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JUDUL: **DESIGN AND FABRICATION OF SHEAR TEST RIG FOR SANDWICH CORES**

SESI PENGAJIAN: **2005/ 2008**

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DESIGN AND FABRICATION OF SHEAR TEST RIG FOR SANDWICH CORES

DAHRUL AKMA BIN MOHD SABRI

A project submitted in partial fulfilment of the
requirement for the award of the Diploma
of Mechanical Engineering

Faculty of Mechanical Engineering
Universiti Malaysia Pahang

NOVEMBER 2007

SUPERVISOR DECLARATION

I hereby declare that I have read this project report and in my opinion this project report is sufficient in terms of scope and quality for the award of the Diploma in Mechanical Engineering

Signature : ....

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Date : 20 NOVEMBER 2007.

DECLARATION

I declare that this thesis entitled "*Design and Fabrication of Shear Test Rig for Sandwich Cores*" is the result of 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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Name : DAHRUL AKMA BIN MOHD SABRI

Date : 20 NOVEMBER 2007..............

DEDICATION

To my beloved parents, Mr. Mohd Sabri bin Jusoh and Mrs. Najat binti Abd Wahab, family and friends, without whom and his/her lifetime efforts, my pursuit of higher education would not have been possible and I would not have had the chance to study for a mechanical course. Also to my supervisor, Mr. Ahmad Basirul Subha bin Alias, because of the guidance without whose wise suggestions, helpful guidance and direct assistance, it could have neither got off the ground nor ever been completed.

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I would like to thank lecturer and technicians at the faculty of mechanical for their valuable comments and sharing their time and knowledge on this research project during my last trip to submit the project. I also gratefully acknowledge the assistance of everybody who helped in the execution of this project in Universiti Malaysia Pahang.

I would like to thank Mr. Ahmad Basirul Subha bin Alias for general help with the facilities, who have given his full effort in guiding to achieve the goal as well as his encouragement to maintain our progress in track. I would to appreciate the guidance given by other supervisor especially in our project presentation that has improved our presentation skills by their comment and tips.

I also thank to Mechanical Students for their friendship and help when thinking through problems and for sharing their knowledge of experimental apparatus and computer systems. Finally, I thank to my family for their continuous support and confidence in my efforts.

ABSTRACT

This project is focused on redesign the current model of shearing testing instrument and it is also used for testing the shear in sandwich constructions in order of driving the need for efficient, safe cost effective and stability of sandwich core upon the shear loading. The device consists of two main components; a stationary upper platform and a lower platform that contains a base as stage. The principle of operation is that the tissue samples are affixed to both the upper and lower platforms using a thin layer of superglue then bathed in an appropriate physiological solution. The lower platform is moved relative to the fixed upper platform using the base stage in order to applied load. The test is performed by clamping a test specimens attached in a 20 millimeters width specimen between two metal fixtures. An upper punch is then forced through the base in the metal fixture causing shear along the edge of the facing. A universal testing machine is used to push the punch until shearing of the specimen occurs. The manufacturing process included in this project is cutting of material, machining, drilling, threading and finishing.

ABSTRAK

Projek ini mengfokuskan mereka cipta model pembikinan ricih yang sedia ada dan ia juga digunakan sebagai menguji rincihan bahan yang berlapis supaya ia dapat meningkatkan kecekapan, kos berpatutan dan keutuhan bahan yang berlapis terhadap bebanan ricih. Alat ini mengandungi dua kompenan penting iaitu pelantaran atas yang tidak bergerak dan pelantaran bawah yang berfungsi sebagai tapak. Prinsip operasi projek ini adalah menggunakan tisu yang dilekatkan pada kedua-dua pelantaran yang menggunakan bahan pelekat yang kuat. Pelantaran bawah bergerak secara relektif dengan pelantaran atas menggunakan tapak supaya dapat menahan beban. Ujian ini dilakukan dengan mencengkam bahan ujian yang dilekatkan pada 20 milimeter lebar diantara kedua-dua besi tersebut. Bahagian atas akan menghasilkan tenaga sepanjang tapak tersebut yang akan menyebabkan berlakunya rincihan sepanjang permukaan sempel tersebut. Pembikinan ricih ini dihasilkan menggunakan proses ,pemotongan bahan, pemesinan, menebuk lubang, membuat ulir dan proses pengemasan.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Project Synopsis

Final year project is one of the subjects for this semester. In this subject, a project needs to do to fulfil the subject requirement. The project involves designing and fabricating an instrument for testing shear. This instrument could be use by the other student in order to test the shear which according to the syllabus. This project title is about Design and Fabrication of Shear Test Rig for Sandwich Cores. The shear test is provides a standard method in obtaining data for the behaviour of the shear strength, shear modulus and shear failure load of the cores. This project is also to design and fabricate the shear test rig for sandwich core property according to standard American Society for Testing and Materials (ASTM) C273. This project also acquires the skills of design, analysis, fabrication and testing.

1.2 Problem Statement

The problem with the current shear test apparatus is:

a) The conventional shear test is difficult to handle.

b) The current design of shear test rig is expensive, not portable and complicated to operate.

1.3 Project Objectives

Objectives for this project are as follows:

a) To design a basic/simple test rig for materials testing.
b) To fabricate a shear test rig in tension mode with few degrees of load setting in sliding motion.

1.4 Project Scope of Work

Basically, this project is based on the scopes of:

a) To design and fabricate a basic/simple shear test rig for materials testing.
b) To fabricate a shear test rig in compression mode and with few degrees of horizontal direction (sliding) and generated by a motor.
c) The test will comply the American Society for Testing & Material (ASTM) standard C 273.

1.5 Project Flow Chart

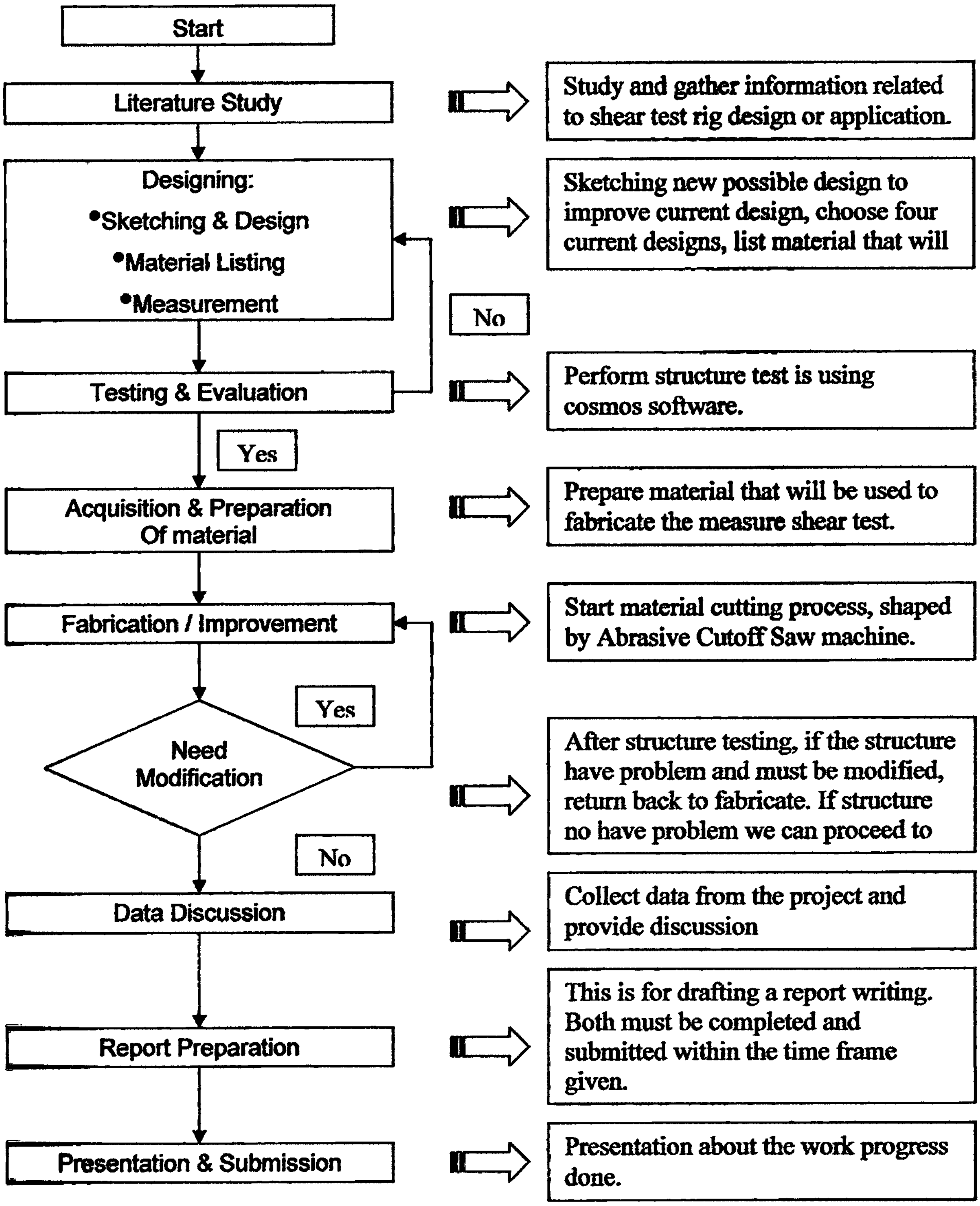

Figure 1.1: Project flow chart

1.6 Project Planning

This project is start with investigation and makes a research and literature review via internet, reference books, supervisor and other relevant academic material that related to this project. To make this project more accurate and suitable, study more about this topic and more than two week to make a literature review.

Beginning week, need to do some schedule management for this project which included schedule management to all member in the group. All schedule will be apply in a Microsoft Excel to make a Gantt chart. It takes a week to accomplish all schedules.

Then, discuss with supervisor and continue detail research about pressure transducer. The good sample must be chosen to make the precise calculation and easy to take the data. The next task is preparation of progress presentation and report writing. These tasks take two week to be finish.

Calibration process is start after midterm. And then, the testing needs to perform. When get the data, the comparison between the actual and experiment data must be done. This task scheduled takes several weeks to finish. Due to the some problem that will be discuss in the other chapter, all these task still cannot be done when this report written except the type of pressure transducer get.

Lastly, the final report writing and prepare the presentation. This takes about one week to arrange and accomplish. A report is guided by UMP thesis format and also guidance from supervisor. Due to all problems that student facing, the management have agreed to extend the time to submit a report and presentation. All task scheduled is take around fourteen weeks to complete.

Scope	Weeks													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Literature Review	X	X	X											
		✓	✓	✓										
Design & sketching			X	X	X	X								
			✓	✓	✓									
Mid Presentation							X							
									✓					
Finalize Design							X	X						
						✓	✓	✓						
Analysis and Testing												X		
													✓	
Fabrication									X	X	X	X	X	
							✓	✓		✓	✓	✓	✓	
Report Preparation			X	X	X	X	X	X	X	X	X	X	X	X
				✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Final Presentation														X
														✓

X	Planning Progress
✓	Actual Progress

Figure 1.2: Gantt chart

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This project is focused on redesign the current model of shearing testing instrument and it is also used for testing the shear in sandwich constructions in order of driving the need for efficient, safe cost effective and stability of sandwich core upon the shear loading. Inadequate or inappropriate is connected to produce an unsafe roof conditions threatening both personnel safety and production capacity. Although the use of composites in infrastructure is higher, there still need for the more comprehensive understanding of their behavior in construction applications in order to provide some standard design methods. Composites research and construction projects are underway at the federal and state level, and at several universities. This project was partially conceived of supporting those efforts.

2.2 Paper Review

2.2.1 American Society for Testing and Materials (ASTM) C273

This test method covers the concept of shear properties of sandwich construction core materials associated with shear distortion of planes parallel to the facings. It covers of shear strength parallel to the plane of the sandwich, and the shear modulus associated with strains in a plane normal to the facings. The test may be conducted on core materials bonded directly to the loading plates or the sandwich facings bonded to the plates. Permissible core material forms include those with continuous bonding surfaces (such as balsa wood and foams) as well as those with discontinuous bonding surfaces (such as honeycomb) [1].

The value stated in either SI units or inch-pound units is to be regarded separately as it standard. Units within of text the inch-pound units are shown in brackets. The value stated in each system is not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the standard [1].

This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use [1].

2.2.2 The Sandwich Concept

Thin, strong and stiff face sheets are separated by a thick, lightweight and relatively compliant core. Sandwich structures provide a high bending stiffness and strength to weight ratio. Widely applied in the field value weight is critical such as aircraft, wind turbine blades etc [2].

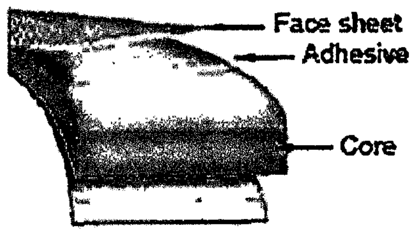

Figure 2.1: Sandwich concept [2]

2.2.2.1 Core Junctions in Sandwich Structures

This is common sub-structures used e.g. in boat-building. Insertion of stiffer and stronger sandwich core sections for local structural reinforcement. Cause stress concentrations that can lead to premature failure of the whole structure [2].

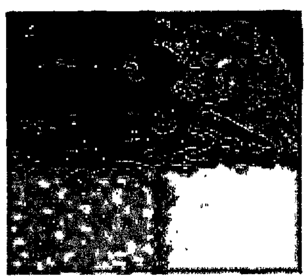

Figure 2.2: Compressive face failure [2]

2.2.2.2 Classical Sandwich Theory

Idealisation of the classical sandwich theory is face sheets are in a pure membrane stress state and the core material carries mainly shear stresses. This is cannot be applied at discontinuities where local effects can only be described by higher order sandwich theories or numerical modelling [2].

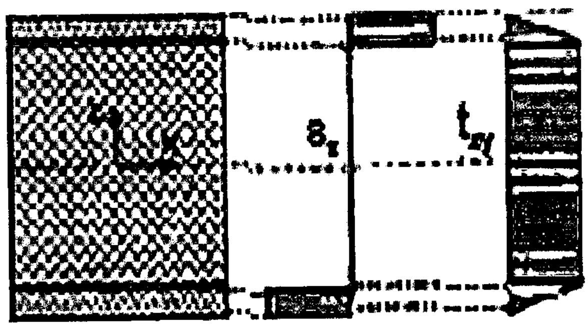

Figure 2.3: Idealised stress distribution [2]

2.3 General Formula of Shear Test Rig

General formula which relate to this project:

$$\text{Shear: } \tau = \frac{F}{A}$$

$$= \frac{N}{m^2}$$

For double faces of shear force:

$$\text{Shear: } \tau = \frac{F}{2A}$$

$$= \frac{N}{2\,m^2}.$$

Where;

τ = Shear
A = Area,
F = Force

2.4 Current Technology

2.4.1 Shear testing rig on deformable soft biological tissues

A novel tri-axial material testing device has been developed for the testing of highly deformable soft biological tissues using a shear deformation.The principle of operation is that the tissue samples are affixed to both the upper and lower platforms using a thin layer of superglue. The lower platform is moved relative to the fixed upper platform using the tri-axial translation stage [3].

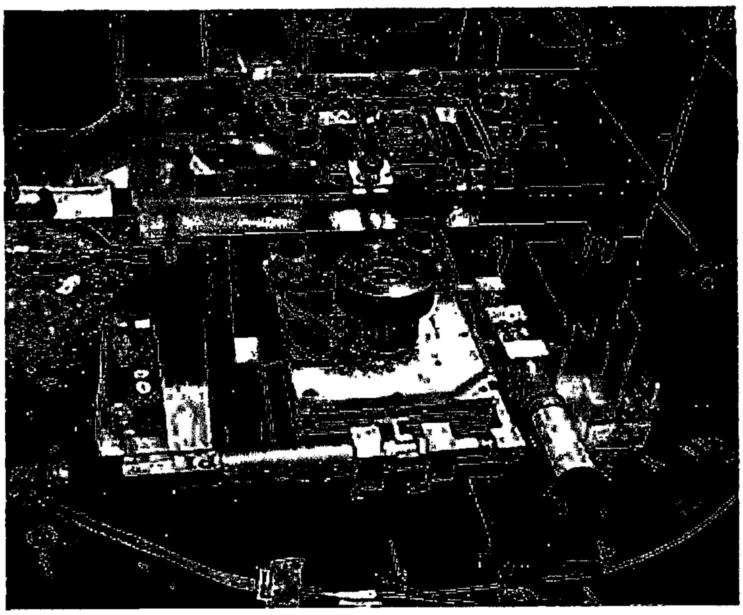

Figure 2.4: Test rig for soft tissues [3]

2.4.2 Shear Test In Compression Loading Mode

The load line should act through the opposite corners of the foam specimen. The foam was bonded to the platens using Araldite glue [4].

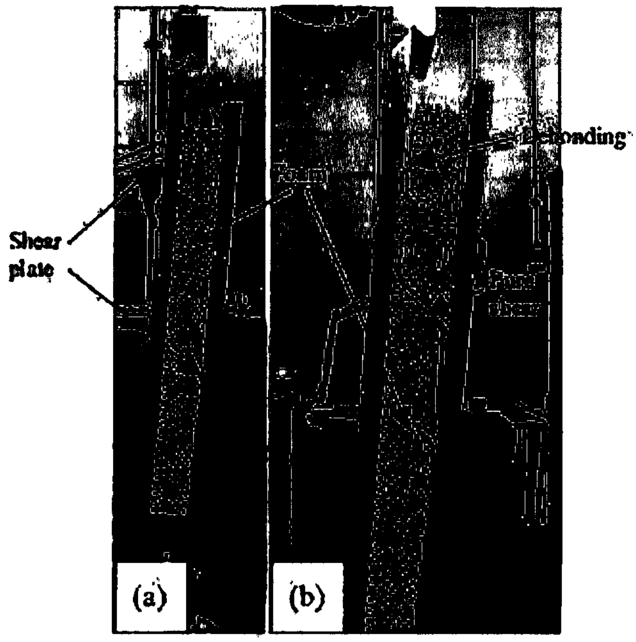

Figure 2.5: Testing and evaluation of polymeric foams [4]

2.4.3 Concrete Beam

This shows a 2-point loading test rig for testing the shear capacity of a reinforced concrete beam. The beam is wired with strain gauges along the areas where the concrete is expected to crack in shear [5].

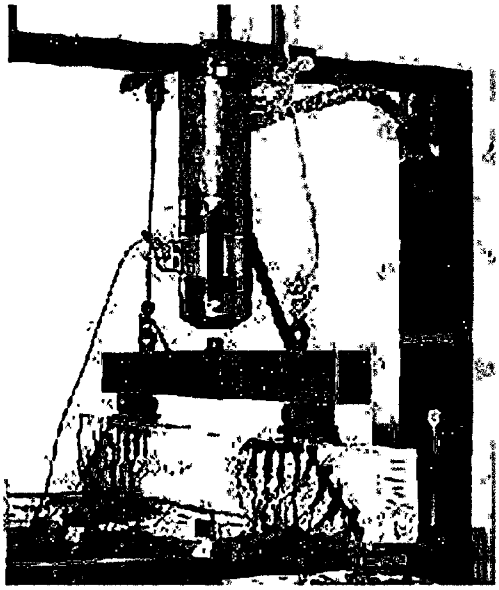

Figure 2.6: Two loading point to test shear [5]

Below are samples of beam failure. The nature and direction of cracks is particularly informative to a concrete structures researcher.

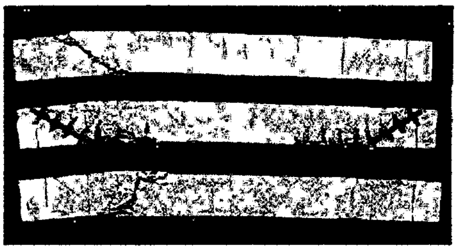

Figure 2.7: Sample of beam failure [5]

2.4.4 Direct Shear Testing

To evaluate the soil material model, it is important that actual physical tests of the soil be simulated. This chapter describes one of the physical tests used for evaluating the soil model the direct shear test. Two other tests a soil modulus failure test and a soil shear failure test are briefly described in appendix A and detailed by Coon [6].

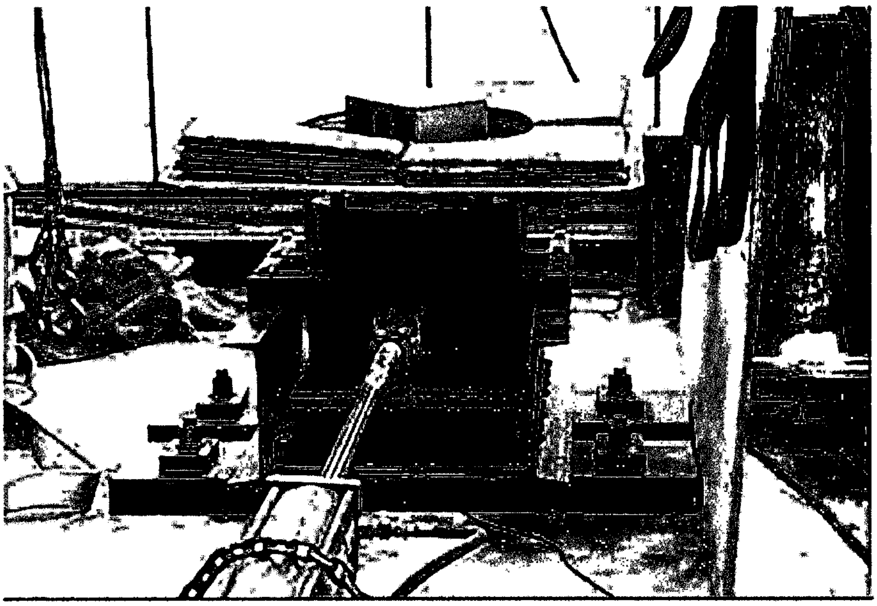

Figure 2.8: Large-scale direct shear testing device [6]

2.5 Milling Machine

2.5.1 Introduction

Milling machines are very versatile. They are usually used to machine flat surfaces. They can also be used to drill, bore, cut gears, and produce slots. The type of milling machine most commonly found in student shops is a vertical spindle machine with a swivelling head. Although there are several other types of milling machines, this document will focus only on the vertical milling machine. A milling machine removes metal by rotating a multi-toothed cutter that is fed into the moving workpiece. The spindle can be fed up and down with a quill feed lever on the head. The bed can also by fed in the x, y, and z axes manually. In this clip the z axis is adjusted first, then the y, than the x. Once an axis is located at a desired position and will no longer be fed, it should be locked into position with the gibb locks. Most milling machines are equipped with power feed for one or more axes. Power feed is smoother than manual feed and, therefore, can produce a better surface finish. Power feed also reduces operator fatigue on long cuts. On some machines, the power feed is controlled by a forward reverse lever and a speed control knob [7].

2.5.2 Types of Milling Machine

Most of the milling machines are constructed of column and knee structure and they are classified into two main types namely Vertical Milling Machine and Horizontal Milling Machine. The name Vertical or Horizontal is given to the machine by virtue of its spindle axis. Horizontal machines can be further classified into Plain Horizontal and Universal Milling Machine. The main difference between the two is that the table of a Universal Milling Machine can be set at an angle for helical milling while the table of a Plain Horizontal Milling Machine is not [7].

2.5.2.1 Vertical Milling Machine

The vertical mill has a vertical spindle, like the drill press, but with an X-Y table that permits positioning the work. Milling cutters are held in the spindle and rotate on its axis. The spindle can generally be extended (or the table can be raised/lowered, giving the same effect), allowing plunge cuts and drilling. Milling cutters are designated in several groups: end mills, facing mills and form cutters. End mills can cut slots, steps and pockets. Face mills are used to cut flat surfaces. Form mills can cut dovetails, bevels and t-slots. A combination machine, called a mill-drill, is quite popular with amateurs as it takes the place of the drill press and a vertical mill [7].

The plain vertical machines are characterized by a spindle located vertically, parallel to the column face, and mounted in a sliding head that can be fed up and down by hand or power. Modern vertical milling machines are designed so the entire head can also swivel to permit working on angular surfaces. The turret and swivel head assembly is designed for making precision cuts and can be swung 360° on its base. Angular cuts to the horizontal plane may be made with precision by setting the head at any required angle within a 180° arc [7].

2.5.2.2 Horizontal Milling Machine

A horizontal mill has the same sort of X-Y table, but the cutters are mounted on a horizontal arbor across the table. Cutters, called side mills, have a cross section like a circular saw, but are generally wider and smaller in diameter. These are used to mill grooves and slots. Plain mills are used to shape flat surfaces. Several cutters may be ganged together on the arbor to mill a complex shape of slots and planes. Special cutters can also cut grooves, bevels, radii, or indeed any section desired. These specialty cutters tend to be expensive [7].

The plain horizontal milling machine's column contains the drive motor and gearing and a fixed position horizontal milling machine spindle. An adjustable overhead arm containing one or more arbor supports projects forward from the top of the column. The arm and arbor supports are used to stabilize long arbors. Supports can be moved along the overhead arm to support the arbor where support is desired depending on the position of the milling cutter or cutters. The horizontal machines can be further classified into plain horizontal milling machine and universal milling machine [7].

The basic difference between a universal horizontal milling machine and a plain horizontal milling machine is the addition of table swivel housing between the table and the saddle of the universal machine. This permits the table to swing up to 45° in either direction for angular and helical milling operations. The universal machine can be fitted with various attachments such as the indexing fixture, rotary table, slotting and rack cutting attachments, and various special fixtures [7].

2.5.3 Milling Cutters

Milling cutters are usually made of high-speed steel and are available in a great variety of shapes and sizes for various purposes. You should know the names of the most common classifications of cutters, their uses, and, in a general way, the sizes best suited to the work at hand [7].

2.5.2.1 Face Mill (Indexable Carbide Insert)

A face mill consists of a cutter body (with the appropriate machine taper) that is designed to hold multiple disposable carbide or ceramic tips or inserts, often golden in color. The tips are not designed to be resharpened and are selected from a range of types that may be determined by various criteria, some of which may be: tip shape, cutting action required, material being cut. When the tips are blunt, they may be removed, rotated (indexed) and replaced to present a fresh, sharp face to the workpiece, this increases the life of the tip and thus their economical cutting life [7].

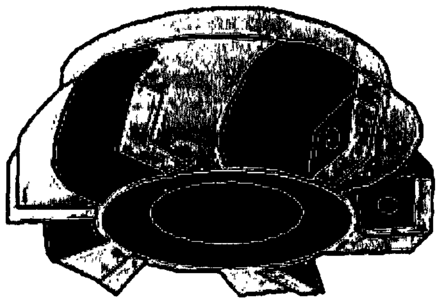

Figure 2.9: Face mill [7]

2.5.3.2 End Mills

End mills (middle row in image) are those tools which have cutting teeth at one end, as well as on the sides. The words *end mill* are generally used to refer to flat bottomed cutters, but also include rounded cutters (referred to as *ball nosed*) and radiused cutters (referred to as *bull nose*, or *torus*). They are usually made from high speed steel(HSS) or carbide, and have one or more flutes. They are the most common tool used in a vertical mill [7].

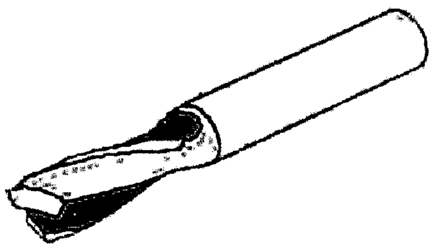

Figure 2.10: End mills [7]

2.5.3.3 Slot Drills

Slot drills (top row in image) are generally two (occasionally three) fluted cutters that are designed to cut on their end as well as the flutes. They are so named for their use in cutting keyway slots for this kind cutters, slot drills, one of their frontal cutting edges should be across the center for drilling function [7].

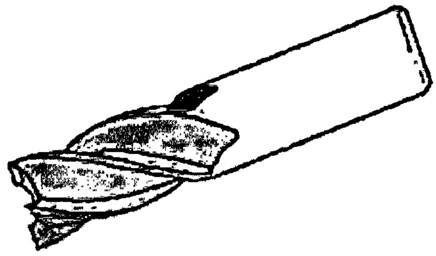

Figure 2.11: Slot drills [7]

2.5.3.4 Slab Mills

Slab mills are used either by themselves or in gang milling operations on manual horizontal or universal milling machines to machine large broad surfaces quickly. They have been superseded by the use of Carbide tipped face mills that are then used in vertical mills or machining centres [7].

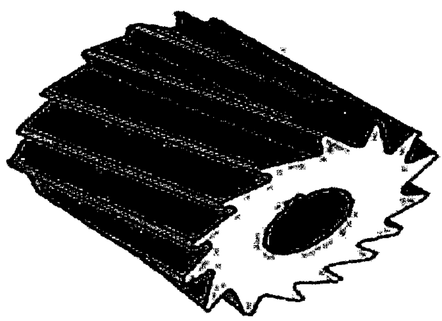

Figure 2.12: Slab mills [7]

2.5.3.5 Side and Face Cutter

The side and face cutter is designed with cutting teeth on its side as well as its circumference. They are made in varying diameters and widths depending on the application. The teeth on the side allow the cutter to make ***unbalanced cuts*** (cutting on one side only) without deflecting the cutter as would happen with a slitting saw or slot cutter (no side teeth) [7].

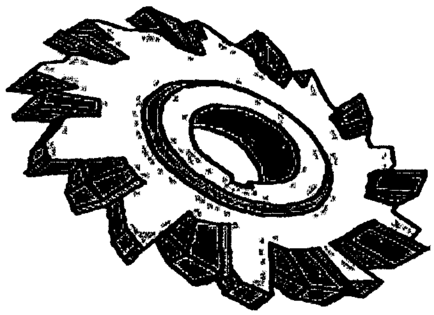

Figure 2.13: Side and face cutter [7]

2.5.4 Selecting a Milling Cutter

Selecting a milling cutter is not a simple task. There are many variables, opinions and lore to consider, but essentially the machinist is trying to choose a tool which will cut the material to the required specification for the least cost. The cost of the job is a combination of the price of the tool, the time taken by the milling machine, and the time taken by the machinist. Often, for jobs of a large number of parts, and days of machining time, the cost of the tool is lowest of the three costs [7].

(a) Material: High speed steel (HSS) are the cheapest, and shortest lived cutters. Carbide tools are more expensive, but last longer, and so prove more economical in the long run.

(b) Diameter: Larger tools can remove material faster than small ones, therefore the largest possible cutter is usually chosen, that will fit in the job.

(c) Flutes

(d) Coating

(e) Helix angle

2.5.5 Industrial Applications

Milling machines are widely used in the tool and die making industry and are commonly used in the manufacturing industry for the production of a wide range of components as shown in figure 11. Typical examples are the milling of flat surface, indexing, gear cutting, as well as the cutting of slots and key-ways. When equipped with digital readout, the machine is capable of producing more precise work for the manufacturing of plastic moulds, tool & dies, and jigs & fixtures. Figure 12 shows a typical plastic mould produced by milling [7].

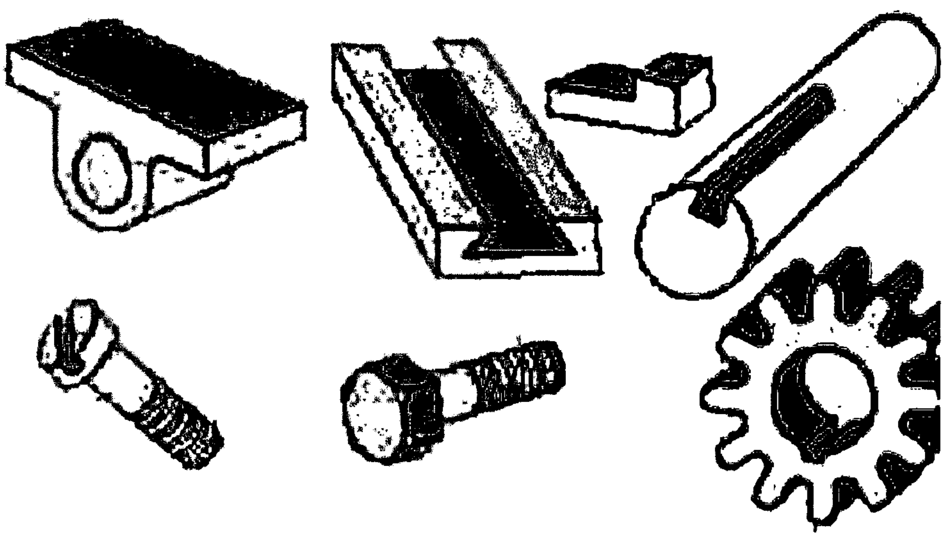

Figure 2.14: Components made by milling [7]

CHAPTER 3

PROJECT METHODOLOGY

3.1 Introduction

The Design of the shear test rig for sandwich core must be compliance to several aspects. The design consideration must be done carefully then the design can be fabricated and the system is functioning. The aspect that must be considered in designing the shear test rig is:

a) Durability: The test rig must have the durability to endure continuous force from the motor during experiment. The force comes in tension modé.

b) Strength: the toughness of the test rig will be the most important criteria in designing, the rig as it will goes highly force acting in order to create shear on the testing material.

c) Material: Material availability will be one of the challenges in the design consideration. The design must fix with the testing material and the test rig must design to be fixing with the testing material.

d) Appearance: Since this test rig will be use in UMP Mechanical Lab, so the design of the system should have the good appearance and suitable with the current technology.

3.2 Design Selection

The Design is separate into three phases. This is, first sketched as many propose design can be produce. Then Select one of it and do its detail drawing and the engineering drawing, and the last phases are design back according to problem occur during fabrication process.

3.2.1 Propose Design

a) First Design

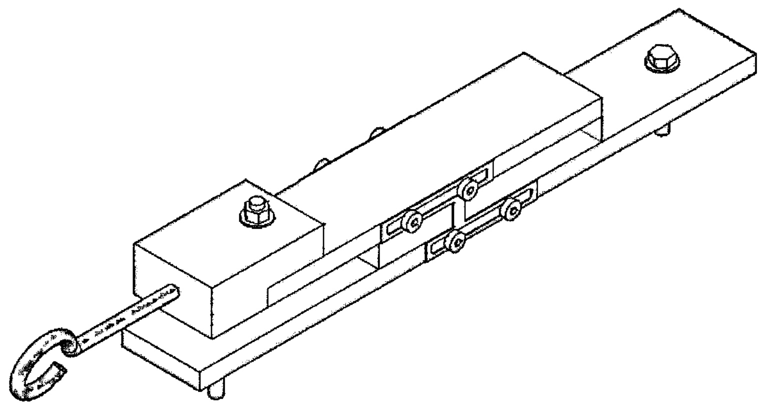

Figure 3.1: First design

This design using two clamps to clamp the sample. To move the upper platform, it required a motor. The lower platform fixed to the table. Use the force gauge to measure the force applied. Material used for figure 3.1 consists of mild steel and aluminium.

b) Second Design

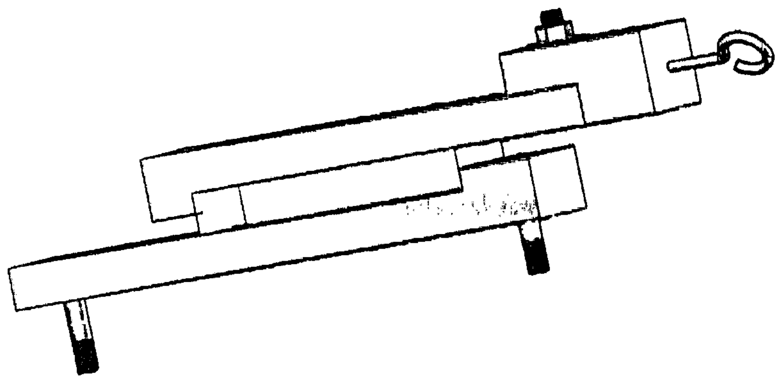

Figure 3.2: Second design

The lower platform fixed to the table. The maximum can be determined at both side of the sample. Material used for figure 3.1 consists of mild steel.

c) Third Design

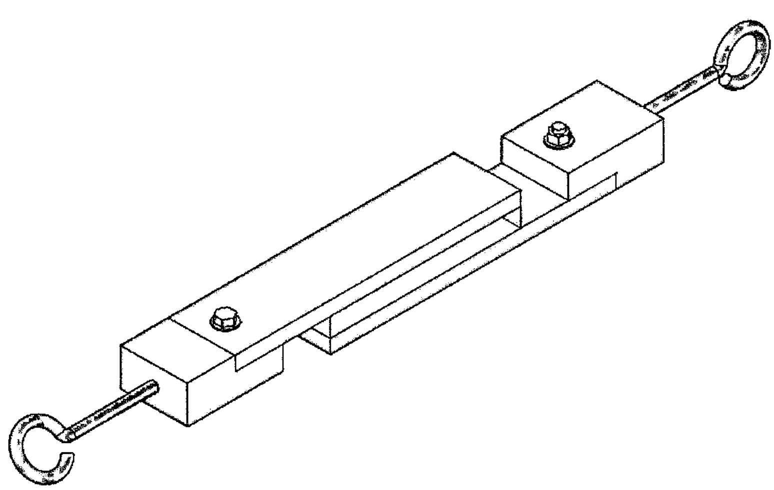

Figure 3.3: Third design

For this design, both platforms can be move. Material used for figure 3.1 consists of mild steel.

3.2.2 Suggestion Design Selection

After several design consideration conducted, a design have been selected is "first design" (Refer to figure 3.1), the selection of this design is because:

a) Material availability: The core material for all part will be easily found at UMP Mechanical Lab.

b) Easy to fabricate: This design use simple joining and only used conventional machine. This design only uses conventional Milling and Drilling Machine.

c) Easy to clamp: This design can use one part as function to clamp two plates between one specimen of material.

3.2.3 Engineering Drawing for Selected Design

After a design has been selected, the next step in the designing process is dimensioning. The design is separated into parts and followed the dimensioning process. Next step, design is drawn using Solidworks application, this software are used to build the solid model.

3.2.4 Detail Design

Please Refer to Appendix B, for part by part design and overall view of the design.

3.3 Material Selection

Material for fabrication is important to decide, aluminium and mild steel is selected because, this material is cheap. It also easy to gather at mechanical laboratory.

3.3.1 Mild Steel

Carbon steel is sometimes referred to as 'mild steel' or 'plain carbon steel'. The American Iron and Steel Institute defines a carbon steel as having no more than 2 % carbon and no other appreciable alloying element. Carbon steel makes up the largest part of steel production and is used in a vast range of applications.

3.3.2 Aluminium

Aluminium is a soft, lightweight, malleable metal with appearance ranging from silvery to dull gray, depending on the surface roughness. Aluminium is nontoxic, nonmagnetic, and nonsparking.

CHAPTER 4

FABRICATION

4.1 Introduction

This process consist of fabrication of all the parts that have design before, followed by the dimension using various type of manufacturing process included in this process cutting of material, machining, drilling, threading and finishing. During the fabricate process, if there is something wrong occur, such as not balanced dimension so the process will be stop and go back to previous step, make modification against.

4.2 Step By Step Processes

4.2.1 Cutting Material

After finish design the multi-function table via engineering drawing, next process is cutting material. The selection of material is depend on material that have been in Ump Mechanical Lab. The acquisition of material must be get agreement from supervisor and lecture. This process is done using the Bend Saw Machine.

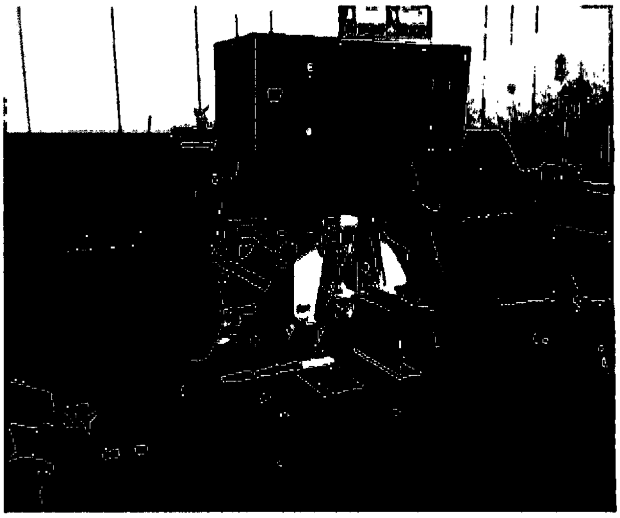

Figure 4.1: Cutting process

4.2.2 Milling Machine Operations

4.2.2.1 Setting Vise Parallel

The vise parallel is setting to the machine table. The dial Indicator or (DTI) assembly set is used for aligning the vise. (The lab instructor will demonstrate the procedure)

4.2.2.2 Secure the Workpiece in the Table

1. The milling machine vise is clean thoroughly.
2. If necessary, place parallels under the workpiece to raise the surface to be milled above the level of the vise jaws.
3. After the workpiece is in place, the vise is tightening securely, and then the workpiece is tap lightly with a fort (lead) hammer to set it. Do not tighten the vise again because this would alter the position of the workpiece and tightness of the parallels.

4.2.2.3 Machine Setup

1. The diameter of the cutter is measure with a vernier caliper.
2. Calculate RPM ,N for cutting speed

$$RPM = (CS \times 1000)/ \pi D$$

Where:

N = R.P.M. of the cutter

CS = Linear Cutting Speed of the material in m/min. (Appendix C)

d = Diameter of cutter in mm

3. The closet RPM is located on spindle speed chart.
   The lever is check in correct position. Follow the instructions on the panel for setting levers depending on whether you are working at the LOW or HIGH speed level (Check with the lab instructor to verify your setup before you continue).
4. The federate is calculate.(refer to the machinery handbook for the feed per tooth)

$$F = f \, . \, u \, . \, N$$

Where:

F = table feed in mm/min

f = movement per tooth of cutter in mm

u = number of teeth of cutter

N = R.P.M. of the cutter

4.2.2.4 Milling a Block Square and Parallel

1. In order to mill the four sides of a piece of work so that its sides are square and parallel, it is important that each side be machined in a definite order. It is very important that dirt and burrs be removed from the work, vise and parallels since they can cause inaccurate work.

2. The lab instructor was demonstrating the procedure to mill a block square and parallel.

NOTE: Always *use cutting lubricant when machine the workpiece.*

4.2.2.4 Milling a Shoulder

1. The workpiece in the table of the milling machine is secure using the vise.
2. To find the reference of the workpiece, we use an edge finder or any suitable tools/methods. (follow like the lab. instructor demonstration on the procedure)
3. The micrometer dial is set on the cross feed and /or DRO for the Y axis to zero.
4. The cutter (rough cut end mill) of sufficient diameter is select to cut the shoulder.
5. The tool is placed at the right position. The required dimension (depth and width) of the shoulder is check.
6. The cutting tool is taken lower or the table is raise using the crank until it touches the top surface of the workpiece gently.
7. The micrometer dial is set on the vertical feed and /or DRO for the Z axis to zero.
8. Before starting, we make sure that that the cutting tool is clear of the workpiece. If not, the workpiece is taken lower by using the crank or the workpiece is move clear from the cutting tool.
9. The machine is turning on.
10. We move the table with longitudinal feed handle to cut the workpiece. We use the up cut method rather than down cut method to cut workpiece. The table 1~2mm for the depth of cut is raised. We need multiple cuts. *Left the allowances about 0.5mm (depth and width) for the finishing cut.*
11. For the finishing cut and repeat again step 7 until 9, we change the tool.

12. Did the finishing cut.

NOTE: *Check the dimensions of your work before you proceed to the next process.*

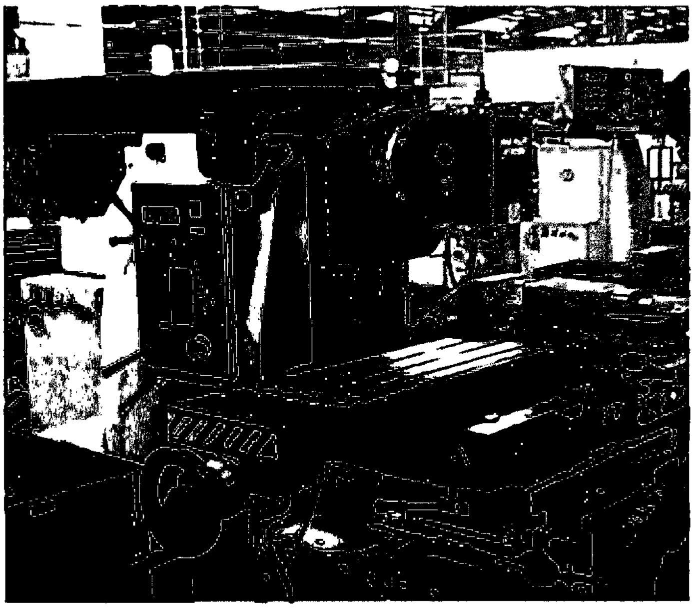

Figure 4.2: Milling machine

4.2.3 Removing Chip and Drilling

After finish milling process, the fabrication is continued with removing chip and drilling process. This process is to make a hole before using a screw and nut to joining a several part.

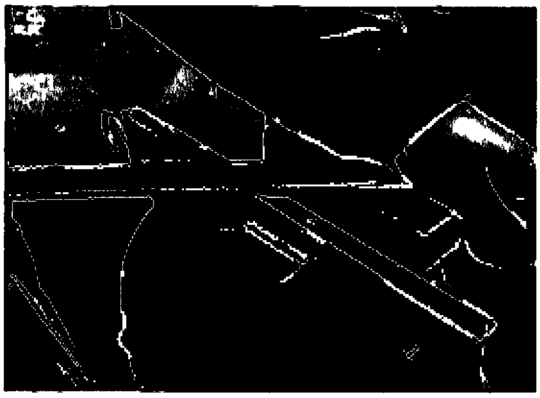

Figure 4.3: Discard the chip process

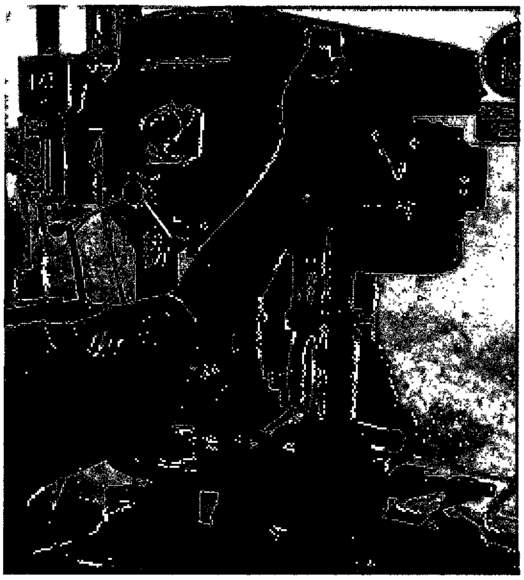

Figure 4.4: Drilling process

4.2.4 Treading Process

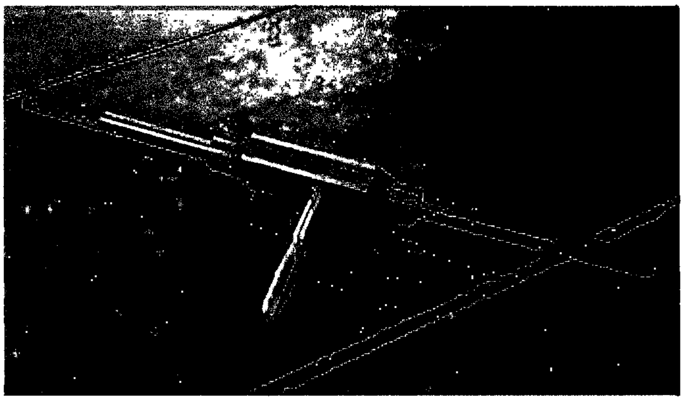

Figure 4.5: Treading tool

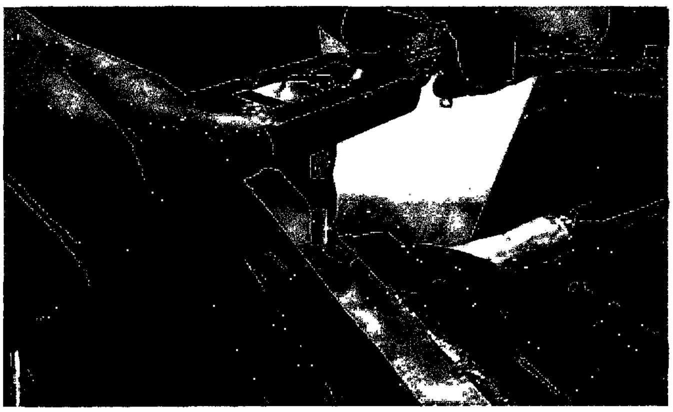

Figure 4.6: Treading process

4.2.5 Sandblasting Finishing Operation

4.2.5.1 Introduction

Sandblasting or bead blasting is a generic term for the process of smoothing, shaping and cleaning a hard surface by forcing solid particles across that surface at high speeds; the effect is similar to that of using sandpaper, but provides a more even finish with no problems at corners or crannies. Sandblasting can occur naturally, usually as a result of the particle blown by the wind causing eolian erosion, or artificially, using compressed air. (Benjamin Chew Tilghman on October 18, 1870)

4.2.5.2 General Procedure of Sandblasting Operation

This process is an important step to make a better finishing model. The process:

1. The fabricated molds from CNC machining will send to fine surface finishing operation. The tool marks need to be eliminated totally so it would not disturb the dimension of the design.
2. The fabricated mold placed inside the sandblasting container and the surface need to be facing the blower.
3. This process slowly conducted to see the result and also to avoid the over blasting to the surface.
4. After finishing this process, some sharp edges which filled up with the sand are knock out by using rubber hammer so it would not harm the mold.

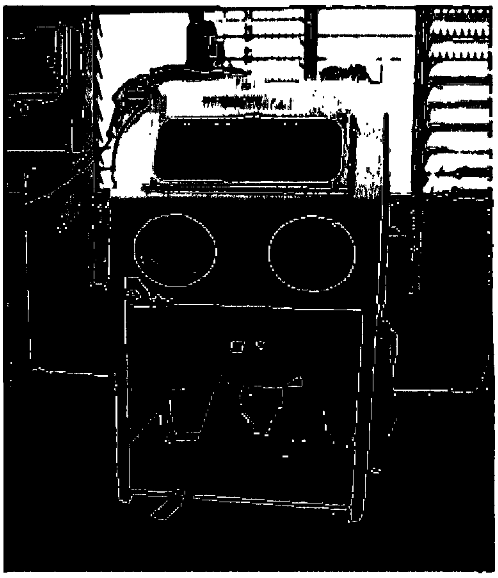

Figure 4.7: Sandblasting machine

4.2.6 Assembly Process

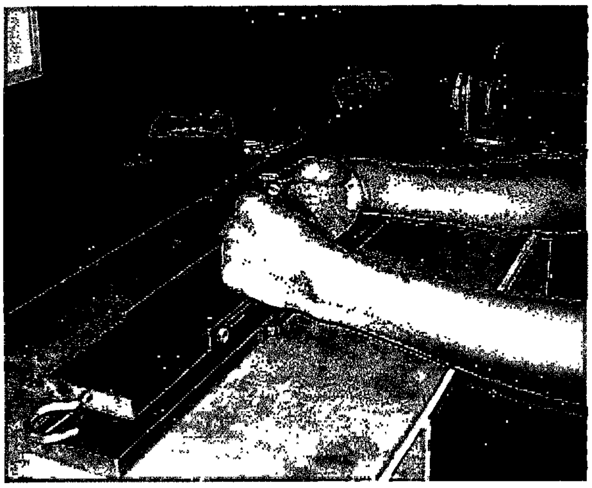

Figure 4.8: Assembly process

4.3 Result

Please refer **Appendix D,** for the test rig after fabrication figure and test apparatus figure.

4.4 Discussion

The device consists of two main components; a stationary upper platform and a lower platform that contains a base as stage. The principle of operation is that the tissue samples are affixed to both the upper and lower platforms using a thin layer of superglue then bathed in an appropriate physiological solution. The lower platform is moved relative to the fixed upper platform using the base stage in order to applied load.

The test is performed by clamping a test specimens attached in a 20 millimeters width specimen between two metal fixtures. An upper punch is then forced through the base in the metal fixture causing shear along the edge of the facing. A universal testing machine is used to push the punch until shearing of the specimen occurs.

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Introduction

This chapter contain an overview of the study as well as suggestion for future research. The investigation considered in this dissertation is focus on shear test rig for sandwich core. The significance of this study, we discussing about introduction project, project objective of work, project scope and project planning are presented in Chapter 1. in Chapter 2, we research about literature review this project. In Chapter 3, we discussing about how to produce design and choose a better design. In Chapter 4, we discusses about fabrication process, result and discussions of the project. In Chapter, we have discussed the conclusion of the project and future recommendation.

5.2 Conclusion

For the conclusion, overall perception of the project carried out was good. This project gains my knowledge by searching information in the internet. The project also generates my capability to make a good research report in thesis form or technical writing. I also get all the objective of this project are accomplished, which are to design a testing rig for sandwich core and fabricate shear test rig (tension mode) on some degree of vertical direction (sliding) using a motor.

5.3 Recommendation

Several recommendations would like to express:

1. Using much more power of motor to source of a force.
2. Using high strength steel for the main part shear test.
3. More stable clamping device.
4. Using an electrical switch to on the motor.

5.4 Future Work

The Future planning, this project can be use by the student to gain knowledge and understanding of the mechanical response in shear and could helpful in the study of sandwich core forming. The shear test rig also to be more efficient, upgrade should involve, using good material (example Stainless Steel) and good component. If the upgrade can be done the shear test rig can have better performance, more accurate data, and last longer. Also that, design a multipurpose shearing test, so it can use for tensile, bending and compression test.

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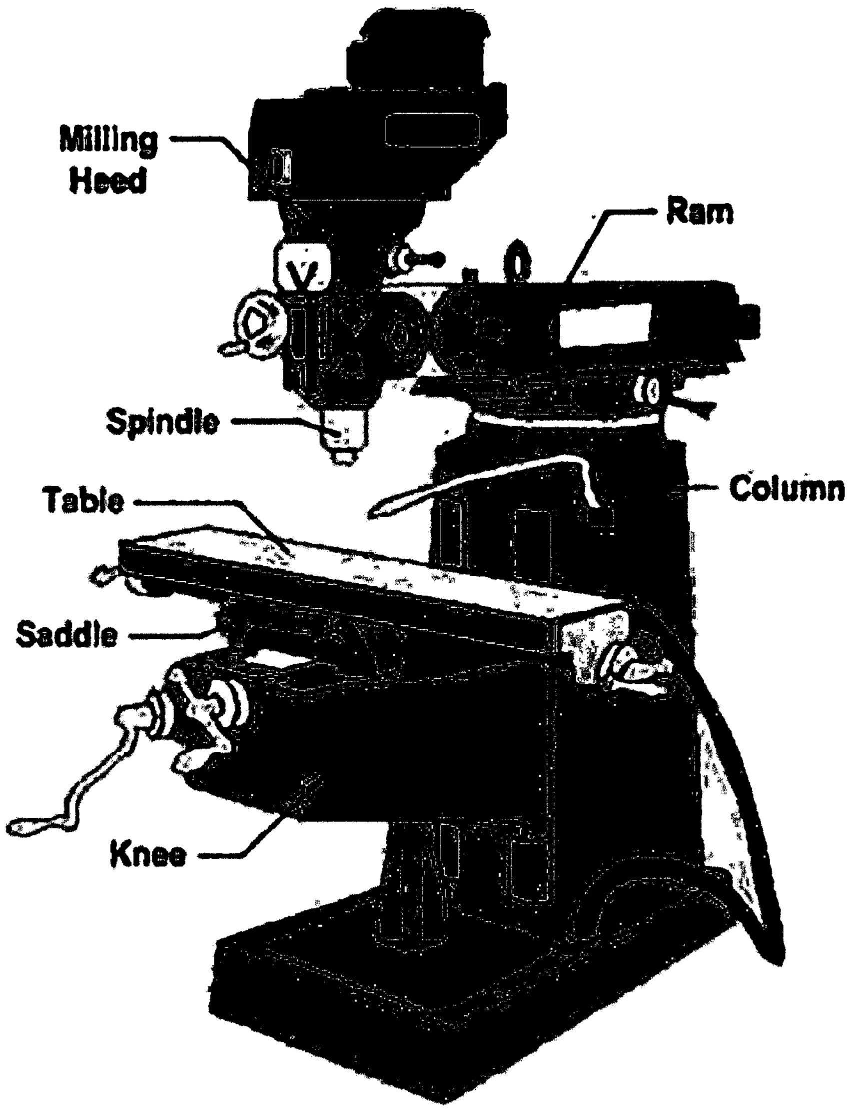
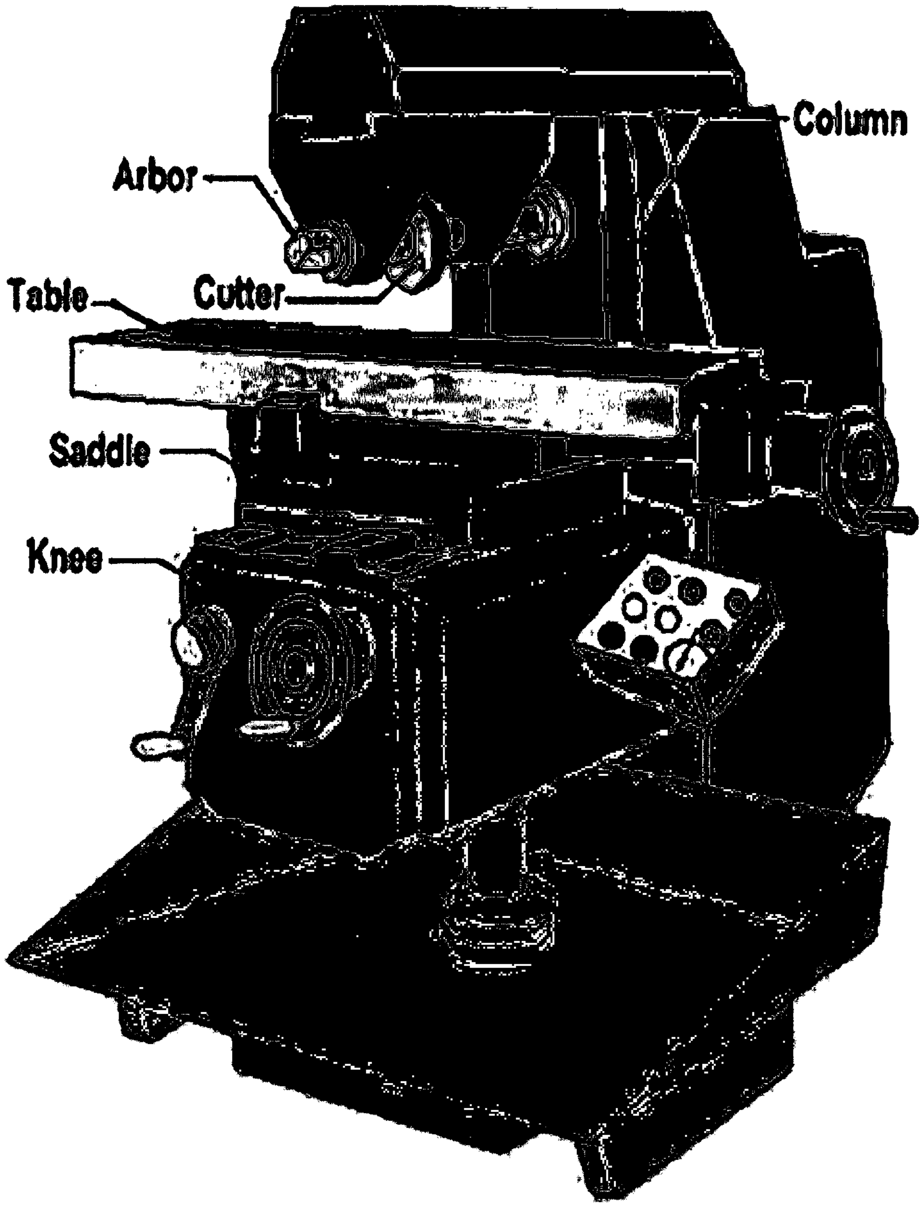
APPENDIX A: Milling Machine



Vertical Milling Machine

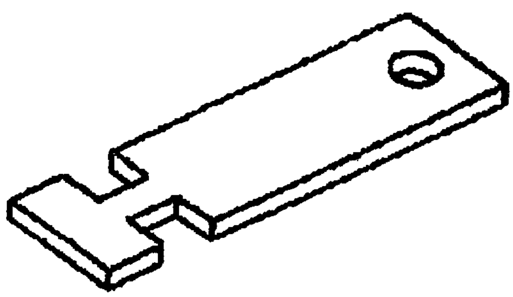


Horizontal Milling Machine

Safety Rules for Milling Machines

Milling machines require special safety precautions while being used.

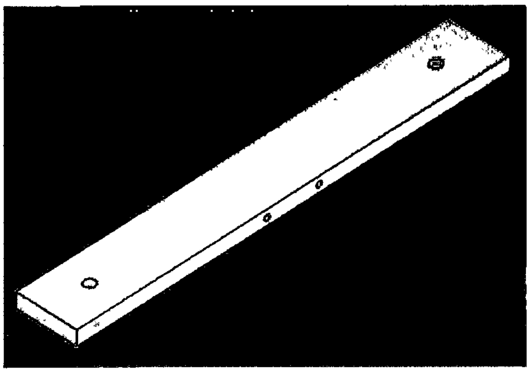
1. Do not make contact with the revolving cutter.
2. Place a wooden pad or suitable cover over the table surface to protect it from possible damage.
3. Use the buddy system when moving heavy attachments.
4. Do not attempt to tighten arbor nuts using machine power.
5. When installing or removing milling cutters, always hold them with a rag to prevent cutting your hands.
6. While setting up work, install the cutter last to avoid being cut.
7. Never adjust the workpiece or work mounting devices when the machine is operating.
8. Chips should be removed from the workpiece with an appropriate rake and a brush.
9. Shut the machine off before making any adjustments or measurements.
10. When using cutting oil, prevent splashing by using appropriate splash guards. Cutting oil on the floor can cause a slippery condition that could result in operator injury



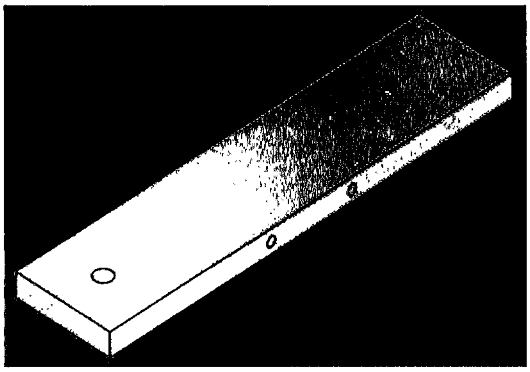
Chip Rake

APPENDIX B: Detail Design

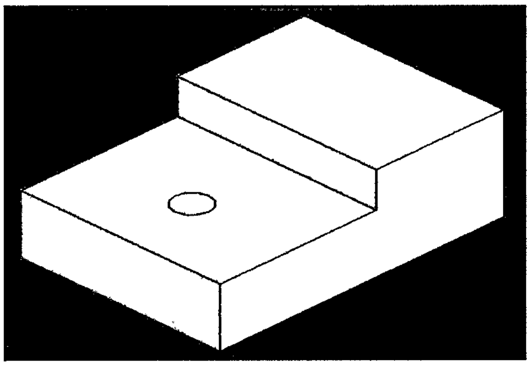
a) Main Part



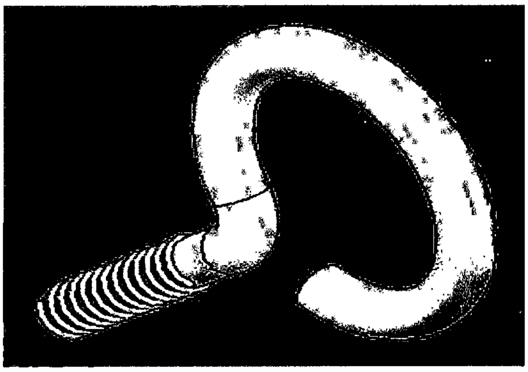
Lower Platform



Upper Platform

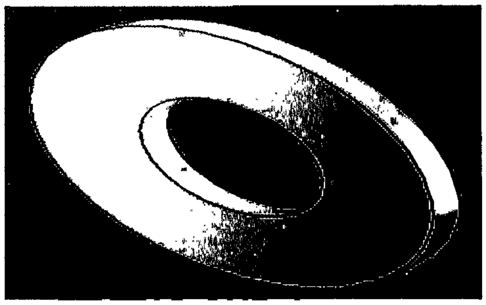


Upper Platform Connection

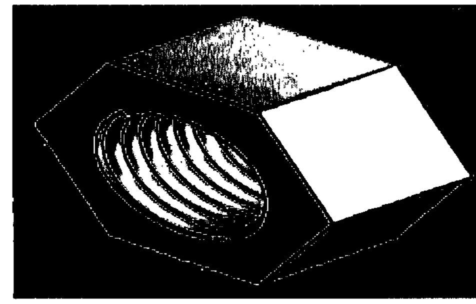


J Hoop

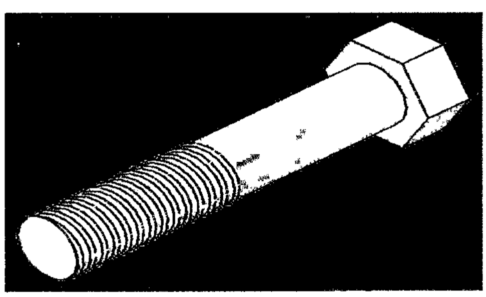
b) Supplement Part



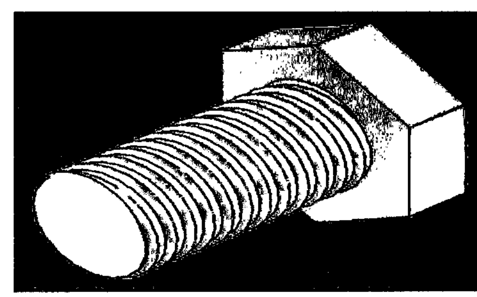
Washer



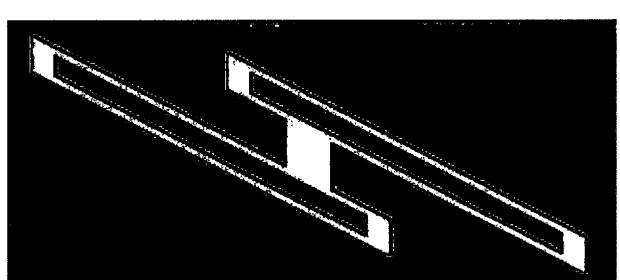
Nut



Screw (body)

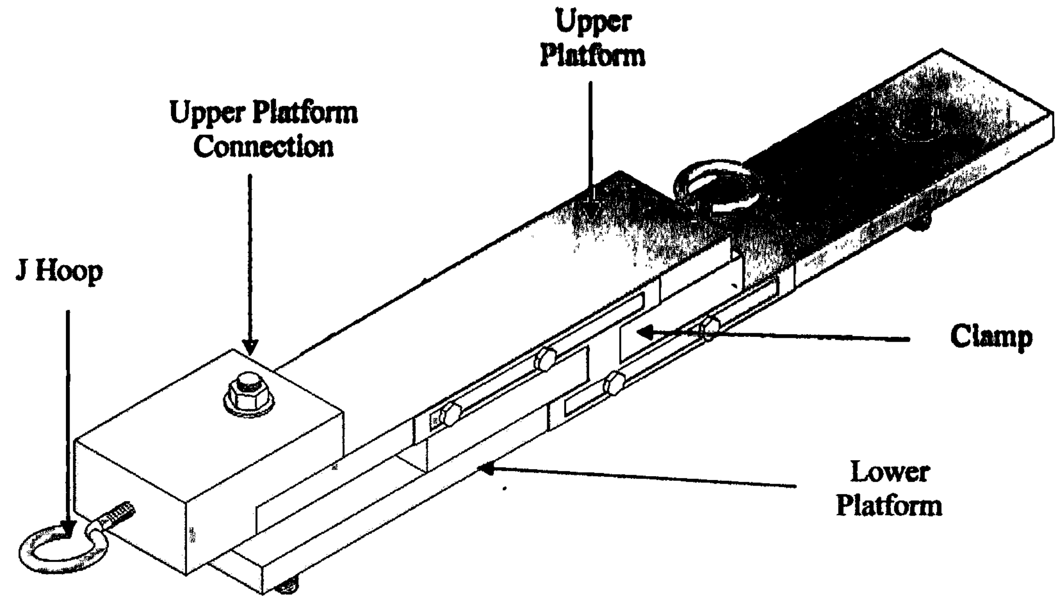


Screw (clamp)



Clamp

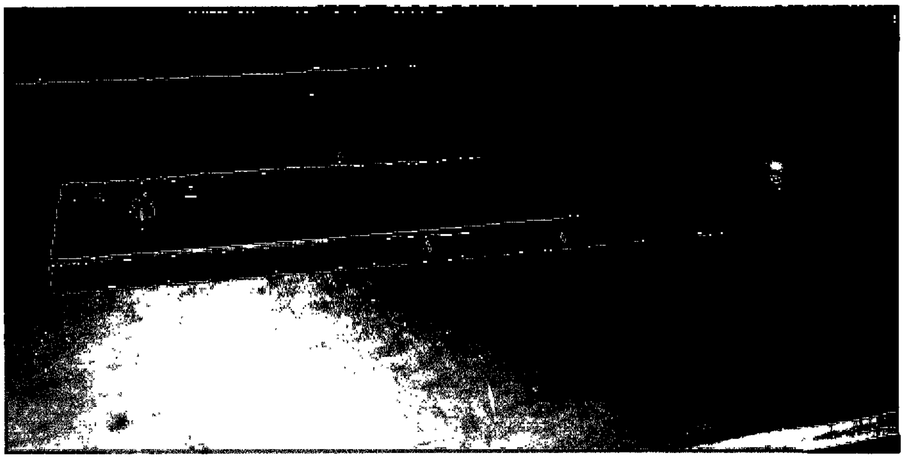
c) Overall View of the Design



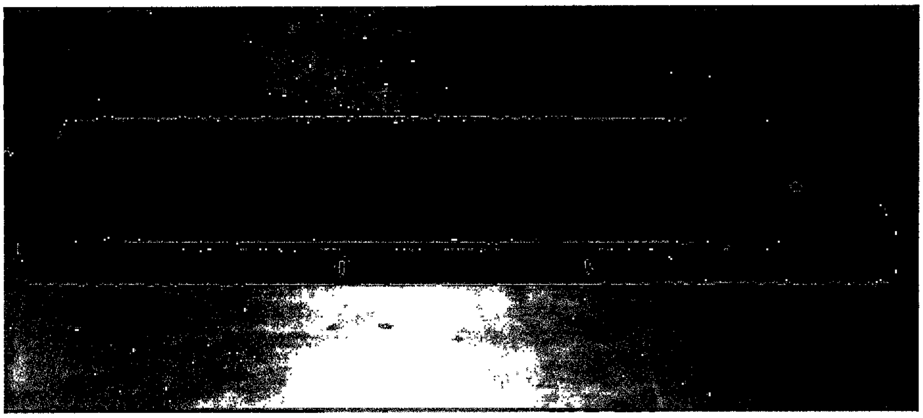
APPENDIX C: Linear Cutting Speed of the Material in m/min

MATERIAL	CUT SPEED (S.F.M.)	1/8" DIA. (RPM)	1/4" DIA. (RPM)	3/8" DIA. (RPM)
Stainless Steel, 303	40	1200	600	400
Stainless Steel, 304	36	1100	500	350
Stainless Steel, 316	30	900	450	300
Steel, 12L14	67	2000	1000	650
Steel, 1018	34	1000	500	350
Steel, 4130	27	800	400	250
Gray Cast Iron	34	1000	500	350
Aluminum, 7075	300	800	2500	2000
Aluminum, 6061	280	2800	2500	2000
Aluminum, 2024	200	2800	2500	2000
Aluminum, Cast	134	2800	2000	1300
Brass	400	2800	2800	2800

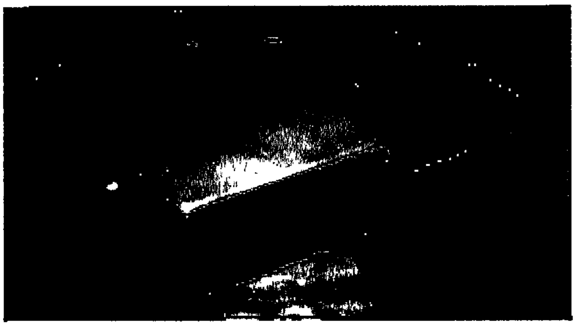
APPENDIX D: The Final Product



Lower Platform

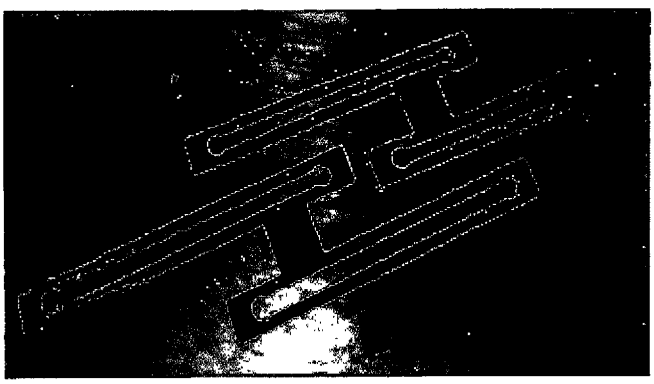


Upper Platform

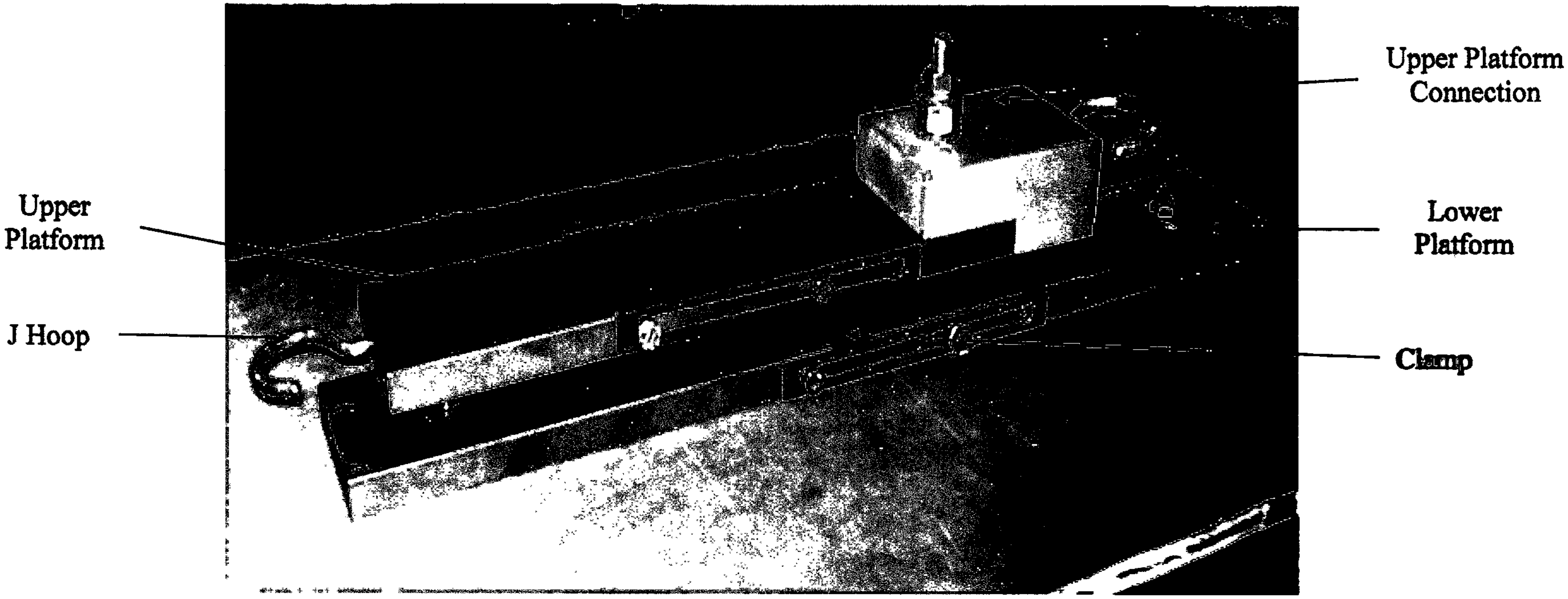


Upper Platform Connection

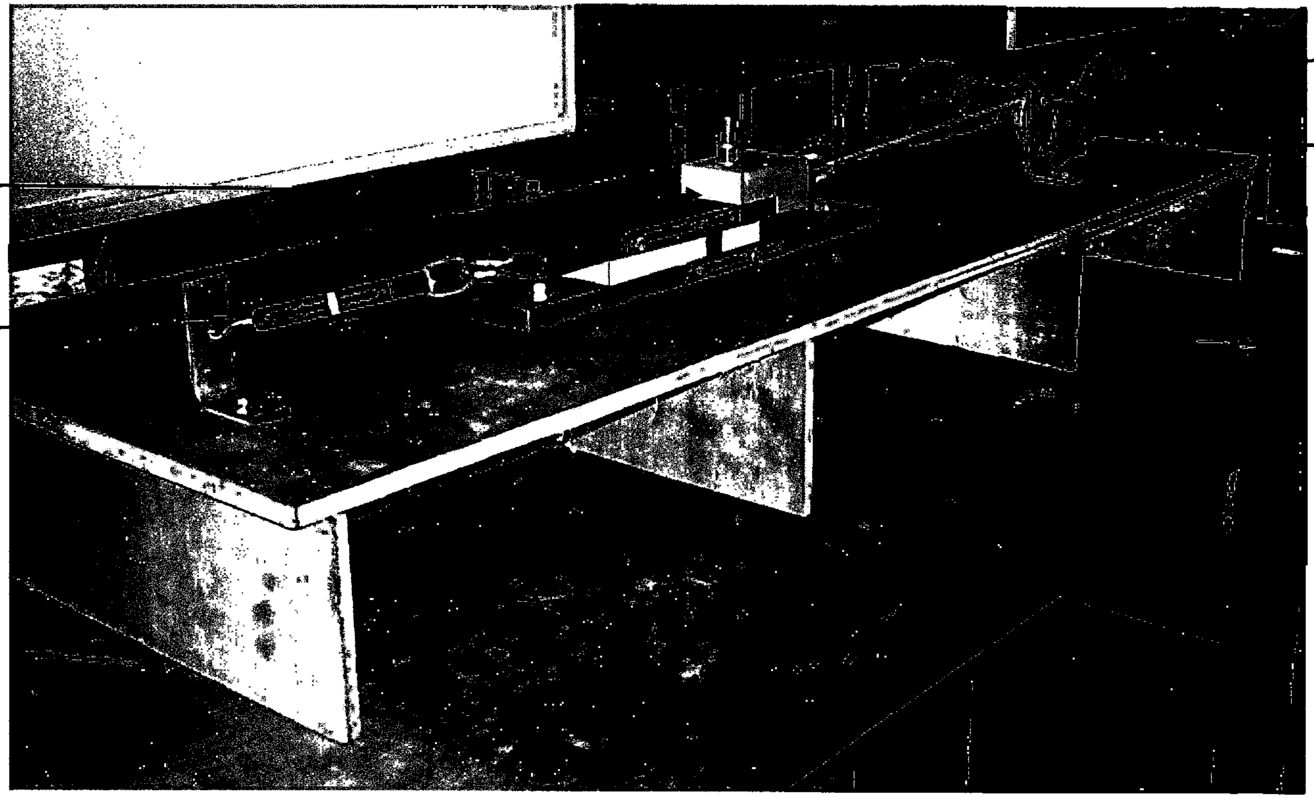
J Hoop



Clamp

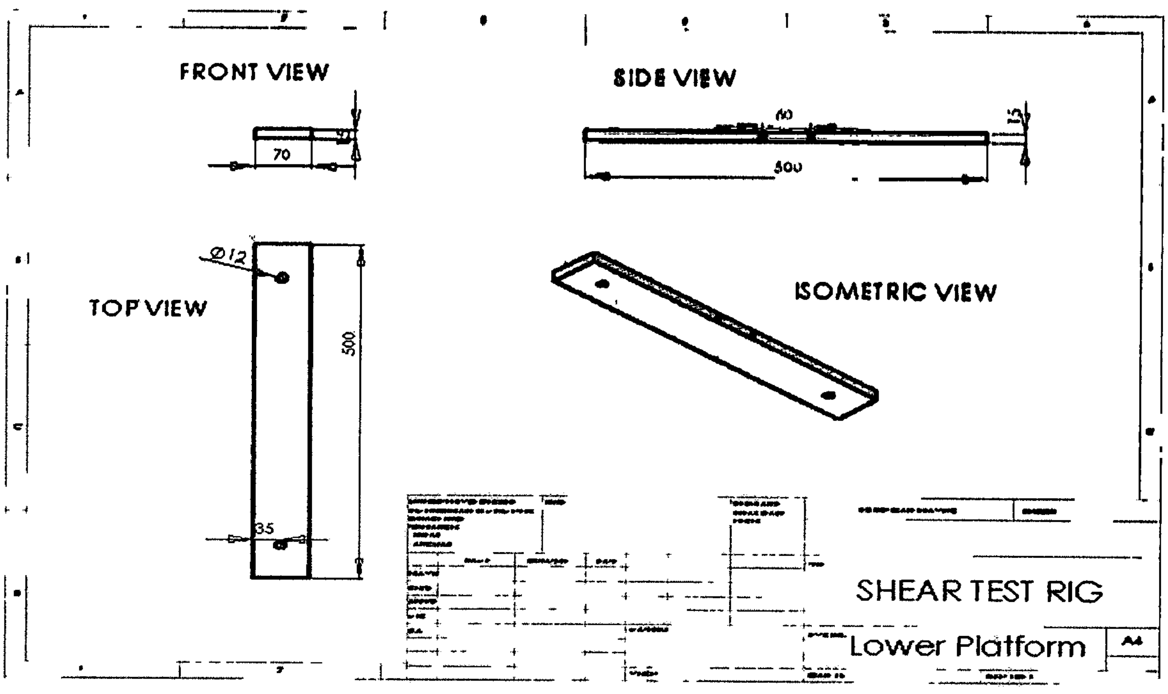


Overall Assembly

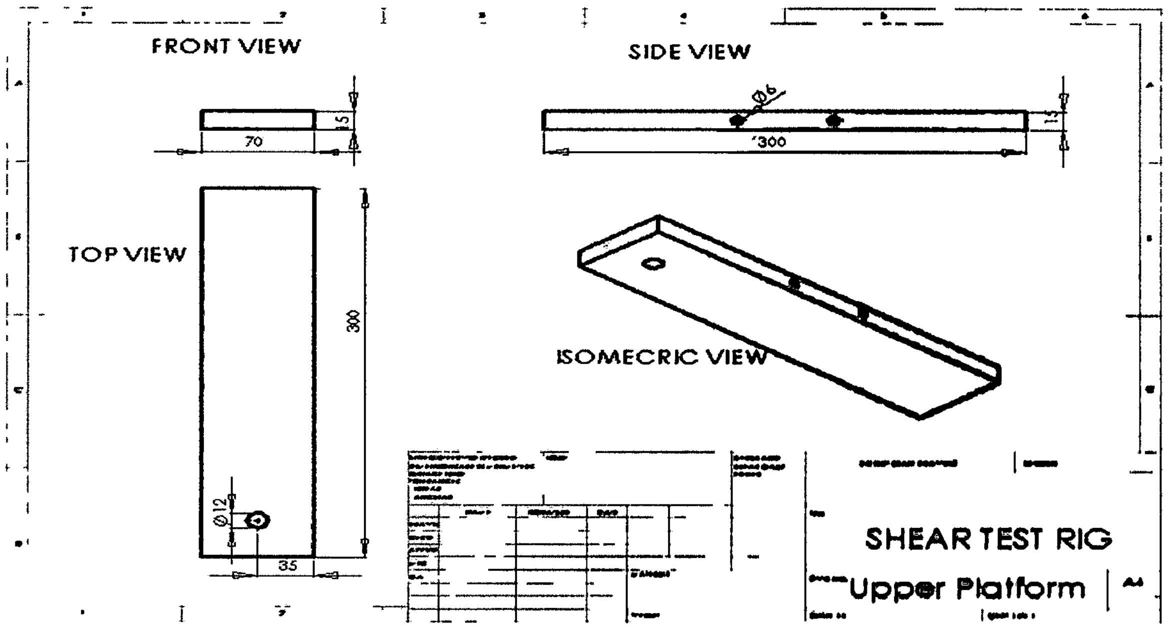


Test Apparatus

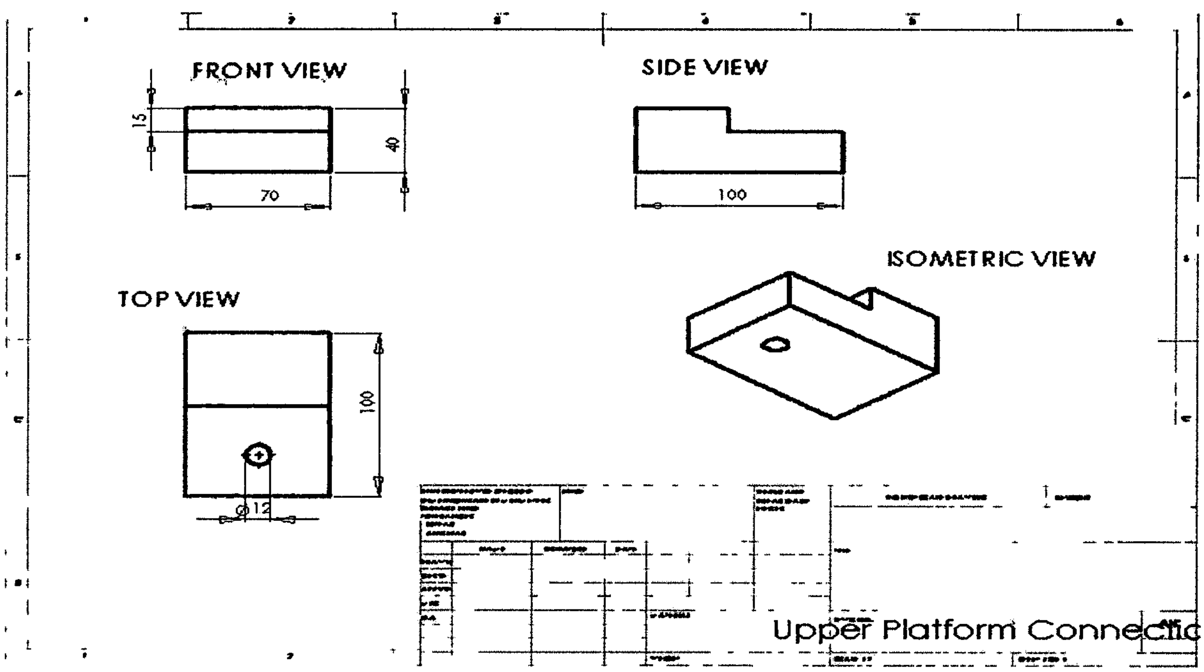
APPENDIX E: Dimension Drawing



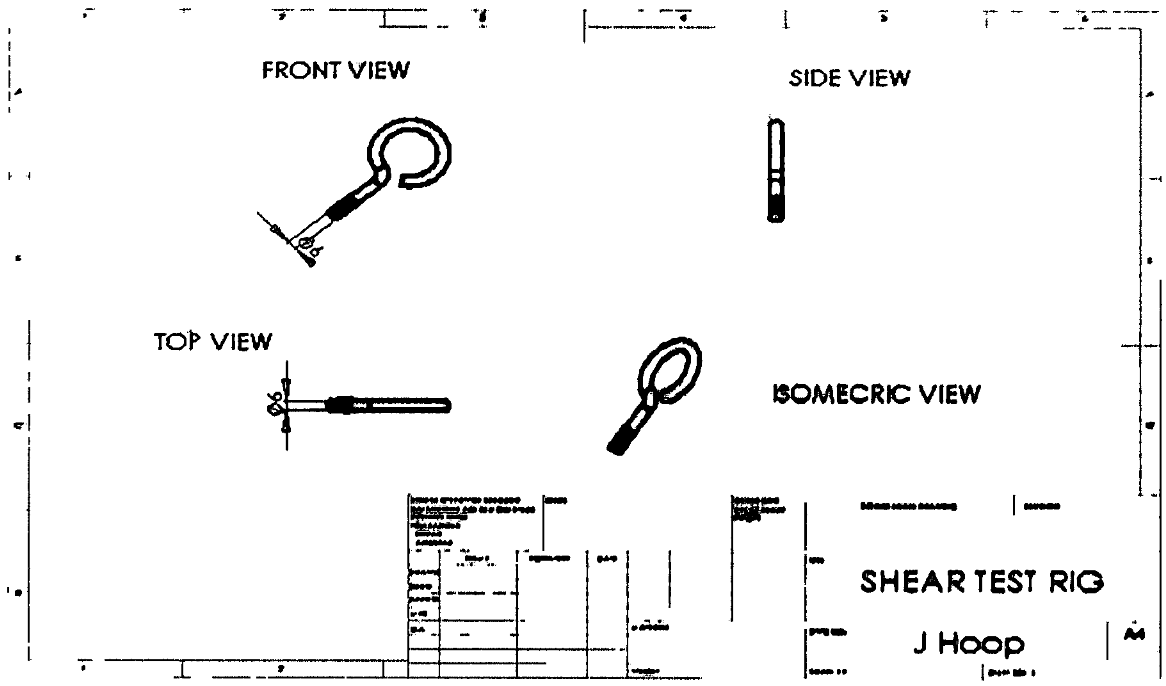
Lower platform



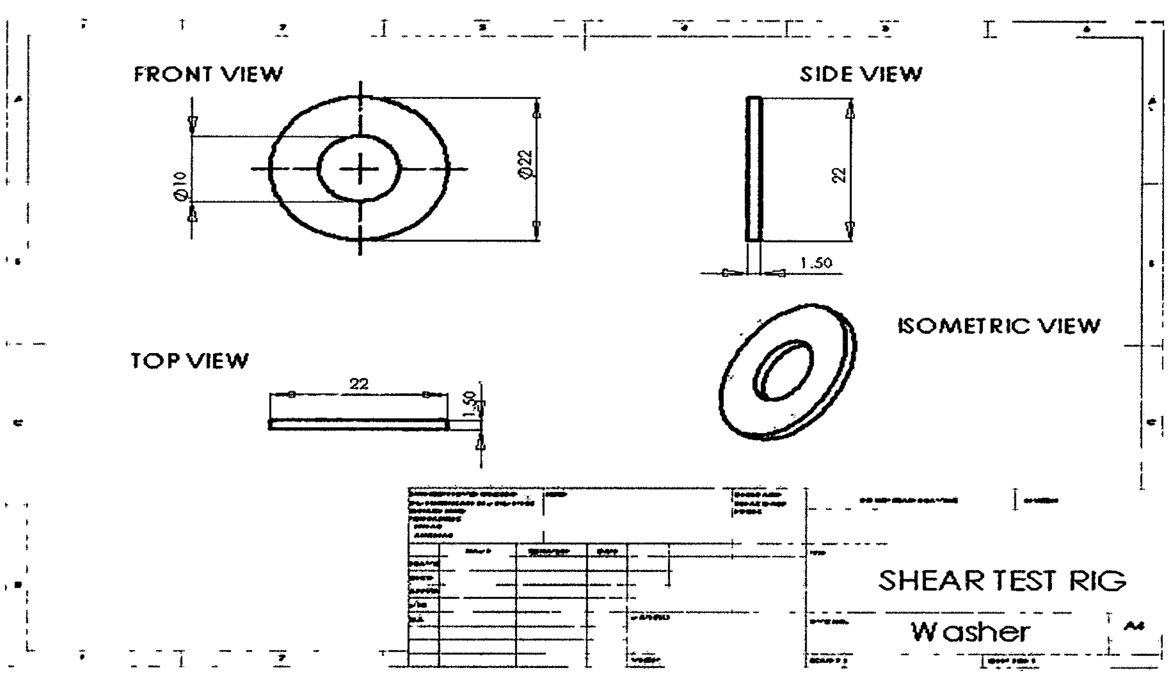
Upper platform



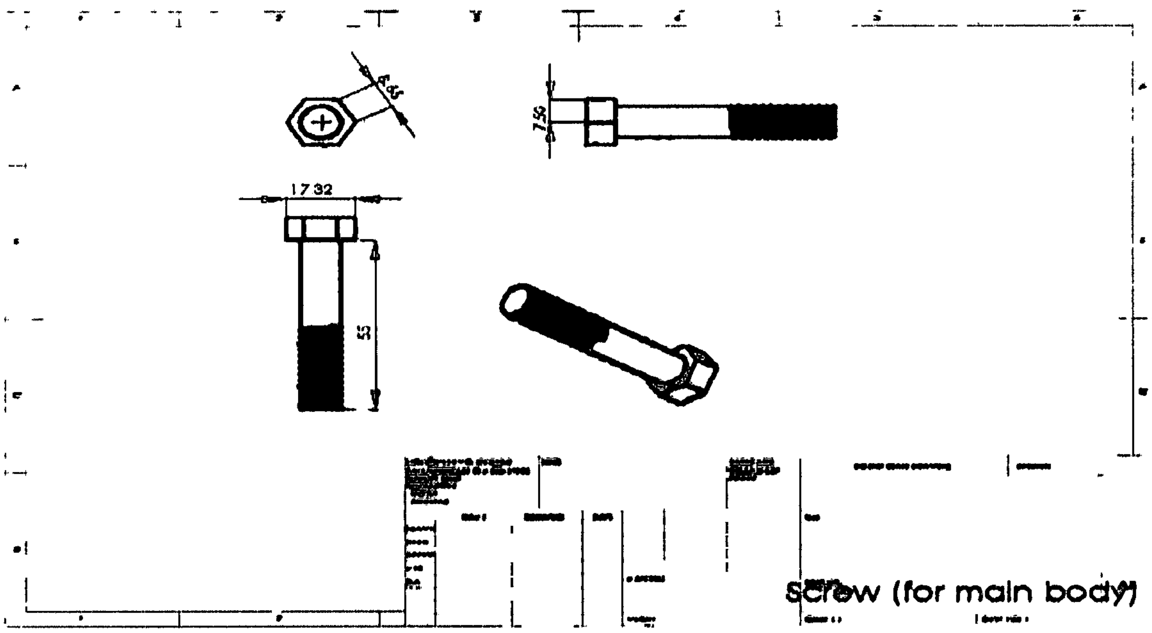
Upper platform connection



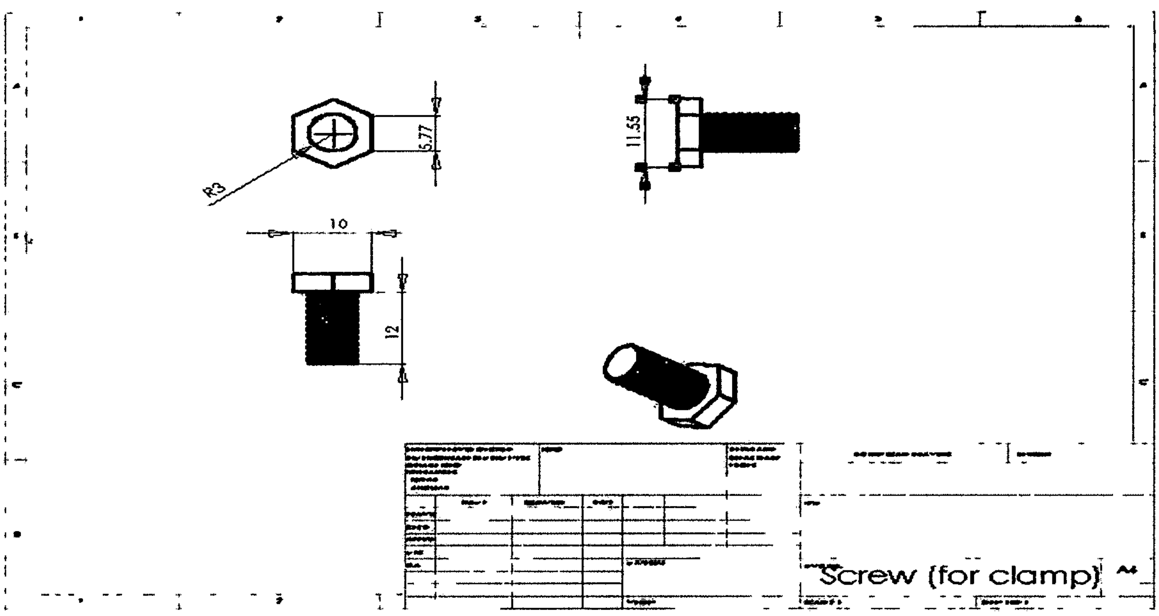
J-hoop



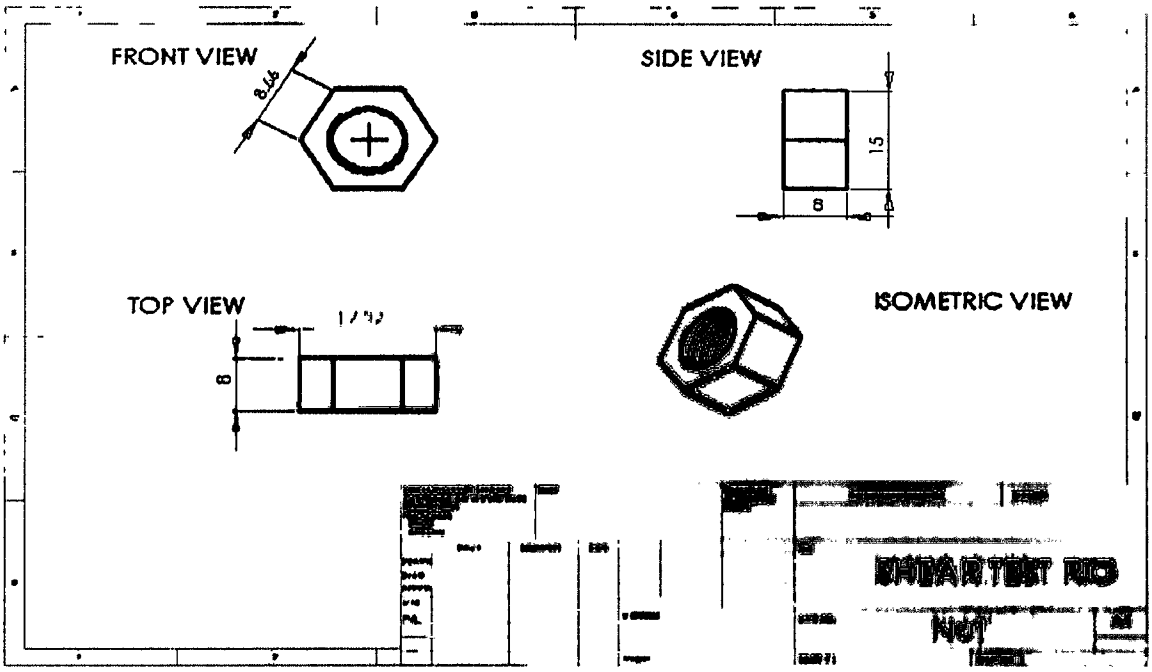
Washer



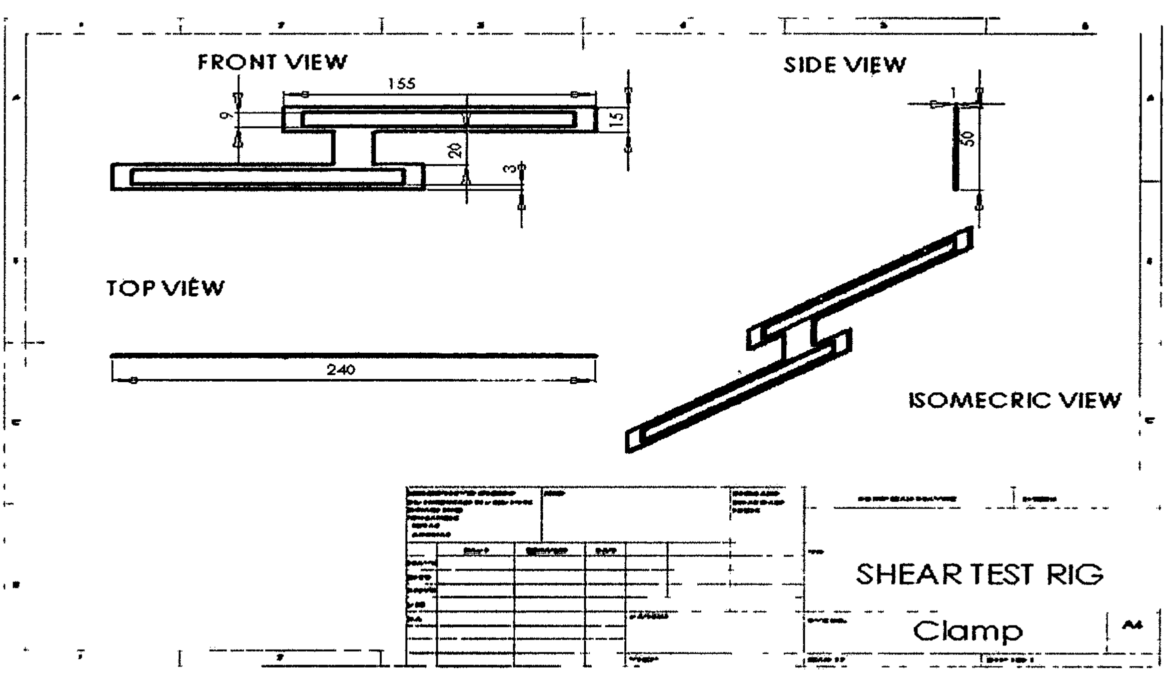
Screw (body)



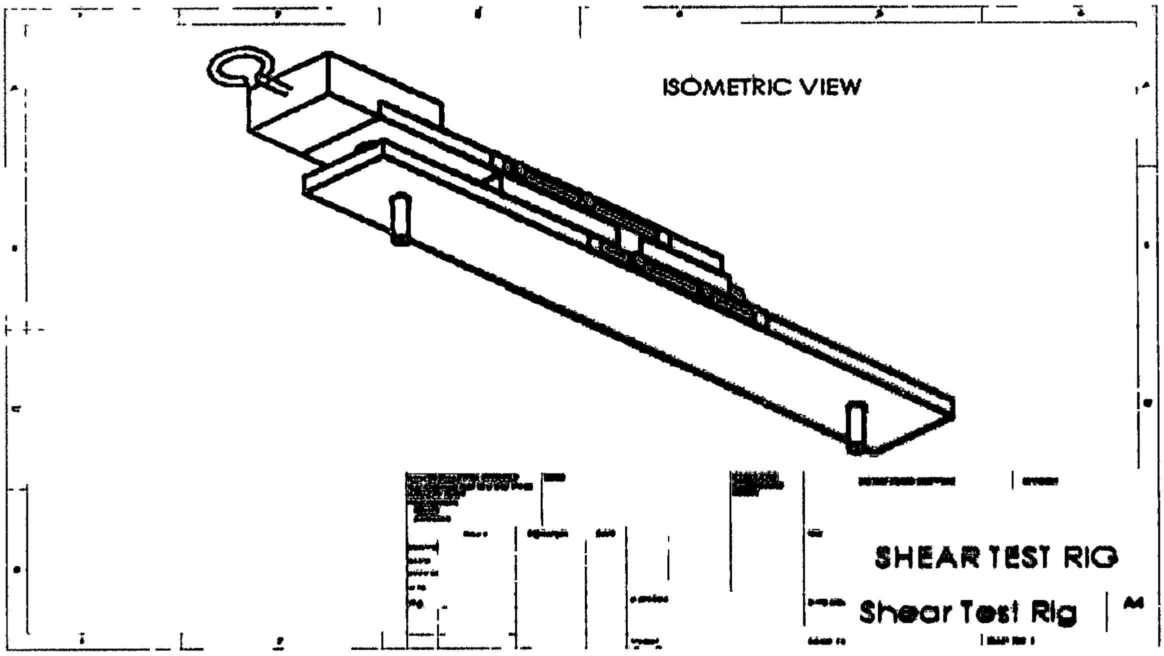
Screw (clamp)


FRONT VIEW
8.66
SIDE VIEW
15
8
TOP VIEW
8
ISOMETRIC VIEW
SHEAR TEST RIG
NUT

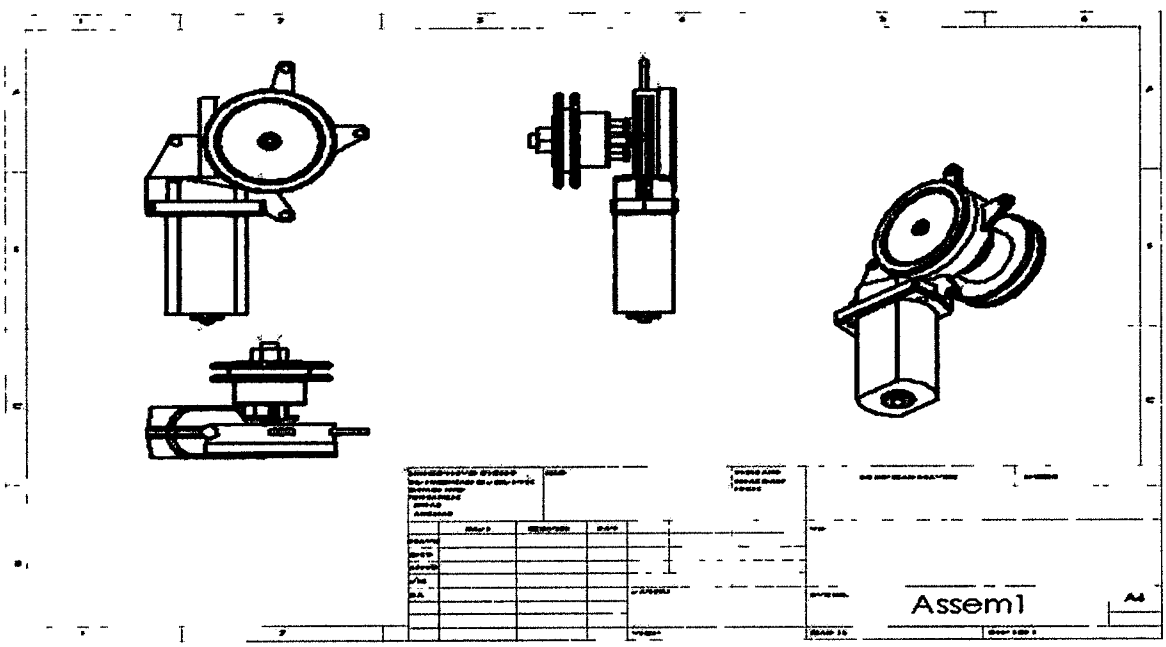
Nut


FRONT VIEW
155
9
15
20
3
SIDE VIEW
1
50
TOP VIEW
240
ISOMECRIC VIEW
SHEAR TEST RIG
Clamp
A4

Clamp



The final product



Motor