DESIGN AND DEVELOPMENT OF A 6X6 OIL PALM FRUIT BUNCH UTILITY TRANSPORTER LIFTER SYSTEM

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DECLARATION

I declare that this project report entitled “Design And Development Of 6x6 Oil Palm Fruit Bunch Utility Transporter Lifter System” is the result of my own work except as cited in the references.

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have read this project report 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.

Signature : .....

Name : .....

Date : .....

DEDICATION

To my beloved mother and father

ABSTRACT

The purpose of this project was to design a new lifter system for a 6x6 oil palm fruit bunch utility transporter. In order to achieve this goal, theoretical and simulation analysis were conducted by using fluid power formula and FESTO FluidSim Software. The main parameter that was observed and compared included hydraulic cylinder and rod cylinder diameter, extension and retraction velocity, power consumed and efficiency of the volumetric flow pump. The two types of model were used in simulation which were single and dual hydraulic open circuit system. They were analyzed by varying the diameter of cylinder piston and rod piston cylinder diameter. It consist of 10cm, 13cm, 15cm and 17cm for rod piston diameters. Meanwhile for cylinder piston diameters were 13cm, 15cm, 17cm, and 19cm. The results obtained from theoretical calculation showed that double cylinder has higher volumetric efficiency which was 70.83% and single cylinder slightly lower for 68% efficiency. These findings verified that double cylinder of hydraulic model was the most practical in consuming less power by the motor but higher volume flow rate efficiency. Then for simulation result, it had slight difference in term of extend velocity and retract velocity values compared with theoretical result. Based on simulation, the highest extend velocity was 0.085 m/s while theoretical was 0.107 m/s with 20.56% deviation. Besides the highest retract velocity from simulation was 0.145 m/s while theoretical was 0.262 m/s with 44.66% deviation. The detail specification of the actuator, pump unit, directional valve, tilting angle, motor, and material of bucket were achieved from current product and previous researches data. All of those information were the key to complete this project. Hopefully, more research about 6x6 palm oil fruit bunch utility transporter will be conducted in a future because palm oil plays a major contribution in increasing Malaysia's economy. This approach might improve the productivity of palm oil industry due to the less manpower consumes to complete the loading and unloading the palm oil fruit bunches in a short time.

ABSTRAK

Tujuan projek adalah untuk mereka bentuk sistem pengangkat untuk sebuah 6x6 pengangkut tandan buah kelapa sawit. Demi memenuhi matlamat tersebut, analisis secara teori dan simulasi dijalankan dengan menggunakan formula kuasa bendalir dan perisian FESTO FluidSim. Parameter utama yang akan dilihat dan dibandingkan termasuk silinder hidraulik, diameter rod silinder, had laju kenaikan dan penurunan, kuasa yang diperlukan dan kecekapan kadar aliran isi padu pam. Dua jenis model yang telah digunakan dalam simulasi iaitu sistem litar terbuka silinder tunggal dan silinder berkembar. Model-model tersebut dianalisis dengan mengubah diameter omboh silinder dan omboh rod. Ia terdiri daripada 10cm, 13cm, 15cm dan 17cm untuk diameter-diameter omboh rod. Manakala untuk diameter-diameter omboh silinder pula terdiri daripada 13cm, 15cm, 17cm dan 19cm. Keputusan yang diperoleh daripada pengiraan teori menunjukkan bahawa silinder berkembar mempunyai kecekapan kadar aliran isi padu yang tinggi iaitu 70.83% manakala untuk silinder tunggal rendah sedikit iaitu 68% kecekapan. Penemuan uji kaji itu mengesahkan model silinder berkembar adalah yang paling sesuai dalam penggunaan kuasa motor yang rendah tetapi kecekapan kadar aliran isi padu pam yang tinggi. Seterusnya untuk keputusan simulasi, ia menunjukkan sedikit perbezaan dari segi nilai-nilai halaju pemanjangan dan halaju penarikan balik berbanding keputusan teori. Berdasarkan keputusan simulasi, halaju pemanjangan tertinggi ialah 0.085 m/s manakala keputusan teori ialah 0.107 m/s dengan 20.56% sisihan. Seterusnya, halaju penarikan balik tertinggi daripada keputusan simulasi ialah 0.145 m/s manakala keputusan teori ialah 0.262 m/s dengan 44.66% sisihan. Spesifikasi terperinci penggerak, unit pam, injap arah, sudut kecondongan, motor, dan bahan bekas beban diperoleh daripada produk semasa dan data kajian-kajian terdahulu. Seluruh maklumat tersebut merupakan tonggak utama dalam menyiapkan projek ini. Diharapkan semoga lebih banyak kajian tentang 6x6 pengangkut tandan buah kelapa sawit akan dijalankan pada masa akan datang kerana kelapa sawit merupakan penyumbang terbesar dalam menaikkan ekonomi Malaysia. Pendekatan sebegini meningkatkan penghasilan dalam industri kelapa sawit disebabkan oleh sedikit tenaga pekerja diperlukan untuk menyelesaikan kerja-kerja mengangkat dan memunggah dalam masa singkat.

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p - Pressure

F - Force

A_p - Area of piston cylinder

A_r - Area of piston rod

D_c - Piston Cylinder Diameter

d_r - Piston Rod Diameter

Δp - Difference in Pressure

v_{ext} - Extension Velocity

v_{ret} - Retraction Velocity

SG - Specific Gravity for Hydraulic Oil

Q_{in} - Volume Flow Rate

P_{ext} - Cylinder Power Extend

P_{ret} - Cylinder Power Retract

η_p - Pump Efficiency

CHAPTER 1

INTRODUCTION

1.1 Introduction

Palm oil fruit bunch utility transporter is a vehicle that transports bunches of palm oil in Felda operation field which consist of 6 wheels and trolley for lifting purpose. It seems that the production of this type of transportation is limited these days as there is no approach in reducing manpower requirement. It is also one of a strategic ways to improve the productivity of palm oil industry (Mohd Solah Deraman et. al.,2013). Many aspects needs to be considered so that it can meet the industrial requirement. The objectives of this vehicle development are to give realistic exposure to the students involved in the aspect of automotive engineering and general product development and to test the student's creative thinking and robustness of technical knowledge understanding. This development processes involves the application of both soft skills and classroom textbook theories in the real working experience.

1.1.1 6X6 Oil Palm Fruit Bunch Utility Transporter

To make the design development processes become more efficient, the vehicle needs to have performance requirement. In order to build new 6x6 vehicle , three component needs to be developed. They are chassis as the mainframe, suspensions to reduce vibration and lifter to operate the lifting of palm oil product. Besides the suitable construction of joint force for the chassis and hydraulic cylinder also necessary in order to ensure that it can withstand the amount of force acting on it. As the force acting on the vehicle system is the main factor in developing these three important component, the

weight of the sprung mass, trolley, passenger, engine, and payload must be considered (Amboji Sudhakar R. et. al.,2014). In addition, based on the current lifter system that already being produced, the main element that must be considered are types of material, the overall dimensions including length, width, and height, design of the bucket load, design of the joint force, design of the chassis, cost and the manufacturing method to fabricate the new lifter system.

1.2 Problem Statements

The current oil pump fruit bunch utility transporter have some disadvantages such as it does not has compact sizes and limited production in the market(Prof. Deshmukh.S.A. et. al., 2016). These major problem indirectly lead to more effort requires by human and consume lot of time to conduct the production work of transporting oil pump fruit bunch. This will cause the production work becomes inefficient.

1.3 Objectives

The objectives of the project can be referred as below:-

a) To develop 3D CAD model of 6x6 oil pump fruit bunch utility transporter lifter system by using CATIA V5 Software.
b) To analyze the performance of the propose design of 6x6 oil pump fruit bunch utility transporter lifter system by using FESTO FluidSim Software.

1.4 Scopes of Project

There are several scopes of this project which are important to accomplish the objectives. The initial work is started by developing conceptual designs of 6x6 oil pump fruit bunch utility transporter lifer system. It continues with choosing appropriate method of choosing the best conceptual design. The chosen design will be developed with details

of 3D CAD Model using CATIA V5 Software. The lifter performance of chosen design will be analyzed especially in terms of structural integrity and payload. FESTO FluidSim for hydraulic will be used to simulate and obtain the graphical result.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter describes about the researches that related with the development of lifter system for 6x6 oil palm fruit bunch utility transporter. It details out regarding the with theory and technical approaches, figures and formulas given that are appropriate to be used in the analysis.

2.2 Current 6x6 Oil Palm Fruit Bunch Utility Transporter

Malaysia is one of the biggest producer of palm oil in an international marketplace. Some developer had manufactured the 6x6 oil palm fruit bunch utility transporter but the numbers are limited to certain oil palm site or field. Figure 2.1 shows the current 6x6 Oil palm fruit bunch utility transporter.

Figure 2.1 : Current 6x6 oil palm fruit bunch utility transporter

In general, six-wheel drive has a single chassis configuration in which the three axles are located and equips with six equal sized tires. Instead of having the common front wheel steering, it is also equipped with an additional steerable rear axle which can be engaged and disengaged depending on user's need. This vehicle also comes with rocking arm and grabber for picking purpose. The arm is hinged to the chassis and allows it to swing up and down by linking to the chassis to ensure better traction on uneven ground as all four rear wheels stay in contact with the ground (Abd Rahim Shuib et. al., 2009).

2.3 Performance Requirement

Many available vehicles are constantly being modified in order to assist humans better. As an example, vehicles with the tipper allow humans in performing specific tasks. The tipper truck is an important machinery in mining, construction sector to unload the material on site with minimum help of workers. The purpose of tipper mechanism is to unload the trolley of a vehicle without or with a little assistant of a human. It provides the means for unloading the trolley with the minimum time period with no effort (Barbara Steward, 2012).

In order to develop lifter system for the 6x6 oil palm fruit bunch utility transporter, performance requirement must be determined firstly. All of these requirement are obtained by observing and comparing the specification of available tipper of a truck in the oil palm sites.

2.3.1 Load Capacity

In any lifter system, the load capacity is the main aspect that must be identified so that the lifting operation is suitable with the ability of mechanism used in lifting operation. This is the priority for the system itself so that there will be no system failure or harmful

accident is going to happen. According to Malaysia Palm Oil Berhad (MPOB), the maximum payload of this type of transport system is 700 kg of oil palm fruit bunch. This is the optimum capacity for the bucket to transport the load from one to another. Meanwhile, the load of the bucket without a palm oil fruit bunch is 1.5 tons which makes the total maximum load capacity of the tipper is 2.2 tons. In this case, it also requires safety design consideration of existing system in order to deliver an efficient output for the manpower usage (Mohd Solah Deraman et. al., 2013).

2.3.2 Tilting Angle

During unloading the load, tilting angle must be considered to prevent the trucks from tipping over. Minimum angle of 60^{o} which is set as to ensure no tipping over or collision occur. A collision will not only lead to damage property but also loss of lives and more often than not, a general disruption for the general public. If there is no consideration of minimum angle, this can cause many unnecessary accidents to occur (Barbara Steward, 2012). Figure 2.2 (Mr. Prakalp S. Moon et al., 2017) shows illustration of tipper truck.

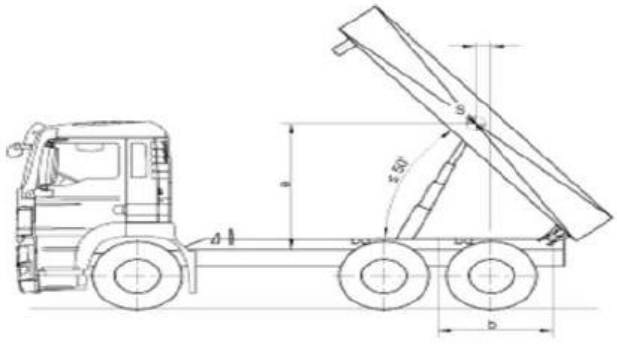

Figure 2.2 : Tipper Truck Illustration

2.3.3 Material of Trolley

The process of transporting heavy material is commonly done by using a trolley or also known as a tipper. There are various types of bodyworks used. Based on this specific case the tipper body is of the free hanging U or box-shaped type. It uses high strength steel with a modern design without any unnecessary beams and stiffeners. It is made from EN8 carbon steel(EN-8 (C-40) SAE 1040) (Mr. Prakalp S. Moon et. al., 2017). EN8 carbon steel is a common medium carbon and medium tensile steel, with improved strength over mild steel. It is constructed through-hardening of medium carbon steel. It is also readily machinable in any condition.. The basic parameters that must be defined to design bucket load specifically for this project consist of total height, total width, upper length and lower length.

Every completed design starts with the frame structure. For this bucket frame, it uses mild steel channel or mostly known as C-shaped mild steel that is produced by hot rolled processes. This type of mild steel has dimensional tolerance and grades according to ASTM A276, ASTM A479, ASME SA479, MTC EN 10204 3.1(Data Sheet Standard Channels Asia). Figure 2.3(Data Sheet Standard Channels Asia) shows cross section of mild steel channel and Table 2.1(Data Sheet Standard Channels Asia) shows general properties of mild steel channel.

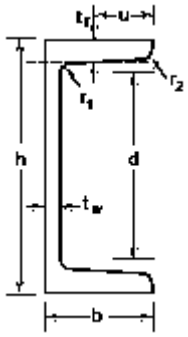

Figure 2.3 : Cross Section of Mild Steel Channel

The design for the frame structure of the bucket needs to be fitted with lower chassis by hydraulic connection. Thus, the bracket at the lower chassis is necessary to hold hydraulic base in a fix position during the operation of loading and unloading the load.

Table 2.1 : General Properties of Mild Steel

Designation		Dimensions						Dimensions for detailing	
	G kg/m	h mm	b mm	t_w mm	t_f mm	r_1 mm	r_2 mm	A mm^2 $x10^2$	d mm
C 100 x 50 x 5 x 7.5*+	9.37	100	50	5	7.5	8	4	11.71	65.3

2.3.4 Specification of Engine

Since 2004 to 2011 years, Daihatsu Motor Co., Ltd. (Daihatsu) had developed the KF engine with a 3-cylinder, 660cc engine, 63 hp, 92Nm torque and four-pole AC motors of powertrain specification. This engine has been chosen as the main power source of the vehicle specifically for this project. Besides having improved environmental performance, power, and quiet operation. It si also lighter in mass with only 47 kg weight and more compact than previous engines. Weight reduction is obtained through the use of an aluminium cylinder block and resin materials. It boosts advancements in intrinsic engine functions to ensure higher fuel efficiency, lower exhaust emissions, and a more powerful drive. Long piston stroke also able to produce higher combustion efficiency. 660cc Daihatsu Engine is shown in Figure 2.4 (Daihatsu Motor Co.,Ltd, 2005) below.

Figure 2.4 : 660cc Daihatsu Engine

Lower exhaust emissions also make Daihatsu engine to achieve world-leading environmental performance level. Transmission specification is 5-speed for manual and 6-speed for automatic which direct drive for EVT. Dimensions of this type of engine are 2 m x 1.4 m x 3.2 m that represent its height, width and length respectively with 1.82 m of wheelbase (Daihatsu Motor Co.,Ltd, 2005).

2.4 Tipper

Transportation of heavy materials such as sand, gravel, coals, and others are mostly run by tipper truck. It can be considered as advanced version of conventional trucks. In conventional truck, manpower is required to unload the material from the truck. During unloading the material, human needs to open the side walls of the trolley and use the spade (Mr. Prakalp S. Moon et. al., 2017). This process is not practical due to time-consuming and the extra cost of manpower to be paid for unloading the material.

Thus, tipper truck was invented to overcome these matters. By consisting of the hydraulic components, it enables the trolley to be lifted upward to unload the material on

the rear side. The hydraulic is connected at the backside of cabin head. This provides the power to the hydraulic components which are situated just below the top of the trolley and the chassis frame. Trolley gets lift upward at the front with the help of hydraulic components that makes the material in the truck to unload at the rear side (Mr. Prakalp S. Moon et. al., 2017). This kind of trucks is much popular in these days due to the practical way of unloading mechanism.

2.4.1 Side tipper

For the side tipper, the center of gravity is low and that makes it more stable. The side tipper can be referred as in Figure 2.5 (farmtrader.co.nz) below. In order to prevent the vehicle from tipping over, trucks which can be carry heavy loads must have low center of gravity. The reason the side tipper is frequently used for transporting materials is ability to prevent any harmful accident to human when unloading the materials (Barbara Steward, 2012).

Figure 2.5 : Side Tipper