# Analysis of Motion Transmissibility of Damper by using Magneto-Rheological Fluid

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***Abstract:*** This paper presents study of magneto-rheological damper and effect of variation in magneto-rheological fluid component percentage on motion transmissibility. Magneto-rheological fluid contains base fluid, surfactant, iron particle. The effect of variation in iron particle percentage, surfactant percentage on response amplitude is observed experimentally. The graphs of response amplitude versus excitation frequency for various iron particle percentage and surfactant percentage has plotted. The resonant amplitude varies as voltage increases. The nature of variation of resonant amplitude with voltage has studied.

***Keywords:*** Magneto-Rheological, Surfactant, Iron particle, Response amplitude, Excitation frequency, Resonant amplitude.

## I. INTRODUCTION

This study is related to vehicle damper used to increase coefficient of damping by using magneto-rheological fluid. Many types of dampers have been designed to meet the comfort and control requirements of passenger vehicles. During recent years the smart fluids such as magneto-rheological and electro-rheological have been used inside the dampers to provide the variable damping under the application of current or voltage. Among the smart fluid Magneto-Rheological fluid is much popular due high dynamic range. In magneto-rheological fluid used in damper contains base fluid such as silicon oil, hydraulic oil & in base fluid small iron particle added. After the application of voltage, iron particle magnetized and aligned in particular way to increase the coefficient of damping of damper.

Typical magneto-rheological fluids are the suspensions of micron sized, magnetisable particles (mainly iron) suspended in an appropriate carrier liquid such as mineral oil, synthetic oil, water or ethylene glycol. In the absence of an applied field, MR fluids are reasonably well approximated as Newtonian liquids. For most engineering applications a simple Bingham plastic model is effective at describing the essential, field-dependent fluid characteristics. However, in the presence of an applied magnetic field, the iron particles acquire a dipole moment aligned with the external field which causes particles to form linear chains aligned to the magnetic field. They are characterized by rapid changes in the fluid viscosity resulting from the rearrangement of the particles in the fluid due to changes in the applied magnetic field. The application of such fluids in dampers allows control of their damping characteristics, adjusting them to the varying needs of the system. This property qualifies MR fluids as ‘‘smart materials.’’ Dampers with MR fluids may offer an improved control of vibrations in airplanes upon landing, in cars, mechanical and medical devices, and industrial machinery. Because this characteristic of MR fluid it is very useful in various application and it is necessary to study its effect on damping characteristics.

These paper provide the effect of variation in iron particle percentage and surfactant percentage in MR fluid on response amplitude for various excitation frequency of exciter. Also the nature of variation in resonant amplitude with voltage i.e. damping force for MR damper has studied.

## II. Experimentation

### 2.1 MR Fluid Samples

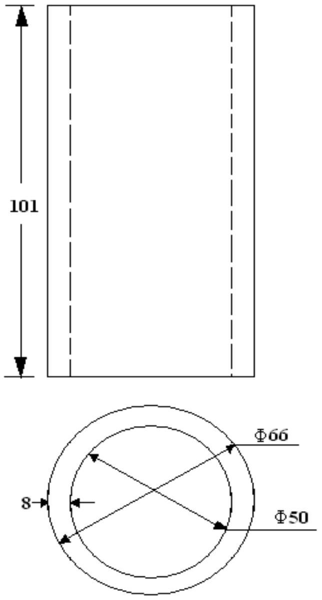
MR fluid samples has prepared by using silicon oil as base fluid, oleic acid as surfactant and 100 mesh iron particle. To prepare MR samples 100ml of silicon has taken then iron particle of 10% weight of iron particle added to that and oleic acid of 5% weight of silicon oil has added. In this way basic sample has been prepared. Total 8 samples of MR fluid has prepared for testing. Four samples are prepared by varying iron particle percentage in base fluid. And next four samples are prepared by varying surfactant percentage. MR fluid samples stir for 24 hour by using motorized stirrer so that sedimentation does not happen. The list of 8 samples as below

1. 1. 100 ml Silicon oil +9.5 gm 100 mesh iron particles (10%) +4.75gm oleic acid (5%). (mrso100)
2. 100 ml Silicon oil +9.5 gm 100 mesh iron particles (10%) +9.5gm oleic acid (10%). (mrso10% 100)
3. 100 ml Silicon oil +9.5 gm 100 mesh iron particles (10%) +14.25gm oleic acid (15%). (mrso15%100)
4. 100 ml Silicon oil +9.5 gm 100 mesh iron particles (10%) +19gm oleic acid (20%). (mrso20% 100)
5. 100 ml Silicon oil +9.5 gm 200 mesh iron particle (10%) +4.75gm oleic acid (5%). (mrso200)
6. 100 ml Silicon oil +14.25 gm 200 mesh iron particles (15%) +4.75gm oleic acid (5%). (mrso200 15%)
7. 100 ml Silicon oil +19 gm 200 mesh iron particles (20%) +4.75gm oleic acid (5%). (mrso200 20%)
8. 100 ml Silicon oil +23.75 gm 200 mesh iron particles (25%) +4.75gm oleic acid (5%). (mrso200 25%)

As mentioned above list 1-4 samples are for variation in oleic acid percentage and next 4-8 samples for iron particle variation. By using these samples effect of variation in iron particle percentage and oleic acid percentage has studied.

### 2.2 Damper specification

For testing of above fluid damper is prepared using following specification



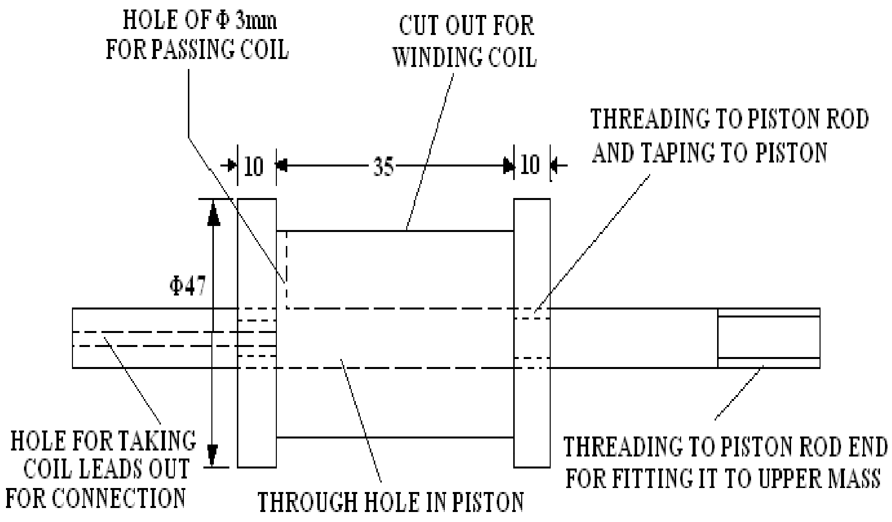




**Fig.2.1 Schematic representation of MR damper cylinder**

**Fig 2.2 Schematic representation of Piston and Piston rod assembly**

Fig. 2.1 and fig. 2.2 shows schematic representation of cylinder and piston of MR damper as shown above. The inner diameter of cylinder is 50 mm and outer diameter of the piston is 47 mm. Total length of piston is 55 mm from that cutout of 35mm length and 7.5 mm deep has taken to wind copper coil around piston. The copper coil of 24 gauge and 75ft. is selected so that magnetic field is generated in MR damper without heating. The voltage applied across this copper wire so that magnetic effect is generated. The material used for preparing MR damper mild steel so that it has minimum resistance to magnetic flux. In order to concentrate the magnetic flux along the piston the material for piston rods is taken to be stainless steel which is non-magnetic.

### 2.3 Experimental setup

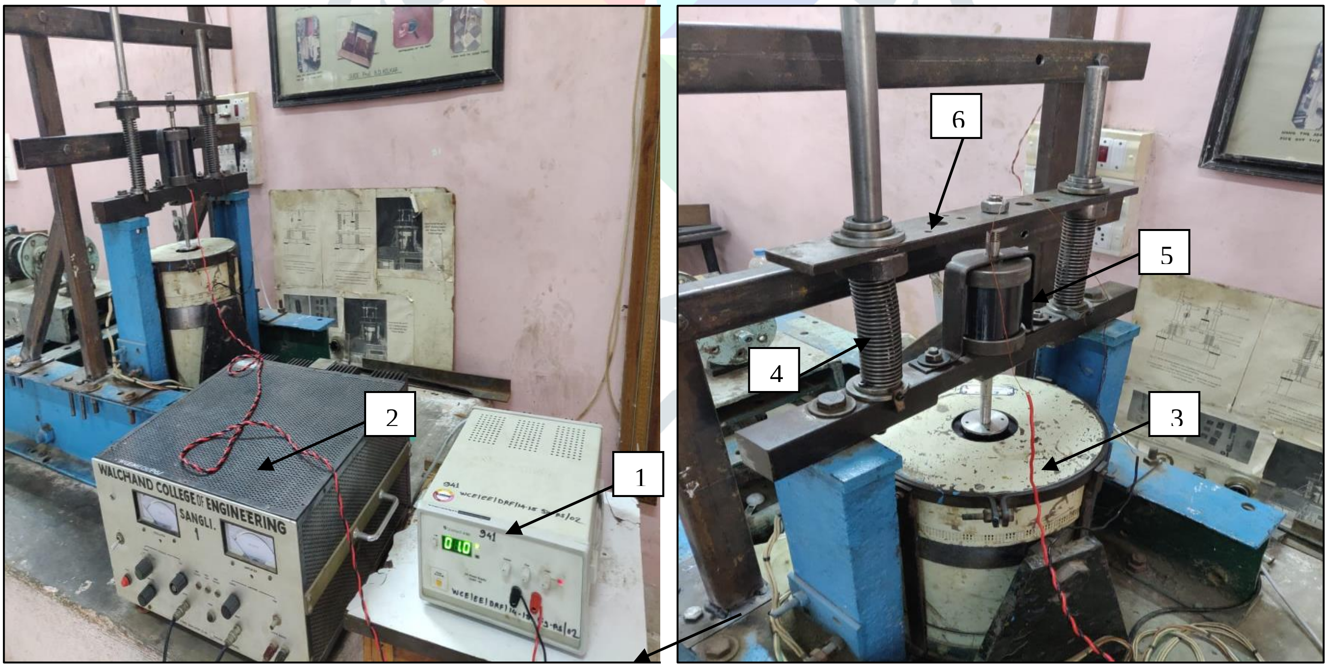



**Fig 2.3 Experimental arrangement for MR damper testing**

1. DC power supply 2. Exciter controller 3. Exciter machine 4. Spring 5.MR damper 6. Mass plate.

The experimental setup of the MR damper testing is as shown in fig 2.3. The damper arranged with mass & spring in such way it form single degree freedom system. The exciter has frequency range from 1-10 Hz. By using dc power supply the voltage is adjusted for copper coil inside the damper so that it produced magnetic field. And readings are taken at different voltages. The system is excited by using exciter and displacement is measured at top of the mass with help of accelerometer. The signal is recorded by using ADASH FFT analyzer. There are features in ADASH FFT analyzer where we can record the signal and analyze it anytime. By analyzing those signals we can plot the graphs of Response amplitude versus excitation frequency.

## III. Results and Discussion

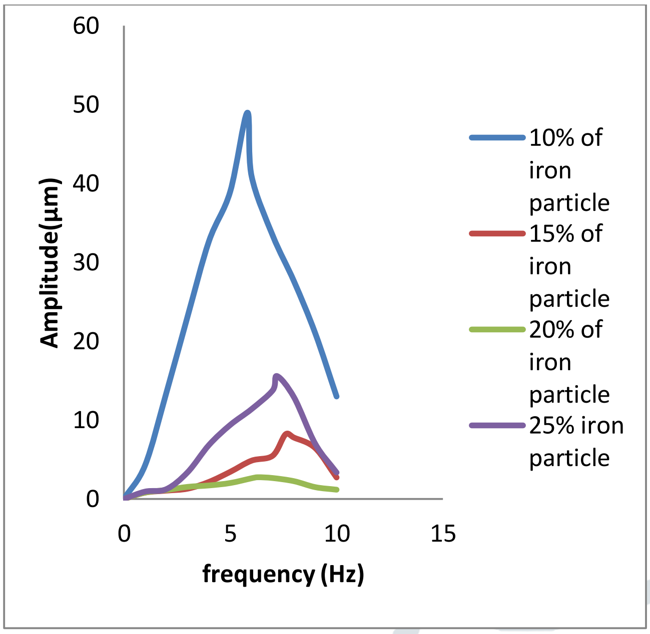



Fig.3.1 Response amplitude vs. frequency of excitation of MR damper for percentage variation in iron particle at 5V

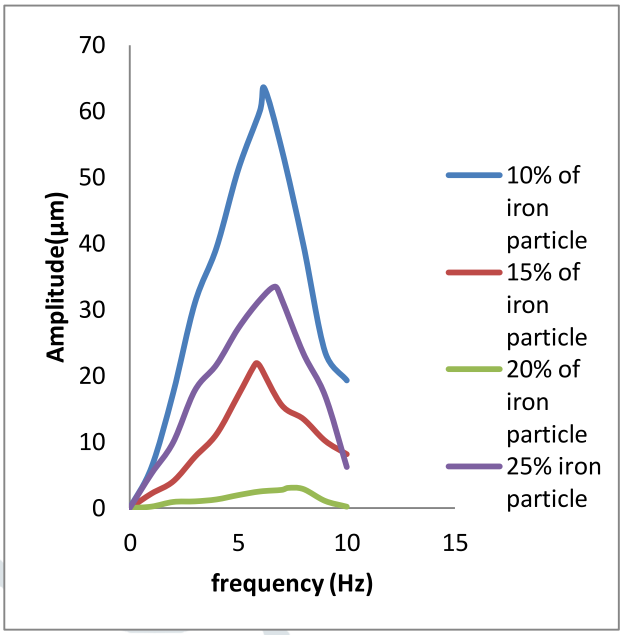



Fig.3.2 Response amplitude vs. frequency of excitation of MR damper for percentage variation in iron particle at 2V

As shown in fig 3.1 and fig. 3.2 shows effect of variation in iron particle percentage. It is observed that as the iron particle percentage in MR fluid increases the amplitude of vibration of MR damper arrangement decreases but for 25% of iron particle in MR fluid it again started increasing. So it can say that the damping increases up to 20% iron particle then it decreases.

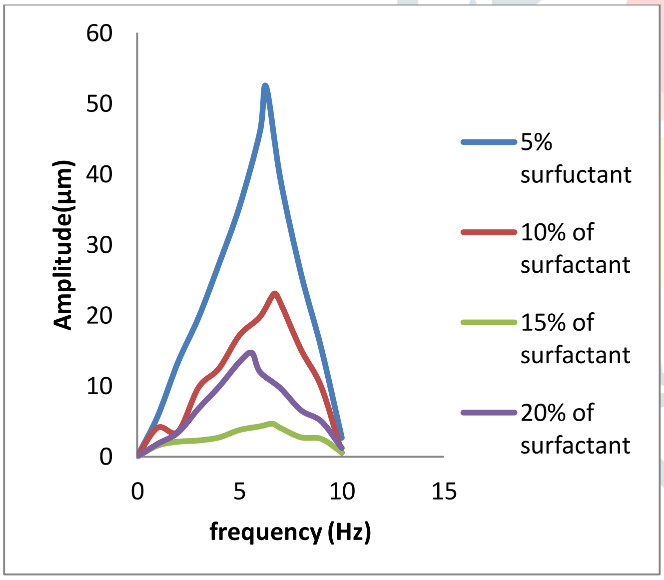



Fig.3.3 Response amplitude vs. frequency of excitation of MR damper for percentage variation in oleic acid at 5V

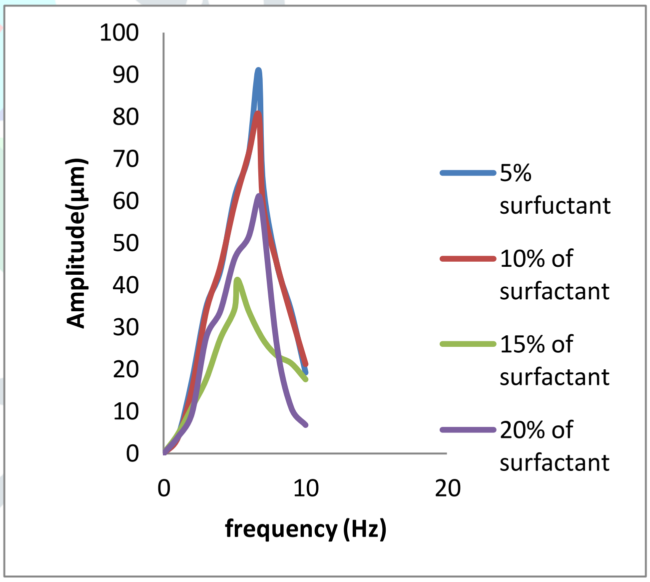



Fig.3.4 Response amplitude vs. frequency of excitation of MR damper for percentage variation in oleic acid at 2V

As shown in fig 3.3 and fig. 3.4 shows effect of variation in surfactant percentage. It is observed that as the surfactant percentage in MR fluid increases the amplitude of vibration of MR damper arrangement decreases but for 20% of surfactant in MR fluid it again started increasing. So it can say that the damping increases up to 15% of surfactant then it decreases.

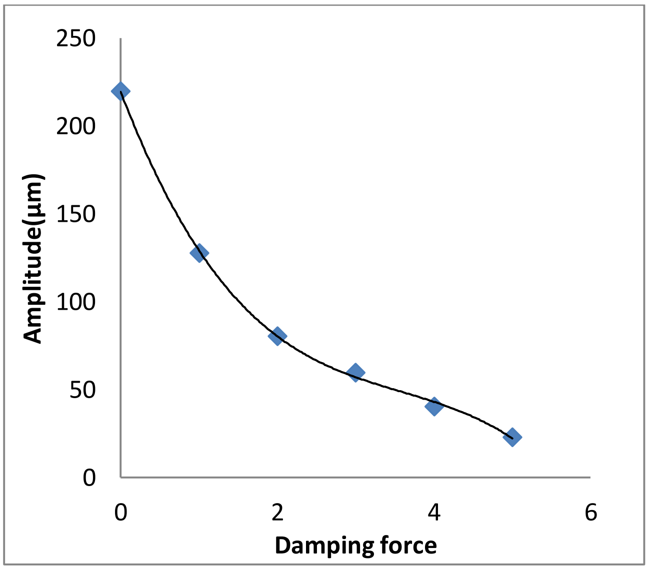



**Fig. 3.5 Response of Resonant amplitude vs. Voltage for MR fluid (Silicon oil+ oleic acid (10%) +iron particle (10%))**

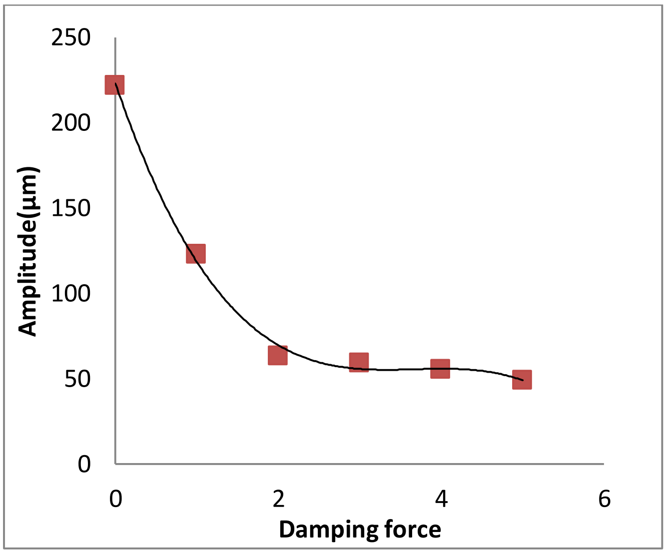



**Fig. 3.6 Response of Resonant amplitude vs. Voltage for MR fluid (Silicon oil +oleic acid (5%) +iron particle (10%))**

The resonant amplitude has plotted for various voltages and tried to fit various polynomial curves through it. It has observed that the cubic curve fit most perfectly than other polynomial curves. Fig.3.5 and Fig.3.6 shows variation of resonant amplitude for 0-5 volts.

## IV. Conclusion

Using results mentioned in this paper it can be conclude that the amplitude of vibration decreases as surfactant percentage increase in MR sample but it is true for samples with surfactant up to 15% of base fluid. Similarly the amplitude of vibration is decreases as percentage of iron particle increase in MR sample but it is true for samples of iron particle up to 20%. And The variation of resonant amplitude with voltage i.e. damping force is cubic.

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