EXPERIMENTAL ANALYSIS OF MAGNETO-RHEOLOGICAL FLUID BASED FRONT FORK DAMPER USING ELECTRO-MAGNETIC CONCEPT

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ABSTRACT
Magnetorheological (MR) fluid damper are semi active control device that have been applied a wide range of practical vibration control application. In this study, the methodology adopted to get a control structure is based on the experimental results. An Experiment has been conducted to establish the behavior of the MR damper. In this paper, the behavior of MR damper is studied and used in implementing vibration control. In this paper we investigated theoretically at fabricated Magnetorheological damper by using different Magnetorheological fluid. Here two types of MR fluid developed first by mixing of prepared nano size iron particle Feo, Fe2o3, and second Fe3o4. And a comparative study had done between these iron particles prepared MR fluid. Here an experimental performed on fabricated MR damper and discussed the behavior of MR damper. The beneficial properties of magnetorheological fluids are applied in the design and testing of a prototype suspension system. Because viscosity of these fluids increased tremendously under the influence of a magnetic field, a suspension shock absorber containing magnetorheological fluids fluid is proposed. The shock system tested displayed resistance to motion with respect to the magnetic field strength.

Keywords: Magnetorheological (MR) fluids; Magnetorheological dampers; Semi-active damper; nano particle; Magnetic field intensity.

1. INTRODUCTION

The suppression of mechanical and structural vibration using semi active control method has been actively worked by many researches in last two decades. Recently, various semi-active suspension system featuring magneto-rheological fluid damper have been proposed and successfully applied in the real field, especially in vehicle suspension systems magneto-rheological damper is becoming the most promising vibration controller in the intelligent suspension presently and it wins the favors of vehicle manufactures, because it takes the advantageous of high strength, good controllability, wide dynamic range, fast response rate, low energy consumption and simple structure. Conventional damper has constant setting throughout their lifetime, and hence will not be able to operate satisfactorily in a wide range of road conditions. it is for these reasons that semi active systems like magneto-rheological damper have attracted the attention of suspension designers and researchers. Models that can accurately represent the behavior of magneto-rheological dampers are essential in understanding the operation and working principles of the device. Such models can eliminate a great deal of uncertainties during the design process, which can subsequently enable control strategies for the damper to be developed efficiently and reliably. A mathematical model is derived from their physical features like geometry and construction can provide insights into the way various parameters affect the performance of the vehicle.

In this dissertation the fundamental design of the magneto-rheological fluid based front fork tally lever suspensions investigated experimentally. An experimentally model is used to characterize the constitutive behavior of the magneto-rheological fluids subject to an external magnetic field strength. Here I introduced a new concept for generating a magnetic field inside the piston cylinder by use of circular armature core.

2. EXPERIMENTAL SETUP DETAILS

The experimental set-up consists of (see Figure 2.1):

1. Variable voltmeter it's a control device here i used for control the current supply on MR damper with variable range (0 to 270v)
2. Speed controller it's also a control device used for control the speed of AC motor which are generate vibration on system Range (0-1500 rpm)
3. Exciter (AC motor) is used for generate the vibration on system, manufacturer by patil electric co. pvt. Ltd. Its maximum speed is 1500 rpm and supply of current maximum is 0.7 amp

4. Multimeter is used for show the exact value of supply current which give on armature coil for generate the magnetic field inside the MR Damper.
5. MR Damper it's a main component of our experiment all analysis is perform on these mechanical system here I used a prototype of fabricated MR Damper.
6. 3 Axis accelerometer sensor is a one type of transducer which is measuring linear acceleration in(X, Y, Z) axis.
7. Gauss and tesla meter is used to measure the magnetic field intensity.
8. LVDT(linear variable differential transducer is a one type of transducer which is measuring linear variable displacement in between the range (0 to 100 mm)
9. Sound card Oslo scope is used to measuring the frequency of vibration.

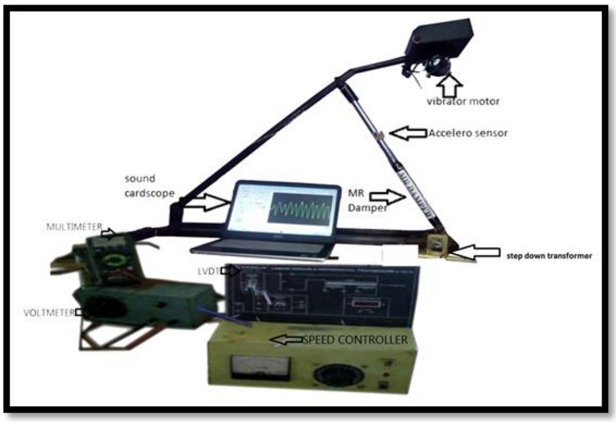


Figure 2.1 show experimental setup for MR Damper Testing

2.1 EXPERIMENTAL LAB TESTING OF MAGNETO-RHEOLOGICAL FLUID-1, MAGNETO-RHEOLOGICAL FLUID-2

Basic requirements for the testing of MR fluid following instruments are required.

- Guassmeter and teslameter
- Electromagnet
- Electrical circuit (Step down transformer, Ammeter)

Guassmeter and teslameter is a magnetometer that used to measure the strength of magnetic field measured in units of gauss and teals respectively. The guassmeter has a probe which is kept in a MR fluid to measure magnetic field intensity. The electromagnet is a device of electrical winding wounded on a core in which magnetic field is produced by applying external electric current. This electromagnet is used for to magnetize the iron particle present in a MR fluid. The electrical circuit is required to vary a current of electromagnet. The step down transformer is used to convert the 230V AC supply into 12V DC supply. Following figure shows an experimental setup for testing the MR fluid.

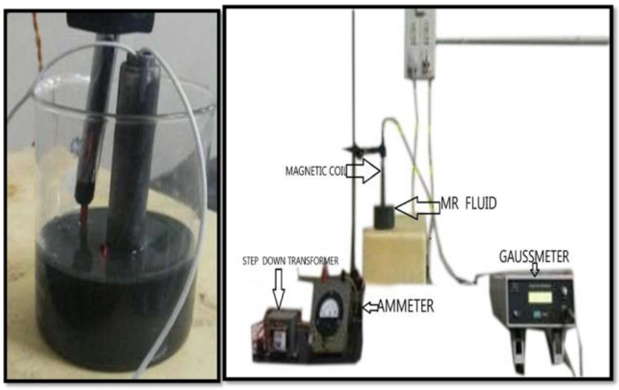


Figure 2.2 Experimental setup for fluid test

3. Results and analysis

3.1 Experimental lab testing of two different magneto-rheological fluids

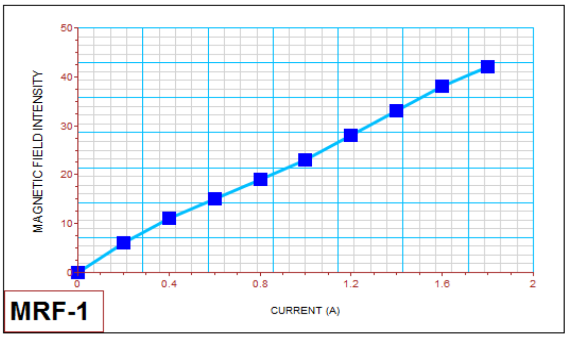
Table Value of magnetic field intensity at magneto-rheological fluid-1

Table 1 current vs. magnetic field intensity MRF1

Current (A)	Magnetic field intensity in gauss
0	0
0.2	6
0.4	11
0.6	15
0.8	19
1.0	23
1.2	28
1.4	33
1.6	38
1.8	42

Following the table shows the reading obtained while testing the magneto-rheological fluid-1 and respective graph.

Above table shows magnetic field intensity in gauss by varying the current.



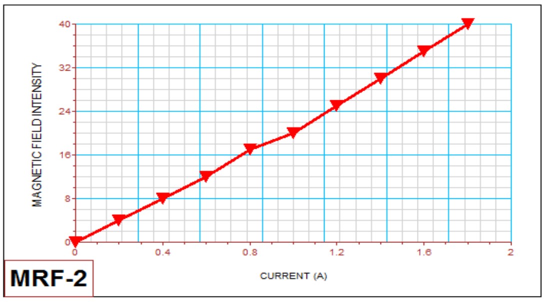
Graph3.1 Magnetic field intensity vs. Current MRF-1

The above graph shows the effect of magnetic field intensity vs. various currents. Using magneto-rheological fluid-1 (mixing "fe2o3" iron particles).magnetic field intensity increases at increasing currents.

Current (A)	Magnetic field intensity in gauss
0	0
0.2	4
0.4	8
0.6	12
0.8	17
1.0	20
1.2	25
1.4	30
1.6	35
1.8	40

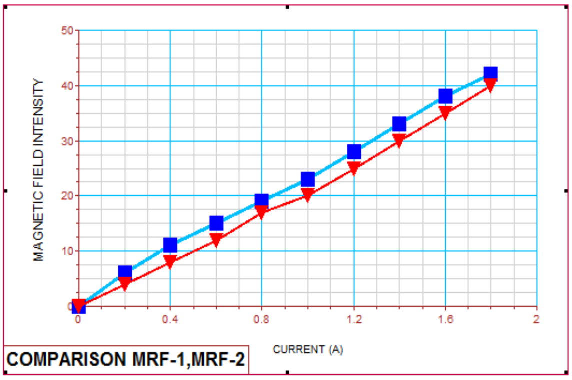
Table 2 current vs. magnetic field intensity MRF

Following the table shows the reading obtained while testing the magneto-rheological fluid-2 and respective graph.



Graph 3.2Magnetic field intensity vs. Current MRF-2

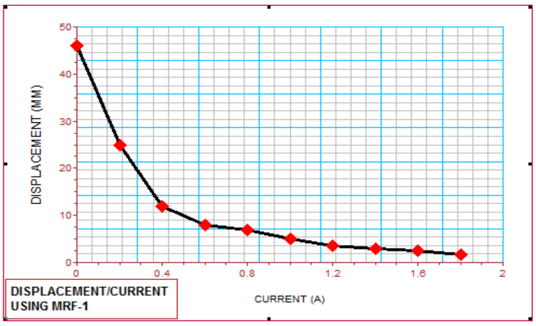
The above graph shows the effect of magnetic field intensity vs. various currents. Using magneto-rheological fluid-2 (mixing "fe3o4" iron particles).magnetic field intensity increases at increasing currents.



Graph 3.3 Comparison Magnetic field intensity vs. Current MRF-1-2

This experimental show the behavior of magneto-rheological fluid by varying the different currents. The above graph shows the comparison between magnetic field intensity of magneto-rheological fluid-1(mixing "fe2o3" iron particles) and magneto-rheological fluid-1(mixing "fe3o4" iron particles). This graph show when the current is increases magnetic field intensity is also increases. And the (MRF1) is more efficient as compare to (MRF2).

3.2 Analysis behavior of magneto-rheological damper piston displacement by varying the supply current



Graph 3.4 Current vs. Displacement

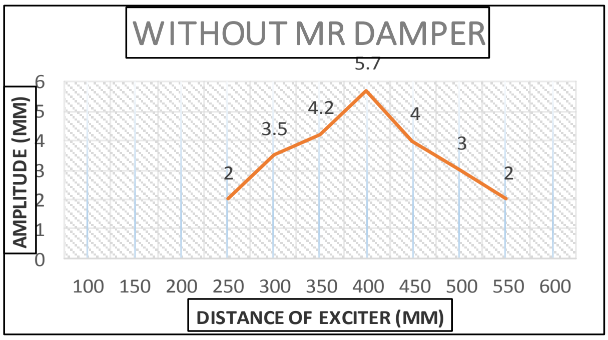
Table 3 current vs. displacement

CURRENT (A)	DISPLACEMENT (MM)
0	46
0.2	25
0.4	12
0.6	8
0.8	7
1.0	5
1.2	3.5
1.4	3
1.6	2.5
1.8	1.7

The experimental test show the behavior of Magneto-rheological piston displacement when the value of current increase the displacement of piston is decrese.it means current is the main parameter that are affected the behavior of MR damper. Here the graph plot between the displacement and current. Current applying 0 to 1.8 amp. Displacement decrease 46mm to 1.8mm.at different current.

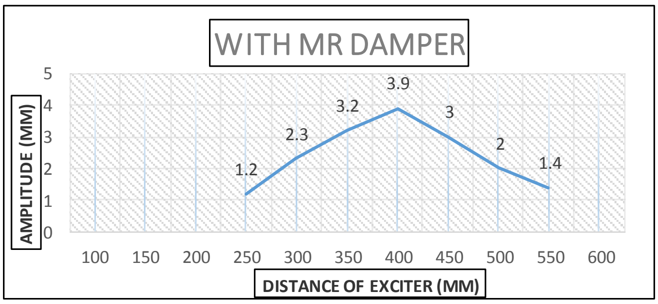
3.3 Amplitude analysis of with & without using magneto-rheological damper

Effect of amplitude of vibration with and without use of magneto-rheological damper at variable distance of exciter



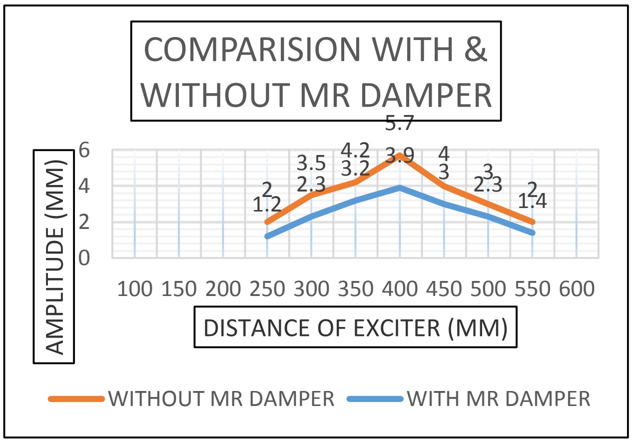
Graph 3.5 Show the effect of amplitude of vibration without magneto-rheological damper

Here this graph show the effect of amplitude of vibration with changing the distance of exciter with and without use of magneto-rheological damper. The variation of amplitude is 0 to 7mm in this experiment show when the variable distance of exciter is varying the amplitude of vibration also vary.at 400 mm distance



Graph 3.6 Show the effect of amplitude of vibration with magneto-rheological damper

Here this graph show the effect of amplitude of vibration with changing the distance of exciter with and without use of magneto-rheological damper. The variation of amplitude is 0 to 7mm in this experiment show when the variable distance of exciter is varying the amplitude of vibration also vary.at 400 mm distance the amplitude of vibration is maximum at 3.9mm amplitude.

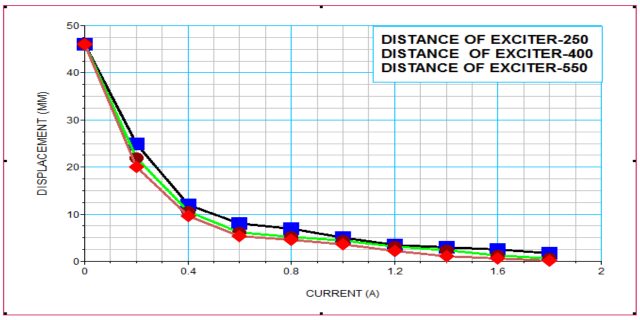


Graph 3.7 Show the combined graph for show the amplitude of vibration with and without use of magneto-rheological damper at variable distance of exciter

The above graph show the comparison between with and without MR damper at variable distance of exciter.at 400 mm maximum distance using without MR damper amplitude is 5.7mm and using with MR damper amplitude is 3.9mm.

3.4 Effect of magneto rheological damper piston displacement by varying the supply current

This experiments test show the behavior of magneto-rheological damper piston when the value of current increase the displacement of piston decrease.it means current is the main parameter that are affected the behavior of magneto-rheological damper



Graph 3.8 Combined graph for show behavior of magneto-rheological damper piston displacement by varying the supply current

Here the graph show the displacement and current at the three different distance of exciter. When graph show the distance of exciter 250 mm displacement of piston 0.2mm at current 1.8 amp. Distance of exciter 400 mm displacement of piston 0.7mm at current 1.8 amp. And distance of exciter 550 mm displacement of piston 1.7mm.at current 1.8 amp.

The experimental shows the good efficiency of prepared magneto-rheological fluid in presence of external magnetic field. The magneto-rheological fluid is tested on gauss meter and tesla meter Graph shows that as current increases then magnetic field intensity of MR fluid also increases. LVDT is used to measuring amplitude and displacement at various currents. Sound card oscilloscope which shows the result as magnetic field is applied to magneto-rheological fluid it changes the physical state that is liquid state to semi-solid state. For our application we have used MR fluid in magneto rheological damper which shows better damping performance under the influence of external magnetic field. .

4 CONCLUSION

The experimental result shows the good efficiency of prepared MR fluid in presence of external magnetic field. The MR fluid is tested on gauss meter which shows the result as magnetic field is applied to MR fluid; it changes the physical state that is liquid state to semi-solid state. Gauss meter shows reading of magnetic field intensity by varying the current. Graph 1 shows that as current increases then magnetic field intensity of MR fluid also increases. For our application we have used MR fluid in magneto rheological damper which shows better damping performance under the influence of external magnetic field. Graph 2 shows that as the current increases gradually to electrical winding of MR damper then displacement goes on decreasing so that we get sufficient damping.

- It was shown that, by minimizing the objective function, the frequency and amplitude conductive time constant are significantly improved at any value of applied current. The vibration of the optimized damper was also significantly reduced.

- The iron particle (feo,fe2o3) is more efficient for reduction of vibration as compare to use of magnetic fe3o4 iron particles on making of MR fluid.
- MR Damper is mainly depended on magnetic flux density.
- AS compare to conventional damper use of MR damper plays an important role in reducing the vibrations because, for every load condition the behavior of MR damper is change positively.

Magnetic circuit and structure integrated optimal design of MRF damper was well completed in our work. Multiple structure parameters and magnetic circuit parameters were simultaneously designed at the same time and it was with highly efficiency.

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