PERFORMANCE EVALUATION OF MAGNETO RHEOLOGICAL DAMPER FOR VEHICLE SUSPENSION WITH SEMI ACTIVE CONTROL SYSTEM -A REVIEW

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ABSTRACT

The vehicle suspension is used to minimize the vibration transferring from the irregular road surfaces. The control of these vibrations is still to be the booming field for the researchers. The increasing demand of ride relief and road stability leads to the development of suspension systems with new control strategies and actuating devices which can provide the strong performance. Hence to achieve this semi active control system is adapted to overcome the limitation of active as well as passive suspension system. Semi active control is well known for its low implementation cost, simplicity in construction and lower power consumption than active control. The actuation devices mostly used for semi active control are piezoelectric dampers, magneto rheological damper, tuned liquid column damper and electro rheological damper, out of which the MR damper has a semi active control and it had been accepted over last several years. MR fluids consist of the oil with iron particles in it. The device forces are adjusted by varying the strength of magnetic field. The devices will become compact and reliable because of less number of components. In addition to this added advantage of higher response rate (respond in milliseconds) with low power requirement, hence now a days this device is the focus of industry towards it. The current paper is a review on performance evaluation of magneto rheological damper with semi active control. This paper also discussed how to prepare magneto rheological fluid.

KEYWORDS: magneto rheological damper, MR fluids, semi active control system

INTRODUCTION

Now day's people require very high quality for things they used in day to day life. Certainly, the comfort in the moving vehicle is peoples concern, so it is desirable to have extraordinary suspension system for vehicles. In the environment of a moving vehicle, passengers often get feeling to uncomfortable due to the vibration of the vehicle body. To improve the ride comfort, effective vibration control of vehicle suspension is very important. Vibration control techniques have been categorized into two areas, namely, passive and active control. In a passive system, the parameters are synthesized through off-line design techniques and no closed loop (On line) feedback actions are used. Since passive system produce fixed designs, the controls will not be optimal when the system or the operating condition changes. On the other hand, active controls have been of popular interest in recent year. Force or torque inputs from actuators are usually used to suppress vibration amplitudes based on on-line measurement from sensors. The advantage of an active approach is that it can adapt for system variations, and can be much more effective than passive system.

In particular, it has been found that magneto-rheological (MR) fluids can be quite promising for vibration reduction applications. MR fluids are magnetic analogs of electro-rheological (ER) fluids and typically they use micron-sized, magnetically polarisable particles dispersed in a carrier medium such as silicon oil or mineral. When a magnetic field is applied to the fluid, particle chains form, and the fluid becomes a semi-solid and exhibits viscoelastic behaviour similar to that of ER fluid. This controllable change of state with some desirable features such as good stability, high strength, broad operational temperature range, and fast response time give rise to vehicle suspension and related system applications. MR fluid dampers considered here are a semi-active control device that uses MR fluids to produce controllable damping.

Over the past decade, there has been a sustained interest in magneto rheological (MR) technology due to the controllable interface provided by the MR fluid. Some examples of MR fluids have been employed include dampers, clutches, transmission and brake. For good ride comfort, shock absorbers with a ‘soft’ setting are preferred to dissipate shock energy from the road, while a ‘hard’ setting is required for good vehicle handling. These inconsistent characteristics of ride comfort and road-holding is a major challenge to researchers of automotive shock absorbers. The tuning of conventional hydraulic shock absorbers normally involves the mechanical adjustments of various valves located inside the piston. Spring type or conventional absorbers don’t have any room for adjustment, and hence will not be able to operate satisfactorily for different variety of roads. That’s a reason why we choose semi-active systems like MR dampers. If there is a fault in the system, the MR type of damper can operate as a passive damping system.

TYPES OF MAGNETORHEOLOGICAL DAMPER

A magneto rheological shock absorber or magneto rheological damper is a damper filled with magneto rheological fluid, which is controlled by magnetic field, usually using an electromagnet. This allows the damping characteristics of the shock absorber to be continuously controlled by varying the current in the electromagnet. This type of shock absorber has found applications in semi-active vehicle suspensions which may adapt to road conditions, as they are driven by continuous sensor monitoring and also with prosthetic limbs.

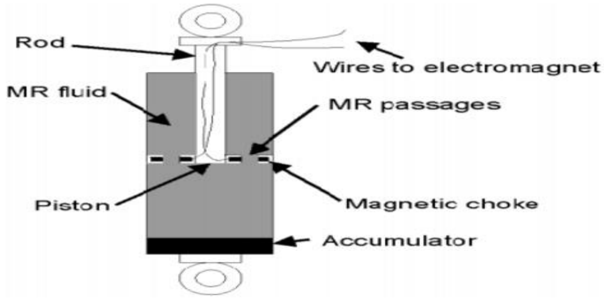

Fig. No.1. Magneto Rheological damper

Above figure shows the schematic of magneto rheological damper which is consist of cylinder, piston, piston rod and electrical winding. There are three types of the magneto rheological damper are,

Mono tube MR damper
Twin tube MR damper
Double-ended MR damper

MONO TUBE MR DAMPER

From the 3 types, the mono tube is that the most typical since it is put in in any direction and it's tiny in size. A mono tube MR damper, shown in Fig no. 2., has only 1 store for the MR fluid and it's related to accumulator mechanism to accommodate the changes in volume that results from connecting rod movement. The accumulator piston is employed for providing a barrier between the MR fluid and a propellant (usually nitrogen) that's used for accommodating the amount changes of liquid that occur once the connecting rod enters the housing.

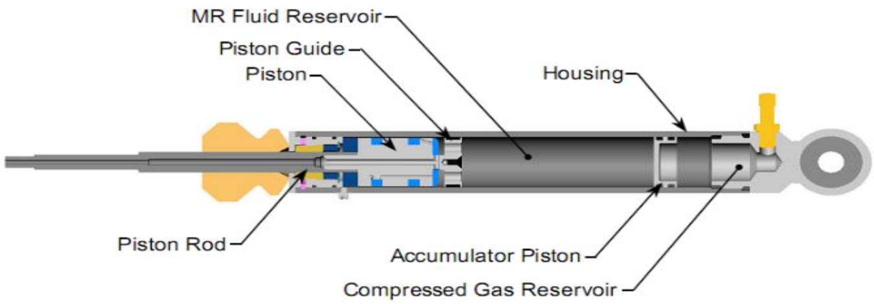

Fig. No.2.Mono tube MR damper section view

TWIN TUBE MR DAMPER

The twin tube MR damper uses two fluid reservoirs, one inside of the other, as shown in Figure 2. In this configuration, the damper has two housing one is inner and other is outer. The inner housing guides the piston rod assembly, in exactly the same as in the case of a mono tube damper. The volume enclosed by the inner housing is referred to as the inner reservoir. Likewise, the volume that is defined by the space between the inner housing and the outer housing is referred to as the outer reservoir. Out of two reservoir the inner one is filled with MR fluid so that no air pockets exist

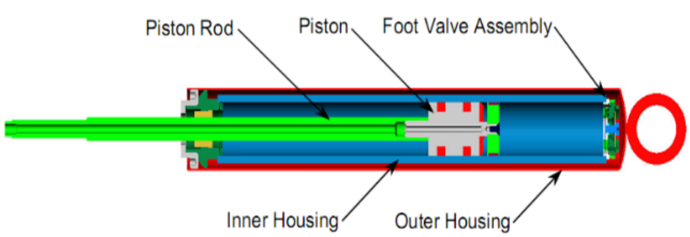

Fig. No.3. Twin tube MR damper

To suppress the changes in volume due to piston rod movement, an outer reservoir that is partially filled with MR fluid is used. Therefore, the outer tube in a twin tube damper plays very important purpose as the pneumatic accumulator mechanism in mono tube dampers. In general practice, a valve assembly is also called as "foot valve" and it is attached to the bottom of the inner housing to regulate the flow of fluid between the two reservoirs.

DOUBLE-ENDED MR DAMPER

The final type of MR damper is called a double-ended damper since a piston rod of equal diameter protrudes from both ends of the damper housing. Figure shows a section view of a typical double-ended MR damper. Since there is no change in volume as the piston rod moves relative to the damper body, the double-ended damper does not require an accumulator mechanism. Double-ended MR dampers have been used for bicycle applications, gun recoil applications, and for controlling building sway motion caused by wind gusts and earthquakes.

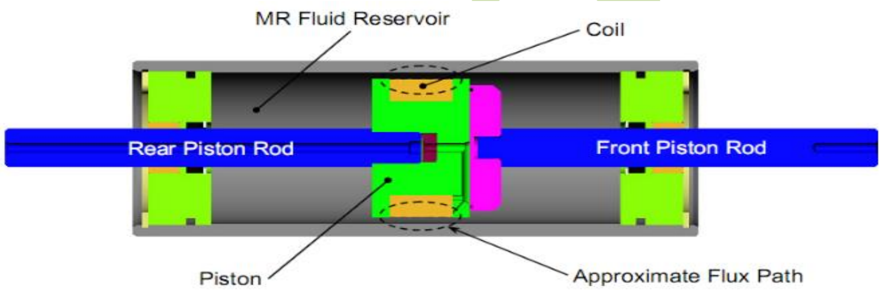

Fig. No.4.Double-ended MR damper

INTRODUCTION TO SUSPENSION SYSTEM

The purpose of this paper is to study the different types of suspension systems, study of magneto-rheological dampers. Suspension is the name given to the system of springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between them. Isolation from the forces transmitted by external excitation is the fundamental task of any suspension system.
The automotive suspension on a vehicle typically has the following basic tasks:

1) To isolate a car body from road disturbances.
2) To keep good road holding, and
3) To support the vehicle static weight.

TYPES OF PRIMARY SUSPENSIONS

There are basically three types of vehicle primary suspension systems are,

1) Passive suspension
2) Active suspension
3) Semi-active suspension

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1) PASSIVE SUSPENSION

The typical passive suspension system can be considered as a spring in parallel with a damper placed at each corner of the vehicle like. In the passive suspension system, the damping parameter and stiffness of the springs are fixed and are effective over a certain range of frequencies. The spring selection criteria solely depends on the size and weight of the vehicle, while the damper is the component that needed for placing suspension system on the compromise curve. Depending on the realistic condition of vehicle, a damper is chosen to make the vehicle performs best in its application. Ideally, the damper should isolate passengers from low-frequency road disturbances and absorb high-frequency road disturbances.

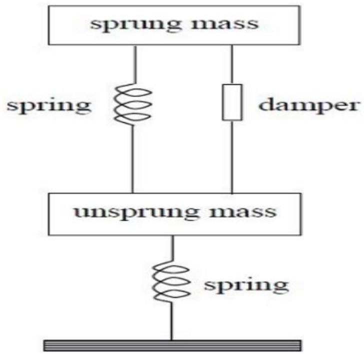

Fig. No.5.Passive suspension (source - Google)

2) ACTIVE SUSPENSION

Active suspension is also called as adaptive suspension and it is user for controlling vertical movement. The system therefore virtually eliminates body roll and pitch variation in many driving situations including accelerating, cornering, and braking. This technology allows car manufacturers to achieve a higher degree of ride quality and car handling by keeping the tires perpendicular to the road in corners, allowing for much higher levels of grip and control.

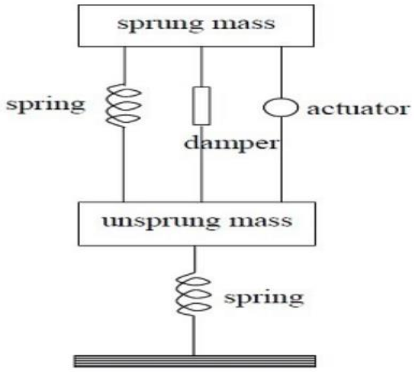

Fig. No.6. Active suspension (source - Google)

An onboard computer able to detect movement of car body by usage of sensors located throughout the vehicle and, using data calculated and software algorithm it controls the action of suspension system. Active suspensions, the first to be introduced, use separate actuators which can exert an independent force on the suspension which show in Figure 3.2 to improve the riding characteristics.

3) SEMI-ACTIVE SUSPENSION

The semi active system combines the advantage of active and passive suspension system. As electronics have become more sophisticated, the opportunities in this area have expanded. Semi-active suspensions include devices such as air springs and switchable shock absorbers, various self-leveling solutions, as well as systems like Hydro pneumatic, Hydro elastic, and Hydra gas suspensions. Mitsubishi Company has developed the semi-active electronically controlled suspension system for cars, in the 1987. Delphi currently sells shock absorbers filled with a magneto-rheological fluid, whose viscosity can be controlled by varying current.

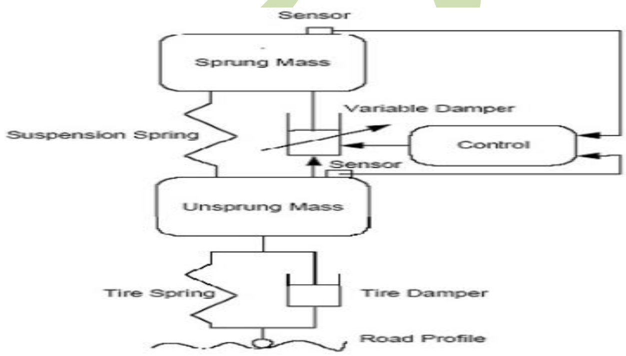

Fig. No.7. Semi-active suspension (source - Google)

The motion of the damping force can be adjusted by controlling orifice area in the damper, thus changing the resistance of fluid flow. As shown in Figure the plant represented a quarter-car body. In the semi-active suspension system, the implemented ECU would provide damping force required for the fuzzy controller.

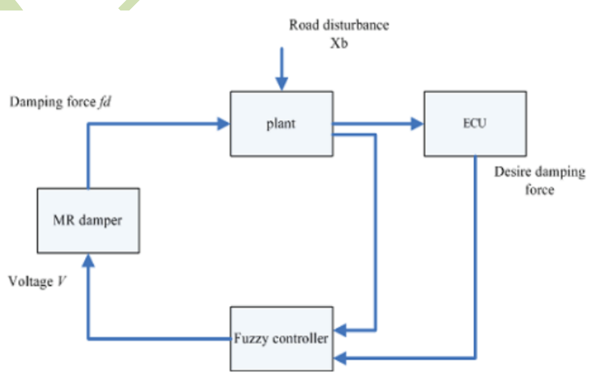

Fig. No.8. Semi-active damping control system block diagram

CONCLUSION

The present study has been carried out in order to study different MR damper & control strategy. The main area of concern in MR damper is design of magnetic coil. It has been shown that the MR damper has a very broad changeable damping force range under magnetic field and the damping coefficient increases with the electric current, but decreases with excitation amplitude. The MR damper will become saturated as the applied electric current reaches a certain value. The vehicle ride quality can also be improved by using semi-active MR damper system to control the vibration of vehicle.

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