Experimental Study of Magneto-Rheological Fluid Damper for Vibration Control

Vivek P. Kolhe¹, Dr. Gopal E. Chaudhari²
¹Research Scholar, ²Associate Professor, Department of Mechanical Engineering,
North Maharashtra University, J. T. Mahajan College of Engineering, Faizpur 425524, Maharashtra-India

Abstract
This article shows the vibration monitoring and evaluation of Magneto-Rheological damper. The semi-active controller has received attention in recent years as they provide the convenience of active controllers without having to source large amounts of energy. Magneto-Rheological (MR) is a semi-conductor that uses MR to obtain absorption. They have the potential to provide highly reliable jobs and can be considered safe because of the fact that they become passive intensity if hardware controls do not work well. The dampers differ from the conventional shock absorbers, they are just a fall down from high frequency insulation and natural frequency isolation, they provide semi-active monitoring, use very little power, respond quickly, have a small change section, tolerate and interact directly with electronics. While maintaining steady Magneto-Rheological odor regarding (he) fluids that can be controlled, it is associated with a class of active substances that have the unique ability to dynamically change dynamic dynamics when affecting the electrical or magnetic field. This feature can be applied to the MR elevator, in which the exiting forces are changed by changing the rheological properties of magnetic fluids. The purpose of the study was to investigate the program of vibration-resistant vibrating mines, special equipment for experiments were invented and equipped. This device has the ability to change the magnetic and non-magnetic force applied to MR damping to test and evaluate its performance.

Keywords: MR Damper, MR Fluids, Vibration Control, FFT

Introduction
Magneto-Rheology is a branch of rheology that acts with flow and deformation of materials under magnetic fields. The discovery of the fluid was attributed to Jacob as the 1949 Rainbow Magneto-Rheological (a mixture of neklirichni (0.05-10 μm) and ultimate soft magnetic particles in organic or aqueous liquids. Various ceramics Metals and alloys have been characterized and can be used for the preparation of his liquids, as long as particles with mnogodomenni shock and show low magnetic forces. Particle size, shape, density, size distribution of particles, magnetic inversion and field particles are compulsory key characteristics of disintegrating shock phase. The basic fluid differs from the magnetic particles of surface-active substances, more against rust that affects rheology, the stability and dispersion of the solids.

MR fluids are similar to liquid pesticides and show comparative viscosity levels in OFF states (0.1 to 1 Pa-s at low cut rates). Visible visibility (105-106 times) is changed within a millisecond when the magnetic field is applied. Changes in viscosity are contradictory when the magnetic field is removed. When the magnetic field is used, it causes a dipole in each magnetic particle. Magneto-Rheological fluids show volatile active conversion and adaptation of a free flow state in semi-solid state over applications of external magnetic fields. These materials determine a dramatic change in their rheological behavior in response to a magnetic field. The liquid, which MR has recently become very interested, can provide a flexible and responsive interface for the reaction between electronic control and mechanical systems. In general, his liquid is a soluble sulfur-resistant fluid similar to diesel. In the presence of the magnetic field responded, however, the particle receives the chance aligned with the external field of the dipole to form a linear particle chaining parallel to the field. This phenomenon can increase the suspension and determine the movement of the fluid. As a result, the yield was generated. The size of the change is related to the magnetic field magnitude used and can only occur in milliseconds.

The potential uses of MR are instructed in the literature. The program is featured in the automotive industry, where benefits can be achieved in areas such as obstruction, brakes, shock absorbers, and activity. Most have suggested that the designers call the "geometric" mode in their design, but found that the rate of voltage systems with "cut-off" geometry was too low to be useful for potential applications. Along with a comprehensive study of the reduction of MR energy, the researchers began to explore other techniques to take advantage of the use of MR to better.

Methods
Magnesium hydroxide belongs to newtonite Group, which does not comply with Newtonite's law of liquid friction (the viscosity coefficient has changed). They also represent liquids that have a viscous liquidity limit and control their properties through magnetic fields. For the most recent years, the magnetometer has undergone extensive investigations, both because of the phenomenal phenomena as well as the ability to use it to control vibration in the air. It is especially important in the automotive industry, with better driving conditions that are safe for motorists.

MR can be described as magnetic storms as part of a group known as liquid or active. Microwave was created by Jacob Atwood at the National Standards Office in 1948. MR liquids contain microscopic particles that are dispersed in any form of transport, either polysaccharide or non-polar water, which then affects his viscosity. On the presence or absence of magnetic fields is a liquid that can regulate the return of drying properties (plastics or molecular complexity) in liquid state or free flow of liquids. In the presence of the magnetism applied, the suspended particles appear to align or cluster and
the fluid thickens or gel. The Atom chain increases the resistance of the current of the fluid. When the magnet is removed, the particles are returned to the original state, which decreases the mass of the solid. The fluid structure depends on several factors, such as magnetic fractions and fluids. The liquid structure is also responsible for rapid innovation and can be returned to the state or free of charge. Sodium conversion or stability or liquid coagulation can be controlled precisely and proportionally by changing the magnetic force applied. These features provide the perfect, quick and easy response point between electronic and mechanical management.

He has a residue that can be divided by small magnetic beams, such as metal particles that are suspended in liquids such as water, minerals, hydroxides, oxides, or gels. He produced 20 to 40 percent of the total iron content of about 3 to 10 million. Features that are similar to lubricants have been added. These ingredients are calculated to tighten gravity and promote the suspension of particles and increase warmth, clarity and protection. The MR responds to the magnetic field with the dramatic changes of the redirection behavior. In addition, MR's fluids can be changed immediately and immediately change from solid material in milliseconds with controlled output momentum when placed in magnetic fields. In the absence of a field applied, liquid liquids are computed in detail as Newton's water - it is automatically flowing with a motor like gasoline. In this case, the metal particles are in the hormonal state. When the magnetic field is applied, the metal particles begin to align the wavelength that forms the atomic part in the fluid. These chains resist and set the fluid movement. As a result, the stress of occurrence in the fluid. The level of change is related to magnetic force, and it is shown that the change can occur per millisecond.

Figure 1: Activation of MR Fluid
(A) No magnetic field is applied, (b) Using a magnetic field

He was composed of oil and the amount of iron that was coated with coagulant. When inactivated, MR liquids behave as normal oils. When exposed to the magnetic field, the atomic iron is dispersed throughout the fluid that aligns itself with the magnetic flow line. The replacement of metallic particles can be considered a large microscopic diameter, which is very thin on the cable. One can imagine a thin string extending from magnetic pole to the other and perpendicular to the pole. Similarly, spherical beams imitate metal particles, and this string follows a single flow line. One can imagine that these strings are connected to each other like a toothbrush. When properly aligned, the metal particles are not changed from their flow lines and act as a barrier to the flow of water.

Composition of MR Fluids

The MR consists of non-static, magnetic, ferromagnetic, or paramagnetic elements and non-magnetized media components. MR's liquids, however, have suitable magnetizing particles (iron, iron, iron, nitrogen, iron, carbide, iron, carbonyl, nickel and cobalt). A magnetic particle that is commonly used to prepare liquid liquids is carbon dioxide. The maximum possible voltage resulting from the effectiveness of the MP's is determined primarily by the lowest suppression and magnetic sizes with the highest levels of dispersed particles. So, the soft magnetic material of high purity, such as carbon steel, appears to be the main magnetic phase for most practical components of MR. Except iron, iron, iron, metal, Fe-Co, and iron, Fe-Ni can also be used as a MR material, where Fe contributes to the creation of high-magnetic magnets. However, certain elements, such as magnetite, erythropyle, irrigated, and irregularly have low magnesium insulators, so it is suitable for low consumption.

Magnesium with metallic powder can be prepared by reducing with hydrogen peroxide or chemical CVD of Fe 2 Co5. When the particles are absorbed, the sphere can grow while keeping the magnet and while increasing the resistance. Saturation with metal magnets can occur when all domains are properly aligned.

The domain wall can easily be moved so that magnetism is the only function of the New Zealand field, so there is no loss of concatenation when the field is returned. Particle size must be chosen carefully so that it can show a variety when placed on the outer magnetic field. MR particles generally range from 0.1 to 10 μm, which is 1,000 times larger than the 1,000 volumes of liquid. In magnesium fluids, the magnetic particles at the given size can provide maximum fraction, without increasing the uncertainty of the zero domain. For example, using a power reducer, a liquid component is used, which accounts for 50% of carbon dioxide. MR material is used to provide a drive link between the two components rotating by itself.

The liquid medium forms a liquid phase for MR. Examples of suitable fluids include petroleum, carboxene, carboxylic, sulfur, oil, coal, plastic, organic solvent, halogenated, digestible, polyoxyalkylene, silicone, fluorinated, oxydode, glycols, aqueous and synthetic hydrocarbon oils. The merger of these liquids can be used as a storage medium for liquids. In the previous patent, the inventors used vibration particles, which were dispersed in light hydrocarbon oils or cooling liquids, antioxidants or semi-solid oils and soluble oils, or suspended or chlorine oils. However, when the particles are limited, the particles are well-formed, the MP's reaction is strongly criticized. Later, to prevent further rainfall, the new components of MR will be added to the continuous viscoelastic and viscoelastic phase to be developed so that stability can be significantly improved. In addition, the compound MR compound is prepared by Pan et al. With a combination of iron particles, starch, gelatin and transport liquid. They have shown that his effects are admirable when there is a lower magnetic and stable force compared to carbon dioxide. Surfactants, nanoparticles, nanomagnifiable or magnetizable can be added to reduce the sedimentation of heavy particles in the liquid phase. When there is more
rainfall with MR's liquid under the influence of high stress and high cut rates over a long period of time, the liquid will grow thicker (to use - compacting). Pit phenomena will diminish its effect, the particles in MR's fluids, and form a robust "cake" with primary particles connected due to incomplete rhythm formation. MR particles, such as carbonyl-iron, can be described as particle erosion and resemble light bulbs, which can be easily removed by a quake or friction. Additionally, anti-grazing agents such as organotole can provide mild precipitation. When MR compounds have low viscosity, it does not dissolve and can easily break.

MR fluid modes of operation and its applications

Liquid-gases that their surgical mode are classified according to how their MRs are injected using a metabolic rate. These devices are classified as operating in one of the three main modes or combinations of these modes: (a) valve mode; (b) - direct shear (c) how to shrink.

Valve mode

This is the most widely used of three modes. He said the device to operate when the water was injected, he was used to prevent the flow of liquid from one tank to another. With the single MR hybrid design exception, all valves operate in valve mode, as shown in the figure 3.

Direct Shear mode

It is assumed to be a liquid device, he operates in cutting, where the transition between two layers is paramagnetic, a thin layer (~ 0.005 to 0.015 inches) of this helium. Cut the system as shown in Figure 4, it is mainly useful for absorbing shock absorbers, which are not necessary for generating large force and fuse and brakes.

Squeeze mode

Tools that use this restriction, the thin film (approximately 0.020 inches) of his liquid, which is inserted between the poles, is paramagnetic on the surface, as shown in Figure 5. The arrangement of the tightening triggers on a plate as a force that is applied in the same direction of the magnetic field to reduce or extend the distance between parallel plates, causing a drop of flow.

When the magnetic field takes particles, the particles formed between the walls become solid, with rapid changes in viscosity. The displacement used in the tightening mode is small (a few millimeters), but needs a lot of force.

Type of suspension system

The vibration management systems used in the construction of the machine can be grouped as follows.
(A) Suspension system
(B) Suspension system active
C) The semi-active suspension system

Suspension systems

The passive vibration management system can be distinguished by the dispersion of the vibration energy without increasing the total energy in the primary system. These solutions are often more designed to be associated with a spring element to the primary system. The best design is available in some sources. The passive suspension system is
one of the components of the component (fan and charger) that has been repaired. Designers of the suspension, according to the purpose and purpose of the design, define these characteristics. Highly-economical suspension will bring good driving, but it will pass a large part of the entrance to the body of the car, where a slight delay will bring the ride, but can reduce the stability of the car. A passive suspension design can help improve travel and stability, but cannot eliminate the compromise.

**Suspension system active**
The active vibration management system is very different from passive. These systems play a structural role by means of force forces, depending on dynamic responses of the structure. The energy applied in this way reduces the vibration to the primary system fully. With an active suspension, the optical intensity or passive curve and spring are replaced by the drive mechanism as shown in Figure 6.
The power drive can add and release power from the system, in contrast to the passive oxygen-inductor. With active suspensions, the force managers can exert force regardless of the displacement or speed of the suspension, resulting in better alignment between road comfort and vehicle stability compared to the passive system.

**Figure 6: Motion suspension for active suspension with passive interruption.**

**Semi-suspension suspension system active**
The semi-active suspension system was proposed for the first time in the early 1970s. In this type of system, the conventional spring element is retained, but the damper is replaced with a controllable damper as shown in Figure 7.

**Figure 7: Passive and Semi Active Suspensions**

**MR Damper**
The Magneto-Rheological apparatus is the most half-active device that is currently used in automotive engineering. The difference is that the hydrocarbons and the presence of electrons embedded inside the salt form the magnetic chain. When electromagnetic currents pass through electromagnetics, fluids change their condition from liquid to semi-solid state by increasing wet properties. Therefore, by controlling the amount of current through the enzyme, we can control the reduction rate of salt.

A shaft or suspension system can be used to control the vibration of the changing system. To reduce the vibration, the vibration management system is essential for the lens system or suspension system. The vibration management technique is classified into two parts: passive and active management. In a passive system, the parameters are synthesized through offline design techniques and no on-line response actions are used. Because the passive system creates a consistent design, the control is poor when the system or operating conditions have changed. On the other hand, active oversight has gained popularity in recent years.

In particular, it has been found that Magneto-Rheological (MR) can successfully renounce the vibration reduction program. MR is a magnetic agent of electromagnetic fluid (ER), and usually has a magnetic mass of magnetic particles that are dispersed by magnesium in containers such as oils, oils, or silicone oils. As the magnetic field is integrated into the solids, the atomic and fluids become semi-rigid and exhibit state change with desirable features such as high strength, good stability, extensive operational range, and faster response time. Go to a lonely program and hang. A liquid detector that is considered to be a mid-range control device that uses MR to produce reduced heat.

MR damper usually has a piston, a magnet scroll, an accumulator, a bear, a seal, and a damper filled with MR. Figure 8 shows the liquid-bed rate gauge used in this study in this ditch when the piston pits into its liquid residues flowing from the high pressure chamber to the lower pressure chambers through the holes at the piston head. Batteries contain compressed gas (usually a nitrogen), and its triggers provide a small portable impedance between the MR and the gas. Batteries have three purposes: (1) It provides a level of fulfillment by providing extra money for changing the volume that occurs when the piston enters the home. (ii) It carries heat of heat. (iii) it blocks cavitation in liquid liquids during piston movement. The magnetic field generated in the region activated by magnetic coupling changes the characteristics of MR. Thus, the magnetic intensity of the moment determines the characteristic of the Ellmor. The maximum force MR damper can provide depends on the properties of MR, its flow patterns and the size of the damper.
Batteries are the amount of gas that is separated from the fluid by using pulses or bladder. Batteries have two purposes. The first is to provide the volume of MRs to occupy when the axes are inserted into the cylinder. The second gives off pressure, so the pressure inside the lower pressure of the MR valve does not lead to cavitation in the MR, reducing the pressure below the pressure of MR.

**Experimental Set Up Development**
Experimental set up has a FFT die, excited excitement, laptop and two speed (one put near or on exciting vibrations and the other on top on the big pan).

The insulin used in the study was 36.5 cm long. Weight and weight 1333 grams. In addition, it requires a 5 cm length length with M8 inner curve with 12V and 9 amp.D.C.power supply. Before the test, the entire installation was connected to the vibrating vibrator with the FFT connection and was run for 10 minutes, meaning that the wavelengths had occurred. The cylinder of the Omega was suppressed with vibration. Vibration is eff ected by FFT which converts rotational motion of the motor column to a linear and wave motion.

**Results**
The damper was tested with a charge of 0 gram, 200 grams and 400 grams. The experienced force in the pad is prevented from the movement, known by the above speedometer, which is positioned on top of the speed and low limit settings placed on the shaft or on vibrating vibrators. The tests were performed using a magnetic field and without the use of 0 gram, 200 grams and 400 grams of zero-degree magnetic fields respectively. The supplied inductor is tested for different load values on the sensor.

**Without Magnetic Field**

<table>
<thead>
<tr>
<th>Loading Condition</th>
<th>Accelerometer Position</th>
<th>Frequency</th>
<th>Amplitude (m/s²)</th>
<th>Ratio (X/Xst)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero Load</td>
<td>Upper</td>
<td>22.375</td>
<td>X = 4.369</td>
<td>1.372</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td></td>
<td>X st= 3.183</td>
<td></td>
</tr>
<tr>
<td>200 gm</td>
<td>Upper</td>
<td>21.00</td>
<td>X = 5.209</td>
<td>1.414</td>
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<tr>
<td></td>
<td>Lower</td>
<td></td>
<td>X st= 3.683</td>
<td></td>
</tr>
<tr>
<td>400 gm</td>
<td>Upper</td>
<td>19.250</td>
<td>X = 11.450</td>
<td>1.534</td>
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</tbody>
</table>

**With Magnetic Field**

<table>
<thead>
<tr>
<th>Loading Condition</th>
<th>Accelerometer Position</th>
<th>Frequency</th>
<th>Amplitude (m/s²)</th>
<th>Ratio (X/Xst)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>X = 3.566</td>
<td>1.351</td>
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<tr>
<td></td>
<td>Lower</td>
<td></td>
<td>X st= 2.639</td>
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</tr>
<tr>
<td>200 gm</td>
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<td>X = 3.371</td>
<td>1.298</td>
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<td></td>
<td>Lower</td>
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<td>X st= 2.597</td>
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<tr>
<td>400 gm</td>
<td>Upper</td>
<td>20.125</td>
<td>X = 4.759</td>
<td>1.291</td>
</tr>
</tbody>
</table>

**Conclusion**

When MR's diagonals are tested without a magnetic field under zero storage, 200 gm storage & 400gm respectively, the frequency decreases by increasing the proportion of inputs to output (X / Xst). And when the MR meter was tested by a low magnetic field containing 200 gm containing 400gm, the frequency decreased with a decrease in the X / Xst output ratio. This study analyzes the vibrations that are controlled by the fluid suspension system. So by studying the relationship with the vibrator and its voltage to activate the magnetic effect, it can be calculated that leads us toward the next generation. As well as this system can be integrated to get a comfortable ride in the car if the suspension system is taken so the program speed can be met with knowledge of the characteristics of the shock absorber system and respond
quickly to effective management actions. The vibration will be done.

References


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