DESIGN AND FABRICATION TEST JIG

FOR CERVICAL BONE

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A report submitted in partial fulfilment of the requirements for the award of

Diploma of Mechanical Engineering

Faculty of Mechanical Engineering

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the Diploma of Mechanical Engineering

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis entitled "Design and fabrication test jig for cervical bone" is my own research except as cited in the references. The thesis has not been accepted for any diploma and is not concurrently submitted in candidature of any other diploma.

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ABSTRACT

This thesis deals with the development of cervical bone test jig. The objectives of this thesis are to design the test jig for cervical bone, fabricate the parts and assemble the parts together to complete the cervical bone test jig. The thesis describes the methods of designing and fabricating the mechanical part of the gate system. There the many steps taken to design and fabricate the mechanical part of the gate system. The structural three-dimensional solid modelling of test jig was developed by using the SolidWorks engineering drawing software. The fabrication process also undergoes many steps such as material marking, cutting, drilling, welding and grinding. Other than that, it is explaining the procedure of testing where the cervical bone of cow “bovine” to operate the mechanism of the test jig. The results of testing the jig also discussed in this thesis. Finally, the conclusion about this project and the recommendations for the future plan also attached together with this thesis.

ABSTRAK

Tesis ini membentangkan perkembangan jig ujian untuk tulang belakang. Objektif tesis ini ialah untuk mereka bentuk jig ujian tulang belakang yang khususnya untuk tulang belakang lembu "bovine". Tesis ini menerangkan cara-cara yang digunakan untuk mereka bentuk dan menghasilkan bahagian jig ujian tersebut. Pelbagai langkah telah diambil untuk menyiapkan projek ini. Lukisan struktur tiga dimensi bentuk jig ujian ini telah direka dengan menggunakan perisian lukisan kejuruteraan yang dinamakan *"SolidWorks"*. Proses penghasilan jig ujian ini telah menjalani banyak proses tertentu seperti mengukur, menanda, memotong bahan mentah, membuat lubang, mencantumkan bahagian-bahagian tertentu, dan mengikir bahagian-bahagian yang terlebih semasa dicantumkan. Di samping itu, tesis ini juga mengandungi langkah pemeriksaan mekanikma operasi, di mana bahagian jig ujian dengan tulang belakang lembu yang digunakan sebagai modal. Hasil keputusan pemeriksaan dan perbincangaan mengenai hasil keputusan turut disertakan dalam tesis ini. Akhir sekali, terdapat juga kesimpulan mengenai projek ini dan perkara-perkara yang boleh diperbaiki dalam projek ini di masa hadapan dalam tesis ini.

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LIST OF SYMBOLS

R	Radius
m	Meter
mm	Millimeter
Ø	Diameter

LIST OF ABBREVIATIONS

SMAW	Shielded metal arc welding

CHAPTER 1

INTRODUCTION

The sole purpose of this project is to understand the fundamental knowledge of the cervical bone test jig fabricating process and its operating system.

Therefore, as a student of mechanical engineering of University Malaysia Pahang, this project given me interest and exposes me the field of manufacturing engineering as a part of mechanical engineering.

The importance of improving manufacturing processes grows each year. Manufacturing production is central to any other manufacturing enterprise. One of the important factors in improving manufacturing and developing automated production system is through knowledge of manufacturing production processes, including data about the processes and conditions under which the processes are carried out.

The design and fabrication of this cervical bone test jig is to develop larger and complex design and commercial cervical bone test jig in future.

1.1 Project Synopsis

The design and fabrication the mechanical part of a cervical bone test jig requires the finished test jig to clamp the bone more tightly and nicer. The use of light and hollow material is applied in order to enhance the test jig's capability and performance as well as to reduce the cost of the project.

1.2 Objective of the Final Year Project

1.2.1 General Objective

This final year project is part of the required subjects to be taken during the Diploma in Mechanical Engineering course. This is done during the final semester before advancing into the industrial training program. Therefore, it is vital to complete this project in order to receive a final grade depending on the effort put in.

The final year project is also to give the students the individual ability and confidence to complete a task with under less supervision of lecturers. With this, students can learn problem solving skills in areas of designing, analysis, fabrication and testing as well learn to do a complete formatted report which is important for future thesis writing.

1.2.2 Specific Objective

There are two specific objectives for this final year project, which are:-

i. To design the mechanical part of a cervical bone test jig.
ii. To fabricate the designed mechanical part of the system.

These objectives must be fulfilled to complete this project

1.3 Scope of Work

Finishing the test as jig requires precise scope of work to be followed. This project title is new as well the knowledge for this project is not entirely answered in the subjects taken during this diploma course. Therefore, the manufacturing knowledge applied is the friction and manufacturing technology detailing in the aspects and scope of designing and fabricating the test jig. Likewise, unique scope of work should be determined to achieve the purpose and goal of the project.

These scopes are:

i. Literature review on the knowledge of clamp device and test jig on other part of bone.
ii. Design the mechanical part of the test jig using theoretical and practical approach.
iii. Fabricate the mechanical part of the test jig using welding skill, drilling, and tapping.
iv. Test designed and fabricated mechanical part of the system together with 'bovine bone' cow's back bone as the model to complete the test on test jig.

Only with these scopes, total effectiveness can take place to satisfyingly complete this title of final year project.

1.4 Project Planning

To start this project, a thoroughly research of literature review is done with the means of the internet, books, available published articles and materials that is related to the title and supervisor's guidance. This is continuing progress until sufficient knowledge is attained to complete the project.

In the first week, an appointment with the supervisor is done to manage the schedule of weekly meeting. The purpose is to inform the supervisor on the progress of the project and guided by supervisor to resolve difficulty.

Briefing based on the introduction and next task of the project is given by the supervisor in the first week.

Designing phase starts of by sketching few designs and models using manual sketch on A4 papers. Then, analyse the designs and choose an appropriate design to finalize. Next, propose the design to the supervisor. After that, convert the design to the three dimensional drawing using SolidWorks software. After done a deep research on cervical bone test jig and the material used propose the appropriate material types and specification to the supervisor.

The preparation of mid-presentation of the project is next. Before presenting, the supervisor will see through the presentation slides and comment on corrections to be made. Then, the presentation on the knowledge attained and instilled in the design phase is presented to the panel of three judges. It takes eight weeks to design and alteration is done.

Following up, is the survey for the materials needed and purchasing the suitable materials. The modification is done on the design so as the model will operate better. Once cut the materials, start the fabrication of mechanical part of the system. This would take about two weeks to complete.

Once drilling process starts, complete the drilling parts by parts. Then, do tapping process at needed parts. Then, assembly of the parts by nat and bolt will be next and then testing. Modifications or add-ons, and some trials will be done until it operates for about the period of one week. Results are jotted done during this time trials.

After that, the final report writing and presentation will be the last task to be accomplished during the week thirteen. The supervisor will review the final presentation and revise the mistakes to be amended. The final presentation then again will be presented to three panels. A draft report would then be submitted to the supervisor to be point out the flaws. Corrections are done and the real final report is

handed over as a completion of the final year project. Some problems I had faced during the project such as milling machine is under maintenance, delay in start project due to process shifting Campus to Pekan Campus.

1.5 Thesis Organization

In chapter two, I will go through the literature review of the gate system. This chapter will discuss about the reviewing study about the cervical bone test jig.

In chapter three, I will go through the methodology of the project. This chapter will discuss more about the fabrication process of the project. It's includes the materials and method of fabrication.

In chapter four, I will discuss about the result and discussion. These will base on the testing of the system and the operating mechanism of cervical bone test jig.

In chapter five, I will conclude the project. This chapter also includes the summary of the project and recommendation for future project.

CHAPTER 2

LITERATURE REVIEW

The title design and fabrication of a cervical bone jig requires an amount of good understanding on the knowledge of the cervical bone structure and basic operating system of a jig. Therefore, executing a research is necessary to obtain all the information available and related to this topic. The information or literature reviews obtained are essentially valuable to assist in the fabrication and specification of this final year project. With this ground established, the project can be accomplished with guidance and assertiveness in achieving the target mark.

2.1 Definition

2.1.1 Cervical bone

Some species, some parts of the skull may be composed of vertebra-like elements and the occipital bone in humans is composed of four vertebra-like segments. In humans, cervical vertebrae are the smallest of the true vertebrae, and can be readily distinguished from those of the thoracic or lumbar regions by the presence of a foramen (hole) in each transverse process, through which passes the vertebral artery.

A jig is any of a large class of tools in woodworking, metalworking, and some other crafts that help to control the location or motion of a tool. Some types of jigs are also called templates or guides.

The primary purpose for a jig is for repeatability and exact duplication of a part for reproduction. An example of a jig is when a key is duplicated, the original is used as a jig so the new key can have the same path as the old one. In the advent of automation and CNC machines, jigs are not required because the tool path is digitally programmed and stored in memory. Jigs may be made for reforming plastics, and also for use in reproduction of materials

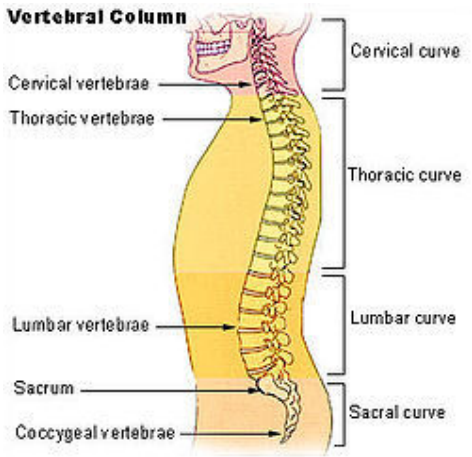


Figure 2.1: Side View of Vertebral Column

(Source : http://www.webbooks.com/eLibrary/Medicine/Physiology/Skeletal)

2.2 Structure of Cervical Bone

These are the general characteristics of the third through sixth cervical vertebrae. The body of these four vertebrae is small, and broader from side to side than from front to back.

i) The anterior and posterior surfaces are flattened and of equal depth; the former is placed on a lower level than the latter, and its inferior border is prolonged downward, so as to overlap the upper and forepart of the vertebra below.

ii) The upper surface is concave transversely, and presents a projecting lip on either side;
iii) the lower surface is concave from front to back, convex from side to side, and presents laterally shallow concavities which receive the corresponding projecting lips of the underlying vertebra.

The pedicles are directed laterally and backward, and are attached to the body midway between its upper and lower borders, so that the superior vertebral notch is as deep as the inferior, but it is, at the same time, narrower. The laminae are narrow, and thinner above than below; the vertebral foramen is large, and of a triangular form. The spinous process is short and bifid, the two divisions being often of unequal size.The superior and inferior articular processes of neighboring vertebrae often fuse on either or both sides to form an articular pillar, a column of bone which projects laterally from the junction of the pedicle and lamina.The articular facets are flat and of an oval form:

i) the superior face backward, upward, and slightly medially.
ii) the inferior face forward, downward, and slightly laterally.

The transverse processes are each pierced by the foramen transversarium, which, in the upper six vertebrae, gives passage to the vertebral artery and vein, as well as a plexus of sympathetic nerves. Each process consists of an anterior and a posterior part. These two parts are joined, outside the foramen, by a bar of bone which exhibits a deep sulcus on its upper surface for the passage of the corresponding spinal nerve.

The anterior portion is the homologue of the rib in the thoracic region, and is therefore named the costal process or costal element. It arises from the side of the body, is directed laterally in front of the foramen, and ends in a tubercle, the anterior tubercle. The posterior part, the true transverse process, springs from the vertebral arch behind the foramen, and is directed forward and laterally; it ends in a flattened vertical tubercle, the posterior tubercle.

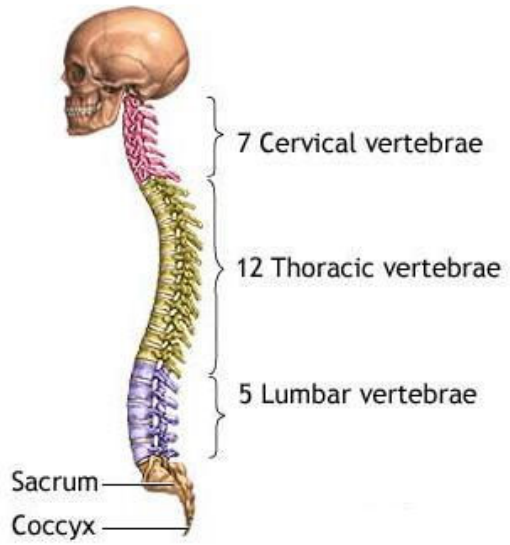


Figure 2.2 : Structure of Cervical Bone

(Source : http://www.nlm.nih.gov/medlineplus/ency/images/ency/fullsize)

2.3 Jig

A device that holds a piece of machine work and guides the tools operating on it device. An instrumentality invented for a particular purpose. A jig includes a main body having at least one tool guide portion, and a referencing member selectively attached to a bone.

2.4 Type of Jig

2.4.1 Test Jig (Knee jig)

Knee joint becomes damaged or diseased, it is known to replace the entire knee joint with a prosthesis. There are a large variety of different knee prostheses, but the most common type consists of a femoral component attached to the distal end of the femur and a separate tibial component attached to the proximal end of the tibia. These components can articulate directly on one another or can be separated by a meniscal bearing component. Where possible, all of the knee ligaments are retained, although in practice it may be necessary to remove at least the posterior

cruciate ligament. It may also be desirable for the tension in the knee ligaments after surgery to be balanced throughout their range of motion.

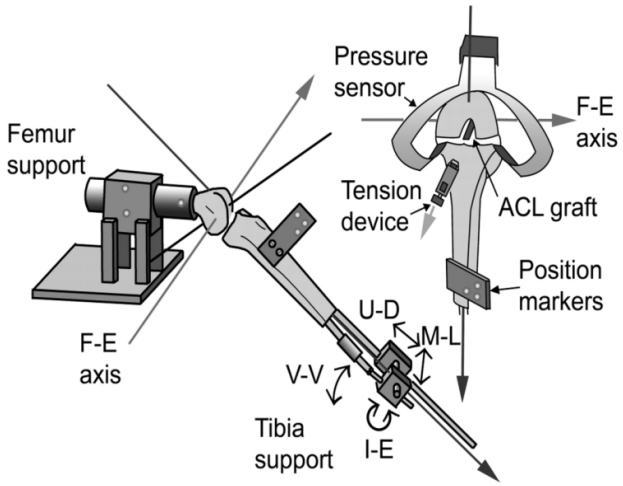


Figure 2.3 : Knee Jig

(Source : http://ajs.sagepub.com/content/35/3/395)

The most complex component of a total knee prosthesis is the femoral component, since it carries not only the condylar bearing surfaces, but also the patella bearing surface which extends along an anterior face of the distal femur. Conventional femoral components require resecting of the distal end surface of the femur and the anterior and posterior faces of the femur. They also usually require two chamfered cuts to be made at the distal end of the femur anteriorly and posteriorly. The anterior or posterior position of the cuts made in the femur are vital in order to restore proper functioning of the knee and balance to the ligaments. Conventional jigs for resecting the femur use as a reference an intramedullary rod with a set anterior or posterior position on the jig on the anterior or posterior axis. The correct positioning of the jig is vitally important to ensuring equal tension in the ligaments after surgery.

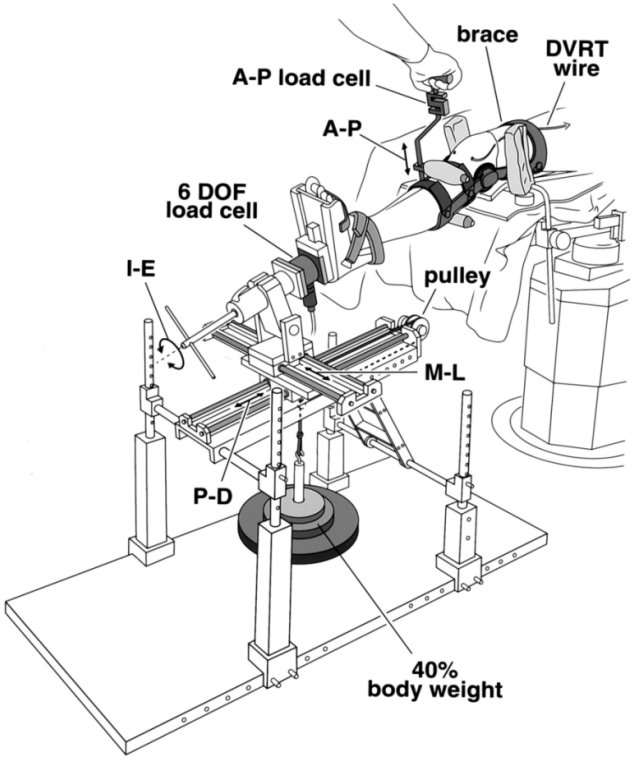


Figure 2.4 : Other Knee Jig Model

(Source : http://ajs.sagepub.com/content/28/6/815)

A method of resecting a first bone, the first bone articulating with a second bone at a joint includes inserting a referencing member into the first bone with a longitudinal axis of an adjusting member aligned substantially perpendicular to an articulation axis of the joint, and with an underside of a main body engaging an end of the first bone. A spacer is inserted between a posterior surface of the main body and an end of the second bone. The adjusting member is adjusted until a desired tension is achieved in ligaments joining the first and second bone.

Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the embodiments of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

2.4.2 Machining Jig (Drill Jig)

Drill jig is a type of jig that expedites repetitive hole center location on multiple interchangeable parts by acting as a template to guide the twist drill or other boring device into the precise location of each intended hole center. In metalworking practice, typically a hardened bushing lines each hole on the jig to keep the twist drill from cutting the jig.Drill jigs started falling into disuse with the invention of the jig borer.

Figure 2.5 : Drill Jig

2.5 Clamping device and Type of Clamping Device

A clamp is a fastening device to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure. There are many types of clamps available for many different purposes. Some are temporary, as used to position components while fixing them together, others are intended to be permanent. A physical clamp of this type is also used to refer to an obscure investment banking term. Anything which performs the action of clamping may be called a clamp, so this gives rise to a wide variety of terms across many fields.

2.5.1 Electromagnetic clamping device

An electromagnetic driving device for a mold clamping system is disclosed, which has a stationary plate fixedly mounted on a lathe bed; a mold guiding mechanism mounted parallel on the lathe bed; a movable plate slidably arranged on the mold guiding mechanism, facing the stationary plate, for generating a relative slide to the stationary plate; and a movable plate driving mechanism for driving the movable plate on the mold guiding mechanism. The electromagnetic driving device utilizes magnetic force to drive the linkage, movable plate etc. to perform open-mold movement, close-mold movement, and mold-locking movement.

A linkage type mold clamping device, comprising: a stationary plate on which a stationary side mold is mountable; a movable plate on which a movable side mold is mountable in a position opposite the stationary side mold; a mold guiding mechanism by which said movable plate can slide; a lathe; and a movable plate driving mechanism for driving the movable plate, using electromagnetic force, on said mold guiding mechanism, said movable plate driving mechanism comprising: a slider guiding mechanism fixedly mounted on said lathe.

A driving slider slidably arranged on the slider guiding mechanism for sliding on the slider guiding mechanism; a magnetic field generating system comprising a magnetic field generating device and a magnetic base, for generating first and second magnetic fields, the magnetic field generating device being attached on the driving slider and the magnetic base being attached on the lathe; a magnetic force controller electrically connected to the magnetic field generating system, for controlling a direction and a magnitude of the magnetic fields; and at least one linkage, one end of the linkage being rotatably mounted on a back side of the movable plate and another end of the linkage being rotatably mounted on the driving slider, where in the first magnetic field causes an attracting force to be generated between the magnetic field generating device and the magnetic base.

The second magnetic field causes a repulsive force to be generated between the magnetic field generating device and the magnetic base, thereby causing the

driving slider to slide and drive the linkage to move the movable plate toward and away from the stationary plate, with a limit position of the linkage being in a dead center position of said movable plate driving mechanism, so that the mold clamping device generates a self-clamping effect to complete a mold-locking movement.

2.5.2 Mechanical Clamping Device

A clamp member for a vice or the like. A hollow spindle is threaded into a stationary block and carries a slide member thereon and a drive rod therein. A limited-torque clutch connects a drive rod to said hollow spindle and solid connecting means connects said manual drive means to said drive rod. Upon rotation of the handle, force is transmitted through the limited-torque clutch to rotate the hollow spindle with respect to the stationary block for advancement of same and simultaneous advancement of the slide until the work-engaging plate initially contacts the workpiece.

Thereafter, the clutch slips and force is then applied through the drive rod to force multiplication means and applied to the work-engaging plate for imposing clamping force thereon. The drive rod is only torsionally stressed for most of its length and hence is not subjected to bending forces. It is compressively stressed only for a short distance at the end adjacent the force multiplication means and can at this point be readily and adequately guided.

A mechanical clamping device having a hollow spindle rotatably supported in a slide member, said hollow spindle being threadably engageable in a stationary bearing block and drivable by means of a hand crank through a drive shaft and torque coupling, an abutment arranged in said slide member having the front end of said hollow spindle mounted on one side and a pair of toggle levers mounted on the other side, pressure rod means supported for longitudinal movement in said hollow spindle and acting onto said pair of toggle levers by means of a pressure pad, said pressure rod means being movable longitudinally of said hollow spindle only after a disengagement of said torque coupling upon further rotation of the hand crank to thereby press apart said pair of toggle levers, wherein the improvement comprises said pressure rod means and said drive shaft being made of one piece to define a

pressure spindle extending lengthwise of said slide member, said pressure spindle having thread means adjacent said pressure pad, said thread means being threadably coupled to said hollow spindle adjacent the front end.

Figure 2.6 : Centring Clamping Device (Mechanical type)

(Source : www.springer-zerspanungstechnik.de)

2.6 Pneumatic and Hydraulic Clamping Device

2.6.1 Pneumatic Clamping Device

Pneumatic clamping device enables simultaneous CNC reworking of up to four diecast parts. The part placement area is designed to match the parts and the swivelling clamp can be turned through 90°, which enables extremely accurate and simple reworking. Processing from three side is possible thanks to clamping of the device in the fourth axis.

The speciality of this pneumatic clamping device is its ability to rework the part both from the front and from the back. To avoid damaging, parts should only be subjected to minor pressure. In this case, the chuck has been designed as a wedge

shape. This means that the parts will be in the correct position despite being subjected to high processing forces, and machining is possible from both sides.

Figure 2.7 : Pneumatic Clamping Device

(Source : www.springer-zerspanungstechnik.de)

2.6.2 Hydraulic Clamping Device

Hydraulic clamping system. As the entire part surface was to be machined, the part could not be fixed from above. For this reason the part is being clamped from the side by a hydraulic cylinder. The device has been designed so that the parts can only be placed in one direction so that operation by untrained personnel is also possible. Hydraulic 90° swivelling clamps enable parts to be placed in the device without problem. Each part is held in position at three points, thus absolutely precise CNC reworking of diecast parts for the automobile industry from three sides is guaranteed.

Figure 2.8 Hydraulics Clamping Device

(Source : www.springer-zerspanungstechnik.de)

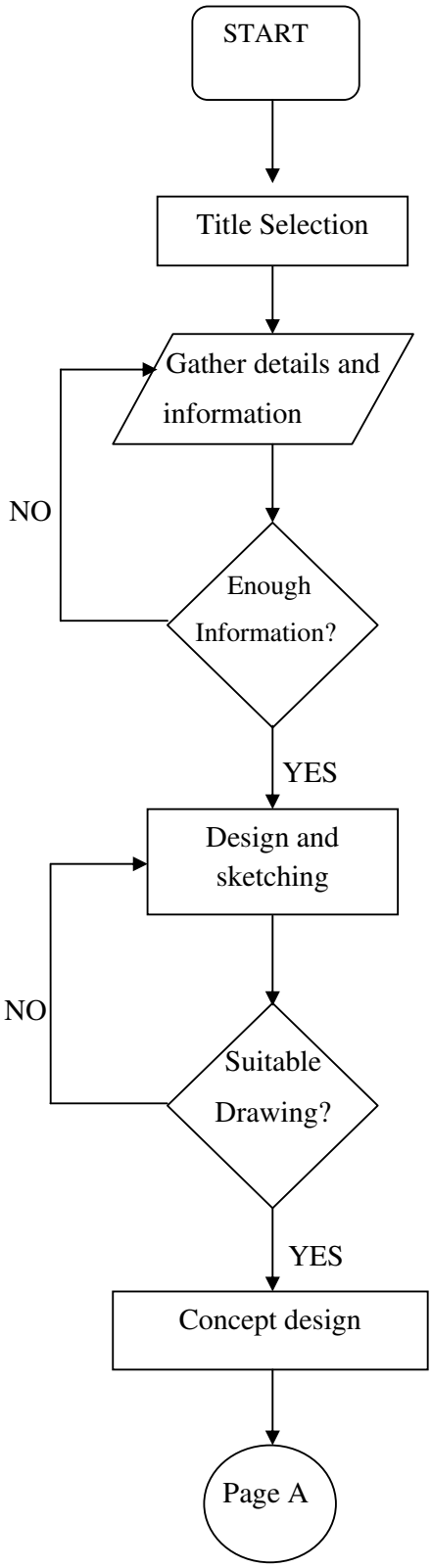
CHAPTER 3

METHODOLOGY

In designing and fabricating the mechanical part of the cervical bone test jig, a flow of methods had to be used to design and fabricate the model. First of all, a process planning had to be charted out. This acts as a guideline to be followed so that, the final model meets the requirement and time could be managed. This would determine the efficiency of the project to be done. Regulating and analyzing these steps are very important as each of it has its own criteria to be followed. The designing process is the backbone of the model, therefore using appropriate the precise method is imperative to this project.

Intense study of the designing phase proved to be essential for the next step. Only with this determination on the designing procedure to be successful, then the fabrication development of the project can be carried out. The fabrication process carried out has to be accurate with the design first. Once this is established, modification grounds can be made triumph during testing of the cervical bone test jig. During testing, the experiment criteria are validated to suite the performance of the cervical bone test jig and understanding. Finally, the analysis of the whole project can be concluded in the next chapter.

3.1 Flow Chart



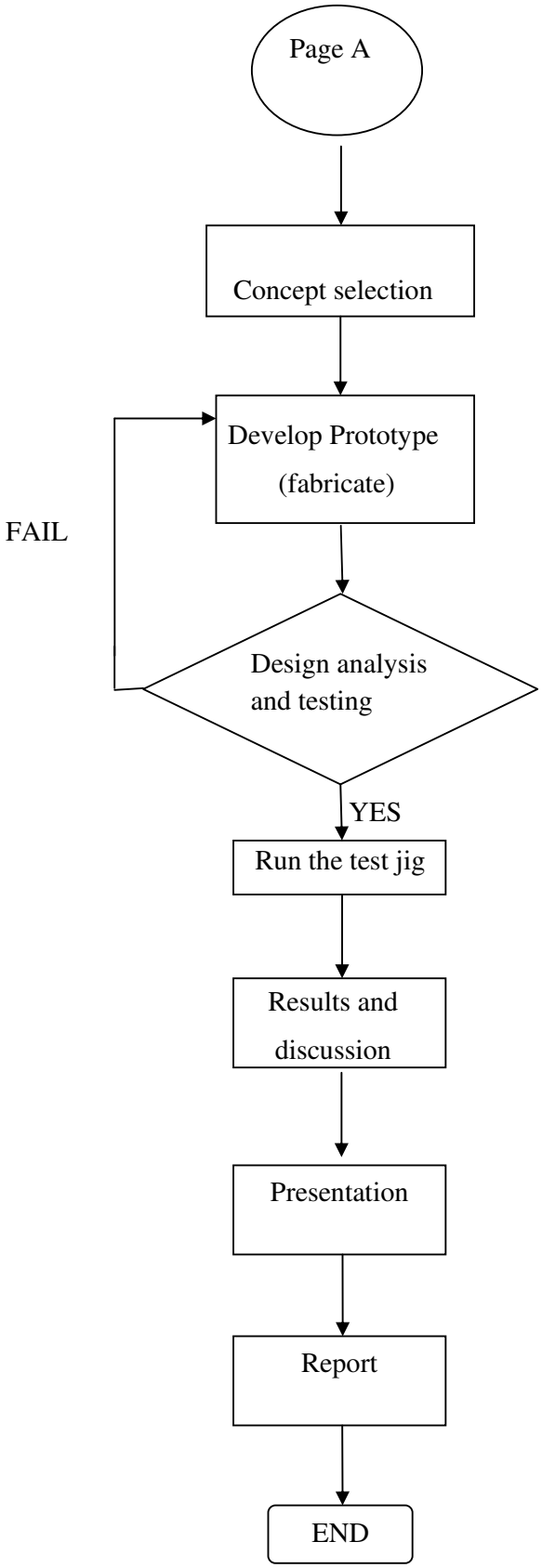


Figure 3.1: Flow chart

The flow chart starts of with the title selection. Here, the title is selected from the numbers of other final year project. Three main titles are selected according to the preferences. The topics are submitted to the Final Year Project coordinator. Here, the titles will be allocated depending on the grade point average. After receiving the title, students are allowed to switch titles with the permission of the supervisor. A declaration is then sign to be under the new supervisor and weekly meetings were scheduled.

Once the title is confirmed, the supervisor request for understanding of the project. Thus, literature review on the title is done thoroughly covering all aspects of the project. The medium researches are via internet and books. Essential information related to the project is gathered for referencing.

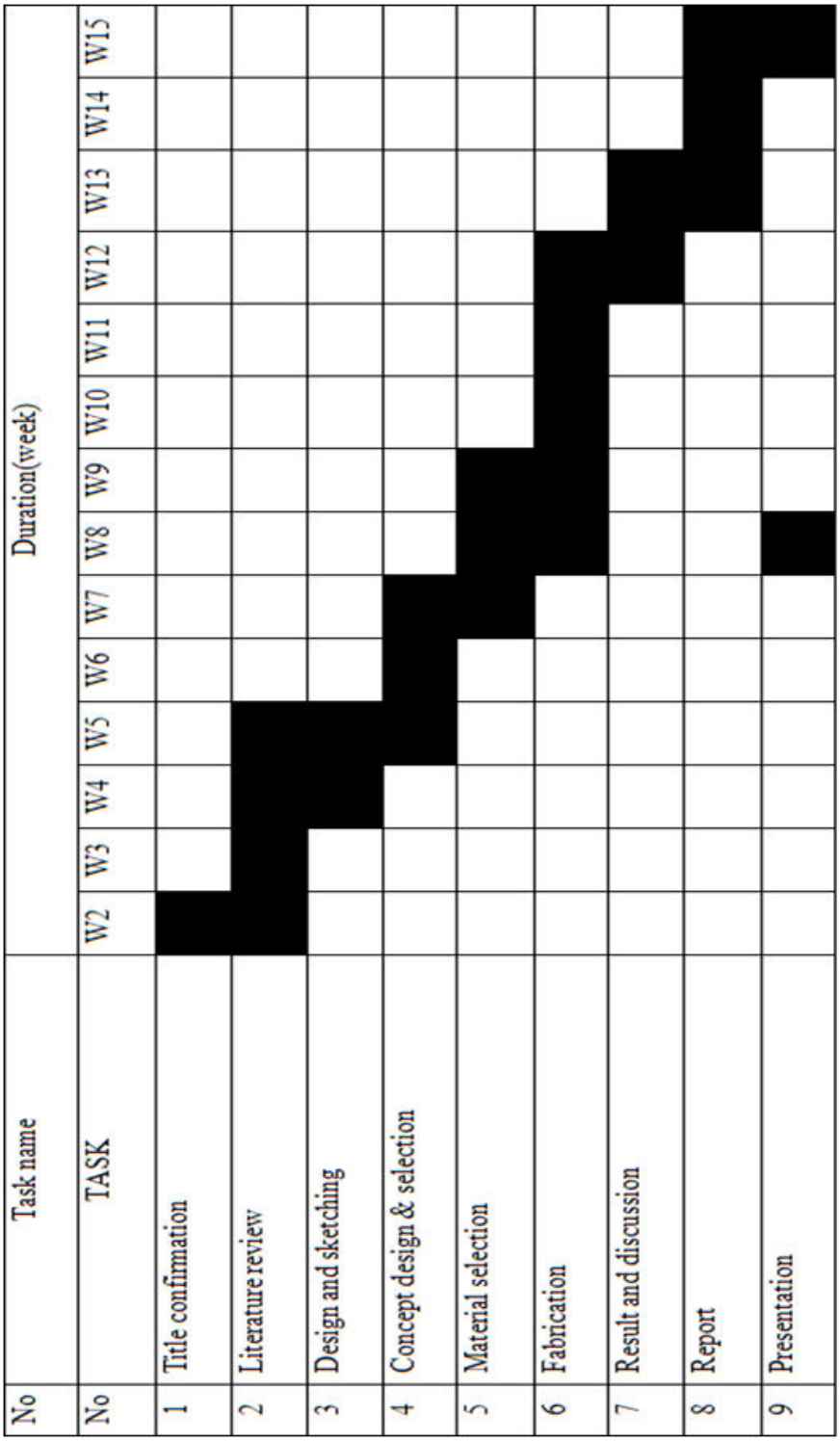
After that, do few designs and sketching of test jig. Then, propose and discussed the designs with supervisor to choose the suitable drawing. Later, convert the selected design to the three dimensional drawing by using Solid Works software.

Next, select the materials to fabricate the test jig. Survey and bought the appropriate materials with supervisor's permission. Once the raw materials received, start the fabricating process. After the fabricating process completed, finalize the test jig.

Then, do the testing to the test jig. The results were collected and continue with the discussion. On the same time, prepare for the final presentation and write the draft report.

After the presentation, the draft report must be submitted to the supervisor. Supervisor will check for errors and do the correction in the draft report. The final thesis must be complete and submit at the Faculty of Mechanical Engineering.

3.2 Gantt Chart



No	Task name	Duration(week)														
No	TASK	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	
1	Title confirmation															
2	Literature review															
3	Design and sketching															
4	Concept design & selection															
5	Material selection															
6	Fabrication															
7	Result and discussion															
8	Report															
9	Presentation															

Table 3.1 : Gantt chart

Week 2, the confirmation of the project title was done. Weekly meetings with the supervisor were scheduled. The supervisor then gives the task to be done, which was to do literature review about the title.

Week 2 until week 5, discussion with the supervisor about the literature found. Next the supervisor requests the design of cervical bone test jig. Literature review was still ongoing to get any information relating to the topic.

Week 4 and week 5, the findings were presented to the supervisor and discussed. The next task would be sketching some designs of cervical bone test jig and choosing the simple and best design.

Week 5 until week 7, discussion with the supervisor about the sketching some design of gate system. Finally, I choose one simple and best design of a gate system. Then, I convert the sketching to the three dimensional drawing using Solid Works software. Besides that, I was preparing the slides for mid-presentation.

Week 8, mid-presentation was held. Then, I choose the material selection and survey the materials needed. Compare the price of materials in different hardware shops and discussed with the supervisor.

Week 8, finalize the material selection. By week 9 bought the needed materials. Start fabricating the modal of the cervical bone test jig. By week 12, the fabricating was finished while report writing was ongoing.

Week 13, I do the analysis and test the test jig. Besides that, the preparation for final presentation was on going. The draft report submitted to the supervisor. Supervisor will check for errors and do the correction in the draft report.

The final presentation also held in week 15. The final thesis must be completed and handed over as a completion of the final year project on week 15.

3.3 Concept Design

The design of cervical bone test jig must be compliance to several aspects. The aspects that must be considered in designing the mechanical part of the test jig is operating mechanism, cost, ease of design, and weight of the test jig.

The design of cervical bone test jig should have a efficient clamp device to create a better hold on cervical bone. The design also should be less weight so that the jig is portable. Other than that, the test jig also must be have some rubber surface to the clamping parts to reduce the damage on testing bone.

Finally, the design should be ease to develop and less cost which allocated to me.

3.3.1 Concept A

Concept A of cervical bone test jig should have a efficient clamp device to create a better hold on cervical bone in vertical position. The design have 3 clamping parts. First is side clamping and then front blocking part then lastly back pushing part which make bone clamped in static position.

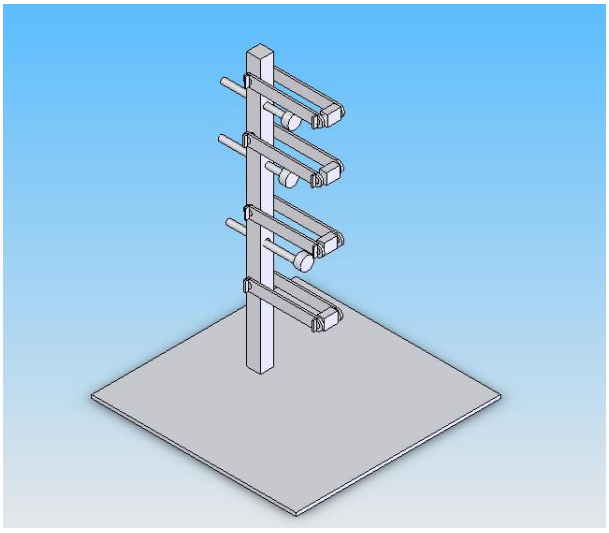


Figure 3.2 : Concept A

3.3.2 Concept B

Concept B of cervical bone test jig should have a efficient clamp device to create a better hold on cervical bone in horizontal position. This design have 2 clamping parts. First is side clamping and top clamping which also make the bone stay in static position during testing. This concept is also effective when doing testing such as drilling process where the top clamping device will make sure the bone will not kick back during the test.

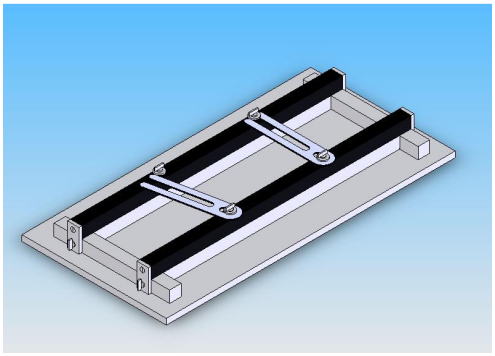


Figure 3.3 : Concept B

3.3.3 Concept C

Concept C of cervical bone test jig should have a efficient clamp device to create a better hold on cervical bone in horizontal position. This design have 2 clamping parts and functions same as Concept B. This concept have a ergonomic design where basement of the test jig is adjustable according to the needed height.

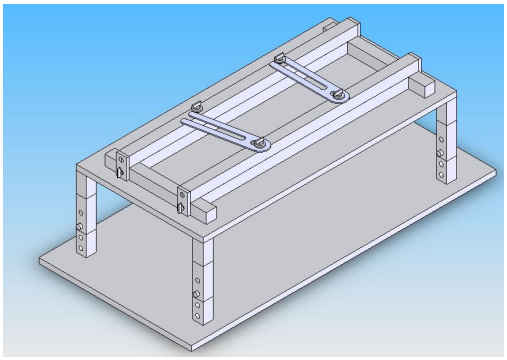


Figure 3.4 : Concept C

3.4 Concept Scoring

The concept scoring method on the three concept designs is shown below :-

		Concepts					
		A		B		C	
Selection Criteria	Weight	Rate	Scoring	Rate	Scoring	Rate	Scoring
Ability of clamping device	40%	4	1.60	5	2.00	5	2.00
Ease of fabrication	15%	2	0.30	4	0.60	3	0.45
Cost	15%	2	0.30	4	0.60	3	0.45
Ease of handling	15%	2	0.30	4	0.60	3	0.45
Stability	10%	2	0.20	5	0.50	4	0.40
Ergonomic	5%	2	0.10	3	0.15	5	0.25
	Total score	2.80		4.45		4.00	
	Rank	3		1		2	
	Continue?	NO		DEVELOP		NO	

Table 3.2 : Concept Scoring

From the data, the Concept A is has a good clamping ability. It needs advanced fabrication skills due to its complex structure. The possible for fabricating failure is also high. The cost to fabricate the concept is high as compare to other concepts and the handling system for this test jig is requires highly skilled people. The concept has a bad stability due to its height for the ground. Finally , this concept has a bad ergonomic status compare to other designs.

Concept B is has an excellent clamping ability. It needs intermediate fabrication skills due to its simple structure. The possible for fabricating failure is low. The cost to fabricate the concept is low compare to other concepts and the handling system for this test jig is requires intermediate skilled people. The concept has a good stability. Finally , this concept has a good ergonomic status compare to other designs.

Concept C is has an excellent clamping ability also but it needs advanced fabrication skills due to its complex structure. The possible for fabricating failure is high also. The cost to fabricate the concept is high compare to concept B and the handling system for this test jig is requires highly skilled people. The concept has a moderate stability. Finally , this concept has a very good ergonomic status compare to other designs because of the adjustable mechanism on it.

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3.4.1 Selected Design Specifications

The design that has been selected was first design Concept B. The selection of this design is easy to fabricate and it simple structure. The concept has low cost and good handling. Finally, this concept has a good stability and good ergonomic

The design specification for this design show below:-

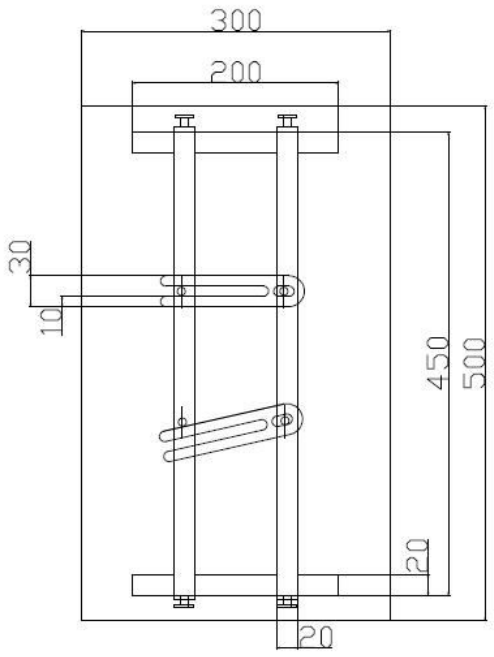

Figure 3.5 : Design specifications for selected design

3.5 Three Dimensional Drawings

The three dimensional drawings include part drawings and assembly drawings. The fabrication of the cervical bone test jig consists of many parts. Here are the part drawings and assembly drawings of the mechanical part of the solar gate system.

3.5.1 Part Drawings

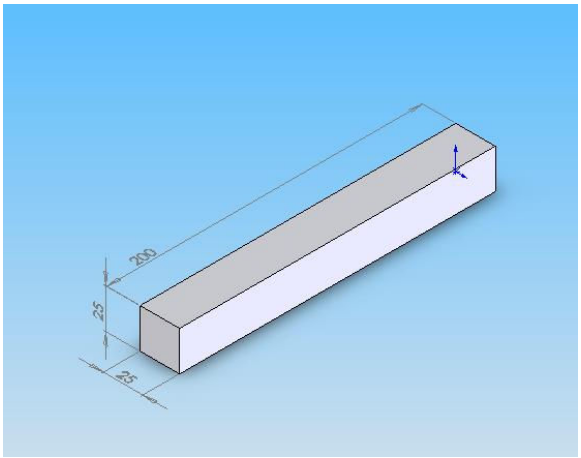

Figure 3.6 : Part drawing 1 (Fixed Vertical Bar)

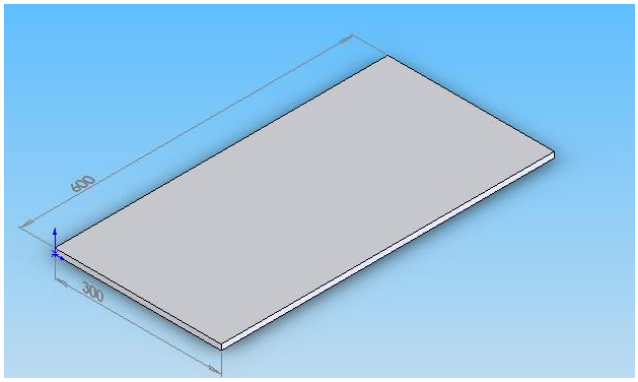

Figure 3.7 : Part drawing 2 (Basement)

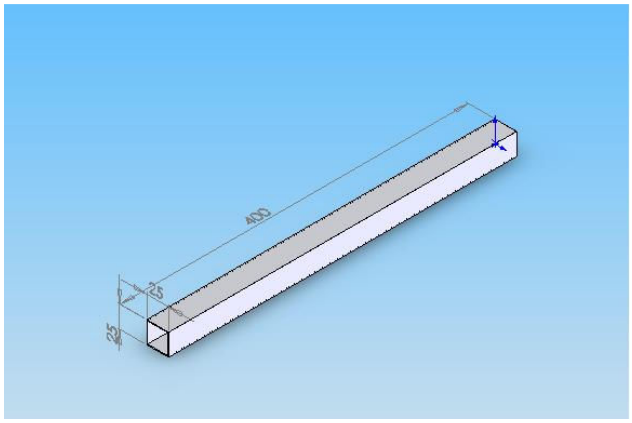

Figure 3.8 Part drawing 3 (Side Clamping Device)

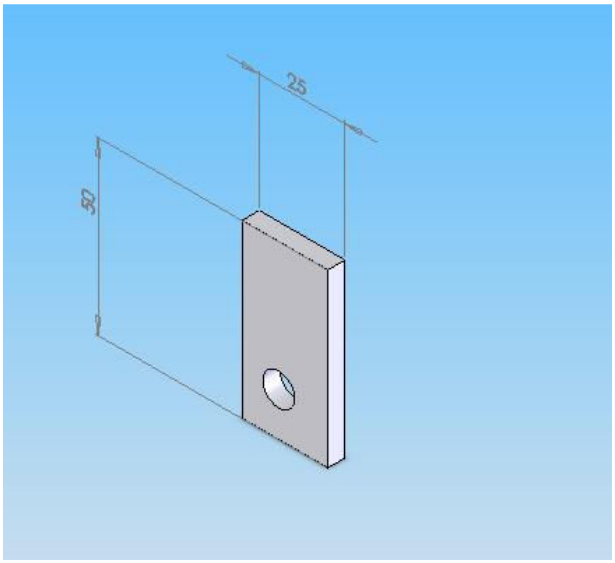

Figure 3.9 : Part drawing 4 (Side Driver Device)

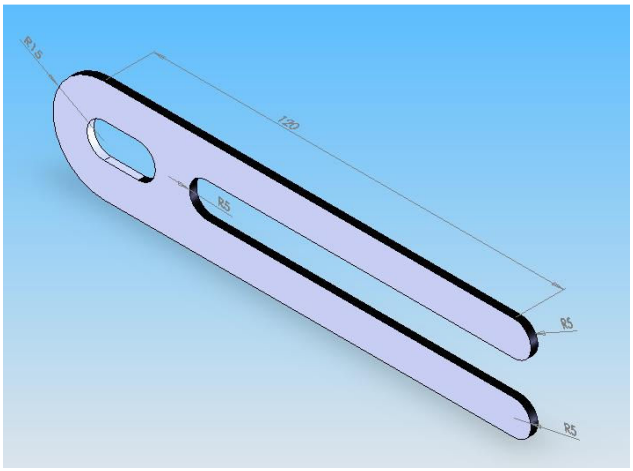

Figure 3.10: Part drawing 5 (Top Clamping Device)

3.5.2 Assembly Drawings

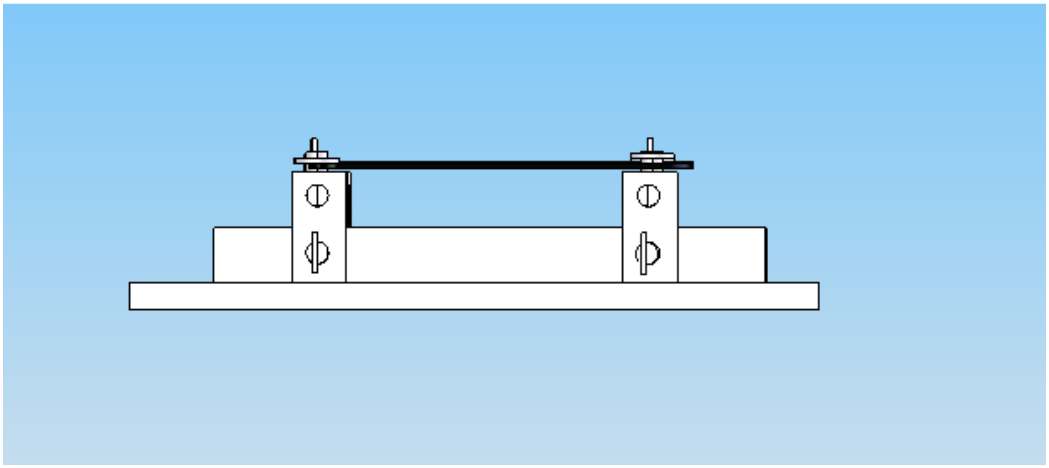

Figure 3.11 : Assembly drawing Front View

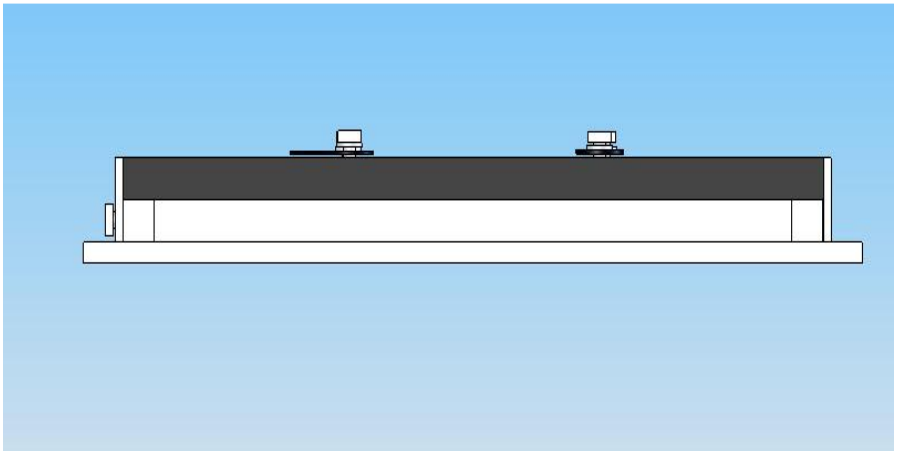

Figure 3.12 : Assembly drawing Side View

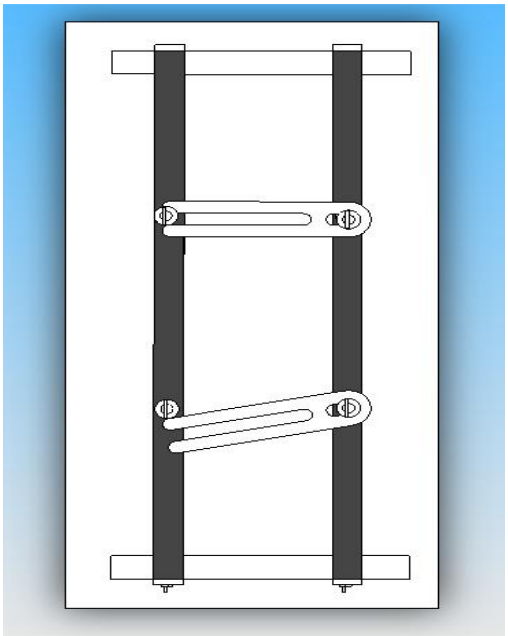

Figure 3.13 : Assembly drawing Top view

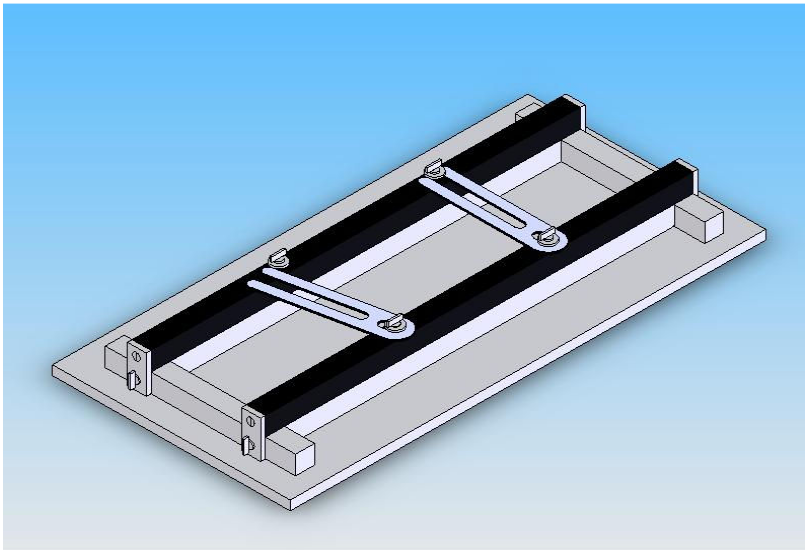

Figure 3.14 : Assembly drawing 4 isometric view

3.6 Selected Material

For this final year project, I used two types of material to fabricate the mechanical part of the gate system. I use the rectangular aluminium bar to fabricate the body of the test jig. I use this material because it is most suitable for low weight and high resistance top corrosion. The material is hard and not brittle.

Next, I use sheet aluminium as the basement of test jig to support the the body of the system. The reason I select this material is high resistance to corrosion and enough strength to support the test jig. Finally, I buy the nat and bolt to joint the body of the test jig

Material	Dimensions	Unit
Rectangular Hollow Mild Steel	30mm x 30mm x 400 30mm x 30mm x 200	2 2
Sheet Mild Steel	30mm x 150mm × 5mm	2
Sheet Aluminim	500mm × 300mm × 5mm	1

Table 3.3 : Descriptions of the materials

3.7 Fabrication Process

Fabrication process is the process to make or built the part / model of the project. This process needs to follow the exact dimension according to the drawing design. In making the design become a real product or model, several processes have been used to fabricate the cervical bone test jig, which are:-

i. Measuring : Measure the material according to the dimension.
ii. Marking : Mark the material after measure it.
iii. Cutting : Cut the material into required part that has been marked.
iv. Drilling : Drill to make the hole.
v. Welding : To assemble the parts of the system.
vi. Grinding : To remove the over melt welding part
vii. Threading :To make thread so that can insert nat

3.7.1 Apparatus / Machines

There are a few apparatus or machines that have been used to fabricate the each part. The machines used are described below :-

i. Cutting : Bendsaw Machine , Vertical Bendsaw & Disk Cutter Machine
ii. Drilling : Drilling Machine
iii. Welding : Shield Metal Arc Welding
iv. Grinding : Grinder Machine

3.7.2 Fabrication Process Steps

The fabrication process starts with measuring and marking the materials into the dimension needed according to the design. The measuring and marking process is done by using steel ruler, measuring tape and scriber.

Figure 3.15 : Measuring Tape

After measuring and marking process done, the materials will be cut according to the marked by using horizontal bendsaw machine for hollow material and vertical bend saw for sheet material.

Figure 3.16: Cuts material using horizontal bend saw

Figure 3.17: Cuts material using vertical bendsaw

After finish cutting the material into the pieces that needed, continue with marking process and then continue with drilling process to make the holes at connecting plate which will attach together with basement and top clamping device.

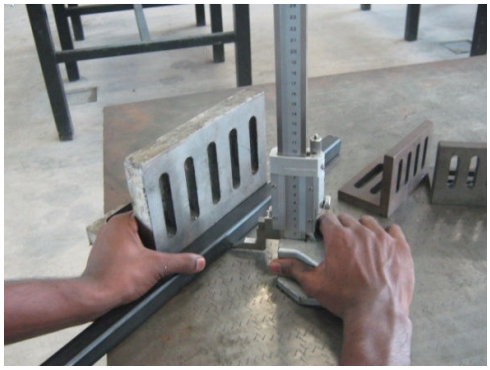

Figure 3.18: Marking material

Figure 3.19: Drill the work piece

Next, the fabrication process continue with threading process at marked point to make thread for assembly product using nat and bolt.

Figure 3.20: Tapping process

After that, the fabrication process continue by assemble the parts by using welding process. The welding that used for this fabrication is shield metal arc welding (SMAW).

Figure 3.21: Weld the parts

After finished welding, the next step is grinding process to dispose the over limited and melted welding parts. This is one of the ways to make the prototype looks clean and attractive.

Figure 3.22: Grinding the weld parts

Finally, finalize the prototype by paint process. This is one of the way to avoid the prototype from corrode. Besides that, the prototype also will look more attractive and have better finishing.

Figure 3.23: Painting process

CHAPTER 4

RESULTS AND DISCUSSION

The result and discussion function as an achievement of the target for the final year project. However, if the target is not met, it means there were problems faced during the process and will be discussed. If the result proves the objective is accomplished, the process is discussed too. This part of the project is about understanding the mechanism of the cervical bone test jig. The mechanism resolves in the performance of the model cervical bone test jig. The performance will prove the design was appropriate and alteration was accurate during the fabrication process. Basically, this analysis is a must for the project because it shows how well the prototype of cervical bone test jig was operated. The focus of this chapter is solely on the mechanism product of this project. Once the target of this chapter is met, then only the whole project process and outcome can be concluded in the next chapter.

4.1 Results

The result of the fabrication and testing was shown below. Firstly, the finished welding part, drilling part, basement of the test jig and painted entire system figures were shown.

Figure 4.1 : Finished side clamping device

The figure 4.1 shows the result of finished welding side clamping device with side drive. This part was done by using rectangular hollow steel and rectangular steel bar. The SMAW welding was used to complete this part. This was the main mechanical part which support the bone in side ways.

Figure 4.2 : Finished fixed vertical bar

The figure 4.2 shows the result of finished fixed vertical bar. This part is actually the driver of the side clamping device. The slot in this part is avoid side clamping device slips the from its path. This part is also as a connecting part to the basement which joint by 2 nats for each.

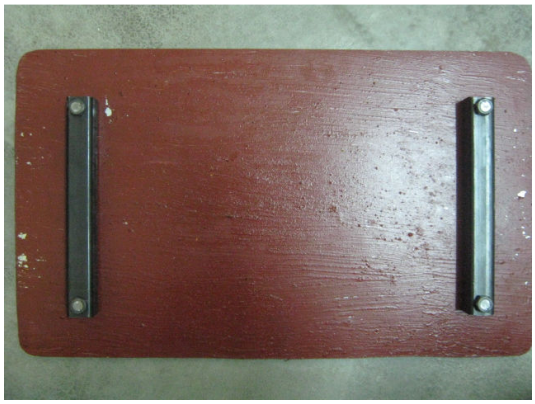

Figure 4.3 : Finished basement and fixed vertical bone

The figure 4.3 shows the result of basement and fixed vertical bar which has joint by 4 nats. This basement supported by the feet of the nats as the stand of the basement itself.

Figure 4.4 : Finished top clamping device

The figure 4.4 shows the result of top clamping device which hold the bone from top. This part is actually function to avoid the bone to kick back when doing testing such as drilling test on it.

Figure 4.5 : Finished painted cervical bone test jig

The figure 4.5 shows the result of complete painted cervical bone test jig. The main objective of the test jig is to hold the bone while doing certain testing on it.

The mechanism of cervical bone test jig is actually starts from adjusting the nats. Where extend the nats so that we can freely move both top clamping device and side clamping device to place the bone on test jig surface.

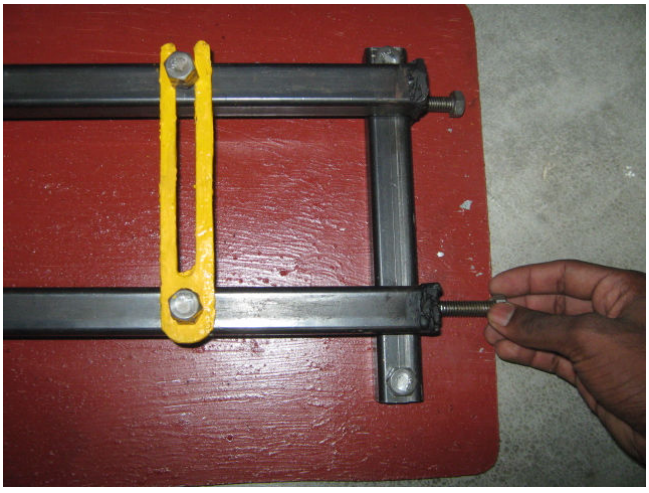

Figure 4.6 : Adjusting Nat on Side Clamping Device

The figure 4.6 shows that nat adjust to with extend the space of test jig to make it easier to place the bone

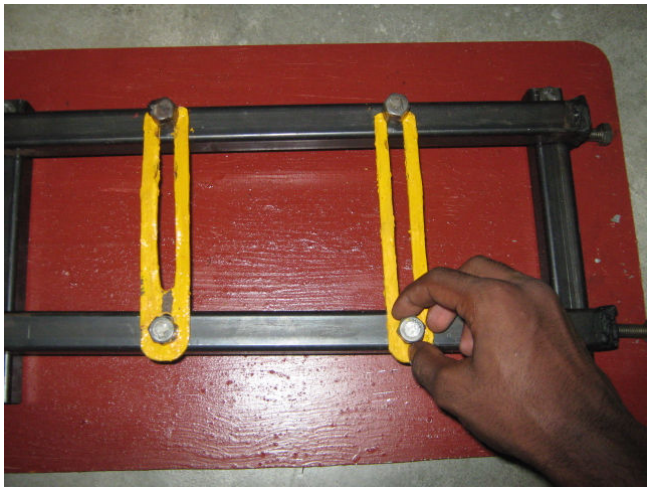

Figure 4.7 : Adjusting Nat on Top Clamping Device

The figure 4.7 shows that the nat extended to remove to top clamping device. This is also to make the bone placing easier.

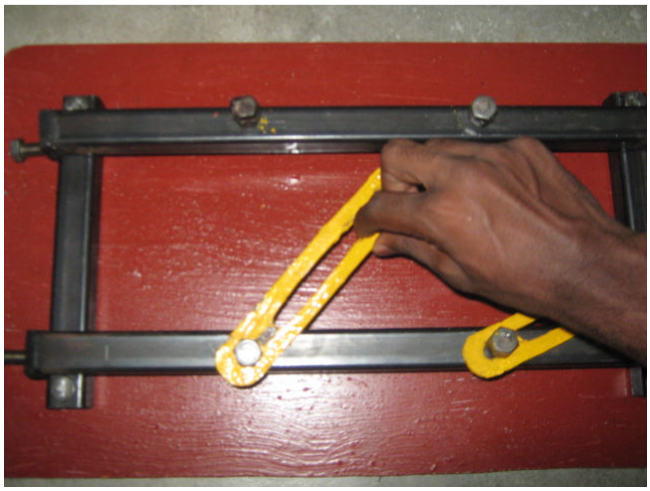

Figure 4.8 : The position when the Top Clamping Device is removed.

The figure 4.8 shows that the position of top clamping device fully opened. After placing the bone model , we have to clamp it back. The clamping process is start from side clamping and continues with top clamping.

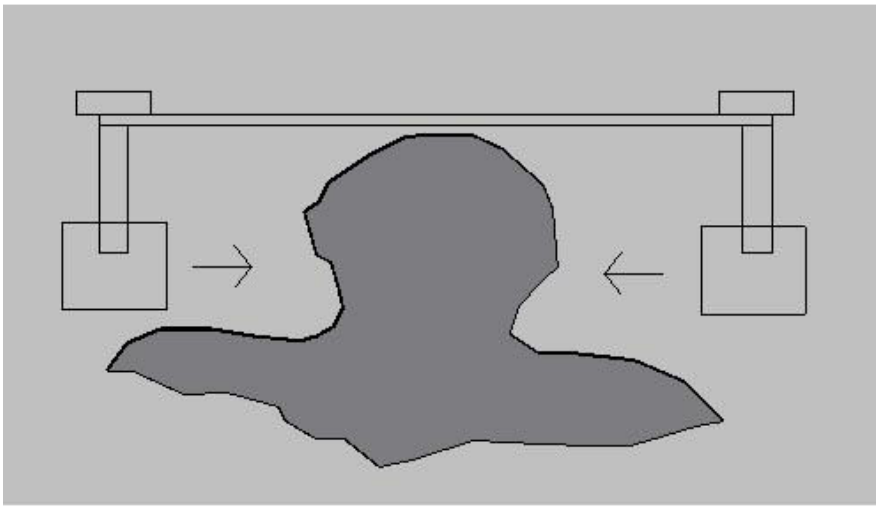

Figure 4.9 : The position when the Side Clamping Device is calmping.

The figure 4.9 shows that the position of side clamping device will hold the bone in sideways and make sure it will not move sideways when done a testing.

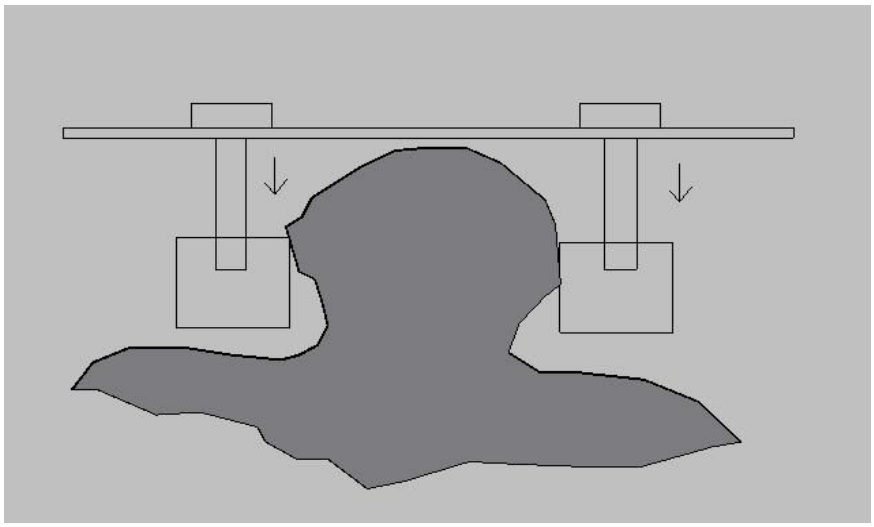

Figure 4.10: The position when the Top Clamping Device is calmping.

The figure 4.10 shows that the position of top clamping device will hold the bone in top and make sure it will not kick back when done a testing.

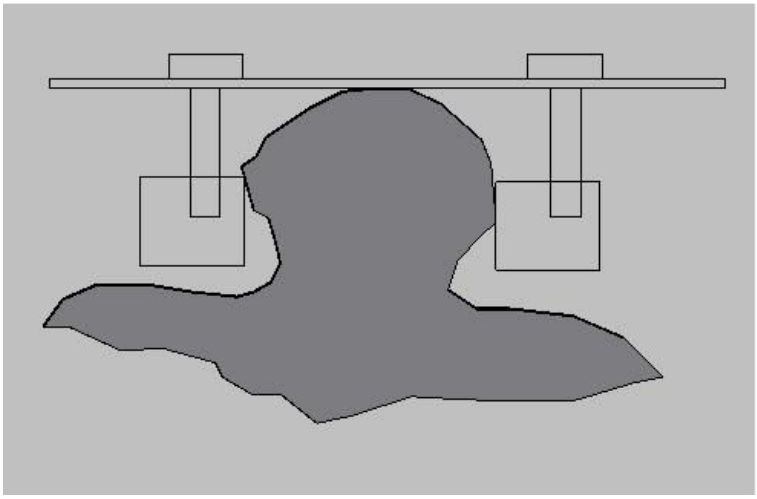

Figure 4.11 : The position after the bone fully clamped.

The figure 4.11 shows that the position after the bone fully clamped. Each clamping device supports the bone from moves sideways and kicking back.

4.2 Discussion

The cervical bone was successfully operated by theatrically. The use of both side clamping and top clamping was the best way to hold a bone efficiency. Actually, the a steel sheet as top clamping is hard to bend but its can hold the bone from kicking back. It's because the complex structure of cervical bone itself. The side clamping device has the most efficiency clamping to hold the bone from moves sideways during a testing period.

The main problem that we faced during the testing is the backbone itself. It because the backbone model is very expensive and hard to get. So the mechanism of the test jig has shown actual mechanism and some 2D drawing which done in AutoCAD. The rubber surface on each clamping device should put to produce a grip to hold the bone and better efficiency when we do testing on it.

Finally, the mechanism of the cervical bone test jig is completely depends on side clamping and top clamping. The use of the rubber on clamping device surface would have provide a better grip. Furthermore, the test jig have to made its own testing table so that it can be a portable device laboratory.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

In this chapter, a summary is established to conclude the whole final year project. However there were problems faced during the course of this project. The measures taken to rectify these problems have been identified and applied. There will be recommendations form future project of the same kind to improve it. Therefore a more complete understanding and enhanced application steps can be attained. In addition, the interest on the knowledge of the manufacturing engineering can be spread to a larger population not only in the engineering field but also for public.

5.1 Problems faced during the project

During the design and fabrication process of the cervical bone test jig project, many obstacles were faced. The first was obtaining the knowledge of the test jig operating principles. This knowledge is not through in any lectures and this project is different from others. Therefore, internet and books from the library was the main source of information.

The next problem faced was attaining the material for fabrication. The receiving of material was delay. So, supervisor advice to use materials that available at laboratory but the materials does not meet the specification. After discussed with supervisor, I tried to use the materials at laboratory with adjusting those material as needed specification.

Other than that, problem that I faced when milling machine is under maintenance where my project need to undergo a process in that particular machine.

The process which need to done is slotting to drive the side drive so that its easier when adjusting side clamping device. So, I used disc cutter to create a slot in the fixed vertical hollow bar.

Besides that, I failed to find the model of cervical bone until week 12. It is because the backbone model is hard to get , it only can get in hospital laboratory but too expensive. There were very limited availability of that cervical bone model in other places, so I bring the problem to my supervisor to get his suggestion. My supervisor give a suggestion where he will get the model bone from last year's PSM student who also done his project which related to my project too. But unfortunely, we face the difficulties to contact the person and we failed to get the bone model.. So, we consider about the budget and decide to do testing in 2D drawing which shows the mechanism of the product and its ability in clamping a bone.

5.2 Conclusion

In conclusion, the project objectives were achieved. The first objective is designing the test jig for cervical bone. The simplest and best design was choose. Then, fabricate the test jig for cervical bone. The design was easier to fabricate and maintenance too. The fabrication process required many skills that have learnt in previous mechanical laboratory such as material measuring, marking, cutting, drilling, welding and grinding. The fabrication process gives student to experience and develop the skills and the ways to operate the machines to complete the project. Besides that, the student also learnt to solve the problems during the designing and fabrication process. It was motivated the student to face the challenges as a professional engineer in this global era.

5.3 Recommendations

My recommendations related to this project are material purchasing and receiving should be on schedule. This will help to complete fabrication process on schedule. Besides that, the material availability at mechanical laboratory must

consider before decide the specification of design. The availability of material should be provided by laboratory instructor to reduce the hassle of searching for the correct material which delays the process.

Other than that, the design concepts can be improved by having better materials like aluminium to get an actual illusion of the test jig. Hope in future I suggested to design and fabricate more efficient cervical bone test jig by giving a better finishing to the test jig.

The nat that use to clamp top clamping device should be long so that it could be extend as much as can to clamping bigger bone. The thread should be long to give a better grip to hold the nat strongly and it will helps us to increase the efficiency of the product. So, choose the appropriate devices for the future project.

Furthermore, the future project also can be improved by designing the rubber surface on each clamping device so that it produce a grip to hold the bone and better efficiency when we do testing on it such as drilling process on it. The product also can be improve with design a test table which attached to the test jig , so that it solve the ergonomic and portable issue.

Finally, the future project can be improve by design and fabricate a clamping device which use hydraulic or pneumatic pressure to clamp the bone if it is possible. Its need more knowledge in hydraulic and pneumatic systems. The used push button clamp the bone while adjusting manually will be make the operating system of the cervical bone test jig much easier.

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APPENDIX A

Figures of Machines

Bendsaw machine

Disc cutter machine

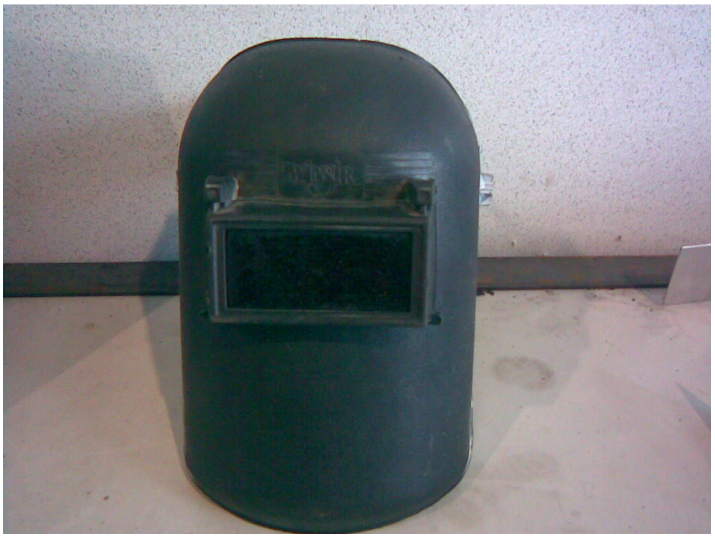
Drilling machine

SMAW welding

Grinding machine

APPENDIX B

Figures of Safety Tools / Wears

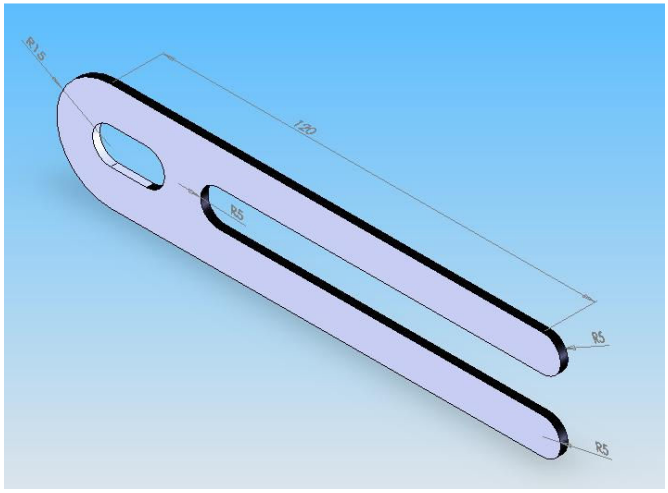


Welding shield

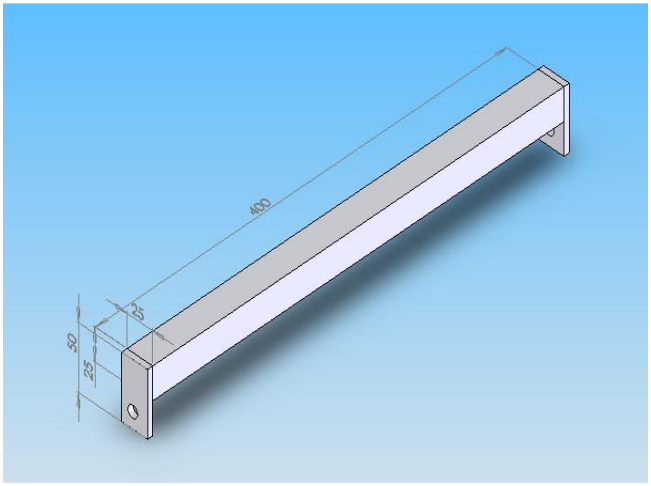
Gloves

APPENDIX C

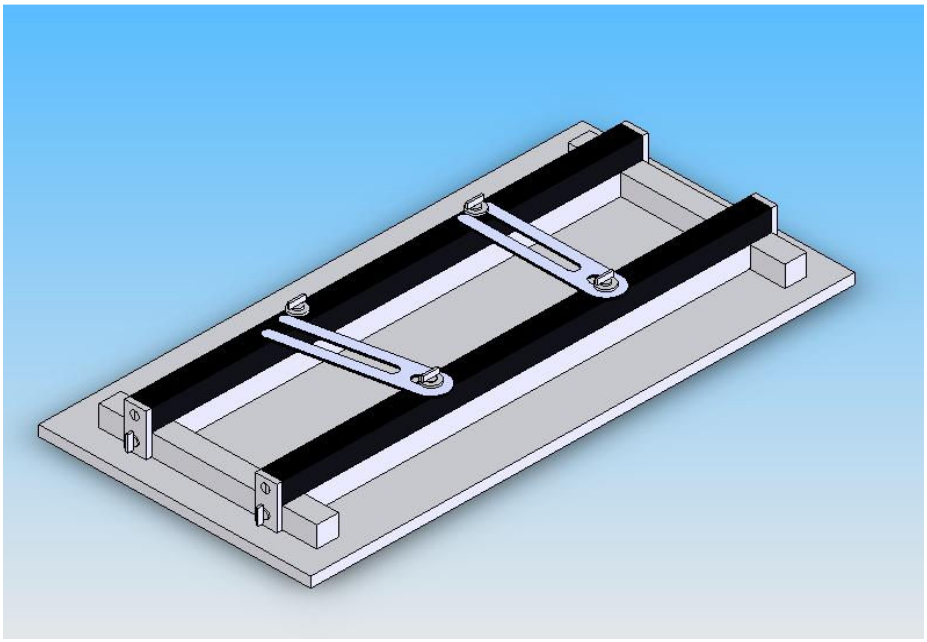
Figures of Three Dimensional Drawings (Different Views)



Top Clamping Device



Side Clamping Device and Side Driver



Complete Cervical Bone Test Jig