UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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VIRTUAL TESTING OF SUSPENSION COIL SPRING USING FE SOFTWARE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Technology Automotive (Department of Mechanical Engineering Technology) (Hons.)

By

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Automotives) (Hons.). The member of the supervisory is as follow:

SAIFUL NAIM SULAIMAN

.....

(Project Supervisor)

ABSTRAK

Spring heliks memainkan peranan penting dalam banyak aplikasi seperti mesin dan kenderaan. Apabila spring heliks dikenakan beban yang statik, perkara penting yang perlu dikenalpasti adalah untuk mengetahui ciri-ciri statik spring tersebut. Dalam kajian ini, kaedah kajian analisis dan kaedah eksperimen digunakan untuk menganalisis spring. "Finite Element Analysis" oleh "Hyperwork" dan kaedah pernomboran menggunakan formula akan diguna pakai untuk mengesahkan dan mengkaji setiap data sebelum dirumuskan

ABSTRACT

Helical spring plays an important role in many applications such as machines, and vehicles. When a helical spring is under a static load, it is important to know their static displacement characteristic. In this research, Numerical and theoretical method are used for the analysis of springs to find the load vs displacement characteristics. finite element analysis by Hyperworks and theoretical method by using formula in designing the spring by were performed to verify and study the data between the comparison of the helical spring results.

DEDICATION

This thesis I dedicate to my parents and my friends for supporting me all the way

ACKNOWLEDGEMENT

I would like to convey my greatest appreciation to our project supervisor, Mr. Saiful Naim Bin Sulaiman on his guidance and discussion to provide information concerning our process to complete this project. His every view and given suggestion has its own value to me and I will take it as a reference for my project foundation. Thanks a million for your support sir!

Sincere thanks to all our friends who helped me in terms of services, moral support and view. Last but not least undying thanks to my parents who always pray for my success. I hope it can bring success on this final project.

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LIST OFABBREVIATIONS

FEA	-	Finite Element Analysis
3D	-	3 Dimension
2D	-	2 Dimension
UTM	-	Universal Testing Machine
ACT	-	Account Control Technologies
FE	-	Finite Element
JIS	-	Japanese Industrial Standard
SUP12	-	Spring Steel Grade
CMM	-	Coordinate Measuring Machine
MM	-	Millimeter
N	-	Newton
K	-	Kilo
F	-	Axial Force

CHAPTER 1
INTRODUCTION

1.1 Project Background

Suspensions, as many other vehicle systems, followed relatively closely the evolution of the transportation technology. For century carts, vehicles were not equipped with any sort of suspension at all. Only later, in the eight century, was a primitive suspension based on an iron chain system developed. Metal springs were first developed in the 17th century and shortly afterwards leaf springs. Various designs were developed until the last century, which saw the development of the concept of suspension based on a spring and a damper. The suspension will determines how smooth or rough the car ride will be. That is the reason why some vehicles are very smooth and others are bumpy. A good suspension is important to get the best riding.

So, a few design of spring coil with different dimension will be created, follow by the analysis to study the results. This modelling of spring and analysis hopefully can be used as in the automotive industry in the future plan maybe in order to improve the automobile comfortable and try to fulfil the customer needed with concern the safety and comfortable for user of vehicle.

1.2 Problem Statement

Reverse engineering method will be done with a few design of the spring followed by analysis in FEA method then compared it with theoretical method. To overcome this problem, this research is done to investigate the different parameters of automotive suspensions systems. Analysis method is done to save the cost of actual testing method. The simulations of spring in the FEA software can help in detect the problem and also help the engineers to solve the problem in the early stage.

1.3 Objective

The objective of this project is:

i. Modelling the coil spring according in Catia Software with variable design parameters of actual coil spring
ii. To create a finite element analysis (FEA) model of the spring and simulate the model using variable design parameters.
iii. Compared and investigate the result between analysis method and the theoretical formula.

1.4 Project Scope

This project is focused on study the different parameter of the spring that will effect on the static characteristic of the linear spring. The purpose of this project is to create the spring model based from the selected model of spring only. Result from

simulation software only investigates the maximum stress and load vs displacement characteristics needed. The spring analysis is performing in FEA software to define the characteristic of the spring without making the experimental method.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The aim of this chapter is to provide all the information of suspension system. How did the change the dimension of the spring will affect the performance of the suspension system of our vehicle? List of testing method of the spring that can be done either the experimental or analysis methods. The suspension system will be discussed thoroughly in this chapter. Various sources including journal, thesis, reference books and literature reviews have been carried out and revised in writing this chapter.

2.2 Background of Springs

"A mechanical spring may be defined as an elastic body whose primary function is to deflect or distort under load (or to absorb energy) and which recovers its original shape when released after being distorted". (Wahl.A.M,1944). Normally people do not know of general definition of the spring which is to support a body or structure, to apply force, to absorb shock, or to provide load control. With these definitions of the spring, the aircraft wings, the body chassis of the car and even the shoes that we wear also will be considered as a spring. The same concept happen to this entire item which is all will depress under load and revert back to its original shape after load is released. A shoe sole will absorb the impress of the foot fall and the bending of arc of the foot and return

to its normal state when the foot is removed. The aircraft wings must take the loading and unloading on take-off and landing of the plane in other to encounters the air turbulence.

2.2.1 Main Objective of Spring

The main objectives of spring are as follows:

i. To apply force: A majority industrial, e.g. to provide the operating force in brakes and clutches, to provide a clamping force, to provide a return load, to keep rotational mechanisms in contact, make electrical contacts, counter balance loading.
ii. To control motion: Typically storing energy, e.g. wind-up springs for motor, constant torque applications, torsion control, and position control.
iii. To control vibration: used in essence for noise and vibration control, e.g. flexible couplings, isolation mounts, spring and dampers.
iv. To reduce impact: Used to reduce the magnitude of the transmitted force due to impact
or shock loading, e.g. buffers, end stops, bump stops.

2.3 Spring in Automotive Industry

In automotive industry, coil spring used in the suspension of vehicle for the last 30 years. The types of coil springs are slightly depending on the weight of the vehicle and the desired ride characteristics. Typical car spring rates range between 130 kilogram and 17000 millimetre. Luxury car tends to use softer springs to provide a smoother ride, while sports cars tend to be stiffer in order to improved handling. (Ken Ziesemer, 1998)

Suspension coil spring act as an elastic object used to store mechanical energy. They can twist, pulled or stretched by some force and can return to their original shape when the force is released. A coil spring is made from a single length of special wire, which is heated and wound on a former, to produce the required shape. The load carrying ability of the spring depends on the diameter of the wire, the overall diameter of the spring, its shape, and the spacing of the coils.

A suspension spring is still required to absorb the shock loadings produced by bumps in the road surface, and it does this by being initially compressed and subsequently expands on the total mass of the car. Figure 2.1 shows the location of coil spring in the vehicle.

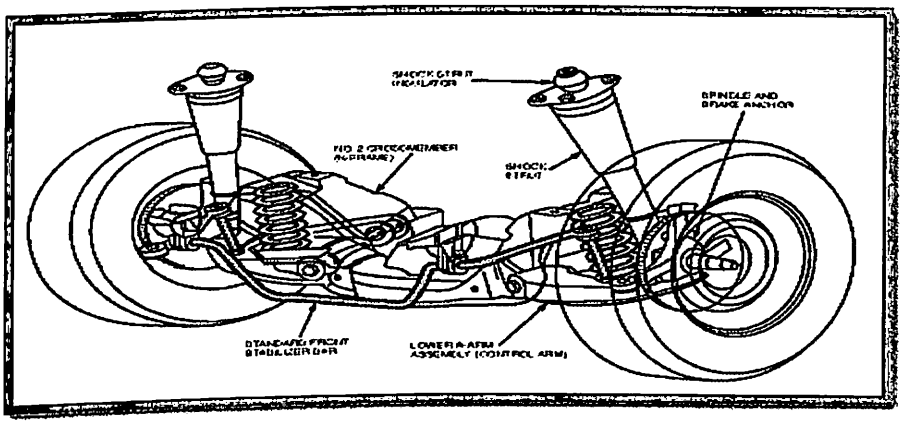
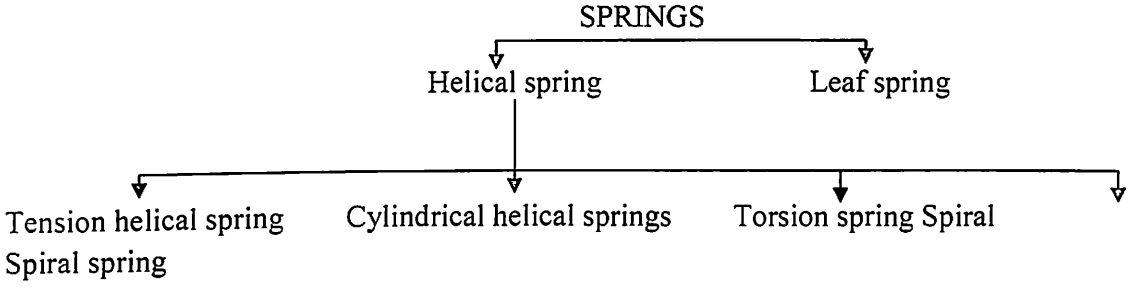


Figure 2.1: Spring Location in Vehicle

2.4 Classification of springs

There are a few types of spring based on the shape behaviour obtained by some applied force; springs are classified into the following ways:



2.4.1 Leaf spring

Leaf springs may be cantilever type or semi elliptical or elliptical. Major stresses of this spring are tensile and compressive. A leaf spring consists of flat leaves or plates or varying lengths clamped together so as to obtain greater efficiency and resilience

2.4.2 Helical Conical Spring

The major stresses produced in this spring also shear due to twisting. If the radius of the coils of a helical spring is constant, then it becomes a cylindrical helical. If a helical spring works in torsion, i.e. the torsional moment is applied about the axis of the helix, then the spring obtained is helical torsion spring. Major stresses produced in this spring are tensile and compression due to bending.

2.4.3 Spiral Spring

If the angle of helix is zero, then it is a spiral spring, consists of a flat strip wound in the form of a spiral and loaded in torsion. The major stresses produced in this are tensile and compression due to bending by load

2.4.4 Cylindrical Helical Spring

The major stresses produced in this are shear due to twisting. The load applied is parallel to the axis of spring. The cross section of the wire may be round, square or rectangular. These springs are wound in the form of a helix of a wire.

2.5 Spring Dimensions

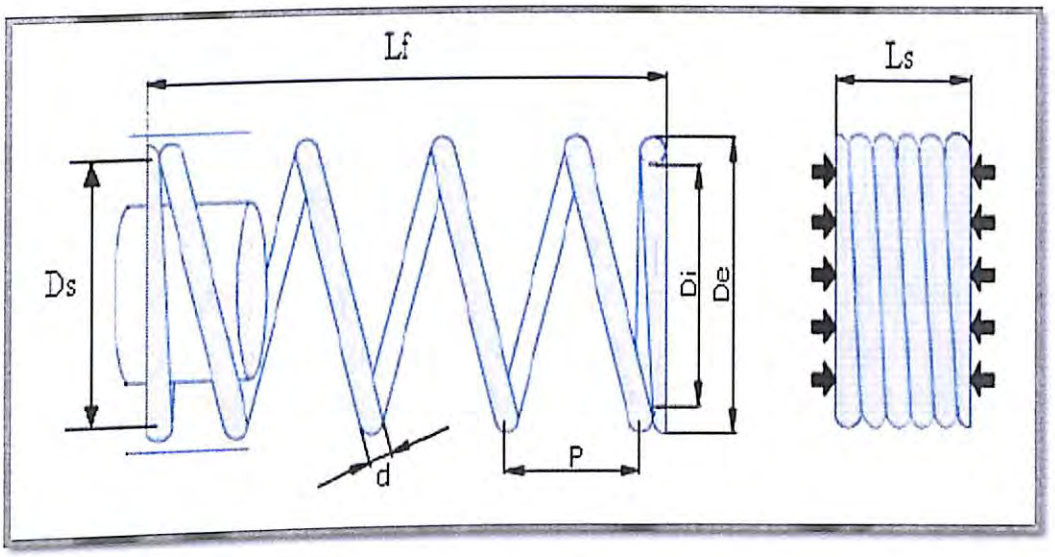


Figure 2.2: Spring Dimensions

- ***d*** = (wire diameter): This parameter describes the diameter of wire used as material for spring.
- ***Di*** = (internal diameter): Internal diameter of a spring can be calculated by subtracting the doubled wire diameter from the external diameter of a spring.
- ***De*** = (external diameter): External diameter of a spring can be calculated by adding the doubled wire diameter to the internal diameter of a spring.
- ***Ls*** = (Solid length): Maximal length of a spring after total blocking. This parameter is shown in the picture on right.