

DESIGN AND FABRICATION TEST JIG
FOR CERVICAL BONE

PERABU A/L MOORTY

A report submitted in partial fulfilment of the requirements for the award of
Diploma of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2009

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

Signature :

Name of Supervisor : MR. CHE KU EEDY NIZWAN BIN CHE KU HUSIN

Position : TUTOR

Date : 27 NOVEMBER 2009

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.

Signature :

Name : PERABU A/L MOORTY

ID Number : MB07006

Date : 27 NOVEMBER 2009

ACKNOWLEDGEMENTS

First of all, the deepest sense of gratitude to the God, who guide and gave me the strength and ability to complete this final year project. Infinite thanks I brace upon Him.

I would like to take this opportunity to express my gratitude and sincere appreciation to all those who gave me the possibility to complete this report. I am very grateful to my supervisor Mr Che Ku Eddy bin Che Ku Husin for his patience, trust and supporting for guide me finished this project. I also sincerely thanks for the time spent proofreading and correcting my many mistakes.

I would like to acknowledge to all the staffs in Mechanical Laboratory, whom gave me permission to use the necessary tools in the laboratory and guide me the machine's operating system.

I would also like to express my deepest appreciation to my parents whom always support me and motivate me to complete this final year project.

My sincere appreciation also extends to all my colleagues, housemates, and friends whom had provided assistance at various occasions by support and ideas for this final year project.

Finally to individuals who has involved neither directly nor indirectly in succession of this thesis. Indeed I could never adequately express my indebtedness to all of them. Hope all of them stay continue support me and give confidence in my efforts in future. Thank you.

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 perbincangan 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.

TABLE OF CONTENTS

	Page
FRONT PAGE	i
SUPERVISOR’S DECLARATION	ii
STUDENT’S DECLARATION	iii
ACKNOWLEDGEMENTS	iv
ABSTRACT	v
ABSTRAK	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF SYMBOLS	xiv
LIST OF ABBREVIATIONS	xv
CHAPTER 1 INTRODUCTION	
1.1 Project Synopsis	2
1.2 Objective of The Final Year Project	2
1.2.1 General Objective	2
1.2.2 Specific Objective	2
1.3 Scope of Work	3
1.4 Project Planning	3
1.5 Thesis Organization	

CHAPTER 2	LITERATURE REVIEW	
2.1	Definition	6
2.1.1	Cervical bone	6
2.2	Structure of Cervical Bone	7
2.3	Jig	9
2.4	Type of Jig	9
2.4.1	Test Jig (Knee jig)	9
2.4.2	Machining Jig (Drill Jig)	12
2.5	Clamping device and Type of Clamping device	12
2.5.1	Electromagnetic clamping device	13
2.5.2	Mechanical Clamping Device	14
2.6	Pneumatic and Hydraulic Clamping Device	15
2.6.1	Pneumatic Clamping Device	15
2.6.2	Hydraulic Clamping Device	16
CHAPTER 3	METHODOLOGY	
3.1	Flow Chart	18
3.2	Gantt Chart	21
3.3	Concept Design	23
3.3.1	Concept A	23
3.3.2	Concept B	24
3.3.3	Concept C	24
3.4	Concept Scoring	25
3.4.1	Selected Design Specifications	26
3.5	Three Dimensional Drawings	27

3.5.1	Part Drawings	27
3.5.2	Assembly Drawings	29
3.6	Selected Material	31
3.7	Fabrication Process	32
3.7.1	Apparatus / Machines	33
3.7.2	Fabrication Process Steps	33
CHAPTER 4 RESULTS AND DISCUSSION		
4.1	Results	37
4.2	Discussion	43
CHAPTER 5 CONCLUSION AND RECOMMENDATION		
5.1	Problems Faced During the Project	44
5.2	Conclusion	45
5.3	Recommendations	46
REFERENCES		47
APPENDICES		
A	Figures of machines	48
B	Figures of safety tools / wears	51
C	Figures of Three Dimensional Drawings (Different Views)	52

LIST OF TABLES

Table No.		Page
3.1	Gantt chart	21
3.2	Concept scoring	25
3.3	Descriptions of the materials	32

LIST OF FIGURES

Figure No.		Page
2.1	Side View of Vertebral Column	7
2.2	Structure of Cervical Bone	9
2.3	Knee Jig	10
2.4	Other Knee Jig Model	11
2.5	Drill Jig	12
2.6	Centring Clamping Device (Mechanical type)	15
2.7	Pneumatic Clamping Device	16
2.8	Hydraulics Clamping Device	16
3.1	Flow chart	18
3.2	Concept A	23
3.3	Concept B	24
3.4	Concept C	24
3.5	Design specifications for selected design	26
3.6	Part drawing 1 (Fixed Vertical Bar)	27
3.7	Part drawing 2 (Basement)	27
3.8	Part drawing 3 (Side Clamping Device)	28
3.9	Part drawing 4 (Side Driver Device)	28
3.10	Part drawing 5 (Top Clamping Device)	29
3.11	Assembly drawing Front View	29
3.12	Assembly drawing Side View	30

3.13	Assembly drawing Top view	30
3.14	Assembly drawing 4 isometric view	31
3.15	Measuring Tape	33
3.16	Cuts material using horizontal bend saw	34
3.17	Cuts material using vertical bendsaw	34
3.18	Marking material	34
3.19	Drill the work piece	35
3.20	Tapping process	35
3.21	Weld the parts	35
3.22	Grinding the weld parts	36
3.23	Painting process	36
4.1	Finished side clamping device	38
4.2	Finished fixed vertical bar	38
4.3	Finished basement and fixed vertical bone	39
4.4	Finished top clamping device	39
4.5	Finished painted cervical bone test jig	40
4.6	Adjusting Nat on Side Clamping Device	40
4.7	Adjusting Nat on Top Clamping Device	41
4.8	The position when the Top Clamping Device is removed	41
4.9	The position when the Side Clamping Device is calmping.	42
4.10	The position when the Top Clamping Device is calmping.	42
4.11	The position after the bone fully clamped	43

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 off 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 nut 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 down 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

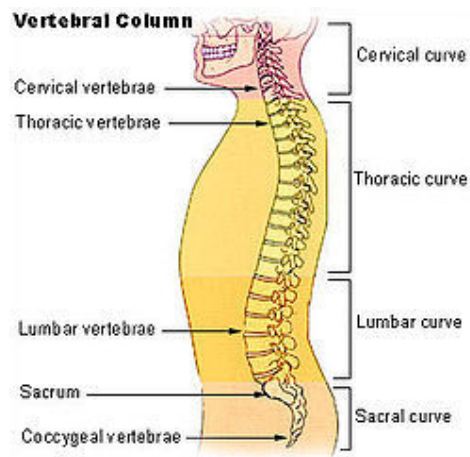


Figure 2.1: Side View of Vertebral Column

(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.

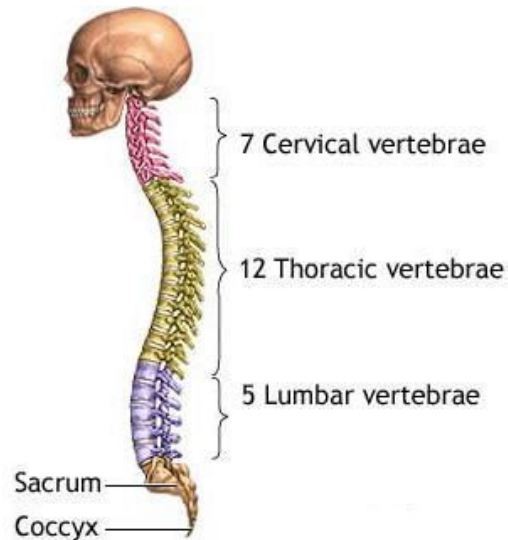


Figure 2.2 : Structure of Cervical Bone

(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.

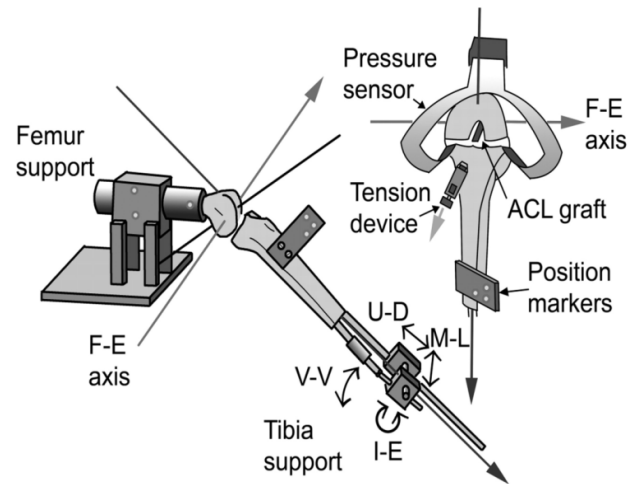


Figure 2.3 : Knee Jig

(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.