"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Mechanical Engineering (Thermal-Fluid)"

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Date: :15 MAY 2007.

THE DEVELOPMENT OF BACKHOE ATTACHMENT UNIT RESEARCH PLATFORM

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This thesis is submitted to Mechanical Engineering Faculty in partial fulfillment of the requirements for the of Degree in Mechanical Engineering (Thermal-Fluid)

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" I hereby declare that this thesis is the result of my own opinion except the passage that I have clearly stated the source on each of them"

Signature :.....

Name : Razif Ismail

Date: :15/5/2007.....

This work is especially dedicated of my beloved mother and all of my family. Your loves and bless remains forever…

To all my comrades; Nasir, Farid, Cigu, Cheng, Backward,Dauh, Mat & Kimi, do remember our friendship. It was a happy moment to be with you guys…

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May Allah, the most Generous, bless them.

ABSTRACT

The development of backhoe attachment unit research platform is to construct a real backhoe attachment unit for Hydraulic and Pneumatic laboratory for the used of future student to study and feel the real life application on the subject. Besides it is used as a research subject for the development in the mobile hydraulic application. The design of the model is made by using SolidWorks software. The design is made after considering the entire parameters such as stresses, factor of safety and other factors which is required in constructing the model. A platform design is constructed on a solid cylindrical foundation and shall be mounted by using tie rod to strengthen the platform. The cylindrical solid base is made by using concrete with the reinforcement of the concrit which will strengthen the solid base from failure or collapse.

ABSTRAK

Pembangunan pengkalan kajian untuk lengan jengkaut adalah bertujuan untuk membangunkan satu pengkalan atau tapak untuk melakukan kajian ke atas lengan jengkaut yang mana akan digunakan sebagai salah satu peralatan tambahan dalam Makmal Hidraulik & Pneumatik untuk mendedahkan kepada para pelajar keadaan sebenar lengan jengkaut tersebut. Selain itu juga, pengkalan tersebut akan digunakan sebagai satu tempat untuk melakukan kajian dan pembangunan ke atas kenderaan hidraulik yang lain. Rekabentuk pengkalan tersebut dilukis dengan menggunakan SolidWorks. Rekabentuk pengkalan ini dibuat setelah menimbangkan segala factor yang berkaitan dengan tekanan, daya, factor keselamatan dan factor-faktor lain. Pengakalan ini akan dibangunkan diatas satu tapak yang mana ianya akan diikat dengan menggunakan rod besi pada tapak tersebut untuk mengukukan lagi kedudukan pengkalan tersebut. Manakala tapak pula dibina pada kedalaman 1500mm dari aras tanah dan 500mm dari permukaan tanah. Tapak ini dubuat dengan menggunakan konkrit yang mana didalam konkrit tersebut terdapat struktur besi pengikat untuk mengelakkan konkrit tersebut patah apabila dikenakan daya.

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LIST OF SYMBOLS

SYMBOL	DEFINITION
σ_u	Ultimate stress
σ_{all}	Allowable stress
σ	Stress
π	pi
A	Area
F.S	Factor of safety
P_{all}	Allowable force
P_{cr}	Critical force
P_u	Ultimate force
σ_m	Maximum stress
L	Length
L_e	Effective length
I	Moment of inertia
E	Modulus of elasticity

CHAPTER 1

INTRODUCTION

1.1 Introduction

The hydraulic excavator is used at a wide variety of sites. Its diversity and convenient operating nature make it popular. Among the different type of work performed by hydraulic excavators, level digging work accounts for a large percentage. When digging or finishing ground surface level using the backhoe front attachment, the boom tip height must be controlled so that the bucket tooth tip can be moved horizontally. The backhoe front attachment of a hydraulic excavator consists of three major parts which is boom, dipper stick and bucket. The operation of boom, dipper stick and bucket are carried out by the operation levers installed in operator cab. Each part in the front attachment is actuated by individual hydraulic cylinder, allowing the boom, dipper stick and bucket to make circular arcs.

The aim of this project is to construct a front backhoe attachment platform and to study the performance of front backhoe attachment unit. By constructing this platform, it will help other student or lecturer to study about other mobile hydraulic. This platform will be used as testing rigs for student.

1.2 Project Objective

The objectives of this proposed project are:

1. To design a research platform for backhoe attachment unit.
2. To develop a compact backhoe attachment unit for backhoe arm.

1.3 Project Scope

The scopes of the proposed project are:

1. To design a platform for a compact backhoe attachment unit by using SolidWorks software.
2. To do stress analysis on the platform model.
3. To refurbished the current backhoe attachment unit.
4. To study possible location for the research platform.

1.4 Expected Results

From this project, the expected results is to finish a construction of a platform for a compact backhoe attachment unit to further the study about overall performance of compact backhoe attachment unit and the use of hydraulic boom unit on mobile hydraulic application.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Mobile Hydraulics

The fluid power industry is traditionally separated between mobile hydraulics and stationary hydraulics. Because stationary hydraulics is mainly utilized in industrial applications it is also called industrial hydraulics.

The processes in the area of industrial hydraulics are typically periodic and seldom modified. The component systems are discrete since the valves usually perform one valve function only. The valves can be either types of on/off, proportional or servo valves. The primary power supplies used are in general electric motors and the number of pumps in system is not restricted. In practice the pump supply is also always sufficient considering both flow and pressure requirements of the system. The volume or weight limitations hardly ever cause difficulties.

Mobile applications are more complex. The space and weight restrictions in machines have a big influence on the fluid power system design hence big power/weight

ratio is required. The working process itself and process environment constantly changes. The operations are performed outdoors under changing environmental conditions such as ambient temperature and moisture. This sets huge demands for adaptiveness and reliability of fluid power system.

The primary power source is typically one diesel engine per machine. Pumps are placed to the engine shaft and thus the number of pumps in the system is limited. The pump system must also be able to handle the limited power and therefore prevent the excess of diesel power available.

Figure 2.1a: Mobile valve

On the component level the main difference compared to industrial hydraulics is the mobile valve. Several directional valves (1-9) are placed into one common valve block (Fig. 2.1a). The compact design is achieved and the need of hosing is decreased. The mobile valve is normally of proportional type. Servo technology is found too unreliable and vulnerable for mobile conditions. Main spools are either electrically (proportional solenoid) or hydraulically pilot operated. They can be open centre type or closed centre with load sensing ability hence the valve can be used with LS-pumps.

There are also several valve functions integrated into the single valve blocks. The most common are pressure compensation, load drop check, pump flow sharing (anti-saturation), pressure relief and anti-cavitations (Fig. 2.1b).

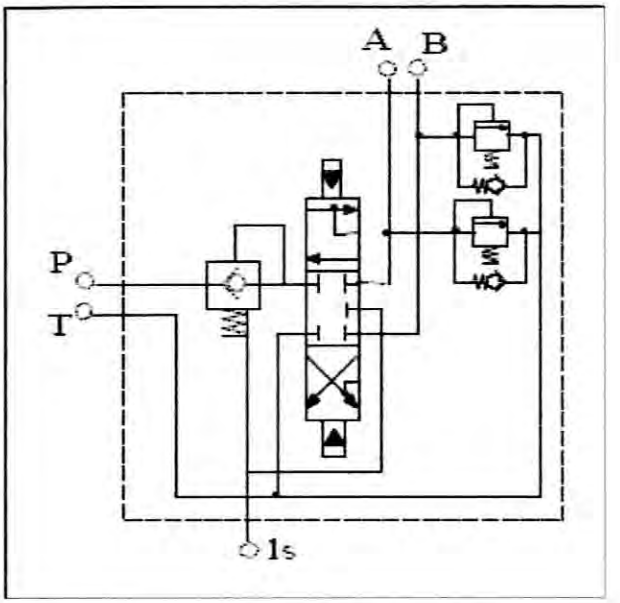

Figure 2.1b: Schematic picture of valve section equipped with main spool, pressure compensator, load drop check valve, pressure relief valves, anti-cavitation valves and LS signal output.

Mechanically mobile machines typically have 3-9 degrees of freedom when mechanism parts are considered as rigid bodies.

The purpose of use of such machines differs but the basic construction is more or less similar. The machines normally include transmission system, crane and an attachment with work hydraulics. Typical examples of mobile hydraulics are forest machines, excavators, personal lifts, drilling machines and agricultural machinery. Somehow typical work cycle for each machine can be determined although the process material and working environment might change considerably.

Figure 2.1c: Example of mobile machinery

2.2 Modeling in Mobile Hydraulics

The nature of mobile hydraulics makes the simulation approach exceptionally well justified. Considering heavy machinery production series are relatively small and unit prices are high.

Due to this physical prototypes are rarely available for machine designers and researchers. There are also a lot of variables to be measured from the prototype machine. Comprehensive study of fluid power system of a mobile machine may require 50 flow and pressure measurements. Therefore the measurement equipment with the same amount of sensors must be installed. Sensors and wiring connections also tend to be sensitive to environmental circumstances such as moisture and dirt. These reasons make field measurements difficult to arrange and very costly. It typically takes weeks to arrange conditions for field measurements to test new ideas.

It gets even more time consuming if several machine configuration, mechanic or hydraulic, are desired to be tested. Changes in mechanical structure require a lot of manufacturing and installation work and a very limited number of variations can be tested in practice. The amount of possible hydraulic configurations depends on the number of hydraulic actuators and pumps in the system. For a mobile machine typically tens or even hundreds of possible combinations can be found.

Analysis of measurement results is difficult since equal conditions for separate measurements are in practice impossible to arrange. The results are affected by the variations in work process and performance of the machine operator as well varying environmental circumstances. A simulation model offers equivalent and repetitive conditions for qualitative analysis and thus comparison between different systems. The basic construction of the mobile machines can be assumed to be quite constant over a long period of time. In this case carefully done and verified simulation model can be used as a design tool for years. All design modifications and R&D ideas can be examined by the model. Based on these facts simulation study can be very beneficial by both technical and financial means in the area of mobile hydraulics.

2.3 Technical Requirements for Simulation Approach

A simulation model of mobile machine is a complex entity including mechanism, fluid power system and control system.

- Due to the nature of mobile hydraulics, a special model library for mobile hydraulics components is unavoidable.
- hydraulic power pack
- mobile valve including integrated valve functions

Combined with mechanism models a complete machine model can be constructed. Since the complete model is relatively large, numerically efficient component models hugely increase the usability of the model. The parameter values are important considering the accuracy and reliability of the model. They can be determined by means of component measurements or using the values available in manufacturers catalogues. The load conditions must be either measured or otherwise determined based on general engineering knowledge.

2.4 Overview of a Backhoe

A backhoe, also called a rear actor, back actor or JCB, is a piece of excavating equipment consisting of a digging bucket on the end of an articulated arm (also called a stick or dipper). Modern backhoes are powered by hydraulics. They are typically mounted on the back of a tractor or front loader. Similar attachments for skid loaders are still called backhoes even though they are mounted on the front. This is because the name refers to the action of the shovel, not its location on the vehicle; a backhoe digs by drawing earth backwards, rather than lifting it with a forward motion like a bulldozer. A backhoe attached to a swiveling cab on top of tracks is called an excavator.

The British company JCB developed the early backhoes. Their first tractor equipped with both a backhoe and a front mounted loading bucket was completed in 1953 and set the standard pattern for future designs. Because of the long-time predominance of this marque in the United Kingdom and Ireland, it has become a genericized trademark there, and all backhoe-equipped diggers are commonly called JCBs, while the term "backhoe" is almost unknown to the general public. The founder of the JCB company holds the honour of being the only non-American in the US construction industry's Hall of Fame.

Figure 2.4a: A skid loader with its bucket replaced by backhoe attachment.

Figure 2.4b. A large backhoe on an excavator.

2.5 Backhoe Loader

Backhoe loader, also called a Loader backhoe, is an engineering vehicle, which consists of a tractor, front shovel/bucket and small backhoe in the rear. Due to its small size and versatility, backhoe loaders are very common in urban engineering and small construction projects.

A common European backhoe-loader,the backhoe is on the right, the bucket/blade on the left. European backhoe-loaders have a side-shift rather than stabilizer legs. Invented in Burlington, Iowa in 1957 the Backhoe loader is probably the most common variation of the classic farm tractor. As the name implies, it has a loader assembly on the front and a backhoe on the back. When both the loader and the backhoe are permanently attached it is almost never called a tractor, not generally used for towing and usually does not have a PTO. When the backhoe is permanently attached, the machine usually has a seat that can swivel to the rear to face the hoe controls.

Removable backhoe attachments almost always have a separate seat on the attachment itself.

Backhoe-loaders are very common and can be used for a wide variety of tasks: construction, small demolitions, light transportation of building materials, powering building equipment and digging holes/excavating, breaking asphalt, and paving roads. The backhoe bucket can often be replaced with other tools such as a breaker for smashing concrete and rock. Some loader buckets have a retractable bottom, enabling it to empty its load more quickly and efficiently. Retractable-bottom loader buckets are also often used for grading and scratching off sand. The front assembly may be a removable attachment or permanently mounted. Often the bucket can be replaced with other devices or tools. The backhoe loader must be equipped with a tool coupler in order to mount different attachments to the loader. A tool coupler consists of two hydraulic cylinders on the end of the loader arm assembly which can expand and retract allowing different tools to be attached to the unit.

Their relatively small frame and precise control make backhoe-loaders very useful and common in urban engineering projects such as construction and repairs in areas too small for larger equipment. Their versatility and compact size makes them one of the most popular urban construction vehicles