# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## Fabrication of Suspension System for The Palm Oil Plantation Agriculture Smart Mover Through Experimental and Numerical Prediction

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

by

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## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

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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 Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

……

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# ABSTRAK

Sistem suspensi merupakan sebuah sistem yang amat dikategorikan sebagai sistem yang penting pada kenderaan. Sistem suspensi juga memainkan peranan yang penting untuk memberikan keselesaan kepada pengguna kenderaan itu sendiri dan juga memberikan satu pengawalan kenderaan yang sempurna.Kajian ini dijalankan untuk memfrabikasi sistem suspensi " Agriculture Smart Mover" dan melakukan satu uji kaji pada suspensi yang telah di fabrikasi dengan menggunakan kaedah uji kaji yang amat tepat. "Agriculture Smart Mover" direka dan difabrikasi bagi membantu sektor pertanian di dalam negara kita terutama di dalam sektor Industri kelapa sawit yang kini sedang berkembang pesat. Ia juga direka dengan harga yang mampu dimiliki. Akhir sekali, setelah selesai aktiviti mereka memfrabikasi dan uji kaji ," Agriculture Smart Mover" barulah akan tersedia untuk digunakan di Industri kelapa sawit.

# ABSTRACT

The suspension system is a system that is categorized as an important system in the vehicle. The suspension system also plays an important role for the convenience of the driver and also provides a good control of vehicle. This project is focus on fabricate the suspension system "Agriculture Smart Mover" and doing an experiment on a suspension that has been fabricated using methods very accurate experiments. "Agriculture Smart Mover" is designed and fabricated to help the agricultural sector in our country, especially in the sectors of oil palm industry is now flourishing. It is also designed with an affordable price. Finally, upon completion of design, fabrication and experimentation, "Agriculture Smart Mover" will then be available for use in the oil palm industry.

# DEDICATION

I want to thank and appreciate all the support and encouragement from my parents Mohamed Aripin Bin Jalal and Hajjah Mahhiran Binti Din and as long as I complete my thesis,

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# CHAPTER 1

## 1.1 INTRODUCTION

The agricultural sector in Malaysia has given the opportunities for Malaysians to support themselves. One of developed agricultural sector is oil palm in Malaysia. Oil palm is one of the most traded agriculture commodities in the world. Global oil palm production is increasing every year, prompted largely by expanding bio fuel markets and by food demand. In Malaysia, oil palm industry has been an important agriculture sector in the economy for the past three decades. There are many steps that have been taken by the farmer and entrepreneur to ensure the best strategy plan for better oil palm production. Malaysia has a vital role to play in achieving the rising global need for oils and fats, as Malaysia is one of the major producer and exporter countries of palm oil and palm oil products.

Nowadays, demand for palm oil has increased drastically. Developments in the oil palm industry should be able to solve the problem to improve the quality and quantity to meet customer needs. Starting at the base, usually in oil palm plantations they use normal wheelbarrow to collect palm fruit which have been taken from the palm trees. This method has been practiced for a decade. This method will increase the number of employees and it will lead to increased costs. Therefore, there is a need to come out with the solution of having a smart mover palm oil fruits that will ease the transportation of the goods from plantation to pick-up truck which Agriculture Smart Mover.

## 1.2 BACKGROUND OF STUDY

The suspension system is an important part of the Agriculture Smart Mover as it will play a main role in order to reduce the impact between the Agriculture Smart Mover parts and the loads when this Agriculture Smart Mover are on off road. The purpose of this project is to fabricate suspension system typically for Agriculture Smart Mover. The implementation of this project involves both experimental and numerical prediction to determine the best suitable type of suspension that suit the Agriculture Smart Mover which is used in the palm oil plantation. The expected outcome from this project is to select and fabricate the suspension system for the vehicle. Vehicle suspension system consists of 3 elements which are wishbones, spring and the shock absorbers. These 3 elements are to filter and transmit forces exerted between the vehicle body and the road. The spring is important as it carries the body mass and isolates the vehicle form uneven road surface. Therefore, it will contribute to the machine's road holding and handling for good active safety, keeping machine occupants comfortable.

## 1.3 PROBLEM STATEMENT

Malaysia is a country that is advance in agriculture sector. The agricultural sector has given the opportunities for Malaysians to support themselves. One of developed agricultural sector is oil palm in Malaysia. Oil palm is one of the most traded agriculture commodities in the world. Global oil palm production is increasing every year, prompted largely by expanding bio fuel markets and by food demand. In Malaysia, oil palm industry has been an important agriculture sector in the economy for the past three decades. There are many steps that have been taken by the farmer and entrepreneur to ensure the best strategy plan for better oil palm production.

Nowadays, demand for palm oil has increased drastically. Developments in the oil palm industry should be able to solve the problem to improve the quality and quantity to meet customer needs. Starting at the base, usually in oil palm plantations they use normal wheelbarrow to collect palm fruit which have been taken from the palm trees.

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Rapid growing of global demand of palm oil in the past decade reflects the total cultivation of oil palm in the producing country such as Malaysia. In order to overwhelming demand. The development in oil palm industry must be able to solve the problem to increase the quantity and the quality to meet customer requirement. However, we find out the one of the problem in the oil palm production is how to gather the oil palm fruit that have been picked up from oi palm tree before it is entered to the truck. Normally, in oil palm plantation, they are using a normal wheelbarrow to gather the oil palm from one tree to another tree. This method has been used by worker for a decade. This method will increase the number of workers in order to save time during gather the oil palm fruit and it will affect the costing as they must pay the workers wage.

The existing wheelbarrow are not durable due to the maximum weight of the oil palm fruit will exert the induce force on the chassis of the wheelbarrow that will make it damage. Other than that, the uneven or bump on off-road surface will affect the durability of wheelbarrow during the worker are use the wheelbarrow to gather the oil palm fruit.

## 1.4 OBJECTIVES

The aim of this project 'Agriculture Smart Mover' are:

1)To determine which type of suspension system that are most suitable to assemble in Agriculture Smart Mover.

2)To achieve the minimum cost in fabricate the suspension system in Agriculture Smart Mover.

3)To manage numerical prediction by carry out structure analysis of selected suspension using Mat Lab.

## 1.5 WORK SCOPE

Before starting the fabrication of suspension system for Agriculture Smart Mover, it is very crucial for an Engineer to understand the characteristic of the project product. The scopes of this project are to fabricate and develop the model of Agriculture Smart Mover which is the brake system by:

1)Fabricate the designed suspension system in Agriculture Smart Mover.

2)Fabricate the designed suspension system in Agriculture Smart Mover by using the minimum cost of suitable material.

3)Testing of selected suspension system subsequently numerical analysis and using Mat Lab

# CHAPTER 2
# LITERATURE REVIEW

## 2.1 SUSPENSION SYSTEM

The suspension of vehicles needs to fulfill various necessities which rely on upon various working states of the vehicle (loaded/unloaded, acceleration/braking, level/uneven road, straight running/ cornering).

Suspension system fill a multi-function to vertical consistence so the wheels capable work on an uneven street/territory, it also isolates the body from induce forces and vibration, therefore suspension system will prevent the induces forces and vibration on the chassis

Other than that, it keeps up the wheels in the best steer and camber attitudes to the road surface. The suspension also acts to control forces produced by the tires-longitudinal (acceleration and braking) forces, lateral (cornering) forces, and braking and driving torques.

Beside the suspension system can be assume as a primary part in order to resist roll of the chassis. Keeps the tires in contact with the road with minimal load variations. The design of front and rear suspension of a vehicle may be different. (*Gillespie*, 1992)

## 2.2SUSPENSION HISTORY

The first pattern of coil spring was inspired by R. Treadwell in 1763 and the main advantages of coil at that time was they did not have to separated and lubricated periodically compared to the leaf spring. In 1906, some European car manufacture had tried coil spring for their suspension system. Gottlieb Daimler in Germany is the leading exponent, but most car maker uses a leaf springs based on low cost and this suspension system can be customized to support varying weights (Kamal and Rahman,2012). Leaf spring has been used since Roman suspended a two-wheeled vehicle called a PILENTUM. A single flat plate was installed on carriages by the French in the 8th century. The venerable leaf spring still used in rear suspension today that introduced by Obadiah Elliot of London in 1804. He attaches one steel plate on top of each other and pin together(Harris,2005). Then, suddenly, in 1934, General Motors, Chrysler Hudson introduces coil spring sprung suspension that each wheel sprung independently. At the time, most cars using hydraulic shock absorber. After World War II, all manufactures using a coil spring for the front suspension. Generally, the small light car was installed with coil spring, while heavy car equipped with a leaf spring. After that, axles with ball joints at both end was introduced to keep the wheel upright in a tank and improve the handling. The air suspension system was officially introduced in 1909 by the COWEY Motor Works in Britain and did not work well due to leakage of the suspension(Harris,2005)

Figure 2.1: Lateral Leaf Spring

## 2.3 BASIC CONSIDERATION OF SUSPENSION SYSTEM

### 2.3.1 VERTICAL LOADING

At the point when the road wheel runs across the bump or a pit on the road it is subjected to vertical forces (tensile or compressive) depending on the load irregularity which are absorbed by the elastic compression, shear, bending, twisting properties of spring. To reduce the pitching tendency of the vehicle, the front system should be less springing than the rear suspension system. (*Shijil P*.2016)

### 2.3.2 ROLLING

The centre of gravity (C.G.) of the vehicle is considerably above the ground. It will cause the centrifugal forces acts outwards on the C.G of vehicle during cornering, while the load resistance acts inwards at the wheels. This give opportunity for rolling to occur.

### 2.3.3 BRAKE DIP AND SQUAT

During brake, the nose of the vehicle dips which depends on the position of C.G. relative to the ground, wheel base and other suspension characteristics. This phenomenon is called as dip. In the same way the torque loads during acceleration will lift the front of vehicle. This effect is called as squat.

### 2.3.4 SIDE THRUST

Centrifugal force during cornering, crosswinds, cambering of the road causes side thrust.

### 2.3.5 ROAD HOLDING

The degree to which vehicle maintains the contact with the road surface in various types of directional changes as well as in straight line motion is called as road holding.

### 2.3.6 UNSPRUNG WEIGHT

Un-sprung weight is the weight of the vehicle components between suspension and road surface (Rear axle assembly, steering knuckle, front axle, wheels).

## 2.4 SPRING AND DAMPERS

Suspension system are incomplete without spring and dampers. These two parts play a main role to make the suspension of vehicle to works fine. In this topic will briefly describe about spring and dampers. Spring is used in order to absorb shocks and for providing springing action for better comfort of the passenger. A spring is an elastic object used to store mechanical energy. Springs are usually made from spring steel. When a spring is compressed or stretched, the force it exerts is proportional to its change in length. The rate or spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring. (*V.B. Bhandari, 2012*)

Without dampers in suspension system, mechanical springs would release the absorbed energy at an uncontrolled rate. In practice, the unwanted spring motion is dampened by dampers which slow down and reduce the magnitude of the vibratory motions by absorbing or dissipating the kinetic energy of the suspension movement. Rubber bushings then absorb the rest of the vibrations. The sole purpose of the damper

in any suspension system is to control the oscillations of the springs, the weight of the vehicle is supported by the spring system.

## 2.4.1 TYPE OF SPRING

### 2.4.1.1 LEAF SPRING

Leaf springs are almost used in commercial vehicles. It is also used in cars for rear suspension. The spring consist of many leaves called blades. The blades vary in length and connected together as shown in the figure.

This spring is mounted on the axle by the U bolt and the one end of spring is mounted on the frame and other is connected with a shackle which allow to change in length between eye of spring when the vehicle come across projection of road and upward movement of wheel.

When there is wide range of loading on vehicle helper spring is also provided with the leaf spring which increase the weight loading capacity of vehicle. These springs are made by the Chrome-Vanadium Steel, Silico-Manganese Steel or Carbon Steel as per requirement. These springs are noisy and does not used where luxuriousness is necessary.

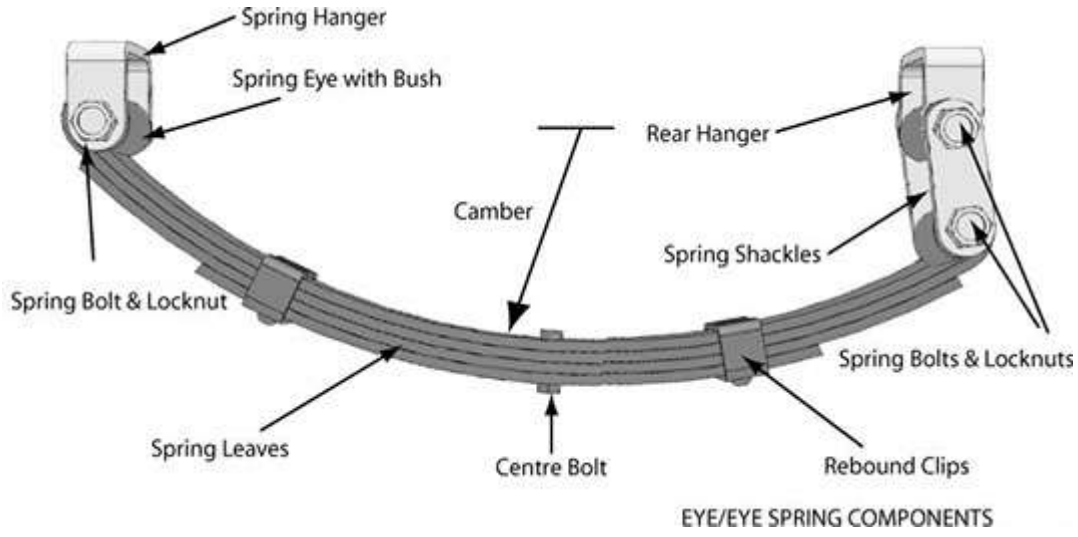


Figure 1.2: Leaf Spring

### 2.4.1.2 COIL SPRING OR HELICAL SPRING

The coil spring or helical spring have been used in our daily routine many times. It is mainly used in the independent suspension. It is also used in the conventional rigid axle suspension as they can be well accommodated in restricted spaces. The energy stored per unit volume is almost double in the case of coil spring than the leaf springs.

These springs do not have noise problems, but they do not take torque reaction and side thrust for which alternative arrangement must be provided.

Figure 2.3: Coil Spring

## 2.5 SUSPENSION TYPE AND PERFORMANCE

### 2.5.1 SUSPENSION PERFORMANCE

According to the control principle and control functions, the suspension system can be divided into passive suspension and semi-active suspension.

These suspension system is very different in the performance aspects. (*Zhou, Qi, 2013*)

#### 2.5.1.1 PASSIVE SUSPENSION

Figure shows a typical type passive suspension system. Passive suspension cannot change stiffness and damping coefficient, and it has no extra power and actuator. It comprises of springs, dampers and situated establishments. Passive suspension is the conventional mechanical structure. It has simple structure, reliable performance, cost effective and no additional energy, which is right now the most broadly utilized on the vehicles. Passive suspension cannot adjust stiffness and damping, according to the random vibration theory, it can only ensure the specific operating conditions to achieve optimal damping effect, it is difficult to adapt to different road and tough use while taking passive suspension is also difficult to acquire good ride comfort and handling stability at the same time, because these two requirements is a pair of contradiction. (*M. M. Fateh and S. S. Alavi, 2009.)*