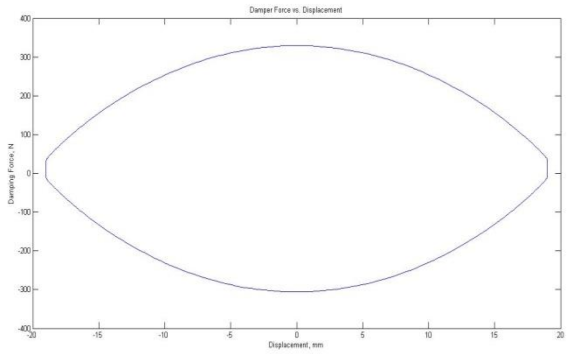

Fig 5: Damper Force Vs displacement Curve

Fig. 5 shows good agreement in elliptical trend of FD plot. The area is at large positive values of displacement, which corresponds to acceleration in the compression stroke.

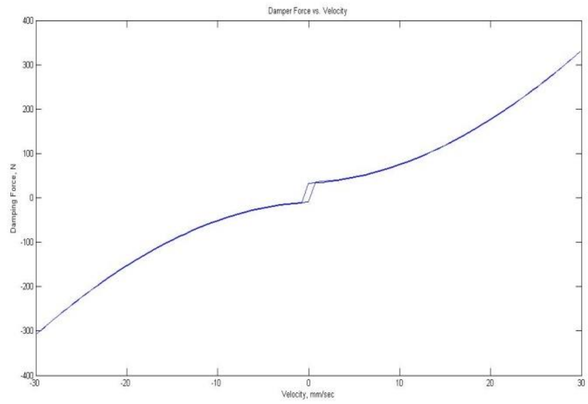

Fig 6: Damper Force Vs Velocity curve

Fig. 6 indicates the damper produces a different force when it is speeding up than when it is slowing down. The term hysteresis is commonly used to refer to this effect and will be used throughout this paper for the difference in forces in the FV plots.

V. CONCLUSION

Parametric model for predicting damper performance was successfully created and correlated to MATLAB analysis results. The model produces FV and FD plots with good agreement with respect to the magnitude of the force and the nonlinear trend of the forces. An interesting observation is that the model correlates well to the portions of the velocity cycle when the damper piston is decreasing in velocity.

For this work, we have developed a methodology for laying out design variations damping characteristics. For use as a design tool in Automobile applications would be of great use in suspension design and reduction of damper testing time and the effort and cost involved in prototype testing..

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