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DESIGNING AND FABRICATING A VARIABLE MAGNETIC DAMPER FOR SEMI ACTIVE SUSPENSION SYSTEM

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Abstract:-

Background/Objectives: The purpose of the project is to formulate MR fluid and fabricate MR damper.MR damper is modelled to provide semi-active suspension system in vehicles.

Methods/Statistical analysis: The stiffness of suspension system can be varied by using MR fluid. The project aims at fabrication of MR damper and preparation of magneto-rheological fluid, which can vary its viscosity inside the damper in the presence of magnetic field. MR fluid varies its stiffness under the magnetic field; this principle is used to control the damping action of the shock absorber.

Findings: The iron particles in the MR fluid opposes the carrier fluid passing through piston head holes. This resistance builds strong opposition for shock absorber oscillation. As With increasing the current provided the number of cycles the damper can sustain is rising which can result in more lifetime of damper.

Improvements/Applications: This Technology can be further implemented in Brake System. These MR Dampers are used in certain automobile industries and vehicles. Some automobile industries are working on it to implement in the near future.

Keywords: MR Fluid, Damper, Suspension, Carrier Fluid.

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1. Introduction

During the past few years, some commercially available products have been developed, Linear MR dampers for real-time active vibration control systems in heavy-duty trucks. These fluids are novel materials, which are suspensions of micron-sized, Magnetisable particles in the oil. Typically, MR fluids are free-flowing liquids having a consistency similar to that of motor oil. However, when a magnetic field is applied, particle chains form, and the fluid becomes a semi-solid.

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An attempt to tackle the proper selection of various MR fluid components like carrier fluid, magnetic particles and additives. Different proportions of MR fluid components are studied for proper selection to satisfy high yield stress applications. This study addresses various properties to suit challenging applications and their properties. He compared properties like particle size, suspended fluid, viscosity,

Reaction time, yield stress and the voltage supply of different smart fluids [1].synthesize various MR fluids which are useful for brake application. They used electrolytic or carbonyl iron powders to synthesize the fluid, and they also used grease as the stabilizer and oleic acid as an anti-friction additive and gaur gum powder as a surface coating to reduce agglomeration of the MR fluid. The carrier fluids used are sunflower oil, synthetic oil and silicone oil. Various MR fluids are prepared by varying relative compositions of carrier fluid, iron powder and other additives. These MR fluid samples are characterized by determination of magnetic, morphological and rheological properties. Their Study helps in identification of most suitable MR fluid for brake application [2].Designed and manufactured magneto-rheological damper, which is used as automobile suspension for semi-active control. The damper structural

Parameters were obtained by integrated optimal design combining magnetic circuit and structure. FEMM software analyzed the magnetic circuit. This work provided proving method for experimental study and design on automobile suspension made of MR damper. FEMM software is used to understand magnetic induction intensity inside the damper in the MR fluid. This software is used to specify parameters of damper design such as diameters and lengths of the parts of the shock absorber; the design is simulated in the software by specifying the surrounding medium to get magnetic field intensity at various points [3].] examined the efficiency of MR damper for cyclic loading conditions. To investigate the performance of MR damper.MR damper is bound to series of excitations at different loading, and peak 9 responses were analyzed, for each case the results indicate that MR damper is quite effective for structural response reduction at different magnetic field strength. The results conclude the increase in damping force for the increase of magnetic field strength. A series of excitations were given to check the deflection in damper [4-8].

2. Related Work

The Author Prabhu Previously work on "Variable magnetic damper for semi-active suspension system" on this Topic with different Fluid and different Process has been carried out [9].

3. Methodology

3.1 Synthesis of MR Fluid

Carrier fluid it is the major constituent of the magneto-rheological fluid, and it is 50 to 80 % by volume, Silicon oil is most commonly used carrier fluid for the synthesis of magneto-rheological fluid however it can also be prepared using water, mineral oil and synthetic oils. A good carrier fluid should have high viscosity, and its value should be nearly independent of temperature. The carrier fluid we used for our work is Silicon oil.

Surfactants are used as additives mainly to avoid gravitational settling of iron particles due to their density in the MR fluid. They also reduce the surface tension of a liquid in which it is dissolved; they help the iron particles to get suspended throughout the MR fluid, and hence they improve the settling stability. The most commonly used surfactants are oleic acid, citric acid and tetraethyl ammonium hydroxide etc. we used oleic acid.

Table 1 .Properties of Silicon oil

Fuel	Silicon oil
Specific Gravity	0.9124
Flashpoint[°C]	113
Boiling point [°C]	> 140
Density [g/cm3]	1.061
Viscosity at 20°C	370 - 390 m Pa s

3.2 MR Fluid Preparations

Iron powder of particle size 1-10μm obtained from ball milling. The mixing proportions to prepare MR fluid are 21% iron powder by weight, 68% silicone oil by weight as carrier fluid and 8% oleic acid and 3% magnesium stearate all by weight are used. Here oleic acid is used as a surfactant and magnesium stearate as anti-friction additive. The weights of all the constituents are measured and kept ready. Initially, the iron powder is coated with magnesium stearate, and then the coated iron particles are added to a beaker along with 8% oleic acid and stirred for about an hour at 500 rpm now this mixture is added with 10% carrier fluid and stirred again with same 500 rpm for an hour. The carrier fluid is added in intervals of 10% by weight each time and stirred at the same time.

3.3 Fabrication of MR Damper

A nanotube without accumulator is chosen to model MR damper. Monotube reduces gravitational settling and avoids clogging of valves. The performance of Damper is efficient by using monotube, due to proper regulation of fluid between two sections.

The piston head of mono tube damper must be modified to acquire variable damping. The piston head must be fitted with variable electromagnet or solenoid to produce the magnetic field inside the damper. The electromagnet is fitted exactly in the piston head to produce the magnetic field over fluid throughout its entire length of displacement. The electromagnet housing must be adjacent to the holes of piston head for attaining maximum field strength over fluid.

A 4.0cm inner diameter tube made of mild steel is chosen as a working tube. A piston rod of outer diameter 2.4cm and 16cm length is chosen and was drilled at its Centre throughout its length with an orifice of 6mm diameter using special drill bit tool. A piston head of 39cm diameter and 4 holes of size 3.0 mm to regulate fluid flow is used. The head is Centre drilled to 2.4cm diameter to accommodate electromagnet.

Fig no. 1 The Machined Parts

Some assumptions were made at the design stage. The following criteria were taken into consideration. Loads that must be carried by the system. Geometric dimensions, restricted by the working environment, Range of temperatures at which proper functioning of the system may be initiated.

4. Results and Discussion

4.1 Performance Test of the Damper

The performance test of the MR damper is done by fatigue testing machine which applies cyclic load on it. A sine vibration of frequency 0.5Hz is applied to it.The load 250N is applied. Firstly the MR damper is tested at 0 amperes and later it was tested at 0.5 and 1 ampere. An electromagnet with 300 turns of copper wire winded over mild steel is used.

The experimental electrical circuit consists of a resistance, ammeter and 9V battery. The resistance is varied manually to change the value of current being supplied.

Before the Experiment, we should ensure that the magneto-rheological damper is clamped tight and we should also check the vertical alignment.

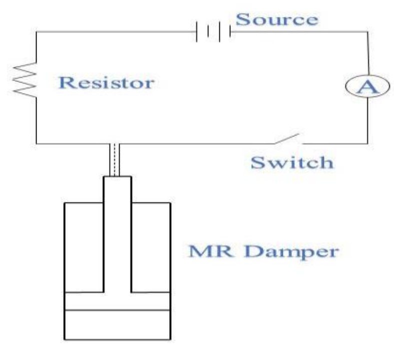

Fig no.2 the experimental electrical circuit

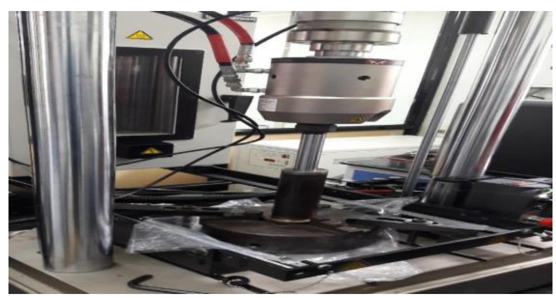

Fig no. 3 The Fatigue testing machine

The force-displacement curve is obtained from the software for 0, 0.5 and 1 ampere. It is observed that when current is set to 1 ampere, the displacement is reduced for the same load applied implying that the MR fluid has become more stiffness and it is not easy for the piston to displace unlike the

Normal case. On supplying electric current, the electromagnet is activated producing the magnetic field around it in the piston head which makes the iron particles to align in magnetic field direction resulting in an increase in the viscosity of the MR fluid.

4.2 Test Results

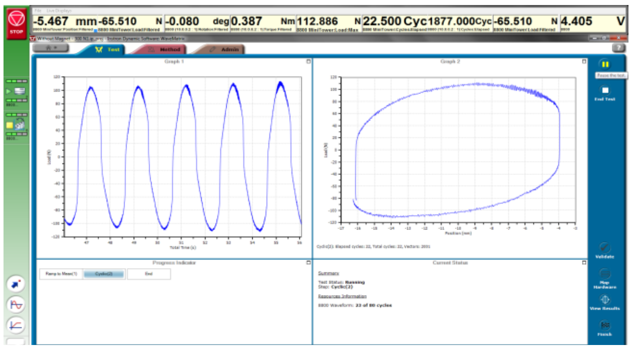

Fig no.4 Damping force-displacement curve at 0A

The above curve shows the force-deflection curve at 0 amperes. At 0 ampere it acts almost like a normal shock absorber.

Observed:

1. Load applied: 300 N
2. Max load taken : 120 N
3. Deflection : 15.5 mm
4. Applied Current : 0 Amp
5. No of cycles : 46/80

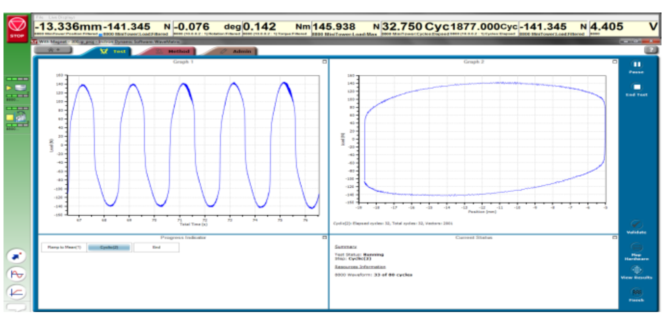

Fig .no 5 Damping force-deflection curve at 0.5A

The above curve shows the force-deflection curve at 0.5 amperes.

Observed:

1. load applied : 300 N
2. Max load taken : 180 N
3. Deflection : 13.5 mm
4. Applied Current : 0.5 Amp
5. No of cycles : 80/80

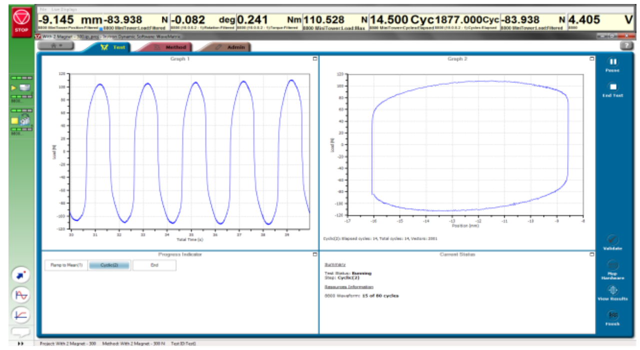

Fig no.6 Damping force-deflection curve at 1A

The above curve shows the force-deflection curve at 1 ampere.

Observed:

1. load applied : 300 N
2. Max load taken : 220 N
3. Deflection : 7.5 mm
4. Applied Current : 1 Amp
5. No of cycles : 80/80

5. Conclusion and Future Scope

The fabricated MR damper is successfully tested. The MR fluid shows increased stiffness with increase in current. With an increase in current the deflection is reduced from 15.5mm to 7.5mm from 0A to 1A this is due to increase in viscosity. The use of MR fluid absorbs the shock from road surface better than normal shock absorbers.

The fabricated MR damper is successfully tested The MR fluid shows increased stiffness with increase in current. When the increase in current the deflection is reduced from 15.5 mm to 7.5 mm for 0 Amp to 1 Amp, this is due to increase in viscosity. The use of MR fluid absorbs the shock from road surface better than normal shock absorbers.

They are already being used in certain automobile industries, and some automobile industries are working on it to implement shortly. In suspension systems, it can be used to achieve variability by anticipating the shock well in advance and then necessary damping action is taken accordingly. With the increase in the current provided the load withstanding capacity of the damper is increasing. With increasing the current provided the number of cycles the damper can sustain is increasing which can result in more lifetime of the damper. With the increase in current, the deflection of the damper is reduced which indicates the performance of damper is accurate.

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