Magneto Rheological Suspension System

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Abstract- *Magneto-rheological dampers are commonly called as MR dampers. MR damper system is a smart damping system, which is used as automobile suspension for vibration control. MR fluids represent a class of smart materials that respond to an applied electric or magnetic field with a dramatic change in rheological behavior. The main advantages of MR dampers are that they need very less control power, has simple construction, quick response to control signal and very few moving parts. MR damper have received a great deal of attention in the last two decades due to there being a potential technology to conduct semi-active control. It is therefore vitally important to understand the dynamic behavior of such devices whose nonlinear hysteresis is a rather complicated phenomenon The behavior of MR dampers can be presented with different mathematical models. In this paper, we discuss the modes in which MR fluid devices operate. A comprehensive review is then presented of the principles, characteristics and engineering applications of the MR fluid devices (especially dampers) studied in the last decade. Finally, the application prospects of MR fluid devices are discussed*

Keywords- Magneto rheological Fluid, Suspension system , damping, non- Newtonian fluid, viscosity, magnetic field, voltage.

I. INTRODUCTION

Magnetorheological (MR) fluid is a non-Newtonian material that respond to an applied magnetic field with a dramatic change in rheological behavior. An MR fluid is in a free-flowing liquid state in the absence of a magnetic field, but under a strong magnetic field its viscosity can be increased by more than two orders of magnitude in a very short time (milliseconds) and it exhibits solid-like characteristics. The strength of an MR fluid can be described by shear yield stress. Moreover, the change in viscosity is continuous and reversible, i.e. after eliminating the magnetic field the MR fluid can revert to a free flowing liquid. Consuming these attributes of MR fluids, MR fluid devices have the capability to provide simple, quiet, brisk response interfaces between electronic controls and mechanical systems.

The research into MR fluids has become an important branch in the field of intelligent materials. Classical MR fluids are non-colloidal suspensions of magnetizable particles, having a size of the order of a few microns, in liquids of low permeability. Devices based on MR fluids include dampers, brakes, clutches and hydraulic valves polishing devices, composite structures, seals, etc. In 1948 Rabinow invented MR fluid and developed an application device (a clutch). In the recent years numerous patents and publications relating to MR fluids appeared. The main advantages of MR fluids are a yield strength of up to 50–100 kPa, which is one order of magnitude higher than ER fluids, insensitivity to contaminants, using 12–24 V low voltage, relatively broad working temperature range (typically 40 to 150 °C). Since the early 1990s there has been a rebirth of interest in MR fluids.

MR damper is becoming the most promising vibration controller in the intelligent suspension presently and it wins the favors of vehicle manufactures. 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 MR dampers have attracted suspension designers and researchers. Moreover, with the increasing requirement of vehicle ride comfortable and safety, intelligent suspension will be widely adopted in normal cars and engineering automobile, consequently, it will bring broad market of automobile suspension made of MR damper.

II. LITERATURE REVIEW

Wu G, Gang Zhang et.al.[1] states that response time increases rapidly with the increasing of electric current at the beginning, and after electric current reaches a certain value, response time increases slowly and then trends toward a constancy, and the response time first decreases rapidly and then closes to a certain value with the increasing of velocity of the piston.

Portillo, M. A., & Iglesias, G. R.[2] studied that the addition of nanoparticles as a carrier indicated that it could be enhancing the magneto rheological behavior of the MR fluid compared to the fluid containing stabilizing and thickening compounds additives. Another remarkable difference of the MR fluid with nanoparticles is the larger magnetic field-induced variation in the viscosity compared with the other fluids under study. The use of nanoparticles as a carrier liquid

in our formulation avoids the formation of compact sediments during long shelf or storage periods.

SA Wahid, I Ismail, et.al [3] has studied to utilize this material in daily applications parallel to the technologies development. Besides, the studies on the enhancement of the magneto rheological fluid application also been done by researchers. Problem of defects and failures also been studied aggressively nowadays. Hard cake, clumping, particles oxidation, Fluid particles separations and stability are the most common failures and defects in magneto-rheological fluid application. Even though some defects and failure cannot be removed or eliminate but it can be managed to specific values.

Tianjun, Z., & Changfu, Z. [4] states that the MR damper significantly increases active MRF chaining area and damping with multi-pole magnetic core and special polarization. Therefore, the active MRF chaining area substantially increased and almost all magnetic fields orthogonally penetrated MRF channel surface. The results confirmed that this novel MRF damper provided much better damping performance than conventional MRF dampers, especially when it was applied to semi-active suspension system.

III. METHODOLOGY FOR MAKING MR FLUID

CI particles (80% by wt.) were mixed with oleic acid (0.25% by wt.) for 30 minutes at 400 R.P.M in the stirrer. After that white grease (0.25% by wt) was poured and mixed for 30 minutes at 400 R.P.M in the same stirrer. Then servo medium e.g. paraffin oil(19.5% by wt.) was poured in small amounts gradually (4% by wt.) after every 30 minutes and mixed for 3 hrs. at 450 R.P.M in the same stirrer.

IV. MANUFACTURING

4.1 Frame

The suitable choice of material for the various parts of a machine is the primary objective in the fabrication of machine. For a design engineer it is must that he be familiar with the effect, which the manufacturing process and heat treatment have on the properties of materials. The choice of material for engineering purposes depends upon the following factors:

- Availability of the materials.
- The cost of materials.
- Physical and chemical properties of material.
- Mechanical properties of material.

The mechanical properties of the metals is the virtue by which the material resist mechanical forces and load.

The science of the metal is a specialized and although it overflows in to realms of knowledge it tends to shut away from the general reader. The knowledge of materials and their properties is of great significance for a design engineer. The machine elements should be made of such a material which has properties suitable for the conditions of operations. In addition to this a design engineer must be familiar with the manufacturing processes and the heat treatments have on the properties of the materials. In designing the various part of the machine it is crucial to know how the material will behave in service. For this certain characteristics or mechanical properties mostly used in mechanical engineering practice are commonly determined from standard tensile tests. In engineering practice, the machine parts are subjected to various forces, which may be due to either one or more of the following.

- Energy transmitted
- Weight of machine
- Frictional resistance
- Inertia of reciprocating parts
- Change of temperature
- Lack of balance of moving parts

The selection of the materials depends upon the various types of stresses that are induced during operation. The material selected should with stand it. Another criteria for selection of metal depends upon the type of load because a machine part resists load more easily than a live load and live load more easily than a shock load.

Selection of the material depends upon factor of safety, which ultimately depends upon the following factors.

- Reliabilities of properties
- Reliability of applied load
- The certainty as to exact mode of failure
- The extent of simplifying assumptions.
- The extent of initial stresses set up during manufacturing.
- The extent loss of life if failure occurs.
- The degree of loss of property if failure occurs.

Material used

- Mild steel

Reasons:

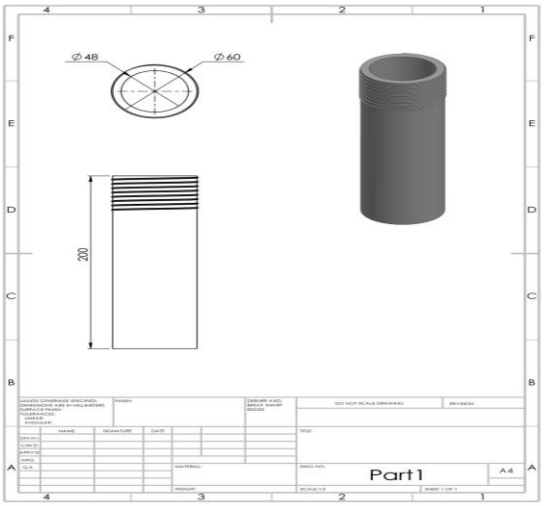
- Mild steel is readily available in market.
- It is economical to use.
- It is available in standard sizes.

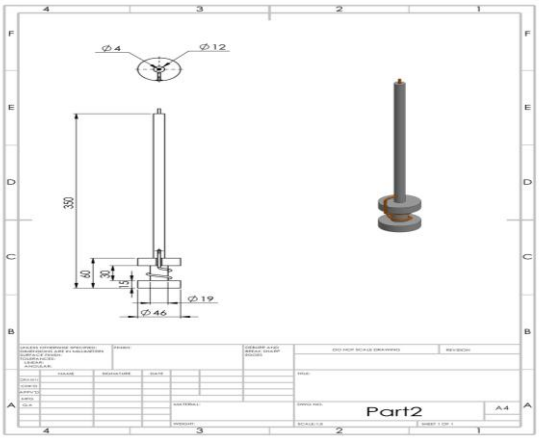
- It has good mechanical properties i.e. it is easily machinable.
- It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure.
- It has high tensile strength.
- Low co-efficient of thermal expansion.

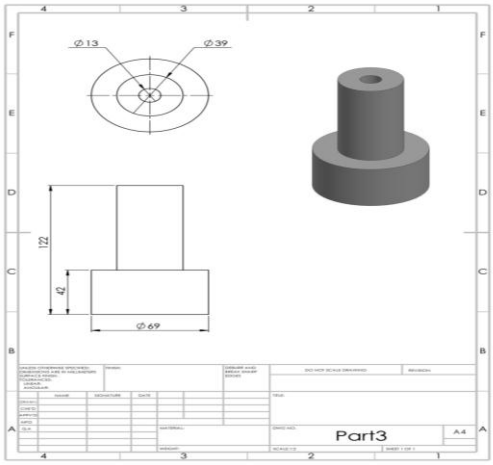
Properties of Mild Steel:

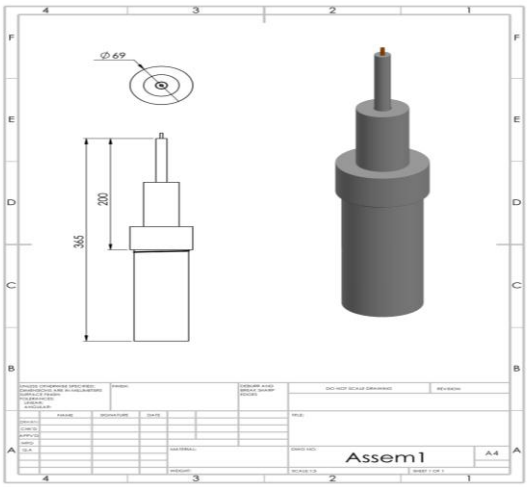
M.S. has carbon content from 0.15% to 0.30%. They are easily weld-able hence can be hardened only. They are similar to wrought iron in properties. Both ultimate tensile and compressive strength of these steel increases with increasing carbon content. They can be easily gas welded or electric or arc welded. With increase in the carbon percentage weld ability decreases. Mild steel serve the purpose and was hence selected because of the above purpose.

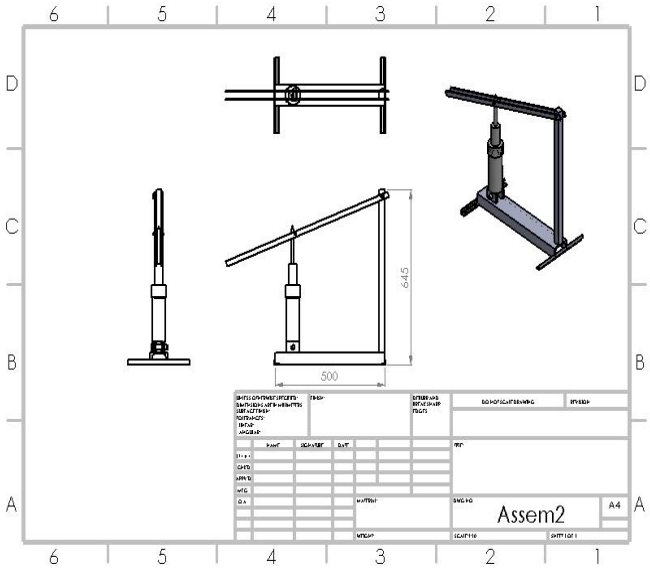
4.2 MODELLING OF FRAME











V. WORKING OF THE M.R. SUSPENSION SYSTEM

The system consists of a coil which is connected to a (6-36) V variable battery and the MR fluid is filled in the fluid gap.

Now when the force is applied the current passes through the coil inside the cylinder and produces magnetic field.

The magnetic field in turn influences the non-Newtonian fluid in fluid gap by increasing its viscosity instantaneously.

Now the almost solid MR fluid restricts the lever moving downwards when the force is applied, hence damping the force.

VI. CONCLUSION

MR fluid devices have been immensely progressive in the last decade and some commercial products have also been developed.

- This technique is being developed competitively in the major industrialized countries such as United States, Belarus, France, Germany and Japan.
- The key for MR fluid technology is to prepare high-performance MR fluids and to design state-of-the-art MR fluid devices

It can be seen that the MR fluid devices introduced in this paper will continue to be key to the extensive research and applications in various field as mentioned before.

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