

DESIGNING AND EVALUATING OF JIG FOR HOLDING CYLINDRICAL PARTS
FOR MASS PRODUCTION FOR DRILLING OPERATION

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for the award of the degree of
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SUPERVISOR'S DECLARATION

“I hereby declare that I have read this project report and in my opinion this project report is sufficient terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.”

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STUDENT'S DECLARATION

"I Fazlina Binti Mansor declare that this report entitled "Designing and Evaluating of Jig for Holding Cylindrical Parts for Mass Production for Drilling Operation" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree."

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DEDICATION

Special Dedication to my beloved parents and my family members, for their love and encouragement.

And,

Special Thanks to my supervisor, Mr. Hadi Bin Abdul Salaam, my fellow course mate and all my faculty members.

For all of your care, support and best wishes.

*Sincerely,
Fazlina Binti Mansor*

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ABSTRACT

The project study is about a designing and evaluating of jig for holding cylindrical parts for mass production of drilling operation. Three design were draw and compared in terms of material and also the strength of the jigs to select the best design. This report begin with an introduction of jigs which is definition and important component in jigs and advantages of the jigs. Drilling jig is used whenever it is necessary to drill hole to exact location. The objective of this study is to design and analyze the drilling jig which can hold 30 work-piece of small cylindrical parts. Design were evaluate in terms of force applied to the jig. Three new jig were designed using SolidWorks software. The design were analyze using FEA tools which is Algor software. Pugh Concept Selection also applied in selection the best design. Material AISI 1040, AISI 1018 and Iron, Fe selected to make analysis and as the result, material AISI 1040 were chosen for the jig. Design also evaluate by using two difference force value which is 400 N and 1000 N to choose the strongest design. The results for force 400 N showed that design 3 have lowest maximum von mises value with 0.5660021 N/mm² compared to design 1 with 1.066816 N/mm² and design 2 with 37.70809 N/mm². Design 3 were selected to be the final design and AISI 1040 selected as the jig material because it strongest compared to AISI 1018 and Iron, Fe.

ABSTRAK

Kajian ini bertajuk “*Designing and Evaluating of Jig for Holding Cylindrical Parts for Mass Production of Drilling Operation*”. Tiga rekabentuk jig direka dan dibandingkan dari segi material dan juga kekuatan jig bagi memilih rekabentuk yang terbaik. Laporan ini bermula dengan pengenalan dan komponen yang penting didalam rekabentuk jig dan kelebihan penggunaan jig. Jig digunakan apabila menjalankan operasi pemesinan ke atas benda kerja untuk mendapatkan hasil kerja yang tepat. Tujuan untuk projek ini adalah untuk memegang 30 benda kerja berbentuk silinder yang kecil yang digunakan oleh syarikat kecil-kecilan untuk melancarkan proses pengeluaran. Rekabentuk dianalisis dengan mengenakan daya terhadap. Berdasarkan kajian, beberapa rekabentuk jig gerudi telah dibuat. Lima lakaran telah dibuat dan hanya tiga lakaran dipilih untuk dilukis dalam bentuk lukisan 3D dengan menggunakan perisian Solidwork 2007. Kemudian, projek melalui proses analisis dengan menggunakan FEA di dalam perisian ALGOR 22. Bahan AISI 1040, AISI 1018 dan Iron, Fe dipilih untuk membuat analisis dan sebagai hasilnya, bahan AISI 1040 dipilih untuk jig tersebut. Rekabentuk juga dianalisis dengan menggunakan dua nilai daya yang berlainan iaitu 400 N dan 1000 N. Keputusan untuk daya 400 N menunjukkan bahawa nilai maksimum bagi von mises untuk rekabentuk 3 adalah yang paling rendah iaitu 0.5660021 N/mm² berbanding dengan rekabentuk 1 iaitu 1.066816 N/mm² dan rekabentuk 2 dengan 37.70809 N/mm². *Pugh Concept Selection* juga diterapkan dalam pemilihan rekabentuk terbaik. Rekabentuk 3 dipilih sebagai rekabentuk untuk projek ini dan AISI 1040 dipilih sebagai bahan jig kerana ia lebih kuat berbanding dengan AISI 1018 dan Iron, Fe.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Mass production aims at high productivity to reduce unit cost and interchangeability to facilitate easy assembly. This necessitates production devices to increase the rate of manufacture and inspection device to speed-up inspection procedure.

Jigs are special purpose tools which are used to facilitate production like machining, assembling and inspection operations. The mass production of work-piece is base on the concept of interchangeability according to which every part produced within an established tolerance. Jigs provide a means of manufacturing interchangeable parts since they establish a relation with predetermined tolerances, between the work and the cutting tool. Once the jig is properly set up, any number of duplicate parts may be readily produced without additional set up. (Sharma,1982)

Jigs are used on drilling, reaming, tapping, milling and tapping. There are many advantages for using jigs in production. Jigs eliminate individual making, positioning and frequent checking. This reduces operation time and increase productivity. There is no need for selective assembly.

To increase production in drilling and milling process for cylindrical part, it is a challenge to hold 30 parts in one time. This chapter discussed about project background

to design jigs for holding 30 cylindrical part and the important to use jig in production. Problem statement, objectives and scopes for the project including in this chapter.

1.2 PROBLEM STATEMENT

Holding cylindrical parts to be drilled is one of major problems faced by the manufacturing company, especially small medium company. Sometimes they need expensive equipment to holds the parts to be drill. Today, customers request in industries is increasing. So, the company must find new method to improve their productivity.

Jigs is important part using in any industry. Before this, jigs always have limited function like just one parts can be support for one process. This makes the production slow and cannot fulfilled customers demand. Nowadays, there are several methods available to improve design to increase the productivity.

Jigs is simplify locating and clamping of the work-piece. Tool guiding elements to ensure correct positioning of the tools with respect to the work-piece. Jigs with easy to setting and can hold more than one items should be design to reduce the cost and time for productivity.

1.3 OBJECTIVES

The objectives of this project are to:

- (i) Design a jig that hold small cylindrical parts to be used by small medium company.
- (ii) Evaluate the design in terms of design.
- (iii) Evaluate the design in terms of force applied to the jig.

1.4 SCOPES

The scopes of this project are:

- (i) Design and evaluation jig which will hold up to 30 small cylindrical part with diameter 10mm.
- (ii) Design jig for Milling Machine to perform drilling operation from the top side.
- (iii) Design of jig drawing using SolidWorks 2007.
- (iv) Analysis force and strength of the design using ALGOR 22 software.

1.5 ARRANGEMENT OF REPORT

This study consist 6 chapter. In the first chapter, the introduction of the study were discussed. This chapter introduced briefly about the project and also provided the problem statement of the study. In this chapter also state about the objectives and scopes of the project.

Chapter two consist of literature review of designing jigs and definition of important component in designing such as design principles common to jigs. This chapter also discussed about advantages, disadvantages of the jig, and also type of jigs that already used today. The important of jigs discussed in this chapter.

Chapter three discussed about the methodology used in this project from starting until completing this project. In methodology were discussed about method and tool that used in this project. In this chapter, the design which using SolidWork 2007 will be evaluating. It include to choose the best design and suitable to the parts, operational function and the problem or disadvantages of product.

Chapter four will be discussed about designing and evaluation the jig. In this chapter including process to select the suitable material for the jigs, layout design and analysis the force and strength of the design using ALGOR software.

Chapter five discussed about the final decision and actual layout performance and the result also were discussed. This chapter also include design selection using PUGH method. Finally, from the analysis, the suitable design are obtained and was selected.

Lastly, chapter 6 discussed about the conclusion for all chapter in this project and recommendation of overall of the projects were be conclude in this chapter. The further process to make sure the project really successful also discussed in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discussed about literature review of jigs designing for the cylindrical part. It begin with introduction to the jigs, type of jigs and components in the jigs. Furthermore, the advantages and disadvantages of the jigs were discuss and the important of the jig design were discussed briefly.

2.2 INTRODUCTION TO JIGS

The most-common jigs are drill and boring jigs. These tools are fundamentally the same. The difference lies in the size, type, and placement of the drill bushings. Boring jigs usually have larger bushings. These bushings may also have internal oil grooves to keep the boring bar lubricated. Often, boring jigs use more than one bushing to support the boring bar throughout the machining cycle.

In the shop, drill jigs are the most-widely used form of jig. Drill jigs are used for drilling, tapping, reaming, chamfering, counter-boring, countersinking, and similar operations. Occasionally, drill jigs also used to perform assembly work. In these

situation, the bushing, guide pin, dowel, or other assembly elements at the jig also important to perform jig ability.

Jigs are further identified by their basic construction. The two type of jigs, they are open and closed. Open jigs carry out operations on only one, or sometimes two, sides of a work-piece. Closed jigs, on the other hand, operate on two or more sides of work-piece. The most-common open jigs are template jigs, plate jigs, table jigs, sandwich jigs, and angle plate jigs. Typical examples of closed jigs include box jigs, channel jigs, and leaf jigs. Other forms of jigs rely more on the application of the tool than on their construction for their identity. These include indexing jigs, trunnion jigs, and multi-station jigs.

Specialized industry applications have led to the development of specialized drill jigs. For example, the need to drill precisely located rivet holes in aircraft fuselages and wings led to the design of large jigs, with bushings and liners installed, contoured to the surface of the aircraft. A portable air-feed drill with a bushing attached to its nose is inserted through the liner in the jig and drilling is accomplished in each location. (Joshi, 2003)

2.2.1 Elements in Jigs

In the jigs design, there have some of important elements should be take note. Generally, all the jigs consist this elements. First is the locating elements. Position of work-piece must be accurate with the respect to the tool guiding or setting elements in the jigs. Clamping is also some of elements consist in jigs design. These elements hold the work-piece securely in the located position during the operation.

The others elements is tool guiding and setting elements. These elements act as guiding aid or setting of the tool in correct position with respect to the work--piece. Drill bushes were guide drill operations accurately to the work-piece.

2.3 IMPORTANT OF JIGS

Jigs is very important in manufacturing industry. This tools needed to make sure that manufacturing process in production line going smooth and easier to operator doing their job. Jig helps operator to holding part which will be processing or in operation. In production rate, using jigs increased the productivity because it will minimize the production time.

2.3.1 Advantages

(i) Productivity

Jigs eliminate individual marking, positioning and frequent checking. This reduces operation time and increases productivity.

(ii) Interchangeability

Jigs facilitate uniform quality in manufacture. There is no need for selective assembly. Any part of the machine would fit properly in assembly, and all similar components are interchangeable.

(iii) Skill reduction

Jigs simplify locating and clamping of the work-pieces. Tool guiding elements ensure correct positioning of the tools with respect to the work-pieces. There is no need for skillful setting of the work-piece or tool. Any average person can be trained to use jigs. The replacement of a skilled workman with unskilled labor can effect substantial saving in labor cost.

(iv) Cost reduction

Higher production, reduction in scrap, easy assembly and savings in labor costs result in substantial reduction in the cost of work-pieces produced with jigs.

2.3.2 Disadvantages

In industry, using jigs is very important in operation. Nowadays, tools is more important than workman skill. This will make the industrial lacking skillful man in workplace. When the tools is breakdown, the production rate will be decrease. Cost for maintenance will be higher.

2.4 INTRODUCTION TO DRILL JIGS

In the drilling jigs, locating and clamping elements in drill jigs are subjected to high torque in the direction perpendicular to the axis of the cutting tool. The jigs and the work-piece are also subjected to thrust in the direction of the feed of the tool.

To produce a good drilling jigs must fulfill a few requirement. The jigs must quick and accurate location of the work-piece. Otherwise, the jigs that designed must to be make sure easy loading and unloading of the work-piece and prevention of wrong loading and also prevention of bending or movement of the work piece during drilling process. In a good jigs design, there is must have ample chip clearance with facilities for swarf removal and cleaning.

In the jigs design, weight is a some important things to take note before produced. Light weight is needed to minimize operator fatigue due to repeated handling. Otherwise, prevention of loss of loose parts by chaining them to the jig body and clearance for overshoot of the drill must be prepared.



Figure 2.1 : Shapes of drilling jigs for cylindrical work-piece.

2.4.1 Types of Drill Jigs

Depending upon their construction and method of operation, drill jigs can be broadly classified in various types.

- (i) Plate jigs and channel jigs with work-piece pots

Mainly consist of a single bush plate with a provision for location and the clamping of work-piece.

(ii) Angle plate jig

In angle plate jig, locaters are generally fixed to the vertical wall of the angular body. The work-piece is located by a central locator and a diamond pin for angular position.

(iii) Turn-over jig

This type of jigs can drilling work-piece which having no suitable resting surface. The work-piece can be drilled conveniently with turn-over jigs. Turn over jigs are plate with jig feet. The feet provide square resting surface to the jig during drilling. The resting diameter of the jig feet should be bigger than the T slots of machine table to prevent the feet from falling into the slots.

(iv) Leaf or latch jig

Have a hinged jig plate. The jig plate can be swung aside. The jig plate must have positive resting face to ensure that the axes of bushes are vertical during drilling. The jig plate must be clamped against the resting face by eyebolt. The open slot in the jig plate and swinging eyebolt facilitate quick clamping and unclamping of the jig plate.

(v) Box jig

Work-piece having holes on a number of sides can be drilled economically with box jigs. The body is generally shaped like a box with one side open for loading and unloading the work-piece. The open side is provided with a hinged latch with bushes on various sides and suitable jig feet n the opposite sides.

(vi) Trunnion-type indexing jig

This jigs is used for process to drilling large and heavy work-piece. Due to the large size and weight of the work-piece and the jig, it impossible to

tumble the jig manually for drilling the holes on the various sides. To ease this operation, the jig body is provided with pivots at both ends. The pivots are supported with ball bearings in the supporting brackets at both ends.

(vii) Sandwich and pump jigs

Have a guide pillars for alignment of jig plate with the base plate. The work-piece is located on the base plate by pins. The based is aligned with the jig plate by guide pillars which locate by engagement with guide bushes correctly with respect to the work-piece located on the base plate.

(viii) Jigs for multi spindle machine

The design of the jigs is similar to the sandwich jig in some respects. The base plate is clamped firmly on the machine table. The base is provided with location and clamping arrangement for the work-piece. The jig plate is suspended on the drill head with four columns having resting nuts.

2.5 MATERIALS

Jigs are made from a variety of materials, some of which can be hardened to resist wear. It is sometimes necessary to use nonferrous metals like phosphor bronze to reduce wear of the mating parts, or nylons or fiber to prevent damage to the work-piece. The materials often used in jigs is steel, iron, nylon, fiber and bronze.

2.5.1 High Speed Steels (HSS)

These contain 18% (or 22%) tungsten for toughness and cutting strength, 4.3% chromium for better hardenability and wear resistance and 1% vandadium for retention of hardness at high temperature (red hardness) and impact resistance. HSS can be air or

oil hardened to RC 64-65 and are suitable for cutting tools such as drills, reamers and cutters. (Joshi, 2003)

The main use of high speed steels continues to be in the manufacture of various cutting tools like drills, taps, milling cutters, tool bits, gear cutters, and saw blades. Although usage for punches and die is increasing.

High speed steels also found a market in fine hand tools where their relatively good toughness at high hardness, coupled with high abrasion resistance and fine, made them suitable for low speed applications requiring a durable keen (sharp) edge, such as files, chisels, hand plane blades, and high quality kitchen and pocket knives.

2.5.2 Carbon Steels

These contain 0.85-1.18% carbon and can be oil hardened to RC 62-63. These can be used for tools for cutting softer materials like woodwork, agriculture, and also for hand tools such as files, chisels and razors. The parts of jigs and fixtures like bushes and locators, which are subjected to heavy wear can also be made from carbon steels and hardened. (Joshi, 2003)

Typical composition of carbon are:

- (i) Mild (low carbon) steel:
Approximately 0.05% to 0.26% carbon content with up to 0.4% manganese content (e.g. AISI 1018 steel). Less strong but cheap and easy to shape; surface hardness can be increased through carburizing.

- (ii) Medium carbon steel:
Approximately 0.29% to 0.54% carbon content with 0.60 to 1.65% manganese content (e.g. AISI 1040 steel). Balances ductility and strength and has good wear resistance which used for large parts, forging and automotive components.