

CUTTING TOOL JIG DESIGN FOR BRAKE DISC SKIMMING MACHINE

HALIDA HANIM BINTI HAFIZ AFANDI

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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HALIDA HANIM BINTI HAFIZ AFANDI

**This report is submitted
in fulfillment of the requirement for the degree of
Bachelor of Mechanical Engineering (Design and Innovation)**

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DECLARATION

I declare that this project report entitled “Cutting Tool Jig Design For Brake Disc Skimming Machine” 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 (Design & Innovation).

Signature :
Name of Supervisor :
Date :

DEDICATION

To my beloved mother and father

ABSTRACT

There are many brake disc problems such as corrosion, warp, grooves and rust. Due to the problems some brake disc need to be change and some just need to be skimmed. A brake disc need to be skim when groove marks form at the surface of brake disc. Groove marks are marks that formed at the surface of the brake disc due to the effect of friction force such as rivet is in contact to the discs surface. In order to obtain a smooth performance on the skimming machine, an adjustable cutting tool jig is design. The study is to design an adjustable cutting tool jig for skimming machine so that it will be easier for the user to use. To design the jig, design method is used which includes the House of Quality, Product Design Specifications, and morphological chart. The House of Quality will be done based on customer requirements or voice of customers and the Product Design Specification will be done based on the datum of the product. Morphological chart will be used to generate a few ideas of the jig design. Based on the design method, three best design will be chosen by using weight selection. Before the three best design is to be inserted in SolidWorks for analysis, calculation to determine the cutting force applied will be done theoretically based on the formula obtain from trusted source. After the analysis is done, a few criteria will be considered and go through to select one design as a final design for the cutting tool jig of the skimming machine.

ABSTRAK

Terdapat banyak masalah brek cakera seperti kakisan, meleding, alur dan karat. Disebabkan oleh beberapa masalah, brek cakera perlu dikikis apabila terbentuknya alur pada permukaan brek cakera. Alur tersebut terhasil pada permukaan brek cakera akibat kesan geseran antara rivet dan permukaan brek cakera. Bagi mendapatkan prestasi yang lancar pada mesin kikis, jig alat pemotong boleh laras dihasilkan. Kajian bertujuan untuk menghasilkan jig alat pemotong boleh laras bagi memudahkan pengguna menggunakan. Kaedah kajian reka bentuk yang digunakan merangkumi Rumah Kualiti, Reka Bentuk Spesifikasi Produk dan carta morfologi. Rumah kualiti akan dihasilkan berdasarkan permintaan pelanggan atau suara pelanggan dan reka bentuk spesifikasi produk akan dibuat berdasarkan datum kepada produk tersebut. Carta morfologi akan digunakan untuk menghasilkan idea reka bentuk jig tersebut. Berdasarkan teknik reka bentuk, tiga reka bentuk terbaik akan dipilih menggunakan teknik pemilihan berat. Sebelum tiga reka bentuk terbaik dimasukkan di dalam SolidWorks bagi melakukan analisis, beberapa pengiraan akan dilakukan bagi mengenal pasti tekanan potongan yang dihasilkan secara teori berdasarkan rumus yang di dapati melalui hasil yang boleh dipercayai. Selepas analisis dilakukan, beberapa kriteria akan dipertimbangkan bagi memilih hanya satu reka bentuk terakhir bagi jig pemotong mesin pengkikis.

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TABLE OF CONTENTS

CHAPTER	CONTENT	PAGE
	SUPERVISOR'S DECLARATION	ii
	APPROVAL.....	iii
	DEDICATION	iv
	ABSTRACT	vi
	ACKNOWLEDGEMENT.....	vii
	TABLE OF CONTENTS	viii
	LIST OF TABLES	xi
	LIST OF FIGURES	xii
	LIST OF SYMBOLS	xiv
	LIST OF ABBREVIATION	xv
	LIST OF APPENDICES	xvi
CHAPTER 1	INTRODUCTION	1
	1.1 Background	1
	1.2 Problem Statement	2
	1.3 Objective	2
	1.4 Scope of project	2
CHAPTER 2	LITERATURE REVIEW	4
	2.1 Brake Disc	4
	2.1.1 Brake Disc Problem	4
	2.1.1.1 Warp	5
	2.1.1.2 Noise	5
	2.1.1.3 Wear	5
	2.1.1.4 Groove	6
	2.1.1.5 Corrosion	6
	2.2 Brake Lathe (Skimming Machine)	6
	2.3 Jig	6
	2.3.1 Material	7
	2.3.1.1 Gray Cast Iron	7

2.3.1.2	Cast Carbon Steel	7
2.3.2	Twin Cutter	7
2.4	Design Method	8
2.4.1	Product Design Specifications	8
2.4.2	House of Quality (HOQ)	8
2.4.3	Morphological Chart	9
2.4.4	Weighted Decision Matrix	10
2.5	Calculation	10
2.5.1	Cutting Force	10
2.5.2	Factor of Safety	14
2.6	Software	15
2.6.1	Computer Aided Three Interactive Application (CATIA) V5R20	15
2.6.2	SolidWorks 2016	15
CHAPTER 3	METHODOLOGY	15
3.1	Product Design Specifications (PDS)	16
3.2	House of Quality (HOQ)	19
3.3	Morphological Chart	21
3.4	Conceptual Design	22
3.4.1	Conceptual Design Table	23
3.4.2	Concept Description	24
3.4.2.1	Datum	24
3.4.2.2	Concept 1	25
3.4.2.3	Concept 2	26
3.4.2.3	Concept 3	27
3.4.2.4	Concept 4	28
3.4.2.5	Concept 5	29
3.4.2.6	Concept 6	30
3.4.2.7	Concept 7	31
3.4.2.8	Concept 8	32

3.5	Weight Decision Matrix	33
3.6	Calculations	35
CHAPTER 4	RESULT AND DISCUSSION	37
4.1	Detail Drawing	37
4.2	Analysis of Conceptual Design	38
4.2.1	Finite Element Analysis	38
4.3	Safety Factor	41
4.4	Design Optimization	43
CHAPTER 5	CONCLUSION AND RECOMMENDATIONS	45
5.1	Conclusion	45
5.2	Recommendations	46
	REFERENCES	47
	APPENDICES	51

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	Morphological Chart	9
2.2	Evaluation scheme for design alternatives or objectives	10
2.3	Average Values of Energy per Unit Material Removal Rate	13
2.4	Speed and Reference table	14
2.5	Factor of Safety table based on application	14
3.1	Components of the twin cutter	17
3.2	Table of specifications for the datum	18
3.3	House of Quality	20
3.4	Morphological chart	21
3.5	Conceptual design table	23
3.6	Weight decision matrix for cutting tool jig	34
4.1	Factor of safety for each design	42
4.2	Weight decision matrix table for design 7 and 8	42
4.3	Difference in thickness and size for both original and modified design	43

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Flowchart	3
2.1	House of Quality	8
3.1	Shark A6950 Ammco Style Twin Cutter	14
3.2	Exploded drawing of A6950 Ammco Style Twin Cutter	17
3.3	Datum	24
3.4	Concept 1	25
3.5	Concept 2	26
3.6	Concept 3	27
3.7	Concept 4	28
3.8	Concept 5	29
3.9	Concept 6	30
3.10	Concept 7	31
3.11	Concept 8	32
3.12	Objective tree for the design of cutting tool jig for Skimming machine	33
4.1	Detail drawing for design 3	37
4.2	Detail drawing for design 7	37
4.3	Detail drawing for design 8	38
4.4	Maximum Von Mises Stress on Datum	39
4.5	Maximum Von Mises Stress on Design 3	40
4.6	Maximum Von Mises Stress on Design 7	40
4.7	Maximum Von Mises Stress on Design 8	41
4.8	Dimension for original design of design 7	43

4.9	Dimension for modified design of design 7	44
4.10	Maximum Von Mises stress for modified design 7	44

LIST OF SYMBOLS

F	-	Force
P	-	Power
V	-	Velocity or cutting speed
F_c	-	Cutting force
V	-	Cutting speed
Q	-	Material removal rate
W	-	Specific power required to cut a material
HP_c	-	Cutting horsepower
HP_μ	-	Unit horsepower, specific power required to cut a material
D	-	Diameter

LIST OF ABBREVIATION

CATIA	Computer Aided Three Interactive Application
US	United States
FEA	Finite Element Analysis
PDS	Product Design Specifications
HOQ	House of Quality

LIST OF APPENDICES

APPENDICES	TITLE
A	Fully assembled skimming machine
B1	Detail drawing of assembly skimming machine
B2	Detail drawing of design 3
B3	Detail drawing of design 7
B4	Detail drawing of design 8
B5	Detail drawing of datum
B6	Detail drawing of jig body for datum
B7	Detail drawing of cutting tool for datum
B8	Detail drawing of holder for datum
B9	Detail drawing of knob for datum
B10	Detail drawing of screw lock for datum
C	Gantt Chart

CHAPTER 1

INTRODUCTION

1.1 Background

Brake is a mechanical device that halts vehicles while brake disc is a disc that slows down the wheel of the vehicle by friction. In a brake system the friction force is the main excitation mechanism. Hydraulic concept is also applied to the brake system as it gives an equal braking force to all four wheels and lower wear rate.

Brake disc should be skim when it is corrode or when there is groove mark form at the surface of the disc brake. Groove mark formed due to the friction of rivet to the brake disc surface making the surface of the brake disc not smooth. Besides that, the brake disc also need to be resurfaced when there is judder or even vibration on the brake. As for the possible consequences, the brake disc might facing a low efficiency on the braking power an able to produce unpleasant noise while breaking. When brake disc facing problems such as corrosion and groove marks formation, skimming process should be done by using skimming machine.

The skimming machine normally use to remove a thin layer of the disc to eliminate minor damage occur on the brake disc surface. Machining the disc as needed will maximize the mileage out of the current disc on the vehicle (Swapnil R. Abhang, 2014). Skimming brake disc able to improve both disc and pad life and the brake efficiency.

In this project, the main focus is on the design of a cutting tool jig for the skimming machine. Engineering methods such as House of Quality and Morphological chart will be applied in the design process.

1.2 Problem Statement

Grooves are deep cuts at the brake disc surface where it follows the disc's curve rotation. It can be happen to one or both side of the brake disc. When brake pads are worn to the rivet, the rivet will be in contact with the brake disc and form groove marks. In order to solve the problem, skimming the surface of the brake discs by using skimming machine is required. Thus, this project will be focus on the design of cutting tool jig for the brake disc skimming machine in order to get a smooth surface of brake discs.

1.3 Objective

The objectives of this projects are :

- 1.3.1 To design a cutting tool jig for skimming machine that is easier for the user to use.
- 1.3.2 To produce an adjustable cutting tool jig.
- 1.3.3 To do analysis using SolidWorks 2016.

1.4 Scope of Project

The scopes of this project are as follows.

- 1.4.1 Focus on design study for the jig by applying engineering design method which are Product Design Specification, House of Quality, Morphological Chart and Weigh Decision Matrix.
- 1.4.2 Performing detail drawing of the product from the design selection method applied by using CATIA (V5R20).
- 1.4.3 Analysis of the cutting tool jig design by using Static Analysis in SolidWorks 2016.
- 1.4.4 Optimization of the selected final cutting tool jig design.

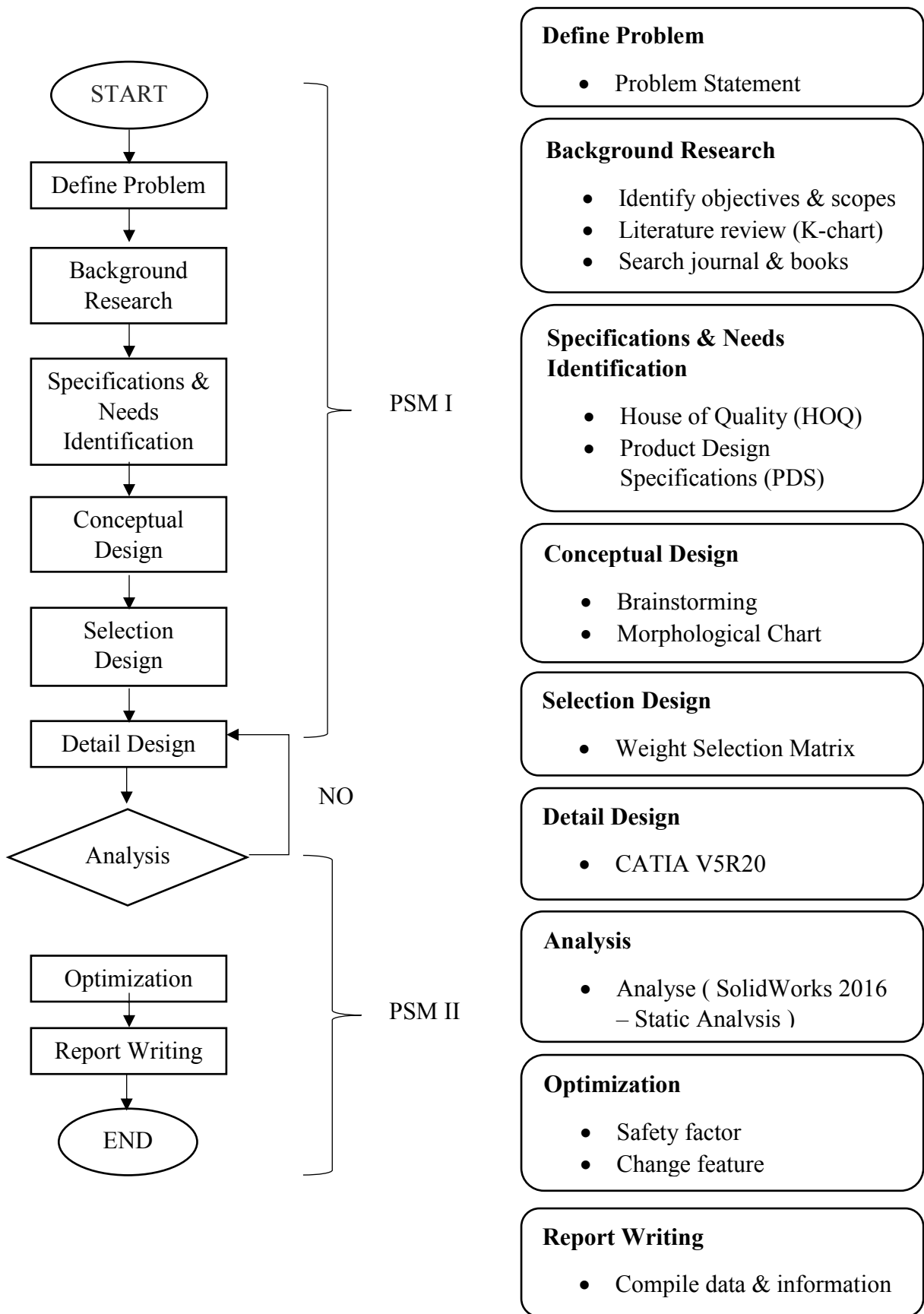


Figure 1.1 : Flowchart

CHAPTER 2

LITERATURE REVIEW

2.1 Brake Disc

Brake discs are brakes that uses force to stop vehicles. Friction force is applied to brake pads of both sides of the brake discs. The discs are normally turns with the wheel of the vehicle and it is overlap with the caliper. Once the brake pedal is pressed, the hydraulic fluid will automatically push the pistons and brake pads to the discs surface. This action will produce friction and tend to halt or slow down the vehicle. The function of the brake pads are to grip the disc until the vehicle slow down or stop (Knight, 2016).

A disc brake consists of rotor, caliper, brake pads and other hardware such as bolts, springs and also clips. Brake disc or brake rotor are normally made up of cast iron where it applies friction to stop or slow the vehicle. Brake rotor can be either solid type where the ventilated rib disc allows air to circulate inside the disc to cool. Brake caliper is a nonrotating part in braking system that is attached to the spindle where it supports the rotor. It comprises of piston, dust boot, caliper housing, piston seal, brake pads and bleeder screw. As for brake pads are thin blocks that clamp the brake rotors to halt or slow down the vehicle. It consists of riveted brake lining that is made of semi metallic friction material or asbestos (Integrated Publishing, n.d.).

2.1.1 Brake Disc Problem

Brake disc normally facing with noise and vibrations. Noise can be categories into two which are low frequency vibration (100-1000 Hz) and medium and high frequency vibration (1000-18000 Hz). Low frequency vibration are due to dimensional variations in brake components and rigid body oscillation of caliper and its mount where it can cause brake roughness, judder and groan. Meanwhile, medium and high frequency vibration is due to the variation in thickness of the rotor which result in squeal or squeak. Besides that, brake disc also face problems such as warp, groove, worn, channels and scratch (United States Patent Patent No. US 7,334,510 B2, 2008).

2.1.1.1 Warp

Brake discs can be warped when there is a vibration or perhaps judder when braking. The uneven thickness of the brake discs also shows that it is warped (Grant, 2016). Due to Carroll Smith in the article of “The Warped Brake Disc and Other Myths of the Braking System” states that the warped brake discs is mostly friction pad material that is transferred unevenly to the brake discs surface. (Smith, n.d.).

2.1.1.2 Noise

The brake system need to fulfil the customer requirements in term of its noise, durability and performance. Brake disc noise has been a concern especially to the manufacturers of the brake disc systems and the friction materials. Squeal is one of the noise produced by brake disc where it is caused by an increase of coefficient of friction due to the speed decreasing when braking. Besides that, squeal is also caused by the system instability of the structural components of the brake system itself (S. K. Rhee, 1989). The noise produced by brake disc can be categorised into three which are low frequency noise, low frequency squeal and high frequency squeal. The low frequency noise is less than 1000 Hz, low frequency squeal is from 1000 Hz to 5000 Hz while a high frequency squeal is more than 5000 Hz (P., R., & P., 2014).

2.1.1.3 Wear

Wear can cause brake disc to become thinner. Due to that, the manufacturers set a minimum thickness for the brake disc. Therefore, when the thickness reach this limit, the brake disc need to be change and normally brake disc need to be replaced in pairs (Brake Problems : Wear, corrosion, distortion and other common causes of failure, 2011).

2.1.1.4 Groove

The disc will undergoes wear normally in a form of grooves where brake pads or rivet in contact against it (Ofria, 2016). Groove marks or scoring are deep cuts on the rotor surface where it follows the curve rotation of the rotor. This is due to the worn brake pads exposing the rivet. When the rivet meets the brake disc groove marks will produce either on one side or both side of the brake disc surface. Therefore, skimming process by using brake lathe is required to obtain a smooth surface of brake disc (Disc Brake Service).

2.1.1.5 Corrosion

Brake discs are made up of cast iron where it a material that can corrode easily. Light corrosion can be remove by heavy breaking but braking is lower on light vehicle and may not be enough to remove the corrosion from the brake disc surface (Brake Problems : Wear, corrosion, distortion and other common causes of failure, 2011).

2.2 Brake Lathe (Skimming Machine)

There are two types of brake lathe which are the normal brake lathe and on-car brake lathe. The normal brake lathe is the brake lathe that need the brake disc to be taken to the lathe machine and do the skimming process. Meanwhile, the on-car brake lathe is the machine itself is place to the vehicle to do the skimming machine. It means the skimming process is done without taking out the brake disc from the vehicle (Brake Lathes, 2016).

2.3 Jig

It is easy to use in locating and supporting the components (Abouhenidi, 2014). Jig does not only facilitate the productivity of the machine but also reduce cost and time. It is easy to assemble and saves labour cost. (Introduction to Jigs and Fixtures).

2.3.1 Material

Selection of materials are important to resist tear and wear. Materials such as phosphor bronze and other non-ferrous metals including composites and nylons helps in preventing damage to manufacturing part used and reduce wear for certain parts (Okpala & C., The Design and Need for Jigs and Fixtures in Manufacturing, 2015).

2.3.1.1 Gray Cast Iron

Cast irons has been used widely including economical manufacturing processes and it is excellent in friction and wear characteristics (J.O.Agunsoye, 2014). Majority of industrial automobiles companies manufactured brake disc parts out off gray cast iron. The material is different from the standard steels with more carbon (C) and silicon (Si) (A, 2010). Gray cast iron has a good performance of machining qualities making easily disposed of chips and yielding surface with good wear characteristics (Krause, 1969).

2.3.1.2 Cast Carbon Steel

Most of the steel products starts with castings where it is made from melted iron in electric furnace and recycled steel. Steel is cast into various of sizes and shapes forming from machining, forging or rolling. Besides that, it can be also cast to produce complex components designed from custom moulds (David , Monroe, & Thomas, 2015).

2.3.2 Twin Cutter

The function of this device is to resurface both sides of the brake disc simultaneously. An accurate measurement in both millimetre micrometres and inch set the depth of the cut for inner and out of the rotor surfaces. The twin cutter increases the brake disc face size that can be cut up to 3 to 0.75 inch. A high quality twin cuter can handle a larger diameter of the brake disc (AMMC0, 2008).