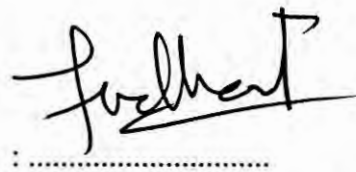


SUPERVISOR DECLARATION

'I admit that had read this thesis and in my opinion this thesis was satisfied from the aspect of scope and quality for the purpose to be awarded Bachelor of Mechanical Engineering (Automotive)'

Signature



:

Name of Supervisor

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Date

: 22 April 2011

DESIGN AND ANALYSIS OF A LIGHTWEIGHT
CLUTCH DISC FOR A MINI FARMING TRACTOR

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This report is submitted in accordance with requirement for the
Bachelor of Mechanical Engineering (Automotive)

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APRIL 2011

DECLARATION

“I verify that this report is my own work except for the citation and quotation that the source has been clarified for each one of them”

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Date : 22 APRIL 2011

To my father, Ibrahim bin Mahmood, my mother, Siti Mariam binti Hamid, my siblings, my friends and my supervisor, Encik Fudhail bin Abdul Munir, for supporting me throughout this project and for their understanding in the way I am.

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ABSTRACT

The name of clutch has become established due to its meaning of grasp or grip tight. The clutch has the function to enable one rotary drive shaft to be coupled to another shaft, either when the both shaft are stationary or when there is relative motion between them. In this project, the dry clutch disc for a mini farming tractor is designed with the aid of Computer Aided Engineering (CAE) software. The clutch disc available in the market is made as the benchmark for the designed clutch disc. The parameters that are also considered in this project include part cracked or fatigue failure due to resonant frequency harmonies with part of rotaring or reciprocating mass of the drive train at a certain speed or RPM and wear due to material or metallurgical properties. This is conducted by using Finite Element Software that available in the institution. The objective of this research is to produce a newly improved designed clutch disc that has the feasible engineering characteristics.

ABSTRAK

Nama klac telah diasaskan daripada maksudnya yang bermaksud gengaman atau cengkaman yang erat. Fungsi klac ialah mengaktifkan putaran aci pemancu dan akan bergabung ke aci yang lain, samada dalam keadaan diam atau gerakan relatif antaranya. Dalam projek ini, plat klac kering untuk traktor mini pertanian direka dengan menggunakan perisian “Computer Aided Engineering (CAE)”. Klac cakera yang terdapat di pasaran telah digunakan sebagai panduan merekabentuk klac cakera yang baru. Parameter yang dipertimbangkan dalam projek ini termasuk keretakan atau kegagalan yang berpunca daripada kelesuan kerana resonan frekuensi harmoni dengan sebahagian daripada putaran atau jisim pusingan pemanduan kereta pada kelajuan tertentu atau RPM berdasarkan bahan-bahan atau sifat metalurginya. Ini dilakukan dengan menggunakan perisian “Finite Element” yang terdapat di institusi ini. Tujuan dari penelitian ini adalah untuk menghasilkan klac cakera baru yang lebih baik dan mempunyai layak untuk ciri-ciri kejuruteraan.

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LIST OF SYMBOL

T	=	torque transmitted, Nm
P_{max}	=	maximum pressure applied onto the clutch, Pa
f	=	coefficient of friction (depends on material used)
r_o	=	outer radius, m
r_i	=	inner radius, m
N	=	number of friction surface
D_i	=	inner diameter of the clutch, m
D_o	=	outer diameter of the clutch, m
F_a	=	axial force, N
P	=	circumferential force, N
i	=	number of splines
h'	=	height, mm
l	=	length of the hub, mm
p	=	bearing pressure
f'	=	effective bearing surface of splines
M_t	=	total torque transmits
D	=	outer diameter of the splines.
σ	=	stress (Yield Strength)
E	=	modulus of elasticity (Young's Modulus)

ϵ	=	strain
d	=	change in length (deformation)
L	=	original length (thickness of clutch disc)

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

A clutch is a mechanical device, by convention understood to be rotating, which provides driving force to another mechanism when required, typically by connecting the driven mechanism to the driving mechanism. The name of clutch has become established due to its meaning of grasp or grip tight (Heinz Heisler, 1999).

Clutches are useful in devices that have two rotating shafts. In these devices, one shaft is typically attached to a motor or other power unit (the driving member), and the other shaft (the driven member) provides output power for work to be done. The clutch connects the two shafts so that they can either be locked together and spin at the same speed (engaged), or be decoupled and spin at different speeds (disengaged).

Dry clutch are widely used on large trucks and heavy industrial units. The main advantages of dry clutch is its large contact area and the main components of a dry disc clutch are pressure plate and the disc.

1.2 OBJECTIVE

The objectives of this project are:

1. To design a lightweight dry clutch disc for a mini farming tractor by using CAD software (CATIA).
2. To do finite element analysis of the design by using FEA software (ANSYS).

1.3 SCOPES

The scopes of study for this project are:

1. Design the lightweight clutch disc for a mini farming tractor.
2. Analysis (static and linear) on the designed clutch disc.
3. Produce engineering drawing of the clutch disc.

1.4 PROBLEM STATEMENT

This project will enable me to understand more about the clutch disc of a vehicle especially tractors because the tractors is used in agricultural to pull equipments like plows, cultivators, and mowers. Apart from that, it is also used to move stationary devices like saws and winches. Since agriculture is the third largest economy in Malaysia, tractors have been used extensively like in paddy field, and palm oil estates to work like plugging, seeding and harvesting.

A lightweight disc clutch is an essential part for a mini farming tractor. The lighter the overall weight, the higher the fuel efficiency will be. Apart from that, the light clutch enables the manoeuvre without the feel of high contact pressure, it is driver friendly. There are not many references that can be obtained pertaining to methods need to be employed in order to design a proper tractor clutch disc. The resources are very limited. Therefore, we need to do a reverse engineering for a design, this method are mostly base on a real model of clutch disc that available in market. Therefore, by embarking into this project, the methods to design a clutch disc can be acquired.

By reducing weight are able to reduce fuel consumption and enhance the performance that can be obtained and knowing how to design clutch disc, we are able to manipulate the parameters involves to improve the design feabilities.

CHAPTER 2

LITERATURE REVIEW

2.1 HISTORY OF TRACTOR

The first engine-powered farm tractors used steam and were introduced in 1868. These engine were built as small road locomotives, and were operated by one man, if the weighed less than five tons. They were used for general road transport and in particular by the timber trade. The most popular steam tractor was the Garrett 4CD.

The Charter Gasoline Engine Company of Sterling, Illinois, is the first company that succesfully using gasoline fuel. Charter's creation of the gasoline fueled engine in 1887 soon led to early gasoline engines before the term "tractor" was used by others. Charter adapted its engine to a Rumley steam-traction-engine chassis, and in 1889 produced six of the machine to become one of the first working gasoline traction engines (Ralph, 1999).

There are several other early gas-powered tractors. John Froelich, a custom thresher man from Iowa, decided to try gasoline power for threshing. He mounted a Van Duzen gasoline engine on a Robinson chassis and rigged his own gearing for propulsion. Froelich used the machine successfully to power a threshing machine by belt during his 52 days harvest season of 1892 in South Dakota. The Froelich tractor, forerunner of the later Waterloo Boy tractor, is considered by many to be the first successful gasoline tractor known. Froelich's machine fathered a long line of stationary gasoline engines and, eventually, the famous John Deere two cylinder tractors.

Henry Ford produced his first experimental gasoline tractor in 1907, under the direction of chief engineer Joseph Galamb. It was referred to as an "automobile plow". After 1910, gasoline powered tractors were used extensively in farming (Dean Stanley, 2001).

2.1.1 General Idea on Farming Tractor

A tractor is a device intended for drawing, towing or pulling something which cannot propel itself and, often, powering it too. The word is commonly used to describe a vehicle intended for such a task on some other vehicle. Generally, tractor is used as a replacement for animal in farming industry. The classic farm tractor is a simple open vehicle with two very large driving wheels on an axle below and slightly behind a single seat and the engines in front of the driver with two steerable wheels below the engine compartment. This basic design has remain unchanged for a number of years, but now enclosed cabs are available for many models of farm tractor. Modern farm tractors range in size from 18 to 500 horsepower (15 to 400 kW). Tractors can be generally classified as two wheel drive, two wheel drive with front wheel assist, or four wheel drive (with articulated steering). In western region, most farmers change from horse to tractor by the end of the World War II.

Modern farm tractors are classed in three groups: general-purpose (land utility) tractors, universal-row-crop (row-crop utility) tractors, and special purpose tractors. *Land utility tractors* are used for major farm operations common to the cultivation of most crops, such as tillage, discing, general cultivation, harrowing, sowing and harvesting. The tractors are also characterized by a low ground clearance, increased engine power and good traction. *Universal-row-crop tractors* are intended for row-crop work, as well as for many other fields task. Some row-crop utility tractors are provided with replaceable driving wheels of different tread widths-wide for general farm and narrow for row-crop work. In order not to damage plants, the tractors have a high ground clearance a wide wheel track that can be adjusted to suit the particular inter-row distance. *Special-purpose tractors* are modification of standard land or row-crop utility tractor models and are used for definite jobs, for example in cotton fields or for various jobs under certain condition, for example on marshy soils or hillsides.



Figure 2.1: Types of Tractors
(Source: www.google.com)

2.1.2 Importance of Farm Tractor

The farm tractor is used for pulling agricultural machinery or trailers, for ploughing, harrowing and similar tasks. Farmers found that tractor can save time and can be used for a combination of operation rather than a single task in a complex chain of process. In Malaysia, tractor mostly used in paddy and palm oil farm to do works like plugging, seeding and harvesting. However, the used of tractor are widening to land clearing, slashing grass and collecting grass clippings, leave and twig. Farming tractor generally used diesel engine to propel the wheels. The main reason is although the initial cost of diesel engine is higher, but it is often offset by the amount of fuel cost that can be saved. In short, usage of diesel tractors is more cost effective than gasoline engine tractor. This is due to the higher efficiency of diesel engine which results in lowering fuel consumption. Moreover, diesel engine always operates at lean fuel mixture. It also have better in term of torque capacity which is good for rough work and uneven terrain.

2.2 TYPE OF CLUTCHS

The name of clutch has become established due to its meaning of grasp or grip tight. The clutch has the function to enable one rotary drive shaft to be coupled to another shaft, either when the both shaft are stationary or when there is relative motion between them (Heinz Heisler, 1999). The need for the clutch stems mainly from the characteristics of the turning effort developed by the engine over its lower speed range. When idling, the engine develops insufficient torque for the transmission to be positively engaged. The engine speed has to be increased before complete coupling without slip may be made. Basically, in agricultural machinery, there are three main clutches that normally used. These clutches are disc clutch, cone clutch, and overrunning clutch (Donald et al. 1974). All these types of clutches come under axial friction clutches (Sandhu, 2001).