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A Review on Magneto Rheological Damper Analysis

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Abstract**—** *Past few years, semi active control devices has got some importance because they offer adaptability of active control device without need of power source. Active control device such MRdamper utilizes MR fluid to control dampers.MR dampers are h ighly reliable as compared with other semi automatic devices. This paper deals with analysis of MR damper and their MR fluids characteristics at different conditions*

Keywords: *Semi active control devices, MR fluids, Highly reliable*

1.INTRODUCTION

Magneto-rheological fluids, ever since it was discovered by Jacob Rabi now in the 1940'shave in recent years has been known to the researchers as a multi-functional fluid for its property of getting magnetized on the application of magnetic field. The MR dampers are not very different from the conventional fluid dampers the only difference being the magneto-rheological oil and the firmly placed solenoid that produces magnetic field on the applying the electric current. MR dampers are well known for their energy dissipating characteristic on the application of the magnetic field. The properties of the MR fluids can be instantly and reversibly modified or reorganized within milliseconds when a magnetic field is applied. In the absence of the applied field, the MR fluids behave like the Newtonian fluid. When a field is applied the suspended particles become polarized which further move so as to reduce the energy stored in the group (Emanuele et al., 2008) [1]. The energy configuration being at a minimum level consists of the particles that are aligned in the chain like format of the applied external field. The figure below shows how exactly the suspended particles acquire dipole moment that helps align the particles in chainlike structures after the external fields that is applied. These chain-like format of the modifies the motion of the fluid there by changing its rheological properties by changing the viscosity of the fluid drastically which further increases it yield stress depending on the magnitude and the direction of the field applied. The mechanical energy that is required to yield these chain like structure increases with the increase in the applied field. The rheological behavior of these types of fluids are characterized separately into two distinct pre-yield and post-yield regimes.

In the pre-yield regime, the fluid behaves like an elastic solid due to the chain-like structures stretching along the length with some of fractures in it while in the case of the post-yield regime, their exists an equilibrium where the chain fractures and the chain formations behave like a viscous Newtonian fluid. Owing to the exceptional behavior of the MR fluids, it has been used in large number of applications such as: rotary brakes, clutches, prosthetic devices, polishing & grinding devicesand many more. Amid them, the MR fluid dampers are semi active control devices that are used many industrial applications today. A characteristic damper includes the MR fluid, housing, a piston, a magnetic coil, an accumulator and some pair of wire as shown in the figure 2a above. In the above figure, the MR fluid is composed in the cylinder and flows through a small orifice. The piston or the housing are in built with the magnetic coils. Depending on the current applied, the controlling damping force is produced. Also, as per the research conducted by Carlson J. D and Weiss K. D, a high reliability operation can be obtained from these devices and their function remains almost uninterrupted due to the temperature fluctuations or due to any impurities in the fluid. Nevertheless, the considerable drawback that hampers the MR fluid damper is its non-linear characteristic which involves force vs displacement and the hysteresis force vs the velocity. So, creating the MR fluid

damper with the maximum efficiency is a major challenge, especially when it is concerned to make an accurate model to take the full advantage of this special device and further to

design a the most efficient algorithm that in turn improves the system performance.

2.Literature review

M.P. Nagarkar, G.J. Vikhe Patil presented paper on Multi-Objective Optimization of LQR Control Quarter Car Suspension System using Genetic Algorithm and concluded that -Multi-objective optimization of weighting matrices LQR controller using GA is presented in this paper. A Macpherson strut quarter car suspension model is used for control application.

- Instead of trial and error or adjusting the weighting matrix parameters of LQR controller, GA based optimization method is proposed to determine the parameters for several objectives.
- Multi-objective optimization with four objectives namely VDV, RMS sprung mass acceleration, maximum sprung mass displacement and maximum suspension space deflection is successfully implanted using multi-objective GA.
- In determining the weight matrices of LQR controller, along with ride comfort and stability of a vehicle passenger health criterion is included in the objective function.
- From step response, for LQR controlled system, sprung mass acceleration has 24.18% reduction in 194 ▪ VOL. 44, No 2, 2016 FME Transactions maximum overshoot. Also settling time is very less as compared to open loop system. Thus the LQR controlled system is having minimum oscillations with good ride comfort
- VDV is reduced by 16.54%, 40.79% and 67.34% for Case I, II and III respectively as compared to passive suspension system. Same trend is observed for RMS sprung mass acceleration.

Harshal K. Bajaj, Gagandeep singh birdi, etal published paper on Application of magneto rheological (mr) fluid damper and its social impact. Magneto-rheological dampers (MR dampers) are being developed for a wide variety of applications where controllable damping is desired. These applications include dampers for automobiles (Ferrari F12 Berlinetta), heavy trucks (U.S. HMMVS), bicycles (BMW R 1200 GS Adventure), prosthetic limbs, gun recoil systems and others. This system can be incorporated to achieve a comfortable journeys in vehicle if the suspension system is adopted so the vibration damping application can be fulfilled by knowing the characteristic of shock absorption system which is accurate and very fast responding to control actions, the effective vibration will be achieved. The passive types of damper have a fixed setting during their lifetime, and hence they are not able to operate satisfactorily in a broad range of road states. This problem can be overcome by active or semi-active suspension systems like the MR damper. By using the MR damper in suspensions, it will provide both ride comfort and vehicle stability

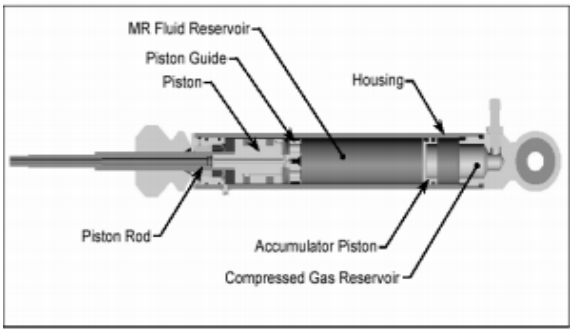
Atmiya K Bhalodi, Jaikit Patel etal presented paper on Magneto-rheological dampers in automotive suspensions and concluded after summation of all the data and results obtained patent to mr fluids, we have come to a conclusion that when the current (i), through the coil around the fluid is increased, the viscosity of the fluid increases, which comes about as the iron particles within the fluid align themselves with the field lines and form a semisolid or bingham plastic, providing better damping properties, which in---turn leads to increased damping. mr fluids being a non-newtonian fluid, acts as a smart fluid whose viscosity varies with magnetic flux, which increases its application based functionality in vast industries and with high efficiency. the mr fluids main features are: fast response, simple interface between electrical power input and the mechanical power output, controllability and integration in complex system, which provides for a reliable technology in the engineering and medical field based applications.

Jong-Seok Oh, Tae-Hoon Lee, and Seung-Bok Cho etal presented paper on Design and Analysis of a New Magnetorheological Damper for Generation of Tunable Shock-Wave Profiles and concluded that, an impact testing machine system was proposed to experimentally investigate the tunability of dual shockwave profles. Te proposed testing system comprised a velocity generator, impact mass, test mass, spring, and MR damper. Te goal of the proposed system was to generate the desired dual shock-wave profles. Based on this, the damping force of the MR damper was calculated using an annular duct model and a damping force model. In order to evaluate the tunability of the shock-wave profles (particularly in Part II), fve experimental conditions were chosen. According to current input conditions, desired shock-wave profles can be altered using the MR damper. From the experimental results, it is known that the error rates in 2nd pulse are 4.8% and 11.7%. Experimental results clearly demonstrated that the MR damper is efective method for impact testing machine for heavy-weight. In future work, the tuning ability of air spring will be analyzed as a second phase of this research

B.F. Spencer Jr., S.J. Dyke, M.K. Sain and J.D. Carlson etal presented paper on Phenomenological Model of a Magneto rheological Damper and concluded that Recently developed MR fluids have high strength, low viscosity and low power require-ments, are stable over a broad temperature range, and are insensitive to impurities commonly in-troduced during manufacturing. The magneto rheological (MR) damper, consisting of a fixed-orifice damper filled with a controllable

MR fluid, is an attractive semi-active control device that appears to have significant potential for structural control applications. To take full advantage of the unique features of the MR damper, a high fidelity model is needed for control design and analysis.

3.CONSTRUCTIONAL DETAILS



1.Accumulator piston- The accumulator piston works to provides a barrier between the MR fluid and a compressed gas (usually nitrogen) which is used to accommodate the volume changes that occur when the piston rod enters the housing.

2.Inner Housing- The function of inner housing is to guide piston rod assembly. The inner housing is filled with MR fluid so that air pocket exists.

3.Outer Housing- Outer housing is partially filled with MR fluid. Its function is to accommodate changes in volume due to piston rod movement

4.Compressed gas reservoir- Its function is to provide passage for storage of compressed gas

4. Damper Chracteristics

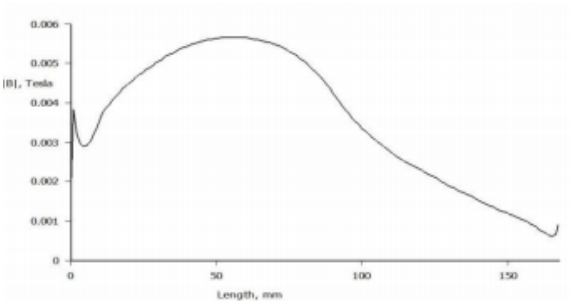


Fig- Variation of magnetic flux with length at 0.2A current

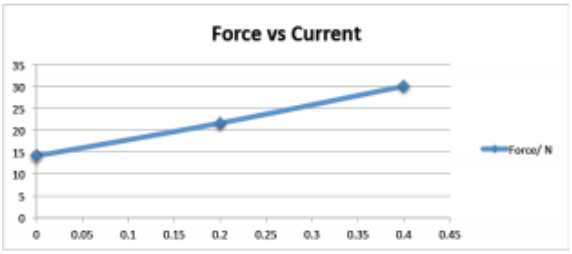


Fig- Force VS Current

1.The suspension will be mounted between two sheet panels. One at bottom which provides the bas and second panel will be attached to the load cell which will help for vertical movement. The function of flat plates to distribute the load uniformly between two positions

2.The top and bottom surfaces of fixture having curved surface that would hold suspension firmly and fulfill the purpose of transferring loads fro flat plates to suspension damper

3.The fixture should be made up of MS or of similar materials

4.Finally fitting necessary size of nut and bolt with washer to have a firm hold over the suspension

5. MR FLUID

Magnetorheological (MR) fluids are materials that respond to an applied field with a dramatic change in their rheological behavior. The essential characteristic of these fluids is their ability to reversibly change from a free-flowing, linear, viscous liquid to a semi-solid with controllable yield strength in milliseconds when exposed to a magnetic field.

Chemical Composition- A typical MR fluid consists of 20%–40% by volume of relatively pure, soft iron particles, typically 3–5 microns, suspended in a carrier liquid such as mineral oil, synthetic oil, water, or glycol. A variety of

proprietary additives similar to those found in commercial lubricants are commonly added to discourage gravitational settling and promote particle suspension, enhance lubricity, modify viscosity, and inhibit wear

6. Experimental Outcome

1.Improvement Damping Effect
2.More comfort to travellers
3.Power requirement will be reduce
4.Life of suspension system will be increased
5.Large shock absorbing capacity

7. REFERENCE

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