DESIGN AND FABRICATION OF JIG FOR BUTT WELDING

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"I hereby declare that I have checked this project and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering."

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"I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any diploma and is not concurrently submitted for award of other diploma."

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ABSTRACT

The title of this final year project is “design and fabrication of jig for butt welding”. Jigs are special purpose tools which are used to facilitate production like machining, assembling and inspection operations. The purpose of this jig is to hold the specimen of the welding specimen which is the sheet metal. The fabrication purpose is to improve the quality of welding by making the better jig compare to the older jig. The students use this jig to hold the specimen and welding it by using the MIG welding at the welding machine. The problems are the specimen is bending after welding because affect by thermal stress. The older clamp cannot hold the specimen properly. This jig must be suitable to place on the existed table. The main objective of this study is to design and fabricate jig for butt welding. Also the objective is the jig need to suitable for hold sheet metal. Four designs were drew and compared in terms of durability, cost, size and weight, easy to use and clamping force. The best design is chosen and fabrication according to the measurement. After testing the product, the clamp has improves the clamping force and the specimen is not bending and affect by the thermal stress.

ABSTRAK

Tajuk untuk projek tahun akhir ini ialah “design and fabrication of jig for butt welding”. Jig adalah alat tujuan khas yang digunakan untuk memudahkan pengeluaran seperti pemesinan, pemasangan dan operasi pemeriksaan. Tujuan jig ini adalah untuk memegang spesimen spesimen kimpalan yang merupakan kepingan logam. Tujuan pembuatan adalah untuk meningkatkan kualiti kimpalan dengan membuat jig yang lebih baik berbanding dengan jig yang lama. Pelajar-pelajar menggunakan jig ini untuk memegang dan menimpal spesimen dengan menggunakan kimpalan MIG di mesin kimpalan. Masalahnya ialah specimen membengkok selepas dikimpal kerana kesan daripada tekanan haba. Pengapit lama tidak dapat memegang specimen dengan sebaiknya. Jig ini mestilah sesuai untuk diletakkan di atas meja yang sedia ada. Objektif utama kajian ini ialah untuk merekabentuk dan membuat jig untuk kimpalan puntung. Juga tujuannya adalah keperluan jig sesuai untuk memegang kepingan logam. Empat reka bentuk telah dilukis dan dibandingkan dari segi ketahanan, kos, saiz, dan berat, mudah untuk digunakan dan kekuatan pegangan. Reka bentuk yang terbaik dipilih dan pembuatan dijalankan mengikut ukuran. Selepas ujian produk, pengapit telah meningkatkan daya pengapitan dan spesimen itu tidak lentur dan terjejas oleh tekanan haba.

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LIST OF SYMBOLS

Symbol	Name	Unit
m	Module	(mm)
PD	Pitch Diameter	(mm)
p	Circular Pitch	(mm)
N	Number of Teeth	
a	Addendum	(mm)
d	Dedendem	(mm)
OD	Outside Diameter	(mm)
RD	Root Diameter	(mm)
BC	Base Circle	(mm)
t	Tooth Thickness	(mm)
hw	Working Depth	(mm)
WD	Whole Depth	(mm)
C	Center Distance	(mm)
G	Gear Ratio	(mm)

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 workpiece 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. (Sharma1982) [12]

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.

There are several factors from the characteristics of jigs that can be analysis and improve the quality of the jigs. These factors can be finds from the design, material of the jigs and also the fabrication of jigs. Discussion about the jigs is also important to improve the quality.

This chapter is discussing about the project background, the problems of the project, objective of the project and the scopes of the project.

1.2 PROJECT BACKGROUND

The title for this final year project is design and fabrication of jig for butt welding. Objective is to design and fabricate a jig for the existing butt welding in the mechanical workshop. After some researches, the information from the journals, internet and also books about the jig, design of jig, butt welding and its process and also about the thermal stress is useful to help in complete this final year project.

Before start the designing and fabrication of the clamp, several factors need to consider to made sure the product is suitable and can easily place at the existing table. The case study for this project is focused on design and fabricates the jig to prevent the thermal stress effect the workpiece and ensure that the jig is suitable for using at existing butt welding machine.

So, for the main problem which is thermal stress, the material selection must be done correctly. It is because the material should be suitable to prevent the thermal stress and also can reduce the heat from the welding area. Besides, the measurement of product must also be consider to prevent the product too big or high and not suitable for the existing table.

1.3 PROBLEM STATEMENT

Students need a good jig to clamp at the workpiece so that their workpiece will be in right position when welding. But, students face many problems about to hold their specimen. The effect of the thermal stress and unsuitable clamping give a lot of problems especially for the students when using the butt welding. One of the effect is the workpiece will be bend and their shape will not in good condition.

Jig is an important device when using the butt welding machine. It is because a good clamping can give a best joint when welding the workpiece. However, when using the butt welding, there will be a thermal stress that can affect the workpiece. So, jig is also functioning to absorb the heat from welder and workpiece.

About welding, first problem is heat dissipation which is a main consideration with any welding tool. Several methods can be used to ensure that proper heat is maintained in the weld area. When metals similar to steel and other poor conductors are joined, the excess heat should be carried off to avoid overheating the weld. [1]

Besides that, main crisis is when structures are manufactured by welding, a non-uniform temperature distribution is produced. This distribution initially causes a rapid thermal expansion followed by a thermal reduction in the weld and surrounding areas, thus generating inhomogeneous arrangement deformation. [2] This is called thermal stress.

During welding, a high quality clamping device not only holds workpieces firmly together, but must also take the thermal strain of the welding heat without damage the strength of the weld joint. [3]

Thus, a jig is fabricated to solve this problem with better specifications. The jig must clamp the workpiece from upper side and make from good conductor material to absorb more heat when welding operation conducted.

1.4 OBJECTIVES

The objectives of this project are:

i. To design a jig suitable for workpiece in sheet metal thickness.
ii. To fabricate a jig to clamp workpiece

1.5 PROJECT SCOPES

The scopes of this project are:

i. Design and fabricate jig for workpiece in thickness of sheet metal.
ii. Design and fabricate jig for existing machine in area 500mm x 300mm.
iii. Fabricate jig using mild steel material.

1.6 ARRANGEMENT OF REPORT

This study consists of 5 chapters. In the first chapter, the introduction of the study was discussed. This chapter introduced briefly about the project background and also provided the problem statement of the study. In this chapter, also states about the objectives and scopes of the project.

Chapter two consist of literature review for this project. It is consist of introduction of jigs, important of jigs which are advantages and disadvantages, also about butt welding, arc welding, MIG welding and TIG welding, thermal stress and lastly some study review about drilling, grinding and tapping.

Chapter three discussed about the methodology used in this project from starting until this report is complete. In methodology were discussed about design concept using the solidwork, fabrication process, flowchart, gantt chart and lastly is material selection which is mild steel and aluminium.

Chapter four will be discussed about the final product and according to the part by part which is clamp, table and base for the product. In this chapter also include the bill of material for this final product.

Chapter five discussed about the conclusion for this final year project and recommendation to improve the product. The conclusion is all about the design of project, fabrication process and testing of product.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will provide the review from previous research that is related to this final year project. There is a lot of research about the jig, butt welding process and thermal stress. This is the most important things about this project. The research also shows the method how to prevent the thermal stress and the suitable design of jig for the existing butt welding machine.

2.2 INTRODUCTION OF JIG

First of all, the research is makes about jig in overall term because jig is use for a lot of works in daily life. Jig is a type of tool used to control the location and or motion of another tool in work. Purpose of jig is to provide repeatability, accuracy, and inter changeability in the manufacturing of products. A jig is often confused with a fixture because they are look like same in function but a fixture holds the work in a fixed location. A device that does both functions holding the work and guiding a tool is called a jig.

Jigs or templates have been known long before the industrial age. There are many types of jigs, and each one is design to do a specific job. Many jigs are created because there is a necessity to do so by the tradesmen. Some are to increase productivity, to do repetitious activities and to do a job more precisely. Some types of jigs are also called templates or guides. Jigs include machining jigs, woodworking jigs, welders jigs and jewel jigs.

Jigs are further identified by their basic construction. The two types 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 workpiece. Typical examples of closed jigs include box jigs, channel jigs, and leaf jigs.

2.2.1 Elements in Jigs

In the jigs design, there have some of important elements should be take note. Generally, all the jigs consists these elements. The first element is the locating elements. Position of workpiece must be accurate with the respect to the tool guiding or setting elements in the jigs. Clamping force 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 are tool guiding and setting elements. These elements act as setting of the tool in correct position with respect to the workpiece.

2.3 IMPORTANT OF JIGS

Jigs are very important in manufacturing industry. These tools needed to make sure that manufacturing process in production line going smooth and easier to operators 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 of jig

(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 and cost reduction

Jigs simplify locating and clamping of the work-pieces. Tool guiding elements ensure correct positioning of the tools with respect to the workpieces. There is no need for skilful setting of the workpiece or tool. Any average person can be trained to use jigs. The replacement of a skilled workman with unskilled labour can effect substantial saving in labour cost. Also can save because reduction in scrap and higher production.

2.4 INTRODUCTION TO JIG FOR BUTT WELDING

Before start a work, process planning must be doing. In process planning, the right selection of jig or work holding device represent an important specification additionally to welding process. [22] So, for the existing butt welding machine, it need a clamp that can hold specimen from upper side so that the specimen not moving or bending while welding.

Clamps provide total control by holding the part in location under the application of external forces during the manufacturing process. It useful to support the specimen and ensure the clamping is strong enough to hold it. [14]The clamping force can be good if the clamp is makes with good quality.

Contact surface can experience slipping, sliding, rolling or tension release depending on the scale of the normal and lateral forces at the contact interface. So, about clamping force must be consider. When the clamping force is high, the welding is better in quality. [11]

For example, in a laser butt welding process, a jig must perfectly hold and align two parts in a given direction with respect to the laser beam. The holding force and laser heat that join the two parts together will indirectly manipulate the joint strength, HAZ (heat affected zone), and cause distortion and dimensional changes. If the clamping is not strong enough, the welding will be not in bad condition. [3]

In mass production, jig is very important because it can save the cost and time, makes the work more precise and accurate, increase productivity and lastly less skill is needed. [7] From the factors, the jigs help a lot in production and give a lot of advantages.

From the condition above, a good clamp can hold the specimen well and can increase the quality of welding. This can help the work by increase the quality of welding result.

Figure 2.1: Jig for butt welding

Source: http://www.jalopyjournal.com/forum/showthread

An example of jig for butt welding that look simple, save in cost and easy to use. This jig is commonly use in automotive production.

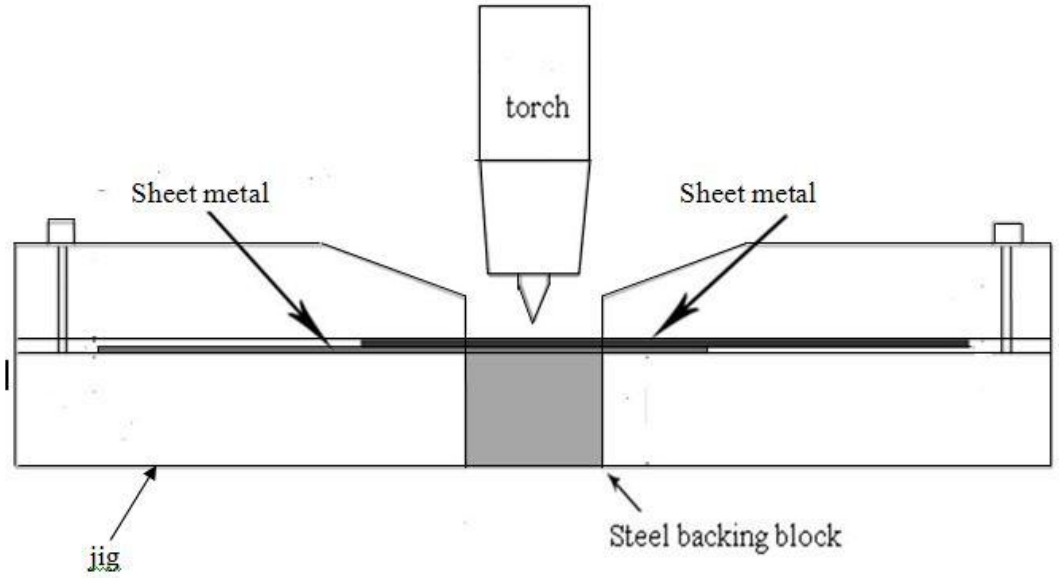


Figure 2.2: example jig for welding sheet metal.

Distance of the jig from the torch must be consider to make sure the torch can welding the sheet metal and the jig not too close with the welding area and heat.

2.4.1 Design of jig

First of all, need to analyze the design to ensure that the assembly process does not disturb with the other outside problem includes the machining process. [17] The process that will be use must be think first and be plan to make sure the work run smoothly according to schedule.

The general factors to be considered when design a jig is firstly, the shape, material and state of the workpiece. Second, remachined surfaces and tolerances, type of operations and the machine tools used, workpiece handling, ergonomics and safety considerations, and lastly economic considerations such as the use of the standard and modular component. These are the common factors when create a design. [4]

Dependable assembly tooling must be able to hold components and subassemblies in an accurate and repeatable position, prevent undesired movement of components, and avoid posing interference problems in assembly tasks. [9] So that, the design must be very important to ensure that the jig function well and make progress of work run smoothly.

Lastly, the size of the design must be consider because it must be suitable to place on the existing table. If the size is bigger than the table, this will give a problem put the jig. Then, the height is also need to be consider because the torch need to be easily welding the specimen. [18]

From the research, known that jigs locate and hold the workpiece in position and ensure that it is in a state of stable equilibrium and that dimensional accuracy is maintained during the manufacturing operation. [17] So, make sure the flatness of the jigs is good enough and make the joint in high quality of welding.

2.5 WELDING

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the work pieces.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding can be done in many different environments, including open air, under water and in outer space. Regardless of location, however, welding remains dangerous, and precautions must be taken to avoid burns, electric shock, eye damage, poisonous fumes, and overexposure to ultraviolet light. [25]

Figure 2.3: Welding process

Source: Wikipedia (1995)

2.5.1 Arc Welding

One of the most common types of arc welding is shielded metal arc welding (SMAW), which is also known as manual metal arc welding (MMA) or stick welding. Electric current is used to strike an arc between the base material and consumable electrode rod, which is made of steel and is covered with a flux that protects the weld area from oxidation and contamination by producing CO_2 gas during the welding process. The electrode core itself acts as filler material, making separate filler unnecessary.

The process is versatile and can be performed with relatively inexpensive equipment, making it well suited to shop jobs and field work. An operator can become reasonably proficient with a modest amount of training and can achieve mastery with experience. Weld times are rather slow, since the consumable electrodes must be frequently replaced and because slag, the residue from the flux, must be chipped away after welding. Furthermore, the process is generally limited to welding ferrous materials, though special electrodes have made possible the welding of cast iron, nickel, aluminum, copper, and other metals. Inexperienced operators may find it difficult to make good out-of-position welds with this process.[25]

2.5.2 MIG Welding

MIG (Metal Inert Gas) or as it even is called GMAW (Gas Metal Arc Welding) uses an aluminum alloy wire as a combined electrode and filler material. The filler metal is added continuously and welding without filler-material is therefore not possible. Since all welding parameters are controlled by the welding machine, the process is also called semi-automatic welding.

The MIG-process uses a direct current power source, with the electrode positive (DC, EP). By using a positive electrode, the oxide layer is efficiently removed from the aluminum surface, which is essential for avoiding lack of fusion and oxide inclusions. The metal is transferred from the filler wire to the weld bead by magnetic forces as small droplets, spray transfer. This gives a deep penetration capability of the process and makes it possible to weld in all positions. It is important for the quality of the weld that the spray transfer is obtained.

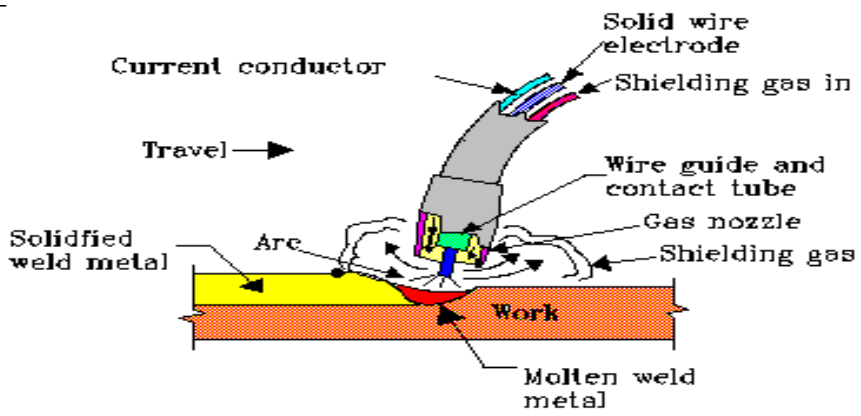


Figure 2.4**:** Schematic of Metal Inert Gas (MIG) Welding

Source: Wikipedia (1995)

2.5.3 TIG Welding

Tungsten Inert Gas (TIG) is a manual welding process that uses a non consumable tungsten electrode, an inert or semi inert gas mixture and a separate filler material. Especially useful for welding thin materials, this method is characterized by a stable arc and high quality welds, but it requires significant operator skill and can only be accomplished at relatively low speeds. TIG can be used on nearly all weld able metals, though it is most often applied to stainless steel and light metals. It is often used when quality welds are extremely important, such as in bicycle, aircraft and naval applications.

2.6 BUTT WELDING

Butt welding is the process of joining two pieces of material together along a single edge in a single plane. This process can be used on many types of materials, however metal and thermoplastics are the most common. When two sheets of steel are laid side by side and joined together along a single joint, this is an example of butt welding.

Welding is a reliable and capable metal joining process in the manufacture of many engineering and structural components. The advantage of welding as joining process includes high joint efficiency, easy set up and low fabrication cost. Welding process consists of melting and solidification of join metal and base metal in restricted fusion zone by a temporary thermal heat source.

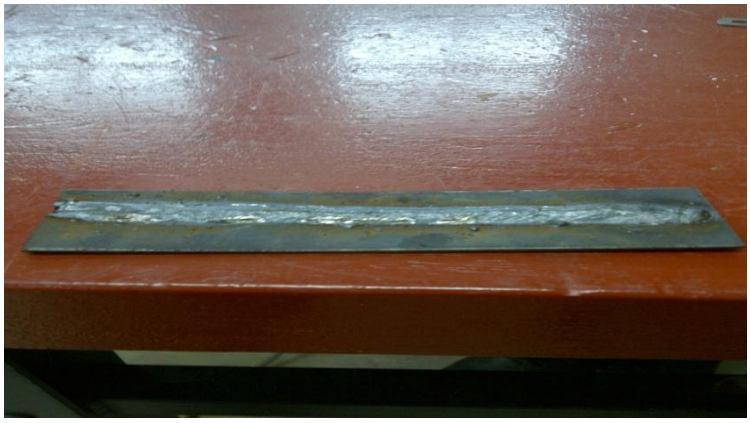


Figure 2.5: Sample Butt welding from lab welding

Figure 2.6: MIG welding machine in mechanical lab

For this project, it is refer to the existing butt welding machine in the mechanical lab. The table of this machine will be the place to put the clamp. So that, this clamp suitable with the size of the table and the screw hole must be provide at the final product to attach the product with this table.

2.7 THERMAL STRESSES IN WELDING PROCESS

Non-uniform contraction is the result for the welding stress which occurs as the join metal solidifies and cools to ambient temperature. [5] All welding processes induce important stresses due to constrained expansion and contraction of material under the influence of a non-uniform thermal field. The highest stresses occur in the welding region. [6]

Besides that, thermal stress also produces a high temperature gradient that leads to a high stress height during operation. Uncontrolled fracture phenomena during the processing of brittle materials and a very high level of stresses in the temperature affected zone will happen that harmfully affect the life time of an item made from a ductile material. [8]

Depending on the temperature gradient in the heated section, extreme thermal stresses can be developed. Such heating applications occur during the welding of metallic components, wherein one end of the workpiece is heated to an elevated temperature, while the other end is kept at the room temperature. As a result, temperature and stress fields turn into uncoupled and the stress field can be determined from the temperature field alone. [12]

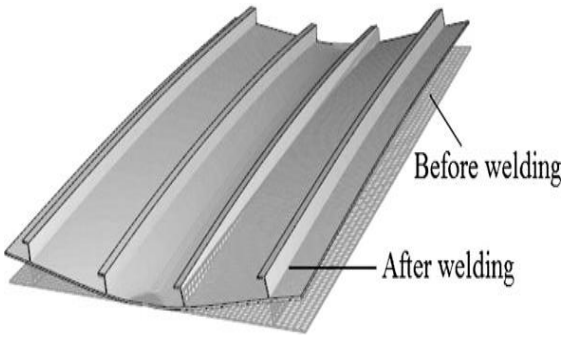


Figure 2.7: Thermal stress effect

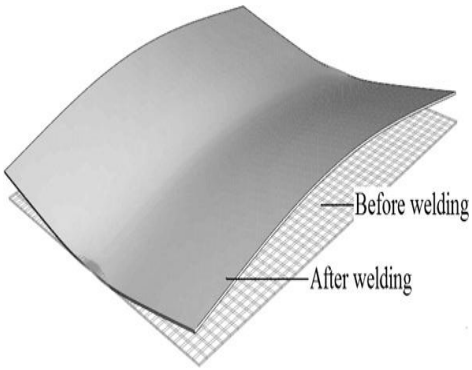


Figure 2.8: Thermal stress effect

The various properties of materials are considered dependent on temperature, and the contact resistance is given in the role of temperature. Besides that, welding current, welding time, electrode force, and hardening tangent effect the production of welding.[10] These factors gives disadvantages and the better methods must be use to avoid them.

In other words, thermal stress field also can be known by during the laser material processing, the heating is localized and, therefore, a very large temperature variation occurs over a small region.[13] This situation means that a small area with high temperature will produce higher risk to become thermal stress and affect the specimen.

Welding residual stresses have important consequences on the performance of engineering components. High residual stresses lead to loss of performance in corrosion, fatigue and fracture. However, residual stress often remains the single largest unknown in industrial damage situations. [15]

Accurate prediction of welding residual stress is very difficult. The numerical duplicate of residual stresses in dissimilar steel welds is generally more challenging than that of residual stresses in similar steel welds because of the differences in the physical, mechanical and metallurgical properties of the materials to be joined. [17]

Friction welding is a complex process, which involves the interaction of thermal, mechanical and metallurgical phenomena. A limited element model to simulate this coupled process is developed to represent the workpieces and surface contact conditions. [16]

2.8 DRILLING

Drilling is easily the most common machining process. One estimate is that 75% of all metal-cutting material removed comes from drilling operations. Drilling involves the creation of holes that are right circular cylinders. This is accomplished most typically by using a twist drill, something most readers will have seen before. The chips must exit through the flutes to the outside of the tool. As can be seen in the figure, the cutting front is embedded within the work piece, making cooling difficult. The cutting area can be flooded, coolant spray mist can be applied, or coolant can be delivered through the drill bit shaft. [26]

2.8.1 Drill Press

A typical manual drill press is shown in the figure below. Compared to other powered metal cutting tools, a drill press is fairly simple, but it has evolved into a versatile necessity for every machine shop. [26]

Figure 2.9: Drill Press Machine in mechanical lab

2.9 GRINDING PROCESS

Grinding is a finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat and cylindrical surfaces by removing a small amount of material. Information in this section is organized according to the subcategory links in the menu bar to the left.

In grinding, an abrasive material rubs against the metal part and removes tiny pieces of material. The abrasive material is typically on the surface of a wheel or belt and abrades material in a way similar to sanding. On a microscopic scale, the chip formation in grinding is the same as that found in other machining processes. The abrasive action of grinding generates excessive heat so that flooding of the cutting area with fluid is necessary. [27]

Figure 2.10: Hand grinder in mechanical lab

2.10 TAPPING

Taps and dies are cutting tools used to create screw threads, which is called threading. A tap is used to cut the female portion of the mating pair example is a nut). The process of cutting threads using a tap is called tapping, whereas the process using a die is called threading. Both tools can be used to clean up a thread, which is called chasing.

Bottoming tap is the first tap that will be used in tapping process. The tap illustrated with almost no taper between 1 and 1.5 threads of taper is typical. It enables a bottoming tap to cut threads to the bottom of a blind hole.

Secondly used is plug tap or intermediate tap that will continue the tapping process after bottoming tap finish. The tap has tapered cutting edges starting the tap into an untapped hole. The number of tapered threads typically ranges from 3 to 5.

Lastly are a taper tap and this tap will finish the tapping process. The small tap illustrated at the bottom of the image is similar to a plug tap but has a more pronounced taper to the cutting edges.

For the project, the double end wrench is used because it is more suitable. Double end adjustable wrenches have one threaded handle which is attached to one of the clamps. The clamp is opened to insert the tool and then tightened down against the tool to secure it. This type of tap wrench is used with larger taps and where there is room for a larger wrench, because a T-handle is more compact. [23]

Figure 2.11: Tap for tapping

Figure 2.12: Double end wrench

2.11 SUMMARY

From the research, there is a lot of information that can be used in complete this final year project. Jig, butt welding and thermal stress is the main keyword that must be considered in making the research. The other minor problem is about to design the jig and make it suitable for the existing butt welding.

Jig is all about the device that used to locate the work accurately, support it properly and hold it securely. So the jig is very important in manufacturing and makes the production better. Another keyword is butt welding which is a type of welding technique used to connect parts which are nearly parallel. Butt welding is an economical and consistent way of jointing without using additional components

Thermal stress is defined as the physical reactions of the worker to temperatures that fall outside of the worker's normal comfort zone. In other word, thermal stress is the stress that come from heat at the same place and become the stress field. This field or area will be a problem to the product because it can make the workpiece bending or crack while the operation is conducted.

The fabrication process is includes measuring, cutting, welding, drilling, tapping and lastly finishing. All of the process can be done using the machine and tools provides by University Malaysia Pahang. All of the fabrication process was flow smoothly and easily.

Lastly, the research hopefully is enough to complete the final year project and help a lot in making the product better than the existing jig. The factors and information used wisely to ensure that the jig can be a good product to help the students and workers when using the butt welding.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter discusses about design concept, final concept, fabrication process, flow chart, gantt chart and lastly material selection.

3.2 DESIGN CONCEPT

Concept 1

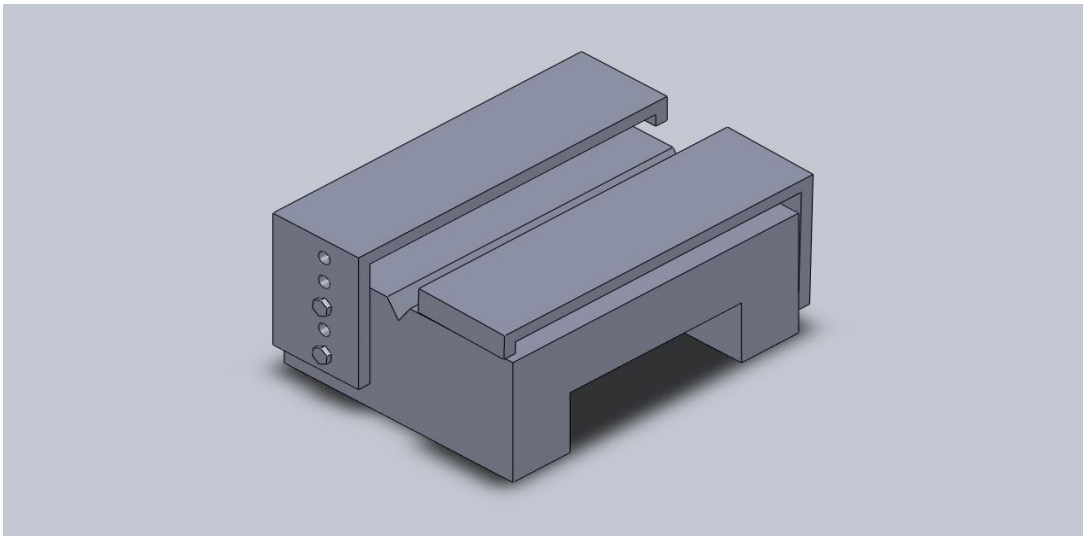


Figure 3.1: Concept 1

Advantages: i) Easy to use and place

ii) Low in cost production

Disadvantages: i) Limited in thickness because it need to follow the hole size.

ii) Low clamping force

Concept 2

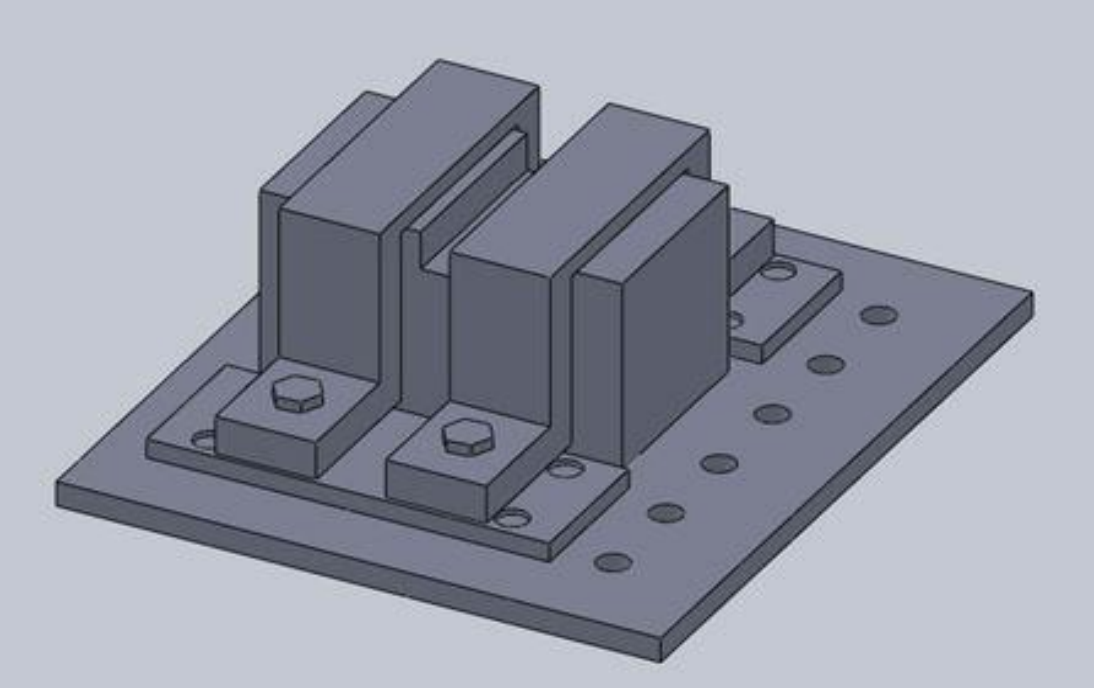


Figure 3.2: Concept 2

Advantages:

i) Easy to place and use

ii) Has high clamping force because clamping force comes from both sides.

iii) Suitable for many sheet thickness because the clamp can be moveable.

Disadvantage:

i) High production cost

Concept 3

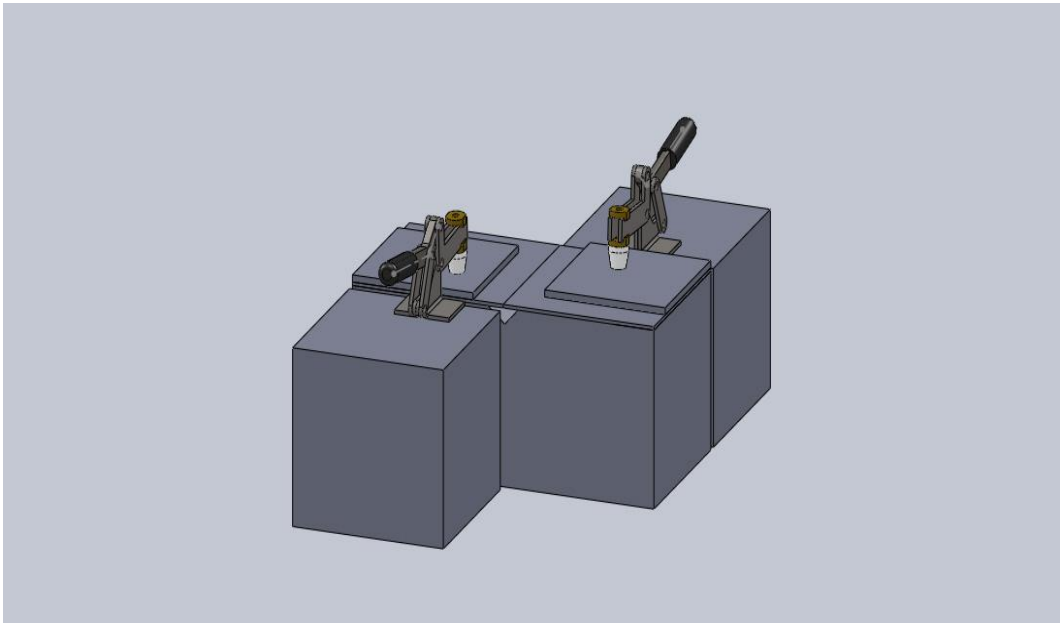


Figure 3.3: Concept 3

Advantages: i) Easy to use and place.

ii) High clamping force by using the toggle clamp concept.

Disadvantages: i) Need another plate to clamp workpiece.

ii) High in cost production

Concept 4

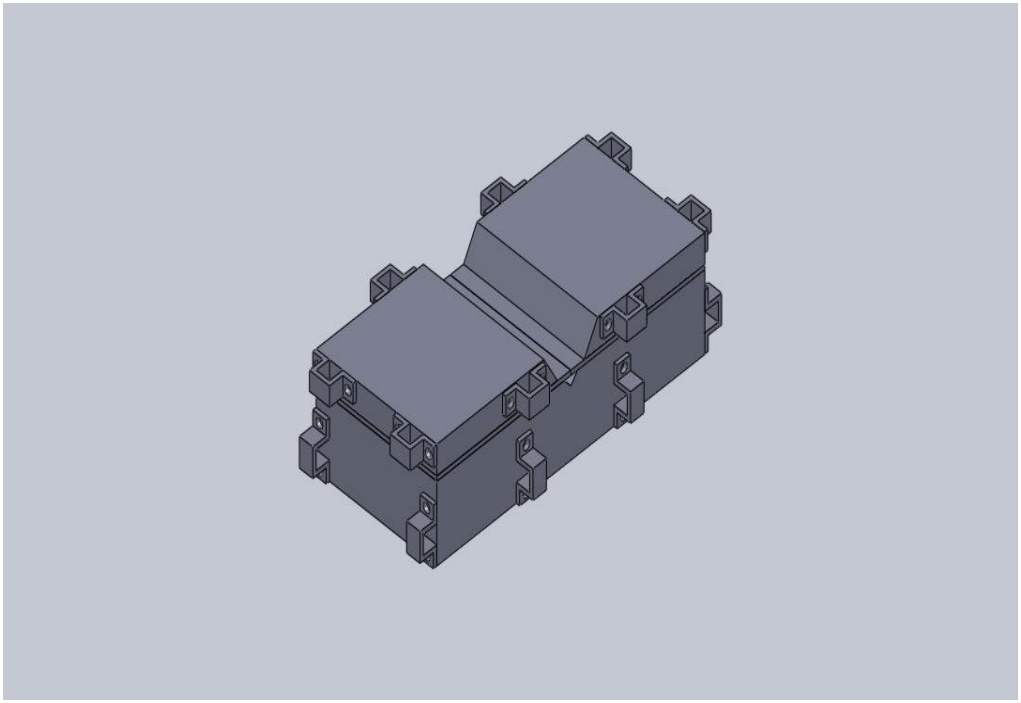


Figure 3.4: Concept 4

Advantages: i) High clamping force

Disadvantages: i) Not easy to use and take more time to set up.

Table 3.1: Characteristic table of design concept

Characteristics	Concept 1	Concept 2	Concept 3	Concept 4
Durability	2	4	4	4
Cost in production	4	3	2	3
Size and height	3	3	2	3
Easy to use	4	5	3	2
Clamping force	2	4	3	5
Total	15	19	14	17

Rating from 1 (bad) to 5 (best)

According to the characteristic table of design concept, design concept 2 is the best concept for the final year project. The concept is very good in durability, low in cost production and the size and height of this design concept is very suitable for the condition of the existing butt welding.

Besides that, this clamp design is very easy to use and it has high clamping force according to the design. Lastly, this final concept can obtain the objectives of the final year project and can be the best design for this final year project.

Final concept

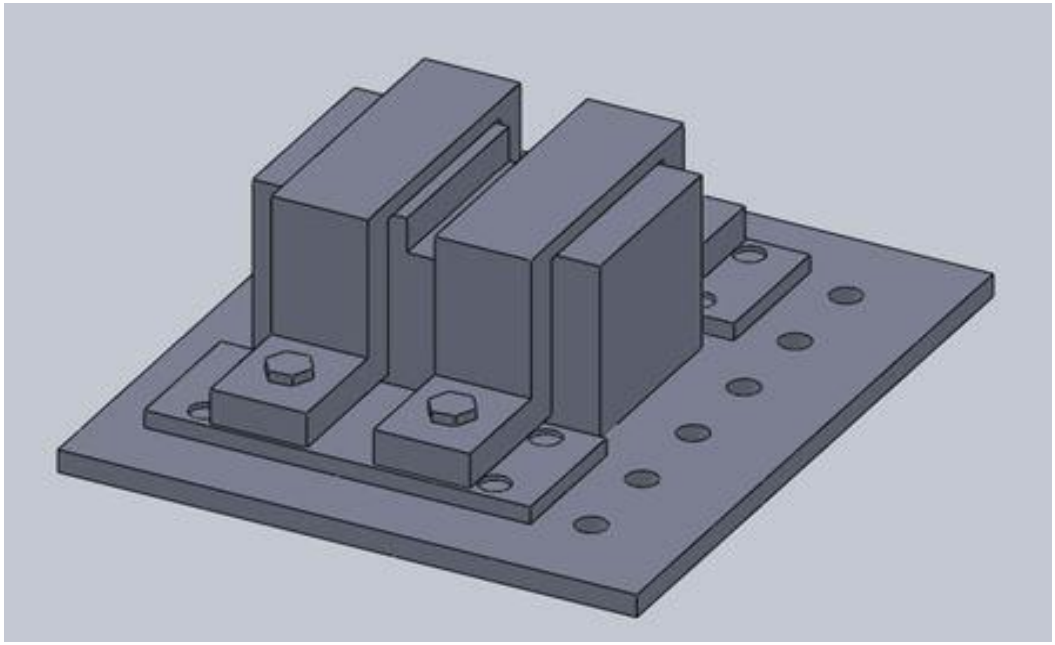
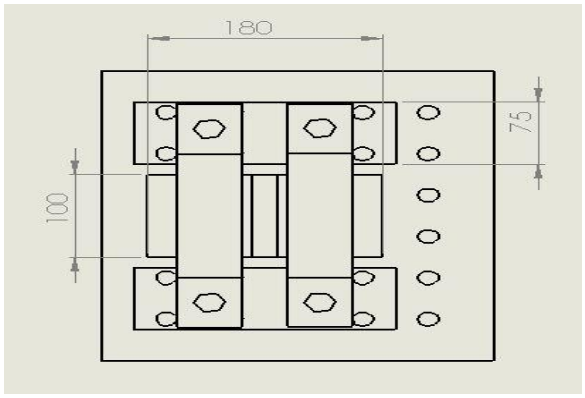
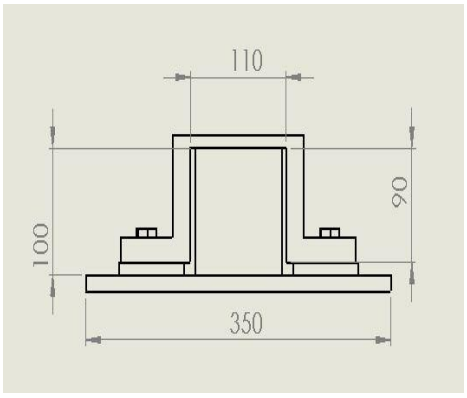


Figure 3.5: Final Concept

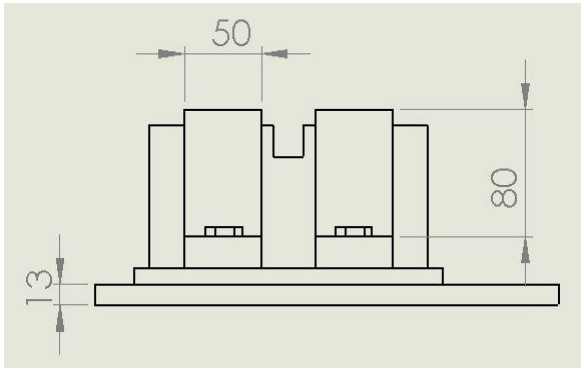
Top View



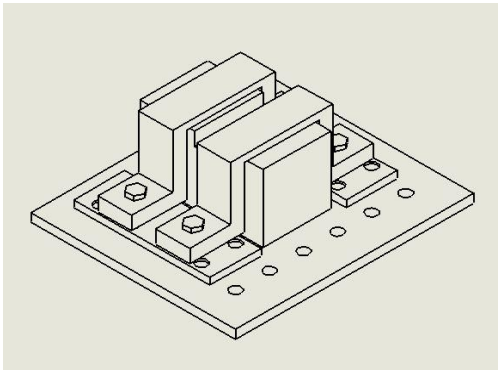
Side View



Front View



Isometric View



3.3 FABRICATION PROCESS

After designing phase is fabrication process. These processes is about using the material Selection and make the product base on the design and by followed the design dimension. Many methods can be used to fabricate a product, like welding, fastening, cutting, drilling and many more method. Fabrication process is difference from manufacturing process in term of production quantity. Fabrication process is a process to make only one product rather than manufacturing process that focus to large scale production. In the project fabrication process needed to make the base plate, framework of display board and display board. Fabrication process was used at the whole system production. This was include part by part fabrication until assembly to others component.

3.3.1 **Fabrication flow**

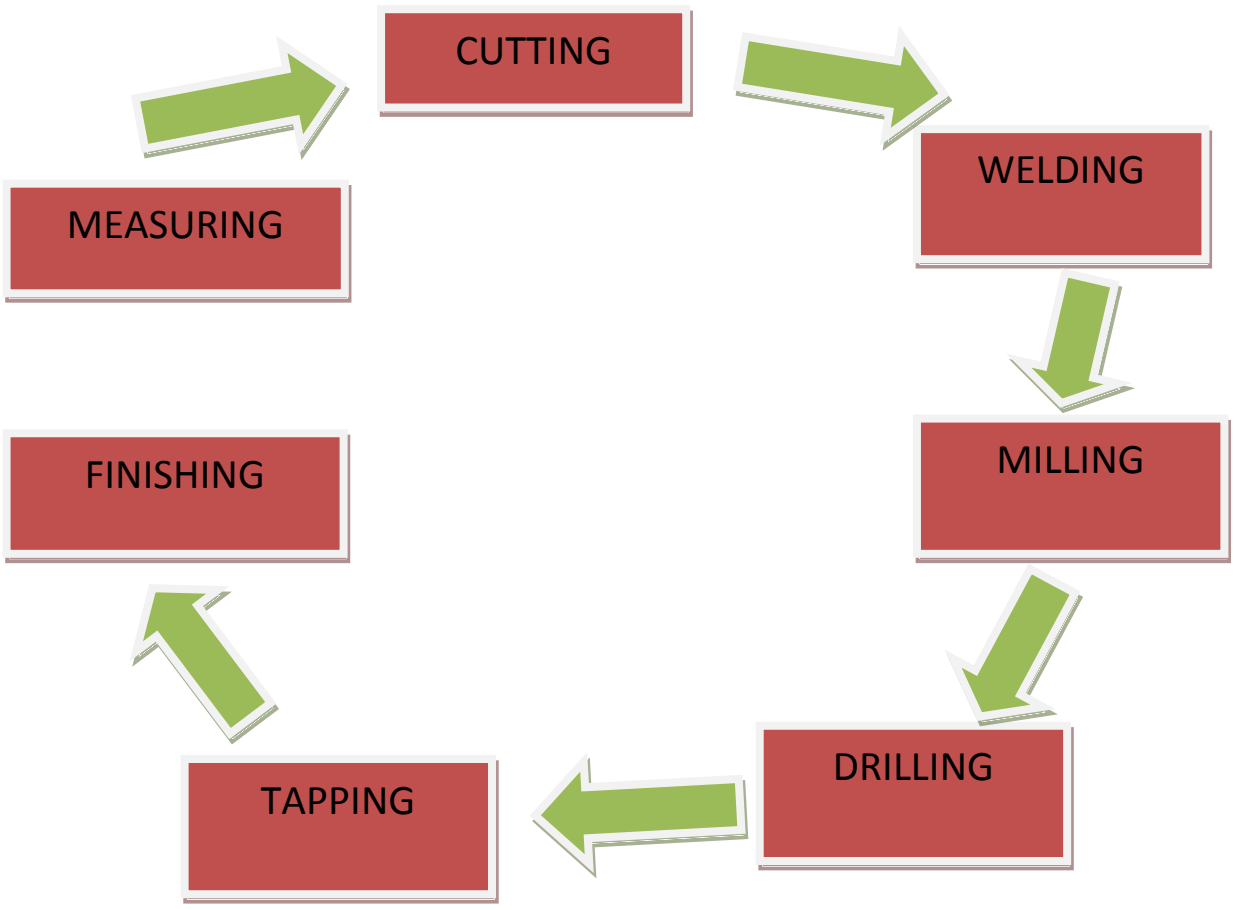


Figure 3.6: Fabrication flow chart for this project.

3.3.2 Measuring process

The fabrication process is start with measuring process. All the materials are measured which is mild steel and aluminium. The measurement are according to the design that I have make and the mild steel material is for clamp product while the aluminium material is for table of the clamp. All the measuring process is done measuring tape.

Figure 3.7: Measuring

3.3.3 Cutting process

After measure the material, cutting of the mild steel material is start according to the measurement by using the cutter machine.

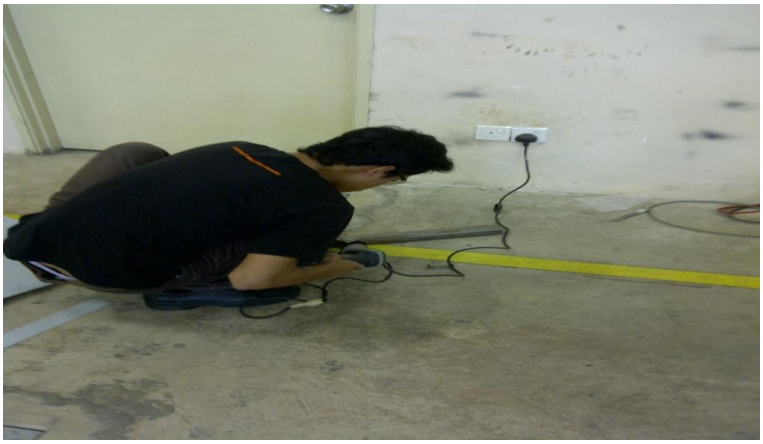


Figure 3.8: Cutting

3.3.4 Welding process

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence.

- Mild Steel is also referred to as soft steel and so mild steel can be easily welded together to connect the metal joints.
- For the project, arc welding is used to join the material according to the design after cutting process. This is one of the important process because the material is need to weld well to ensure the joint can withstand for long time.
- Also, Metal inert gas (MIG) welding, a common welding process using an electrical arc from a wire electrode, is typically used to joint mild steel together.

Figure 3.9: Welding process

3.3.5 Milling process

For the milling process, firstly use a edge finder to find origin position for the workpart so that the workpart will be easier to milling according to the measurement. If the edge finder is not use, the measurement will affect the workpart.

Use the end milling with 20 millimetres diameter to make slot at the middle of the table and using face milling with 60 millimetres diameter to increase the flatness of the surface of the table part. It is important for the surface to be flat so that the clamp can be at the same level. Besides that, the milling machine can make the clamp more precise and the surface is clean.

Figure 3.10: Milling process

Figure 3.11: Edge finder

3.3.6 Drilling process

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips from what will become the hole being drilled.

For the project, need to make the hole for the tapping process. The hole is according to existing table at the butt welding machine which is 8 millimetres in diameter. Also make four holes for the clamp's holes. The holes are bigger than the table holes because the bigger screw is used for the clamp so that the clamping force can be higher.

Figure 3.12: Drilling

3.3.7 Tapping

Tapping process is also important process for this project because the thread needs to make for the screw at many parts. First, at the table part where need to attach the aluminium block with the existing table. Second, at the base part so that the base can be attach to the existing table.

Figure 3.13: Tapping process

3.3.8 Finishing

For finishing process, the product is painting by using the silver spray to avoid the rusting especially for the clamp part because it is made of mild steel. The coating is very important because it also can make the product more attractive.

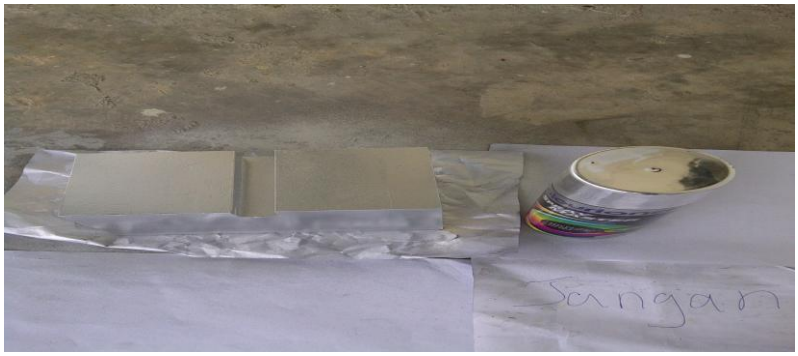


Figure 3.14: Painting process

3.6 MATERIAL SELECTION

For the project, mild steel is choose for the clamp part and aluminium for the table part and base part because they are the suitable material that can be use for the project according to several factors and advantages of these materials.

3.6.1 Mild steel

- Mild Steel is one of the most common of all metals and one of the least expensive steels used. It is to be found in almost every product created from metal.
- It is weldable, very durable, it is relatively hard and is easily annealed.
- Having less than 2 % carbon it will magnetize well and being relatively cheap can be used in most projects requiring a lot of steel. However when it comes to load bearing, its structural strength is not usually sufficient to be used in structural beams and girders.

Mild steel has a many advantages compare to other material. So, with these advantages, production of a good product can be produce for this final year project.

- Cheap and readily available in different sizes.
- Flexible in design and fast to erect.
- Easy to use because it can be cut, drilled, machined, threaded or tapped, rolled, formed and bent.
- Easy to manufacture (weldable) because it is softer metal and its properties allow electrical current to flow easily through it without upsetting its structural integrity.
- This steel is far less brittle so not easy to crack and break.
- Disadvantage is it is poor resistance to corrosion so it must be protected by painting to prevent it from rusting. It also not durable for a very long time.

3.6.2 Aluminium

Aluminium is a relatively soft, durable, lightweight, ductile and malleable metal with appearance ranging silvery to dull gray, depending on the surface roughness. It is nonmagnetic and does not easily ignite.

Aluminium is a good thermal and electrical conductor, having 59% the conductivity of copper, both thermal and electrical. Corrosion resistance can be excellent due to a thin surface layer of aluminium oxide that forms when the metal is exposed to air, effectively preventing further oxidation.

Aluminium is a very light metal with a specific weight of 2.7 g/cm^3, about a third that of steel. Besides, aluminium is a good reflector of visible light. Aluminium is ductile and has a low melting point and density. In a molten condition it can be processed in a number of ways. Aluminium is 100 percent recyclable with no downgrading of its qualities. The re-melting of aluminium requires little energy: only about 5 percent of the energy required to produce the primary metal initially is needed in the recycling process.

Disadvantages of aluminium are aluminium is very expensive compare to steel and it has low melting point. Besides, it is hard to welding the aluminium.

3.7 BILL OF MATERIAL

Table 3.2: Bill of material

No.	Part	Material	Dimension	Quantity
1	Clamp	Mild steel bar	50mmx20mmx450mm	2
2	Table	Aluminium block	100mmx100mmx180mm	1
3	Base	Aluminium bar	75mmx10mmx200mm	2

3.7 SUMMARY

Methodology of this project start with the design concepts that comes from the ideas after the researches of many resources includes the journals, internet, books and people. These design concepts are very important to give a choice for the best design and lastly will be the final design of this project.

Then, after final design is done, the fabrication will start the progress of the manufacturing the product. This is also one of the important processes of this final year project which is to fabricate the clamp. Explanations about the process have been discussed from the start of the process until the end of the fabrication process.

Flowchart is also includes in this methodology. This flowchart is to ensure the whole process will run according to the plan. Besides that, gantt chart is also need to ensure the progress is move in time and the project can be done in target. The gantt chart is start from week one of the project until week fourteen which is the last week of the final year project submission week.

Lastly, this chapter is discuss about the material selection which the material that need to use for the project. After the research and discussion with the supervisor, mild steel and aluminium is the material that will be use. The material is very important because it can affect the quality of product so material selection is also very important process.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 FINAL PRODUCT

4.1.1 Clamp

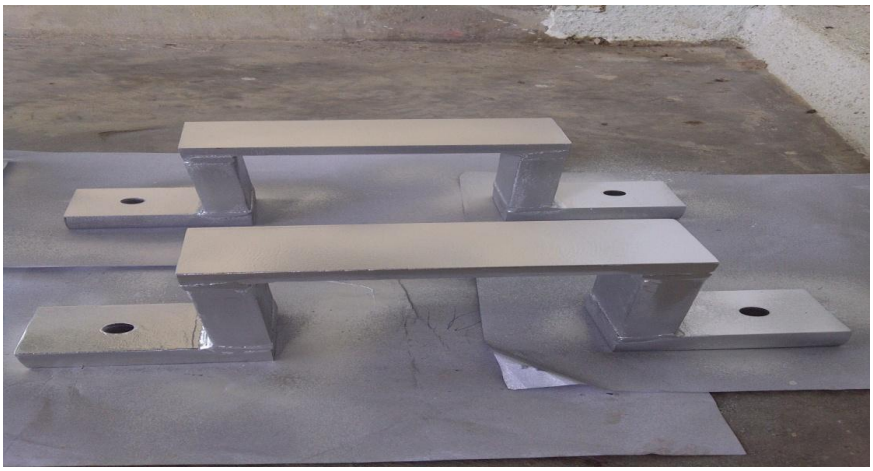


Figure 4.1: Clamp part

4.1.2 Table

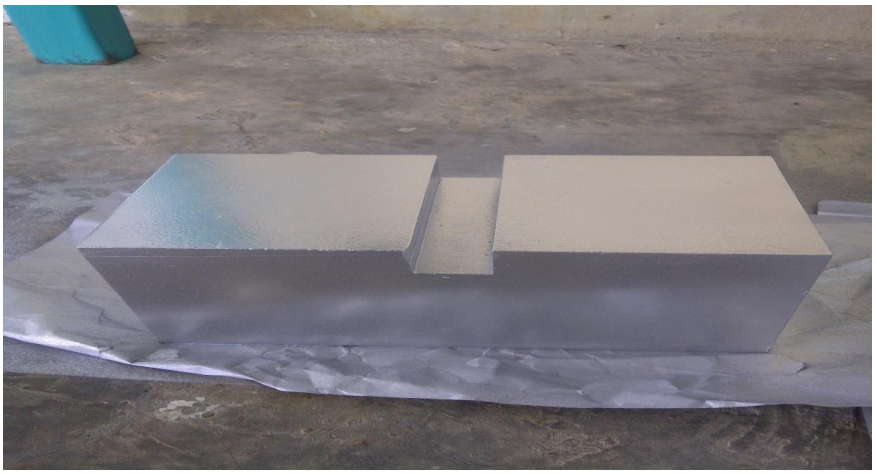


Figure 4.2: Table part

4.1.3 Base

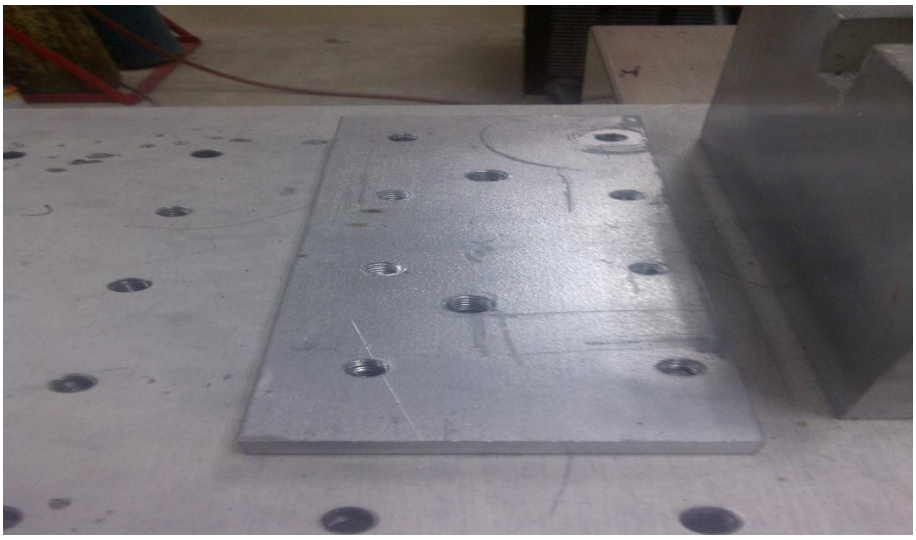


Figure 4.3: Base part

4.1.4 Product assembly

Figure 4.4: Assembly product

4.2 TESTING PRODUCT

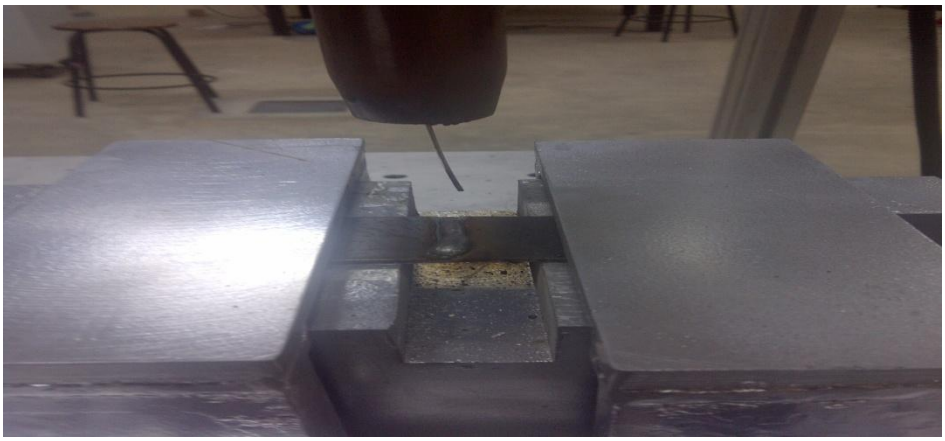


Figure 4.5: Welding specimen by using new jig

Figure 4.6: Result of welding using new jig

The specimen looks very good condition because there is no distortion on bending after the welding process. This has improves the jig better than the older jig. Besides that, the clamp force is so strong and the specimen is not move while welding.

Bending part

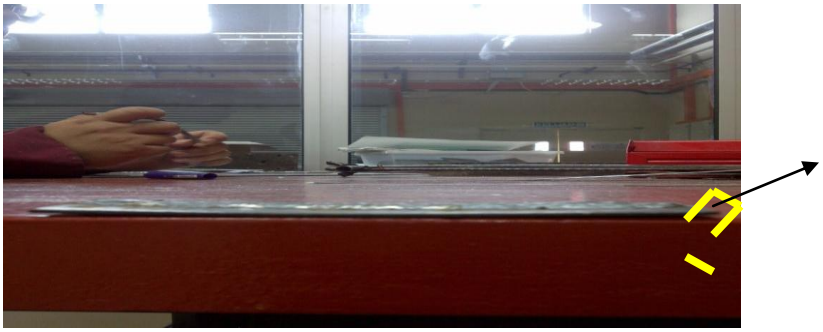


Figure 4.7: Result of welding using older jig

The specimen looks not in good condition because of the bending and distortion effect by the thermal stress. The jig not hold the specimen properly and the clamping force is not enough to prevent the specimen from bending.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

i. The best design is choose according to the characteristic which is good in durability, low in cost production and suitable in size and height, easy to use and lastly high clamping force. The design is a good choice and material used is very good with the welding condition. The product can be surely use at the existing welding machine and this can solve the problem of the students.

ii. The fabrication processes include measuring, cutting, welding, milling, drilling, tapping and finishing. These processes are suitable to their function of the machine. Firstly, the measurement of material is at the starting of the process followed by cutting the clamp part using the cutter machine. Then welding the clamp and milling the table part for the slot. Next process, drilling for the holes and make thread using tapping process. Lastly, finishing process which is painting the product. All of these processes complete using the right tools and methods.

iii. The testing weld is made to compare the result of welding using the new jig with the older jig. The weld of specimen looks very good condition because the specimen not bending compare to older specimen result. The jig also improves in clamping force and the thermal stress cannot effect the specimen because of the good quality of clamping by the new jig.

5.2 RECOMMENDATION

The recommendations can improve this product in the future:

i. The material of the clamp should be not too heavy and suitable for students. For more quality should use stainless steel because the material not rusting.

ii. The process of making the clamp should using the wire cut process and not by welding the material because the wire cut process can make finishing process of the clamp more beautiful.

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APPENDIX

1. Gantt chart

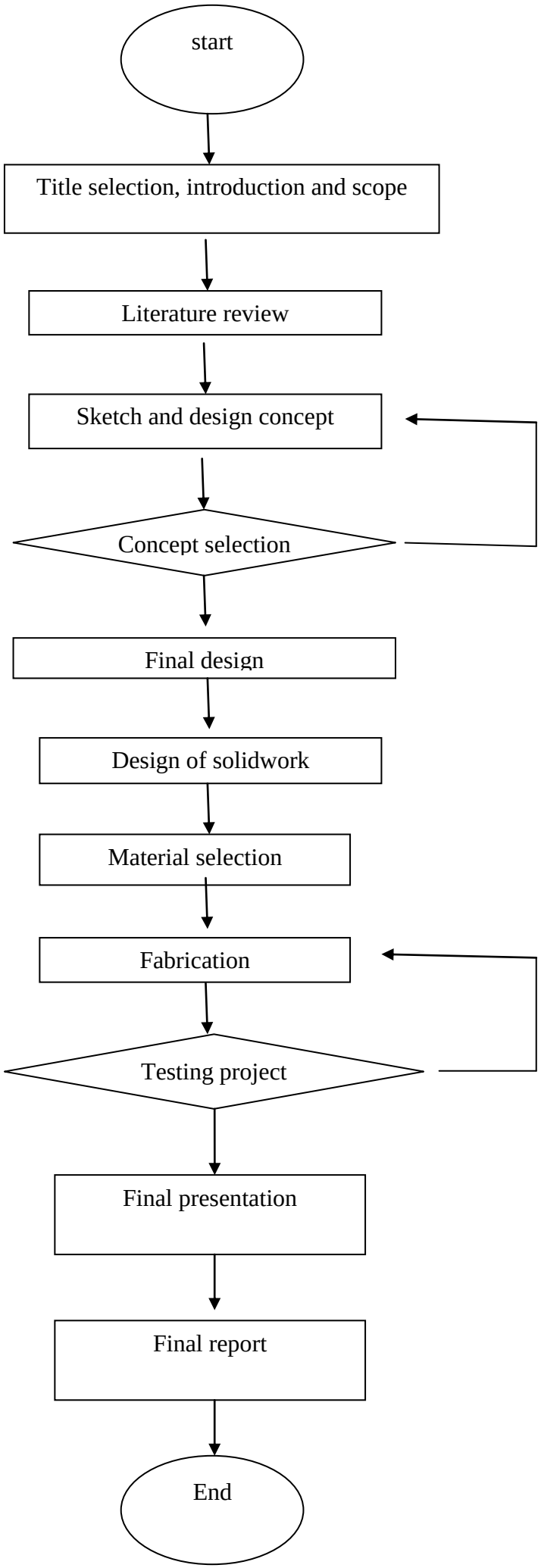
2. Flowchart

GANTT CHART

Table 5.1: Gantt chart

Week / activities		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Title selection, introduction and scope	plan														
	actual														
Literature review	plan														
	actual														
Sketch and design concept	plan														
	actual														
Analysis and concept selection	plan														
	actual														
Design of solidwork	plan														
	actual														
Material selection	plan														
	actual														
fabrication	plan														
	actual														
Testing project	plan														
	actual														
Presentation	plan														
	actual														

FLOWCHART


start
Title selection, introduction and scope
Literature review
Sketch and design concept
Concept selection
Final design
Design of solidwork
Material selection
Fabrication
Testing project
Final presentation
Final report
End