

STUDY OF ENERGY REGENERATIVE SUSPENSION SYSTEM FOR VEHICLE

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“This report is prepared in fulfillment for awarding the Degree of Bachelor Mechanical Engineering (Design and Innovation)”.

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SUPERVISOR DECLARATION

“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovation).”

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“I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged.”

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Author :

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Special to
Beloved Mom and Dad

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ABSTRACT

This Final Year Project, the research is to study the reliability and to analyze the energy harvest from vehicle suspension system. The regenerative suspension system (**RSS**) is a device that converts the kinetic energy of an oscillating object into electric energy. Normally, this kinetic energy is dumped in a form of thermal energy in a conventional of mechanical shock absorber

The suspension systems in modern vehicles better work of dissipating energy. The onward energy in a vehicle to be changed into vertical energy can be form at any bump in the road or terrain. The energy existence that is wasted from the modern vehicle suspensions systems can be harvested and converted into a form that can be used in a different part in the vehicle. More purposely, this energy can be transformed into electrical energy that can be used to charge a car battery. This could possibly balance in small or more of the work done by the alternator, resulting in rose up of fuel efficiency. If this system is carried out in electric vehicles, energy regenerated could recharge the battery and will longer the distance of these vehicles to travel. The method used for this project is to conduct the experiments on the induced electric from electromagnet that attach to the suspension system components and the components of the vibration energy regeneration and conversion.

The main target of this project is to design and analyze the operation of the **RSS**. Among the method used to design computer-aided drawing is through the use of CATIA V5 R20. This drawing includes drawing where the concept of this drawings on the concept of regenerative suspension system. This project uses the concept of functional electromagnetic induction to convert mechanical energy from vibration into electrical energy. In order to characterize the initial requirements that the **RSS** has to satisfy, the construction and performance of currently used shock absorbers were studied first. For this study case, two versions of were analyzed qualitatively and the most suitable design was selected. The next topic was the design calculations for the chosen type of the **RSS**. The designed was studied under steady-state conditions to determine its electromechanical characteristics. The dynamic model of the whole system of the **RSS** was proposed and described using the voltage equilibrium equation for the electrical port and the force equilibrium equation for the mechanical port. The performing of the **RSS** acquired from simulations was compared with mechanical parameters of the mechanical shock absorber. The assumption that is obtained shows that the **RSS** is able to store part of the recovered energy in the battery. However, a great part of this energy is lost in the generator resistance and in the external resistance, which is necessary to be connected to the generator output terminal in order to obtain the desire electromechanical parameters.

ABSTRAK

Di dalam Projek Akhir Tahun untuk semester kali ini, kajian yang dibuat adalah untuk mengkaji kebolehpercayaan dan menganalisis untuk mendapatkan tenaga daripada sistem suspensi kenderaan. Sistem Penjanaan Suspensi (SPS) adalah satu alat yang menukarkan tenaga kinetik menjadi tenaga elektrik. Biasanya, tenaga kinetik dibuang dalam bentuk tenaga haba.

Sistem suspensi di dalam kenderaan moden yang lebih baik digunakan pakai untuk mendapatkan tenaga yang terbuang daripada melesapkan tenaga. Tenaga yang seterusnya di dalam kenderaan untuk ditukar menjadi tenaga boleh menjadi hasil di mana-mana benjolan di jalan raya atau kawasan. Kewujudan tenaga yang sia-sia dari penggantungan kenderaan moden sistem boleh dituai dan ditukar ke dalam bentuk yang boleh digunakan di bahagian yang berlainan di dalam kenderaan itu. Lebih sengaja, tenaga ini boleh diubah menjadi tenaga elektrik yang boleh digunakan untuk mengenakan bateri kereta. Ini mungkin boleh mengimbangi di kecil atau lebih daripada kerja yang dilakukan oleh alternator, menyebabkan meningkat daripada kecekapan bahan api. Jika sistem ini dijalankan di dalam kenderaan elektrik, tenaga boleh dijana semula bateri dan akan lebih lama jarak kenderaan ini perjalanan. Kaedah yang digunakan untuk projek ini adalah untuk menjalankan eksperimen ke atas disebabkan elektrik dari elektromagnet yang diikat pada komponen sistem penggantungan dan komponen penjanaan tenaga getaran dan penukaran.

Sasaran utama projek ini adalah untuk mereka bentuk dan menganalisis operasi RSS. Antara kaedah yang digunakan untuk mereka bentuk lukisan bantuan komputer adalah melalui penggunaan CATIA V5 R20. Ini termasuk lukisan lukisan di mana konsep ini lukisan konsep sistem penggantungan regeneratif. Projek ini menggunakan konsep induksi elektromagnetik berfungsi untuk menukarkan tenaga mekanikal dari getaran menjadi tenaga elektrik. Dalam usaha untuk mencirikan keperluan awal bahawa RSS mempunyai untuk memenuhi, pembinaan dan prestasi penyerap kejutan kini digunakan dikaji pertama. Bagi kajian kes ini, kedua-dua versi dianalisis secara kualitatif dan reka bentuk yang paling sesuai telah dipilih. Topik seterusnya adalah pengiraan reka bentuk untuk jenis dipilih daripada SPS. Yang direka telah dikaji di bawah keadaan mantap untuk menentukan ciri-ciri elektromekanik itu. Model dinamik keseluruhan sistem RSS telah dicadangkan dan diterangkan dengan menggunakan persamaan keseimbangan voltan pelabuhan elektrik dan persamaan keseimbangan kuasa untuk pelabuhan mekanikal. Yang melakukan satu SPS diperolehi daripada simulasi telah dibandingkan dengan parameter mekanikal penyerap kejutan mekanikal. Andaian yang diperolehi menunjukkan bahawa SPS mampu untuk menyimpan sebahagian daripada tenaga pulih dalam bateri. Walau bagaimanapun, sebahagian besar dari tenaga ini hilang dalam rintangan penjana dan rintangan luaran, yang perlu disambungkan ke terminal output penjana untuk mendapatkan parameter elektromekanik keinginan.

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CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

To advance the vehicle performance such as ride comfort and road handling, the active suspension system should be used. However, the current active suspension system has a top activity consumption therefore reducing the fuel economy. In this Final Year Project, a source of mechanical energy is harvest by the vibration excited by road unevenness. It is converted into electrical energy to compensate for the energy consumption by the active suspension which is call as “Regenerative Suspension System” (**RSS**). To accomplish this Final Year Project, an electromagnetic active suspension system has been introduced we call as “Energy Regenerative Suspension System” (**ERSS**). The ability generated from this accessory has been used as input power of the vehicle for the electronic device.

Shocks absorbers are used to reduce oscillation by absorbing the energy contained in the springs or torsion bars when the wheels of an automobile move up and down. Regular shock absorbers do not support vehicle weight. They lower the dynamic wheel-load changes and avoid the wheels from lifting off the road surface except on extremely rough surfaces and making possible much more careful steering and braking. The shock absorbers turn the kinetic energy of suspension movement into thermal energy or heat energy to be dissipated within the hydraulic fluid. Still, this kind of kinetic energy can be converted into electric energy which in chance can be stored in a battery. It is potential if **RSS** is used. This is particularly essential if an electric vehicle is considered. The overall efficiency of the electric drive is getting higher by converting the oscillation energy and storing it in the battery. On at a time the energy causes to the extension of the travelling distance under the single charge. Up to now there has no a qualitative proportional study of various types of **RSS** and a selection of the most suitable design. The design calculations approach in use to determine the main design parameters of the selected version. To determine its electromechanical performance by simulate the dynamics of **RSS**.

1.1 OBJECTIVE

The objectives in this project are to study the reliability of the regenerative suspension system which the experimental will be conduct to identify how much the source power will it produce and does it is useable to use for the vehicle. Another objective for this project is to design and fabricate the regenerative suspension system. In design process, the software that use for CAD drawing is using CATIA V5 Release 20.

1.2 SCOPE OF PROJECT

This project consists of design, analysis and fabricates the regenerative system for the scope of the project.

1.3 PROBLEM STATEMENT

Nowadays, there is much research towards new methods to obtain energy without relying on petroleum resources simply diminishing day by day. Although, there are many factors that contribute to the failure of non-sustainable energy sources, the method is less efficient and so. Today's, there are many researches towards new methods to obtain energy without relying on petroleum resources. This project will introduce a new method of obtaining energy from suspension system for vehicles. We call this method as "energy regenerative suspension system" a new method of obtaining energy from suspension system for land vehicles. As is known, the suspension system is installed in a vehicle in each car and when the car is moving, there will be movement in the suspension system will then produce energy that can be converted into energy that can be used for other applications such as electricity. So as an alternative, the regenerate of energy from the suspension system using electromagnetic induction concept that will generate electricity. The electricity was generated by the suspension system to be used in smaller applications such as car radios, lights and others.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

Regenerative energy from the suspension is a method that uses energy from the kinetic energy resulting from the vibration of vehicle while driving on the road. This energy can be converted into useful energy like electricity and useful. The electricity generated from this method can be used by vehicles as a second source of energy after the engine. The product that will be design in this project is call as “Regenerative Suspension System” (RSS). Benefits of this suspension system are that it can reduce engine load because the energy consumption of the engine is reduced. Based on studies that have been made, the profile of the road surface in this country mostly uneven, bumpy and cracked and this will produce vibrations in the vehicle while driving. Out of this situation and with the regeneration vibration energy can be produced. This chapter

will discuss the reliability of the regeneration of energy from the suspension system for ground vehicles. In this system, the use of magnets and coils will help to produce energy regeneration to convert mechanical energy generated to the beneficial energy of electricity.

2.1 SUSPENSION SYSTEM

2.1.1 Function of Suspension System

The main function of the suspension system is to optimize the friction between the tire and road surface. It helps to create stability in control when driving. At freshly paved highways, the interaction with the wheels of a car has subtle imperfections. It's these imperfections that apply forces to the wheels. According to Newton's laws of motion, all forces have both magnitude and direction. Suspension system is also designed to ensure the comfort of the driver and passengers in the vehicle. While driving, the suspension system will absorb the impact to ensure that the vehicle is stable and under. The magnitude depends on whether the wheel is striking a giant bump or a tiny speck. The car wheel experiences a vertical acceleration over an imperfection control as it passes on the road. The wheel move up and down perpendicular to the road surface causes by a bump in the road. One of the most important components of the suspension system is found in the spring. The function of the spring is to absorb impact and vibration from the road surface so that the resulting energy of the vibration is not passed directly to the vehicle body. It also aims to prevent the existence of attractive forces between the tire and road surface. The second component is just as important as a shock absorber spring. Shock absorber is designed to launch a shock absorption and

impact and dissipate kinetic energy. Shock absorber valves oil and gas to absorb the excess energy resulting from the spring.

2.1.2 Work Principle of Suspension System

When the vehicle violates hump, moving through the road surface is cracked or broken, it will cause the tire to move down and angled up from the road surface. The magnitude of the movement depends on whether the breach with a large humps or fine detail. Without a dominant structure, the resulting total energy will flow to the vehicle frame moving in the same direction. In this situation, the tires may lose control and not in contact with the road surface as a whole. Then, the gravitational pull of facing down will cause shock between the tire and road surface. Function of the suspension system in this situation is to absorb the energy and vibration of the resulting shock, and ensure the vehicle body frame and move without being interrupted when the vehicle through the bumps on the road.

2.1.3 Types of Suspension System

In this sub-heading will indicate the type of suspension system used in the automotive world of the kind familiar to the more sophisticated type. Standard shocks are the ones that are commonly used in cars that hardly perform heavy-duty activities. These are vehicles which are more or less designed for personal use. Since they are less likely to be involved in strenuous tasks, a standard shock absorber will do. Heavy-duty shocks is implied in the term “heavy duty,” heavy duty shocks are utilized in cars that

are more exposed to rough terrains. Likewise, these are also applied to vehicles that are designed to carry cargos or passengers. Excess shocks give support for vehicles that are go through suspension problems both in the front or rear systems. Overload shocks are perfect for those that suffer from under steering. An air shock is a common feature of cargo trucks and other vehicles that tend to carry massive weight or load. There are five types of suspension which are Double Wishbone, Multi-link, Strut, Air Suspension and Bose Acoustic (Johnny Schultz, 2011).

2.1.3.1 Double Wishbone suspension

In automobiles, Double Wishbone suspension is an independent suspension design using two which is occasionally parallel. It is wishbone-shaped arms to locate the wheel. Each wishbone has two mounting points to the chassis and one joint at the knuckle. Have lower control arms are longer. It also has an upper control arm is shorter to hold the tires firmly on the frame. This allows the control arm to move the tire better flexibility. Lower control arm is bigger because it needs to withstand large loads when the vehicle is moving. The shock absorber and coil spring mount to the wishbones to control vertical movement. Double wishbone carefully control the motion of the wheel throughout suspension travel, controlling such parameters as camber angle, caster angle, toe pattern and roll center height, scrub radius, scuff and more. The example of the Double Wishbone suspension system is such as **Figure 2.1**.

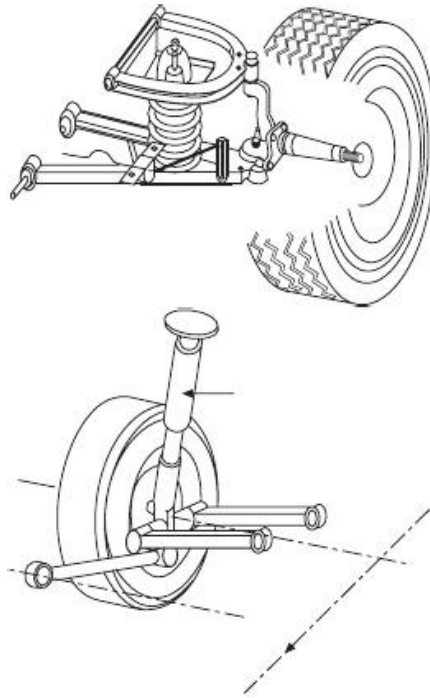


Figure 2.1 Double Wishbones (Julian Happian-Smith, 2002)

2.1.3.2 Multi-link suspension

This is more advanced than double wishbone. It's even more added flexibility and improved to meet the various types and driving situations. Separate each arm connected to the spindle. This is better than connecting with a solid unit. It allows the arm rotates depending on the movement of the steering wheel. The multilink suspension is the best independent system for a production car because it offers the best compromises between handling and space efficiency and comfort and handling. Moreover, because such a suspension allows a vehicle to flex more, it's also a very good solution for off road driving. The example of the Multi-link suspension system is such as **Figure 2.2** (Autoevolution, 2012).