DESIGN AND DEVELOPMENT OF A DUAL ACTING MAGNETICALLY ACTIVATED SHOCK ABSORBER

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"I admit that I have read this report and found that it is suffice from aspect of scope and quality to pass the
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DECLARATION

"I admit this report is done all by myself except statement that I have already stated on each one of them

Signature:.....

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Date :12/5/2008

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ABSTRACT

Dual acting magnetically activated shock absorber is a shock absorber that uses Magneto-rheological fluid or commonly knows as dual acting MR fluid damper. The application of this device is focus on the automotive sector such as automobile and motorcycle. The purpose of developing the dual acting shock absorber is to reduce the vibration on body and tire. This thesis wills overview the MR fluid damper through the discussions of MR Fluid technologies that adapt to the development of this MR Damper. Then, this thesis will introduce regular damper and the MR Fluid dual acting damper. In this section it will include discussion of MR damper types, type of MR damper operation mode and device using MR technology. The literature review of this thesis wills discuses the study and information collected to the MR damper. In this section the mathematical fundamental will also discussion the formula used to solve the design problem. The Methodology that used to solve the design problem will be explained in this thesis. The method uses in this thesis writing is MatLab and Solidwork software. By using Mat Lab the maximum damping force and best parameter to design a MR damper were obtain by using simulink. Finally, the best design of MR damper was present in 3D modeling by using Solidwork and the prototype is produce. The lab experimental also conducted to perform evaluation on the characteristics of the damper. In conclusion, recommendations are made for improving the prototype and future work that should been done.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

The purpose of this chapter is to provide overview information on Double Acting Magnetically Activated Shock Absorber of simply know as DAMSA and the objective of the project and scope that will be conducted in this thesis. The overview of the magnetorheological fluid also will be explained in this chapter. Mainly this chapter will briefly explain about what will be discuss on other chapter.

1.1 Overview of Dual Acting Magnetically Activated Shock Absorber.

The basic automotive suspension designs have been a compromise between the two conflicting criteria of road holding and passenger comfort. The suspension system must support the weight of the vehicle, provide directional control during handling maneuvers, and provide effective isolation of passengers and payload from road disturbances [3].

The dual acting magnetically activated shock absorber is the new device in automotive suspension and it operates same as normal shock absorber to absorb vibration on the tire and body of vehicle. The difference of this shock absorber is on the design and concept of the shock absorber. The dual acting shock absorber operate

with both side of the piston rod expand separately and can be simplify as combination of two damper. Mean while the single acting shock absorber only one side of the piston rod expand. In this thesis, the physical of the dual acting magnetically activated shock absorber will be explain detail on the component used, basic operation and the fluid used in the system.

1.2 Overview of Magnetorheological Fluid

Magnetorheological fluid was invented by Jacop Rabinow in 1949 at the US National Bureau of standard in the late 1949 [1]. The MR fluid was not used in many applications because there was no way to properly control it. Today, there many research to develop the MR fluid for commercial used because of digital signal processors and fast, cheap computers that can control the magnetic field applied to the fluid [1].

Now, many researches have done to the MR fluid, the main company that involve in this research is Lord Corporation. Refer to Lord Corporation research, MR Fluid consists of 20-40 percent by volume of relatively pure, 3-10 micron diameter iron particles, suspended in a carrier liquid such as mineral oil, synthetic oil, water or glycol. Varieties of proprietary additives, similar to those found in commercial lubricants to discourage gravitational setting and promote particle suspension, are commonly added to LORD Corporation's state-of-the-art MR fluids to enhance lubricity, modify viscosity and inhibit wear. For most engineering applications, a simple Bingham plastic model is effective in describing the essential, field-dependent fluid characteristics [2]. The MR Fluid is activated with application of magnetic flied across the fluid. The magnetic field will form and can create the iron particles to be aligned in column type structure parallel to field lines. This will cause the MR Fluid viscosity change to liquid to semi solid or pure solid depend on the electrical current in the system.

Today, the applications of MR Fluid are expand. Now, MR Fluid is applying on automotive sector. The Lord Corporation has already developed MR Fluid Shock absorber for automotive sector and be the pioneer on the product base on the MR Fluid. The other products that have been applied with MR fluid is MR controllable friction damper, motion monster ride management system and MR rotary brake [4].

In future more application of MR fluid will be create because of it rheological and physical properties. For this thesis report, however, I will focus my attention on the conceptual design of MR fluids for damper or shock absorbers.

1.3 Research Objective

The main objective of this project:

1. To conceptually design a dual acting magnetically activated shock absorber.
2. To develop the prototype of the dual acting magnetically activated shock absorber.
3. To investigate the performance of the dual acting magnetically in simulation studies and experimentally.

1.4 Scope Of The Project

The scope of the Project is:

1. Design and development of the dual acting magnetically activated shock absorber.
2. Performance evaluation of the dual acting magnetically activated shock absorber.

1.5 Definitions of Term

1.5.1 Conventional Passive Suspension, Semi Active Suspension and Active Suspension.

Traditional springs and dampers are referred to as passive suspensions. If the suspension is externally controlled then it is a semi-active or active suspension. Semi-active suspensions include devices such as air springs and switchable shock absorbers, various self-levelling solutions, as well as systems like Hydropneumatic, Hydrolastic, and Hydragas suspensions [5]. The dual acting magnetically activated shock absorber in this project filled with a magnetorheological fluid, whose viscosity can be changed electromagnetically, thereby giving variable control without switching valves, which is faster and thus more effective. Fully active suspensions use electronic monitoring of vehicle conditions, coupled with the means to impact vehicle suspension and behavior in real time to directly control the motion of the car [5].

1.5.2 Magnetorheological fluid

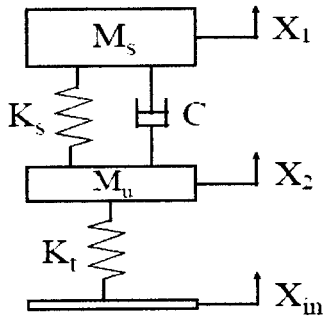
Type of smart fluid. It is a suspension of micrometre-sized magnetic particles in a carrier fluid, usually a type of oil. When subjected to a magnetic field, the fluid greatly increases its viscosity, to the point of becoming a viscoelastic solid. Importantly, the yield stress of the fluid when in its 'on' state can be controlled very accurately by varying the magnetic field intensity. The upshot, then, is that the fluid's ability to transmit force can be controlled with an electromagnet, which gives rise to its many potential control-based applications [6].

1.5.3 Magnetorheological dual acting damper

MR dual acting damper is semi active suspensions that replace the basic hydraulic damper. The dual acting motion of this damper can reduce the both body and tire vibration course of the road surface and the load of the vehicle.

1.5.4 Quarter Car Model

A typical vehicle primary suspension can be modeled as figure 1.0. Since the model is represent a single suspension from one of the four corner of the vehicle, this often referred as quarter car model.



Ms= Sprung mass
Mu= Unsprung Mass
Kt = Tire Stiffness
Ks= Spring Stiffness
C = Damper Coefficient

Figure 1 Quarter Car Model Diagram

1.6 Approach

In this project, there are several approaches that will be attended to complete this research. The approach was a study the different design of MR Damper before decided to develop a new design for the Dual Acting Magnetic Activated Shock Absorber. The several design of the MR damper that has been found during the study are mono tube, twin tube and the double-ended MR damper [7]. To obtain the

equation for damping force, the quarter car model and Matlab simulation software were used. Then the 3D modeling using Catia is used to perform the design of the Dual Acting Magnetically activated Shock Absorber.

1.7 Outline

In chapter 2 of this thesis will explain the MR Fluid physical properties and theory in detail, the passive suspension, the semi active suspension and the other device using the MR Fluid technologies. The chapter also will explain the literature review of other research thesis related to this project. Chapter 3 will be discuss the route of this project overall and step taken to complete this research project including damper. Chapter 4 will be discussing about result and analysis that have been made during this research and the mathematical model of dual acting magnetic damper. Chapter 5 mainly will be the conclusion of overall report and the future recommendation.

CHAPTER 2

MR SHOCK ABSORBER BACKGROUND AND LITERATURE REVIEW

2.0 Introduction

This chapter mainly will provide information on the traditionally basic hydraulic shock absorber that is a passive suspension system, the semi active suspension system and the fully active suspension to make this project easily to understand. Then the background of the MR Fluid that will apply in this project will be describe base on the characteristics of MR Fluids and explain how the fluids operate in dampers. The previous research that related with this project also describe in this chapter.

2.1. Passive Suspension System

A passive suspension system is one in which the characteristics of the components (springs and dampers) are fixed. These characteristics are determined by the designer of the suspension, according to the design goals and the intended application. Passive suspension design is a compromise between vehicle handling and ride comforts.

A heavily damped suspension will yield good vehicle handling, but also transfers much of the road input to the vehicle body. When the vehicle is traveling at

low speed on a rough road or at high speed in a straight line, this will be perceived as a harsh ride. The vehicle operators may find the harsh ride objectionable, or it may damage cargo. A lightly damped suspension will yield a more comfortable ride, but can significantly reduce the stability of the vehicle in turns, lane change maneuvers, or in negotiating an exit ramp. Good design of a passive suspension can to some extent optimize ride and stability, but cannot eliminate this compromise.

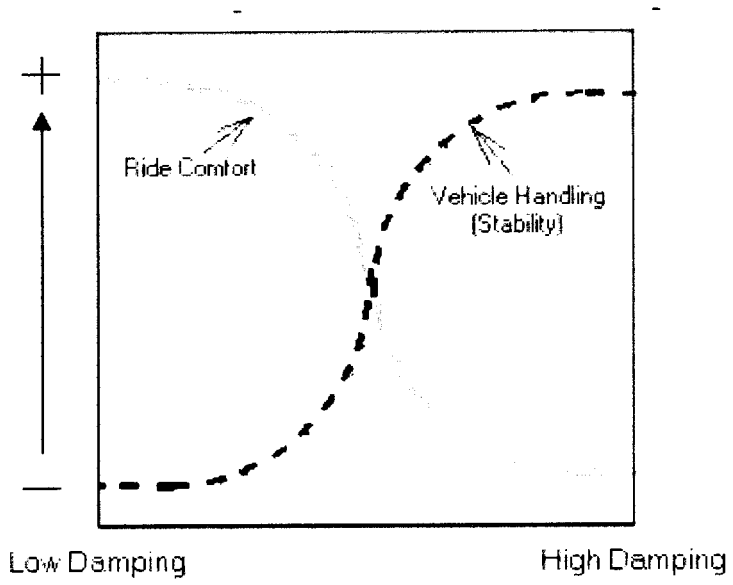


Figure 2 : Damping Compromise for passive damper

2.2. Semi Active Suspension System

Semiactive suspension systems were first proposed in the early 1970's. In this type of system, the conventional spring element is retained, but the damper is replaced with a controllable damper.

For the active suspension, the outside energy source is needed to power the actuate the actuator but for the semiactive suspension, outside power only is needed to adjust the damping on a control strategy, and automatically adjusts the damper to

achieve that damping. One of the most common semiactive control policy is skyhook control which adjusts thedamping level to emulate the effect of a damper connected from the vehicle to a stationary ground, as shown in Figure 2.7.

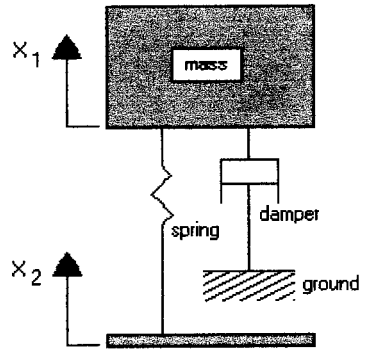


Figure 3: Quarter Car Model with Skyhook Damper

2.3. Fully active suspension system

An active suspension system has the capability to adjust itself continuously to changing road conditions. It "artificially" extends the design parameters of the system by constantly monitoring and adjusting itself, thereby changing its character on an ongoing basis. It's schizophrenic, if you will, but with a purpose. With advanced sensors and microprocessors feeding it information all the time, its identity remains fluid, contextual, and amorphous. By changing its character to respond to varying road conditions, active suspension offers superior handling, road feel, responsiveness and safety.

Active suspension systems (also known as Computerized Ride Control) consist of the following components: a computer or two (sometimes called an electronic control unit, or ECU, for short), adjustable shocks and springs, a series of sensors at each wheel and throughout the car, and an actuator or servo atop each shock and spring. The components may vary slightly from manufacturer to manufacturer, but these are the basic parts that make up an active suspension system.

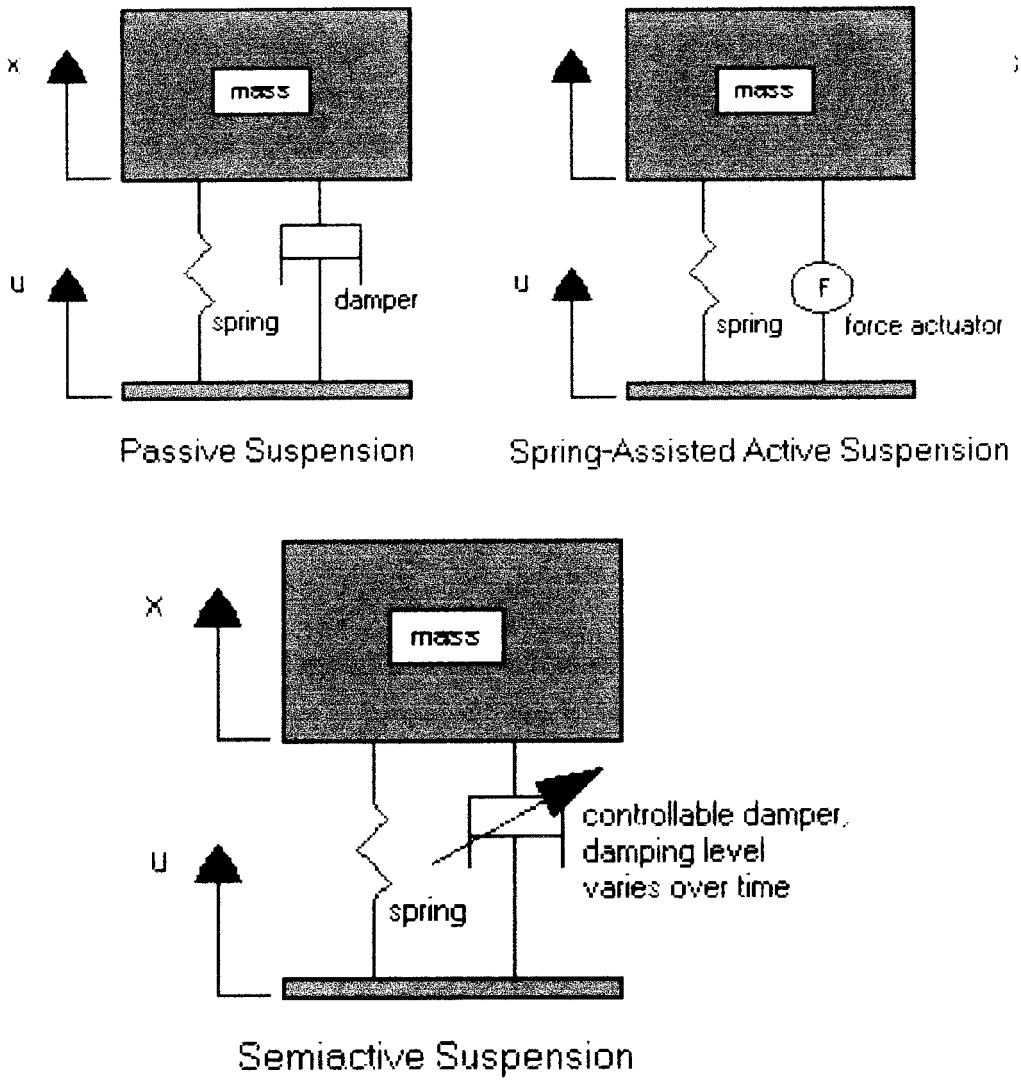


Figure 4: Different Of Passive, Semiactive and Active Suspension

2.4 MR Fluid

Magnetorheological Fluid is materials that respond to the magnetic field with a dramatic change of rheological behavior. This fluid can instantaneously change from a free flowing liquid to a semi-solid with controllable yield strength when exposed to magnetic field.