FATIGUE STRAIN SIGNAL BEHAVIOR OF AUTOMOBILE SUSPENSION SYSTEM

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in term of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Structure and Material).

Signature :…….

Name of supervisor :…….

Date :…….

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DECLARATION

I declare that this project report entitled “Fatigue Strain Signal Behaviour of Automobile Suspension System” is the result of my own work except as cited in the references.

Signature	:…….
Name of Author	: Mohamad Iqmal Faris bin Idris
Date	:

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To my beloved family especially my mother, Samirah binti Simoh and my father, Idris bin Kassim

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In the name of Allah, the most Gracious and most Merciful

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ABSTRACT

Generally, spring suspension is one of the important part in automobile components which act to support and holds the body of the automobile from shaking and vibration. Driving become uncomfortable when automobile passes through the high magnitude road such as hills and small magnitude road such as road roughness. Therefore, this project discusses the fatigue life prediction of the spring suspension by obtaining the strain signal behaviour of two different road surface and the static analysis using Ansys workbench software. An investigation and analysis is done by Solidwork drawing, Ansys for static and Design life nCode software for fatigue analysis. The behaviour of strain signals was analysed by using statistical method. The damage and life cycle value of the spring suspension also been obtained by using commercial Design life software. Basically, the fatigue strain signal behaviour significantly influenced by the type of road surfaces which directly affected the damage and life cycle of the spring suspension. After all the information been identify, the fatigue life prediction can be done to evaluate the reliability and suitability of the spring. Perodua Myvi is choose in this project due to higher sales in Malaysia market and the result can be used in the future for further study.

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ABSTRAK

Secara umumnya, pegas penggantungan adalah salah satu bahagian yang penting dalam komponen kereta yang bertindak untuk menyokong dan memegang badan kereta dari gegaran dan getaran. Pemanduan menjadi tidak memuaskan apabila kereta dipandu melalui jalan yang berbukit dan kekerasan jalan yang berbeza. Oleh itu, projek ini membincangkan ramalan hayat pegas penggantungan dengan mendapatkan tingkah laku isyarat tekanan daripada dua permukaan jalan yang berbeza dan analisis statik menggunakan perisian Ansys. Penyiasatan dan analisis dilakukan dengan lukisan Solidwork, ANSYS untuk analisis kekal dan ncode untuk menilai jangka hayat pegas setelah tekanan berulang dikenakan.. Kelakuan isyarat tekanan dianalisis dengan menggunakan kaedah statistik. Kerosakan dan kehidupan nilai kitaran pegas penggantungan juga diperolehi dengan menggunakan perisian kehidupan reka bentuk yang komersial digunakan. Pada asasnya, tingkah laku isyarat tekanan yang berulang jelas ketara dipengaruhi oleh jenis permukaan jalan raya yang secara langsung memberi kesan kerosakan dan kehidupan kepada pegas penggantungan. Selepas mengenal pasti semua maklumat, ramalan hayat boleh dilakukan untuk menilai kebolehpercayaan dan kesesuaian pegas penggantunagn. Perodua Myvi dipilih dalam projek ini kerana jualan yang lebih tinggi di pasaran Malaysia dan hasilnya boleh digunakan pada masa akan datang untuk kajian lanjut.

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LIST OF SYMBOLS

R.M. S	Root Mean Square

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CHAPTER 1

INTRODUCTION

1.0 BACKGROUND

Suspension is one of the most crucial components in a car system. The main function of this suspension system is to protect the passenger and the car from shaking when they drive across the road with bump or hole or even on the smooth road in order to ensure the wheels follow the road profile. Suspension system is creating to provide a good ride and handling performance of the car. It consists of three main part including suspension spring, suspension damper and suspension bushes.

In the present type of car spring, there come in three types which are leaf spring, torsion bar spring and coiled spring. Leaf spring is a layer of metal beams that entwined and it is associated with the axle. The torsion bar all alone is a strange little contraption which gives wound spring-like execution in view of the contorting properties of a steel bar. One end of the steel shaft is associated with the axle and the other side which is opened into a tube and held there by splines. For the coiled spring, it is a steel bar but it is coiled up and the mechanism of pushing it down is similar as twisting the metal bar.

This car part as named shock absorber plays role to dampen the vertical motion when the drive along rough surface. In addition, this part is to make sure the wheels are always planted on the road. If the car only had spring, the passenger will experience the wallow along the road until they got physically sick and hard to get out or the car.

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Furthermore, at one stage the suspension system will achieved failure due to the stress and force applied to the component. The type of failure is fatigue. Fatigue is a phenomenon related with variable loading or more precisely to cyclic stressing or straining of a material. Fatigue obviously occur when a specific task is repeatedly performed, in same method metallic components subjected to variable loading get fatigue, which leads to their ultimately failure under specific conditions (Chetan et al. 2012).

According to ASTM fatigue life clearly specify as the number of stress cycles of a specified character that specimens maintain before failure of a specified nature ensue. Suspension system of vehicle can achieve failure due to the cyclic load. Stress-life method, strain life method and linear-elastic fracture mechanics method are the three basic fatigue life method used in design and analysis. Mechanistically, fatigue failure can be pursuing by gradual enlargement of fatigue cracks during the tensile part of the loading cycle. Once a crack reaches a certain critical size, a big failure ensues. The application and behaviour of fatigue crack growth is fully effected by the formation of characteristic striation patterns on the fracture surface called beach markings. In another point of view, fatigue failure is associated with distinctive dislocation network arrangements, which result from the cyclical nature of loading (Chetan et al., 2012).

Thus, fatigue study and life prediction on the suspension system is necessary in order to verify the safety of this suspension system during its operation. Nowadays, many researchers in the automobile industry have taken the opportunity to improve the design of suspension system.

This study examines and to predict the fatigue life of suspension system by analyse the characteristic of three different road profiles using statistical method. This investigation will be done by attached the strain gauge to a suspension system that will be connected to data acquisition in order to obtain the signals. At the end of this research, the fatigue life of suspension system will be predicted.

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1.1 PROBLEM STATEMENT

The issue that always be raised is the driving become uncomfortable when passes through the high magnitude road such as hills and small magnitude road such as road roughness. In other word, it influences by road disturbance. Next, load disturbance also one of the role which the variation of the load induced such as when accelerating, braking and cornering. In addition, the suspension sometime is less in performance due to the contact of tyre with road. The suspension of automobile achieves the failure in a short time in certain condition and this must be preventing correctly.

1.2 OBJECTIVE

1) To obtain the fatigue strain signal of spring suspension when driven into different road surface.
2) To determine fatigue strain signal characteristic using statistical method.
3) To predict the fatigue life of automobile spring suspension system.

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1.3 SCOPE OF PROJECT

The first element need to be considered is to do the finite element analysis using software analysis. Analysis enables to get the static analysis and stress analysis to be done on the suspension. Static analysis formed in terms of load of the car, model CAD and constrains.

The second element is conducting the experiment to get the data. The strain gauge is placed at the suspension of the car to verify the signal. Then the data collected from strain gauge proceed with statistical analysis.

The third element is fatigue life analysis that runs by using Design Life software. The result of static analysis from analysis software imported to this stage. The data signal from strain gauge also is imported to run this software. Design Life software is an engineering test data analysis with specific application for fatigue analysis.

Lastly, the process requires analysis of the signal classification based on the value of the statistical analysis result. Behaviour of the strain signals at different type of road is determined and fatigue life prediction is made.

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CHAPTER 2

LITERITURE REVIEW

2.1 AUTOMOBILE SUSPENSION SYSTEM

Car suspension systems play a major role in car performance. The performance of the car is not necessarily depending on the engine system. Every vehicle moving on the randomly profiled road is exposed to vibrations which are hazardous to the passengers in terms of comfort and for the sustainability of the vehicle itself. Many aspects need to be consider in order to get the best performance of the car and suspension is one of the aspects. In general, a good suspension should provide a comfortable ride and good handling (Lavanya, et al., 2014). Besides that, all of this is directly depending on the purpose of the vehicle. Sports cars normally have stiff, hard suspensions with poor ride quality while luxury sedans have softer suspensions but with bad road handling capabilities but the aim clearly same which is to reduce all the disturbances. A fundamental suspension system includes of the parts springs, axles, shock absorbers, arms rods and ball joints as shown on Figure 2.1. The main purpose of the suspension is to ensure the tires in contact with the road smoothly, regardless of road surface.

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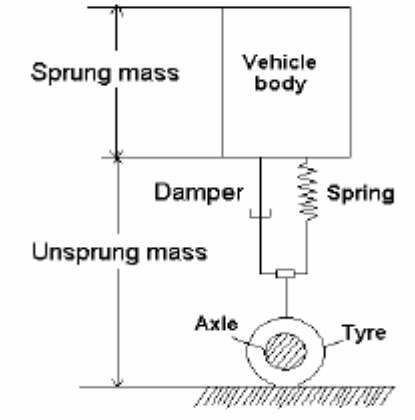

Figure 2.1: Free body diagram of quarter car model

(Jadhav et all., 2014)

2.2 HELICAL SPRING OF SUSPENSION

Helical spring is one of the parts on suspension system with embedded to maintain the capability of the suspension. Based on the Puff (2010), the helical spring had been applied to Reciprocating Compressors with significant importance to control the noise and vibration of the compressor. Springs are basically used in mechanical part as a main function to absorb the load from moving part, which may be continuously, or abrupt difference. Elastic energy is being form in order to absorb the loads. Energy is stored in the spring until the force is released end up at one point the spring will return to the original shape when force is released.

In addition, a helical spring comes with variety of shape which is cylindrical, conical, tapered, concave or convex. But the most frequent type of spring been used in automobile industry is coil spring although there are many other types provided and quite depend on the vehicle suspension system. The cylindrical shape had been choosing in this study due to the present usage in car industry as shown on Figure 2.2

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Figure 2.2: Helical spring

(Jadhav et al., 2014)

The first automotive coil spring was on the model-T (Ford) in (Berti & Monti, n.d.). The advance coil spring material used had about 500 MPa design stress level. Coil spring materials have grown forward where today the design stress of around 1200 MPa in order to sustain the durability. Nowadays, most automobile company have high attention to reduce the weight of car components without changing the remaining system and coil spring was not exempted from it. In this case, the way to implement by reducing the spring wire diameter at same time sustain the mechanical properties of the coil spring. This effort ensues due to obtain the better performance of the automobile.

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2.3 MANUFACTURING OF HELICAL SPRING

Regularly, the operating environment is the single most crucial consideration for proper spring material selection. In order to obtain the successful application, material must be highly adaptable with the environment and resists effects of temperature and corrosion without an excessive loss in spring performance. The spring reliability will reduce significantly influence by the corrosion and elevated temperatures. From this information, the proper material selection will be made in producing the helical spring. The determination of maximum allowable stress together with the load requirements and suitable dimensions will be selected.

The fundamental factor considered in the design of a spring is the strain energy of a material. The specific strain energy in the material is expressed as

$$U = \frac{\sigma^2}{2 \times \rho \times E} \tag{2.1}$$

From this equation can be consider that material having lower density (ρ) and Young's modulus (E) will be having quite higher specific strain energy under the same stress condition. The coil spring is made from rods which are installed wound as a helix. Rod width, spring measurement and the quantity of coil turns per unit length are the primary outline parameters of a coil spring.

Chiu, Hwan, (2007) was implement the study on four different types of helical compression springs made of rubber core unidirectional laminates (UR), unidirectional laminates (AU), rubber core unidirectional laminates with a braided outer layer (BUR) and unidirectional laminates with a braided outer layer (BU), respectively. The outcomes demonstrate that the spring with BUR failure load in compression to 18% alongside the upgrade of 16% in spring constant while for the helical composite springs with a rubber core has 12% more load bearing limit.

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