DESIGN AND FABRICATION OF A NEW FREE AND FORCE VIBRATION TEST RIG

MUHAMMAD NAIM BIN OTHMAN

UNIVERSITI MALAYSIA PAHANG

UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS◆

JUDUL: DESIGN AND FABRICATION OF A NEW FREE AND FORCE VIBRATION TEST RIG

SESI PENGAJIAN: 2011/2012

Saya, **MUHAMMAD NAIM BIN OTHMAN (900310-01-6029)**
(HURUF BESAR)

mengaku membenarkan tesis Projek Tahun Akhir ini disimpan di perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Tesis ini adalah hakmilik Universiti Malaysia Pahang (UMP).
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (√)

☐	**SULIT**	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD**	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi / badan di mana penyelidikan dijalankan)
√	**TIDAK TERHAD**	

Disahkan oleh:

_____ (TANDATANGAN PENULIS)

Alamat Tetap:

No 30, Jln Kemboja 5,
Tmn Plentong Baru,
81750,Masai,Johor.

Tarikh: **10 JANUARY 2012**

_____ (TANDATANGAN PENYELIA)

NURAZIMA BINTI ISMAIL
(Nama Penyelia)

Tarikh: **10 JANUARY 2012**

CATATAN: * Potong yang tidak berkenaan.

** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

◆ Tesis dimaksudkan sebagai tesis bagi Diploma secara penyelidikan atau disertai bagi pengajian secara kerja kursus.

DESIGN AND FABRICATION OF A NEW FREE AND FORCE VIBRATION TEST RIG

MUHAMMAD NAIM BIN OTHMAN

Report submitted in partial fulfillment of the requirements
for the award of Diploma in Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

JANUARY 2012

SUPERVISOR'S DECLARATION

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

Signature :
Name of Supervisor : Nurazima Binti Ismail
Position : Lecturer
Date : 10 January 2012

STUDENT DECLARATION

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

Signature :
Name : Muhammad Naim Bin Othman
ID Number : MB09003
Date : 10 January 2012

ACKNOWLEDGEMENT

Praise to God for His help and guidance that I am able to complete the task of the Final Year Project. I am thankful and grateful to my supervisor, Mrs Nurazima Binti Ismail for her advice and knowledge that she shared in the completion of the project. I appreciate her help for me while I am doing the Final Year Project from week 1 to the day I finished my Final Year Project.

I also would like to thank all my friends who have been really helpful during the course of the conducting the Final Year Project. I also would like to thank laboratory assistants especially to Mr Aziha Bin Abdul Aziz and who have help me in conducting machine and sharing knowledge in conjunction with the project that I am conducting.

I sincerely grateful to my parents, Othman Bin Yusof and Fatimah Binti Bujang for they love and sacrifice that they had for me throughout my life and their support for me in all my activities that I have done. I also wanted to that other people who have directly or indirectly help in the completion of my Final Year Project. I sincerely appreciate all your help.

ABSTRACT

This design and fabrication of a vibration test rig shows the combination of free and force vibration test rig. The objective of the project is to design and fabricate the combination of free and force vibration test rig. This report also describes about the free and force vibration experiment and their functionality. Design generation is shown and solid three dimensional structures modelling of the test rig was developed using Solidworks software. This report also explains the fabrication process that is needed for this project. Material that was being used in this project is aluminium. The problems encountered during completion of this project are also show in the report. An idea of improvement for the combination of test rig is also provided for further improvement of the test rig. The expected result for this project can solve the entire stated problem statement.

ABSTRAK

Laporan ini menunjukkan lukisan dan pembuatan alat uji getaran yang menggabungkan alat uji getaran bebas dan getaran paksa. Objektif laporan ini adalah untuk lukisan dan pembuatan yang menggabungkan alat uji getaran bebas dan getaran paksa. Laporan ini juga menerangkan tentang maksud eksperimen getaran bebas dan getaran paksa dan juga fungsinya. Konsep lukisan telah ditunjukkan dan permodelan struktur-struktur bongkah tiga dimensi untuk alat uji getaran telah dihasilkan menggunakan perisian lukisan bantuan komputer. Laporan ini juga menerangkan proses pembuatan yang diperlukan untuk projek ini. Bahan yang akan digunakan dalam projek ini ialah aluminium dan Allen keys skru. Masalah yang dihadapi semasa menyiapkan projek ini juga terdapat di dalam laporan ini. Idea penambahbaikan untuk alat uji getaran juga disediakan untuk pembaharuan masa akan datang. Keputusan yang dijangkakan bagi projek ini ialah dapat menyelesaikan segala penyataan masalah yang telah di nyatakan.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

For this chapter, it is about discussion of the problem background, problem statement, objectives of the project and lastly scope of the project.

1.2 PROJECT BACKGROUND

Free and Force vibration test rig are the place to conduct the vibration experiments on a beam. Free vibration test rig occurs when the system is disturbed with constant force but immediately allowed to move without restraint. But for the force vibration test rig, it occurs when the beam has unbalanced force. Usually, all the type of vibration experiment has their own test rig. The test rig are quite big and need big area to place it.

So, this project is to design and fabricate the new free and force vibration test rig. And the project is to combine both free and force vibration test rig into one test rig. It is also to improve the existing test rig.

1.3 PROBLEM STATEMENT

Big area are needed in order to place the free and force vibration test rig in the Noise, Vibration and Harshness Laboratory separately. So, I decide to design a combination of free and force vibration test rig. Furthermore, the existing part on the test rig like clamps, unbalance rotator and beam holder can use rectangle beam only. So, I decide to design all parts which can use various shape of beam like round, triangle, rectangle and also square beam.

1.4 OBJECTIVES

The main objectives of this project are :

i. To design the combination of free and force vibration test rig.
ii. To fabricate the simple combination of the test rig.

1.5 SCOPES

The scopes of this project are :

i. To design the test rig using Solidworks software.
ii. To design the parts of the test rig that can use various shape of beam like round, triangle, square and rectangle beam.

1.6 GANTT CHART

Gantt chart is an important to guide the work process during this project. With gantt chart what need to be done first can be plan accordingly. Other than that, this project will run smoothly and finish on time. Refer Appendix A to see a gantt chart that being used for this project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This section is about the literature review of the project. In this chapter, there is definition and information about both free and force vibration test rig. Besides that, it is consist the analysis from both of test rig.

2.2 FREE VIBRATION TEST RIG

Figure 2.1 shows all parts on the free vibration test rig that have in Noise, Vibration and Harshness Laboratory.

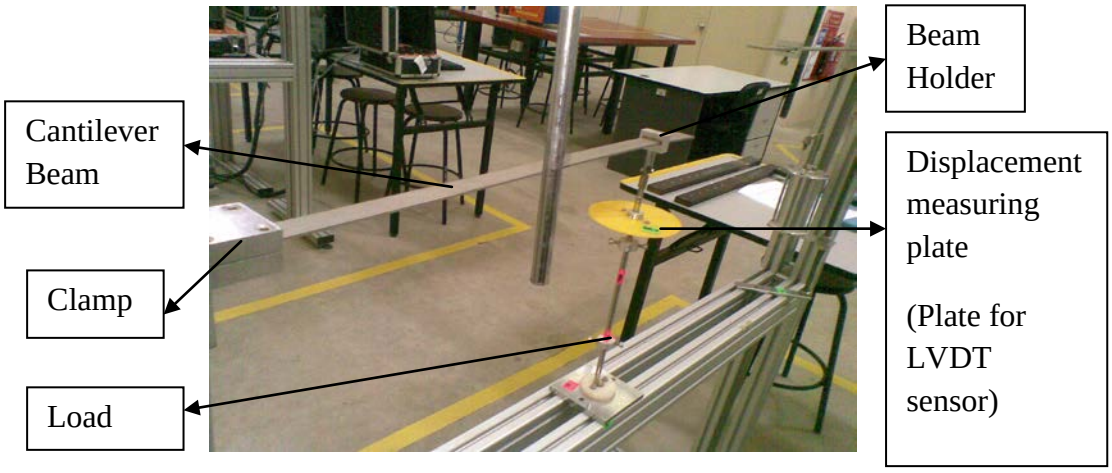


Figure 2.1: Free Vibration Test Rig

2.2.1 Definition

Free vibration test rig is used to calculate the stiffness and vibration of the beam. It's occurs when a system is disturbed with constant force but immediately allowed to move without restraint. Figure 2.2 shows the schematic diagram for free vibration operation.

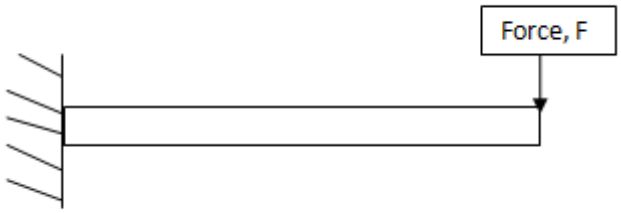


Figure 2.2 : Schematic Diagram For Free Vibration

2.2.2 Tools

For free vibration experiment, there are tools needed to operate this experiment. The tools are :

i. Cantilever beam
ii. Load rod
iii. Mass (5N, 10N and above)
iv. LVDT sensor
v. Displacement measuring plate
vi. Computer
vii. Software (QuickDAQ)

2.2.3 Procedure

There are procedures to conduct this experiment. The procedures are :

i. Make sure the cantilever beam is fixed to clamped support.
ii. Decide on the mass to be used for loading the beam. The mass is usually at 5N, 10N and above.
iii. Insert the loading rod through hole at the centre of the mass.
iv. Setting the LVDT sensor on the displacement measuring plate and make sure computer is ready for record the data.
v. Make a force on end of the beam and make sure the force is constant when repeat the experiment using different mass.
vi. Record the data on the computer.

2.3 FORCE VIBRATION TEST RIG

Figure 2.3 shows all parts on the force vibration test rig that have in Noise, Vibration and Harshness Laboratory.

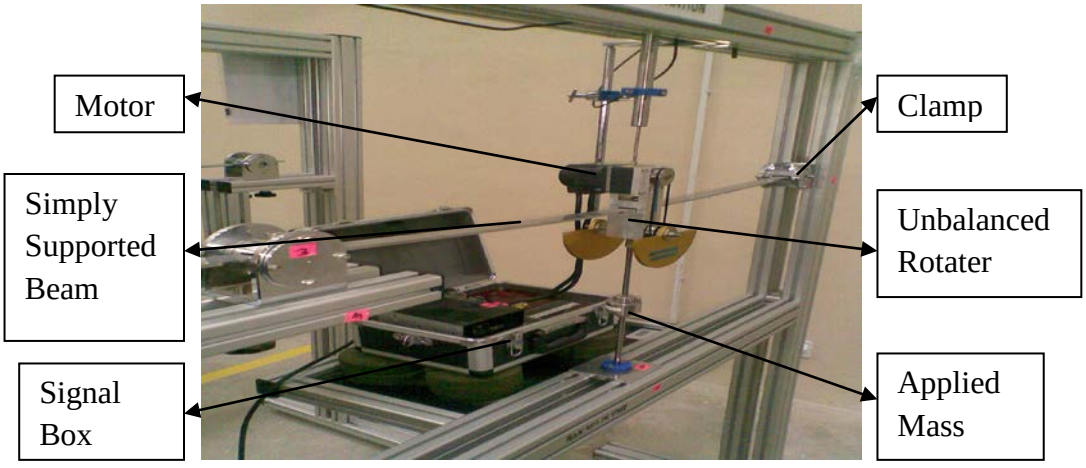


Figure 2.3: Force Vibration Test Rig

2.3.1 Definition

Forced vibration test rig is used to calculate the stiffness and vibration of the simply supported beam. It's occurring when the beam has unbalanced force. Figure 2.4 shows the schematic diagram for force vibration operation.

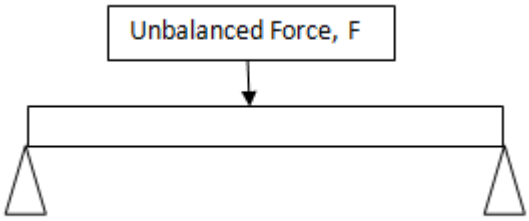


Figure 2.4 : Schematic Diagram For Force Vibration

2.3.2 Tools

For force vibration experiment, there are tools needed to operate this experiment. The tools are :

i. Simply supported beam
ii. Clamp
iii. Rotate unbalance
iv. Motor
v. Signal box
vi. LVDT sensor
vii. Software (QuickDAQ)

2.3.3 Procedure

There are procedures to conduct this experiment. The procedures are :

i. Make sure the simply supported beam is fixed to clamped support.
ii. Make sure the unbalance rotating is centre of the beam.
iii. Decide on the RPM for the motor to rotate the unbalance rotating.
iv. Setting the LVDT sensor and make sure computer is ready for record the data.
v. Start the motor to the given RPM to make the unbalanced force to the beam and repeatedly with different RPM.
vi. Record the data on the computer.

2.4 ANALYSIS

2.4.1 The Different of Free and Force Vibration Test Rig

There are a lots of different between free and force vibration test rig. The different are :

a. Different of the beams.
    i. Free Vibration Test Rig used Cantilever beam.
    ii. Force Vibration Test Rig used Simply Supported beam.

b. The load.
    i. Free Vibration Test Rig used different mass of load (Load changes).
    ii. Force Vibration Test Rig used constant mass of load (weight of motor, unbalance rotating is calculate and same repeatedly).

c. Force Applied.
    i. Free Vibration Test Rig used static force (Constant).
    ii. Force Vibration Test Rig used unbalanced force (RPM changes).

2.4.2 The Similarity of Free and Force Vibration Test Rig

The similarity of both test rig is their objective of the experiment that is the stiffness of the beam. Their objective are :

i. Get frequency from the data on the computer.
ii. Period of vibration. (How much second in 1 cycle)

2.4.3 Conclusion from Analysis

From the analysis, I decide to make the design of test rig use simply supported beam that can operate both of free and force vibration experiment. Furthermore, the design can use more type of beam like round ,triangle, and rectangle beam.

2.5 FABRICATION PLANNING PROCESS

2.5.1 Lathe

A lathe is a machine tool which turns cylindrical material, touches a cutting tool to it, and cuts the material. A material is firmly fixed to the chuck of a lathe. The lathe is switched on and the chuck is rotated. And since the table which fixed the byte can be moved in the vertical direction and the right-and-left direction by operating some handles.

In order to get an efficient process and beautiful surface at the lathe machining, it is important to adjust a rotating speed, a cutting depth and a sending speed as shown in Figure 2.5. I plan to use lathe machine for the clamp of my project. I use it to make a facing and material remove to get an actual dimension.

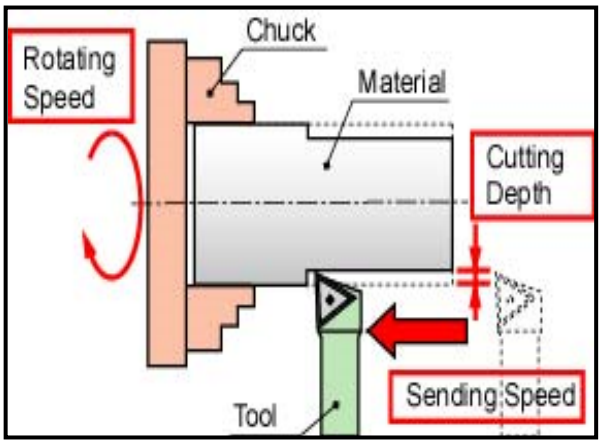


Figure 2.5: Important element of lathe machine

Source: nmri

2.5.2 Milling

Milling is the most common form of machining, a material removal process, which can create a variety of features on a part by cutting away the unwanted material. The milling process requires a milling machine, workpiece, fixture, and cutter. The workpiece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to a platform inside the milling machine. The cutter is a cutting tool with sharp teeth that is also secured in the milling machine and rotates at high speeds. By feeding the workpiece into the rotating cutter, material is cut away from this workpiece in the form of small chips to create the desired shape. Milling is typically used to produce parts that are not axially symmetric and have many features, such as holes, slots, pockets, and even three dimensional surface contours.

I plan to make unbalance rotator and beam holder using a conventional milling machine. Figure 2.6 below is an example of milling process.

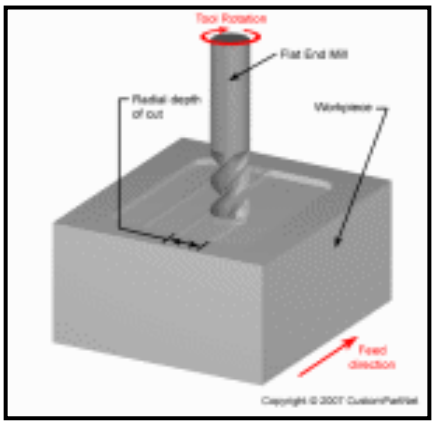


Figure 2.6: Slot cut

Source: Custompartnet

2.5.3 Drilling

There are many machines capable and used to drill, ream or thread holes in a part. Drilling is the manufacturing process where a round hole is created within a workpiece or enlarged by rotating an end cutting tool, a drill. For this project, I plan to make a hole for screw to hold the beam neatly. Figure 2.7 below show the drilling process.

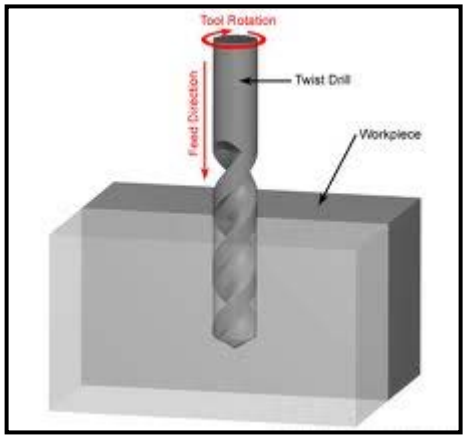


Figure 2.7: Drilling process

2.5.4 Threading

Thread cutting is cutting of helical turns of threads out of the tapping that is size of hole or bolt in order to create screwed connections. Figure 2.8 show the process of threading. The size of thread tools that usually use are M5, M6, M8, and M10. Figure 2.9 shows the types of thread tools.

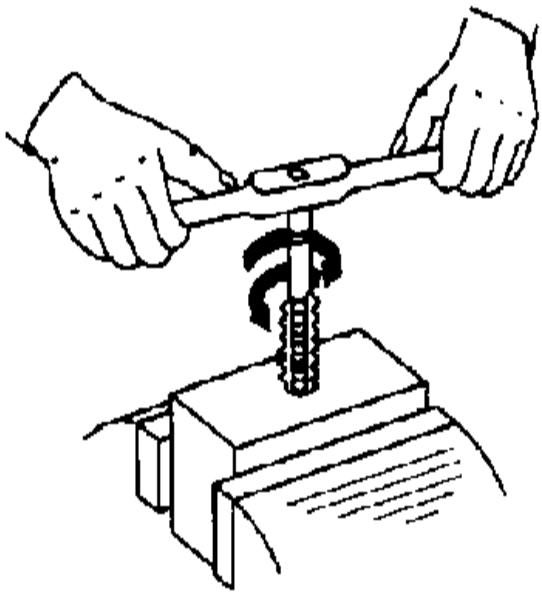


Figure 2.8 : Thread cutting

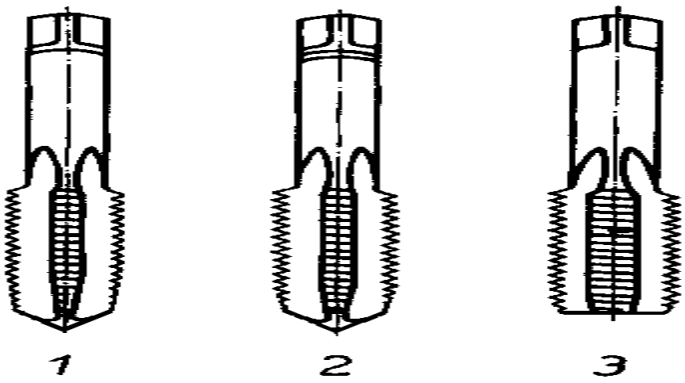


Figure 2.9 : Tools of Threading

A complete screwed connection requires an internal thread and a matching external thread as a counterpart. For this process, I plan to make thread for all parts of my project to enable the screws.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Chapter 3 is about the methodology that has been used to fabricate the combination of free and force vibration test rig. In this chapter, a project flow chart is defined. Figure 3.1 shows the flow chart in my project. The information that included is establishing target specification, design concept, select final design concept, searching material for the product and fabrication of the product. It also allows others to replicate our study and run new and different studies that are based on our methodology.

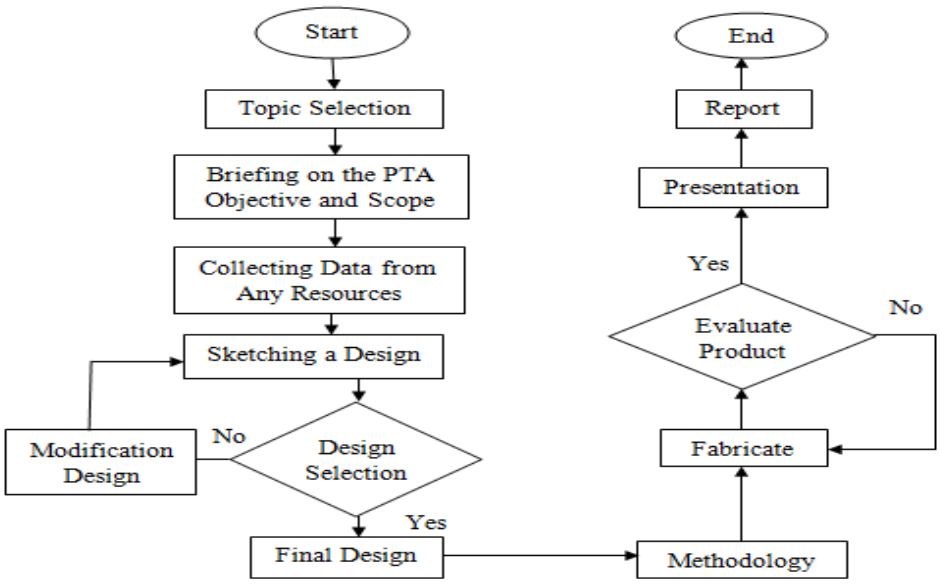


Figure 3.1: Flow Chart

The project starts identify the problem. It is a first step for the project flow in order to find the problem in current product. This step helps to create a different design to improve the product. After identify the problem for the project, project continues with identify the objective. The objective is very important in every work because every procedure to make a project will depend on it. It will help to know the main point to make the project success or not.

The project continues with identify the scope of the project because this scope can help the progress to create the new product design for the project and to make sure the method chose will be within the range of achievable objective. Next continue it with literature review and research about the title. This consist a review of the existing test rig design. These tasks have been done through research on the internet.

From the flow chart, start to design new concept. Then improve the design. Try to come with several concepts. Then compare the criteria from each design which are the best. If the best design chosen still needed to be improved go back to the previous step. If no improvement is needed go to next step. Produce the drawing together with dimension of the product and the type of materials needed. After completing the previous task, start the fabrication process. Gather the parts needed for the project to proceeds the fabrication process.

Here come the testing and evaluation process. The test rig will be test to see if it full fills the requirement such as safety, ability and strength. During the testing, if a problem occurs, the process of fabrication test rig will step back to the previous process. The reason to step back is to fix the error. After all the parts had been joined together and no error, here comes the phase of result and discussion. In this part, how the test rig functions will be informs. Beside, how to achieve objective and solve problem statement of the project will be discuss in this phase.

3.2 PROCESS FLOW

Table 3.1 shows below the process flow of making the combination of free and force vibration test rig. The manufacturing process consists of 5 phases.

Table 3.1: Process flow

PHASE	TITLE
Phase 1	Establish target specification.
Phase 2	Design concept.
Phase 3	Select final design.
Phase 4	Searching material for the product.
Phase 5	Fabrication of the product.

3.3 PHASE 1 - ESTABLISH TARGET SPECIFICATION

After the investigation of the objective, criteria selection will be developed. Criteria selection here means the criteria that what people will look on the product. It is focus on the existing test rig on the laboratory. Then, when the new product is done, compare it with the existing test rig on the laboratory. The new good design should have better criteria than the product on the market.

This is the criteria that I had to use to the new design for the combination of free and force vibration test rig.

a. Easy to use
b. Safety
c. Durable / long life time
d. Lightweight
e. Nice design
f. Low cost
g. Strong
h. High resistance to corrosion

3.4 PHASE 2 - DESIGN CONCEPT

The purpose of this project is to design the combination of free and force vibration test rig that can operate both experiment on one test rig. It is also should look more efficient than existing test rig on the laboratory. The motivation for this project is to improve the design of the combination of free and force vibration test rig that can use any shape of beam. So the new design should have shape that various beam can through the part. The parts are clamps, unbalance rotator and beam holder. Furthermore, the test rig should be able to operate both free and force vibration experiment easily.

3.4.1 Overall Design of the Test Rig

This concept is combination of both test rig that are free and force vibration test rig. Figure 3.2 shows the design for force vibration experiment and Figure 3.3 shows the design for free vibration experiment.

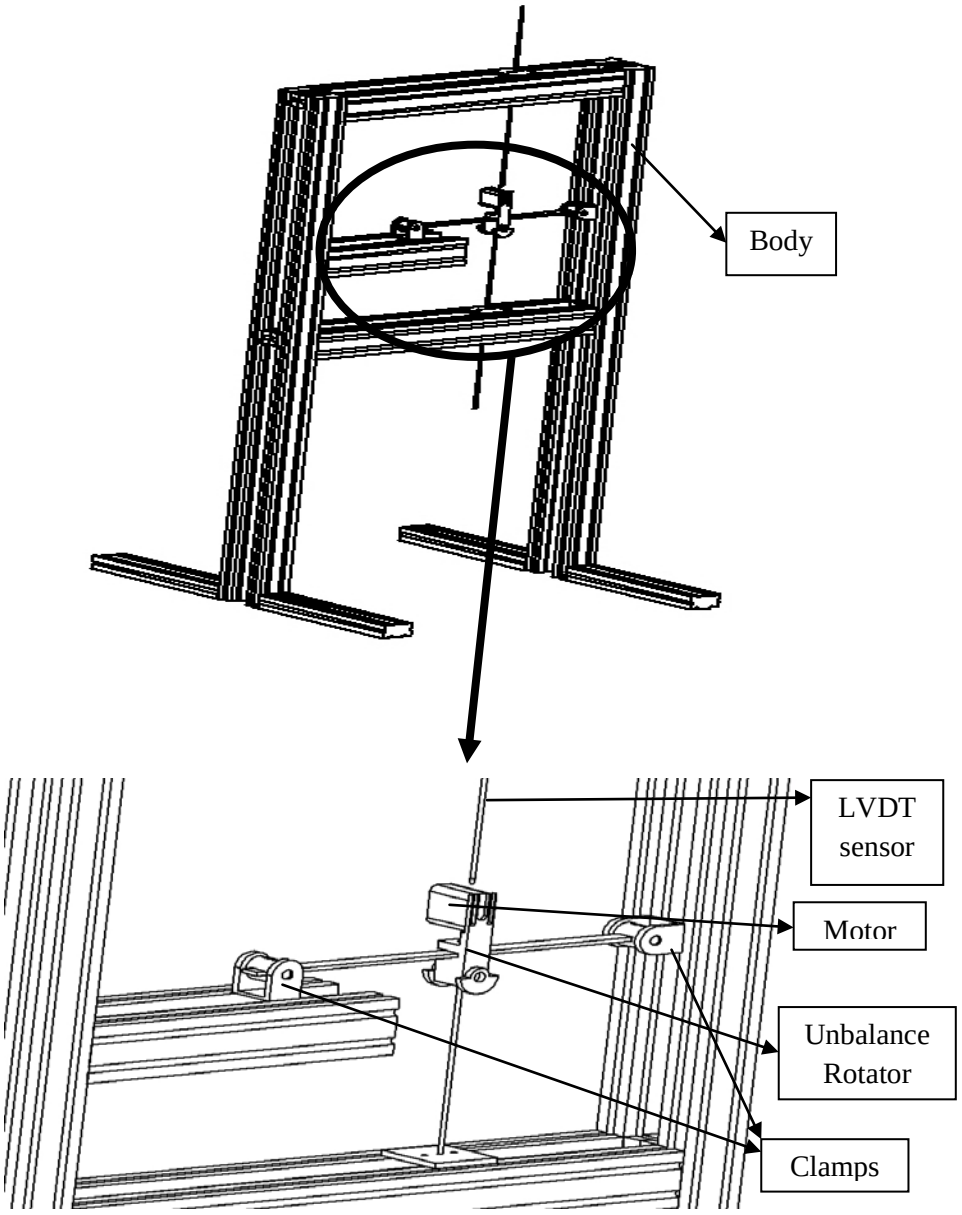


Figure 3.2: The force vibration experiment design

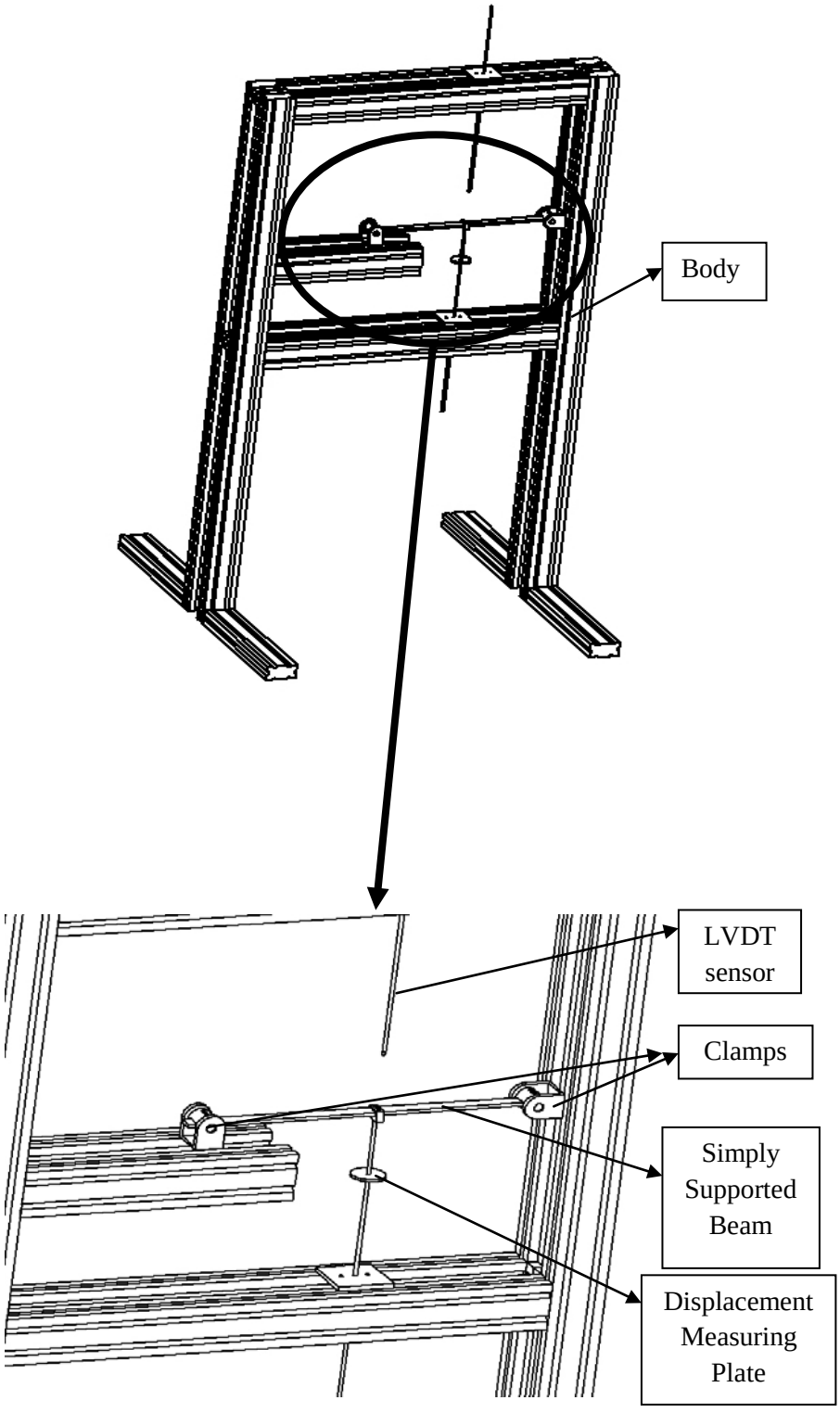
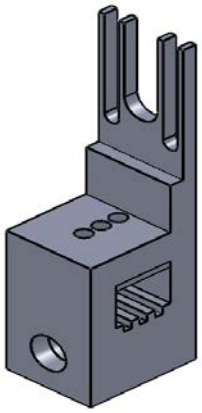


Figure 3.3: The free vibration experiment design

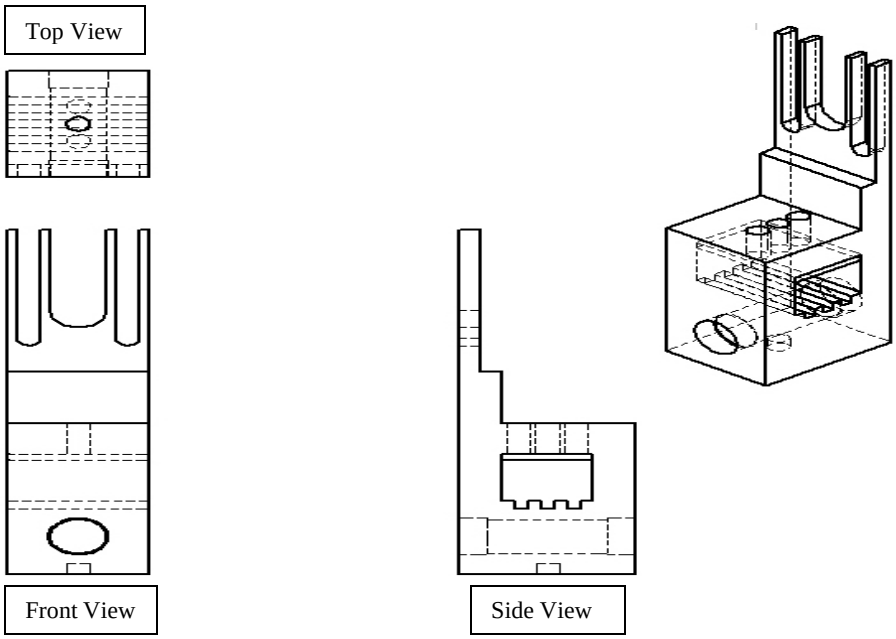
Both experiments are operates on one test rig. The part that should be change are unbalance rotator and beam holder. When the force vibration experiment starting, the part that should have are unbalance rotator, clamps, rod and beam. If the experiment is change to the free vibration experiment, the part that should change is unbalance rotator to the beam holder. So, the design of parts can make the experiment change easily and can use various shape of beam.

3.4.2 Design Concept 1

This concept can hold the various type of beam tightly.

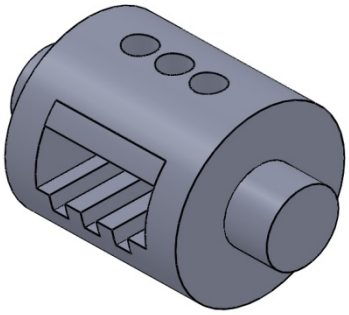


(a)

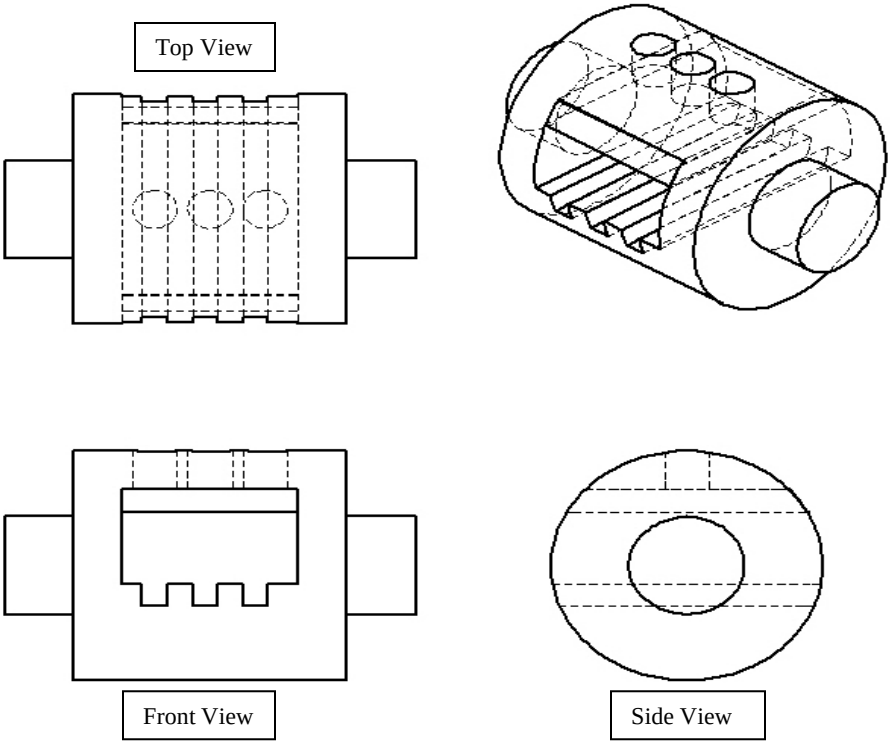


(b)

Figure 3.4: The drawing of unbalance rotator; a) 3D drawing and b) orthographic drawing

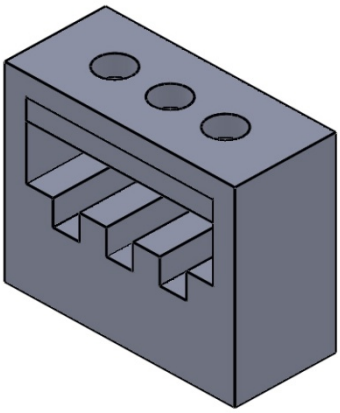


(a)

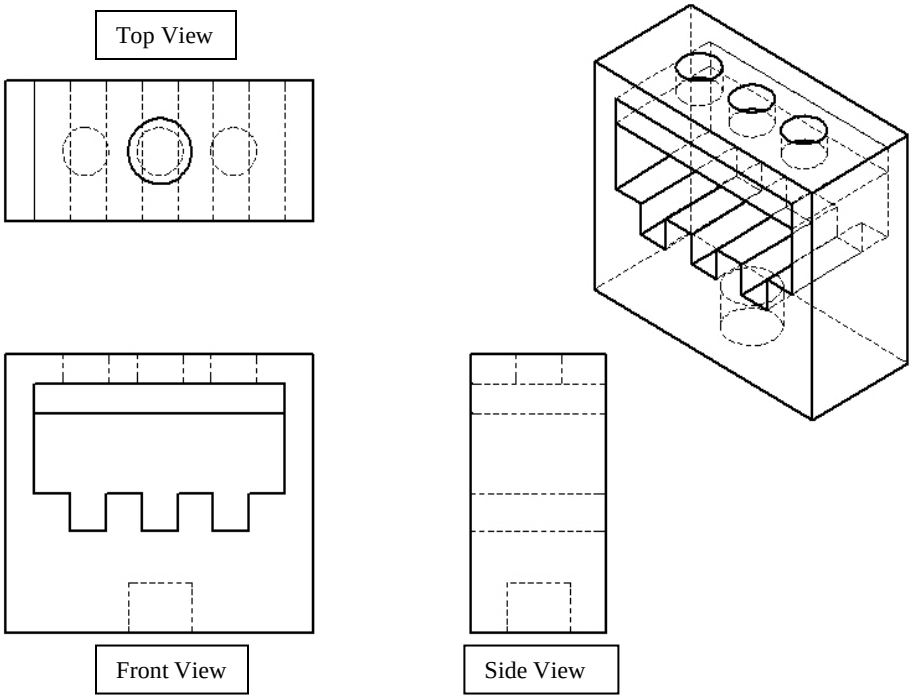


(b)

Figure 3.5: The drawing of clamp; a) 3D drawing and b) orthographic drawing



(a)

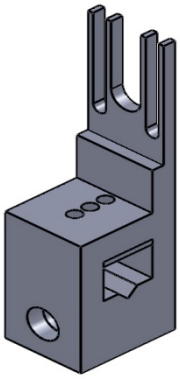


(b)

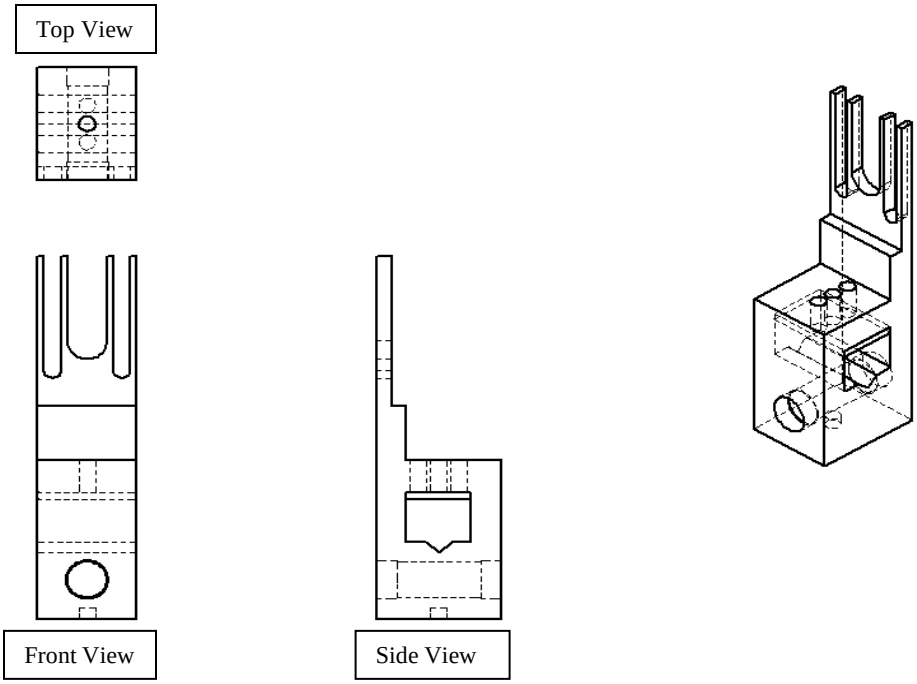
Figure 3.6: The drawing of beam holder; a) 3D drawing and b) orthographic drawing

3.4.3 Design Concept 2

This concept can hold the various shape of beam tightly and has simple design.

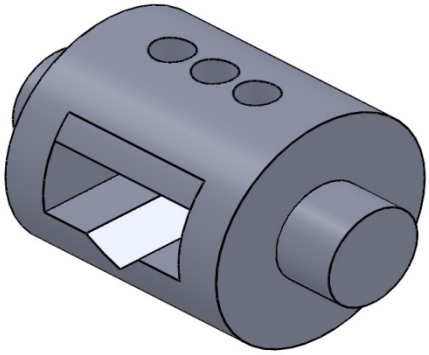


(a)

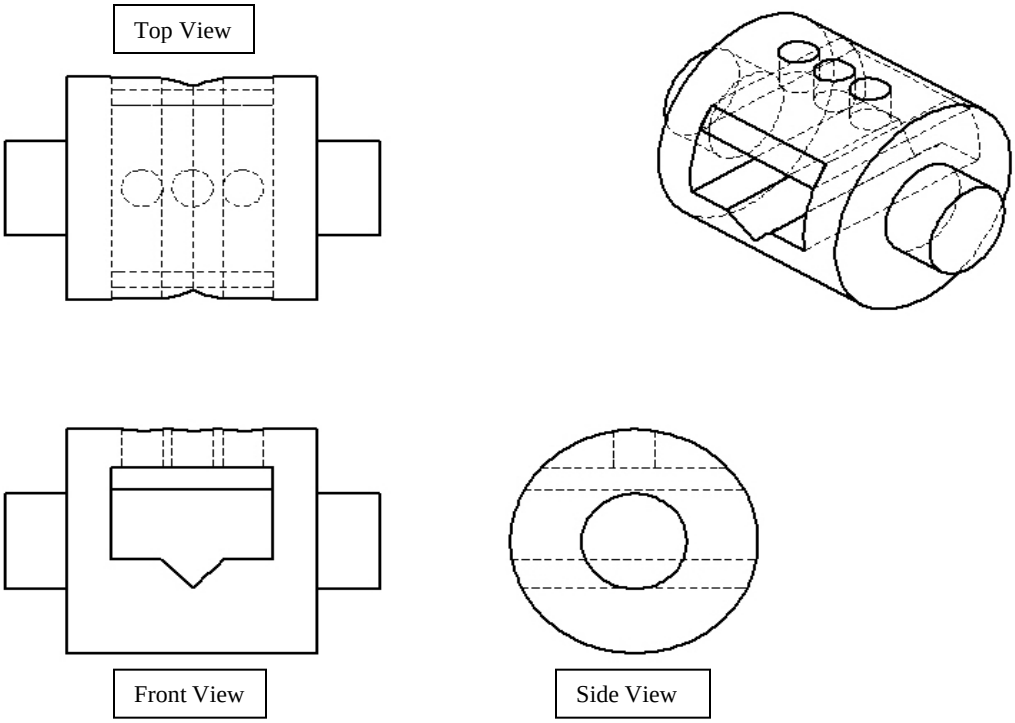


(b)

Figure 3.7: The drawing of unbalance rotator; a) 3D drawing and b) orthographic drawing

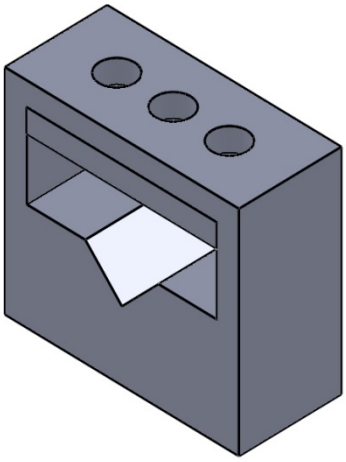


(a)

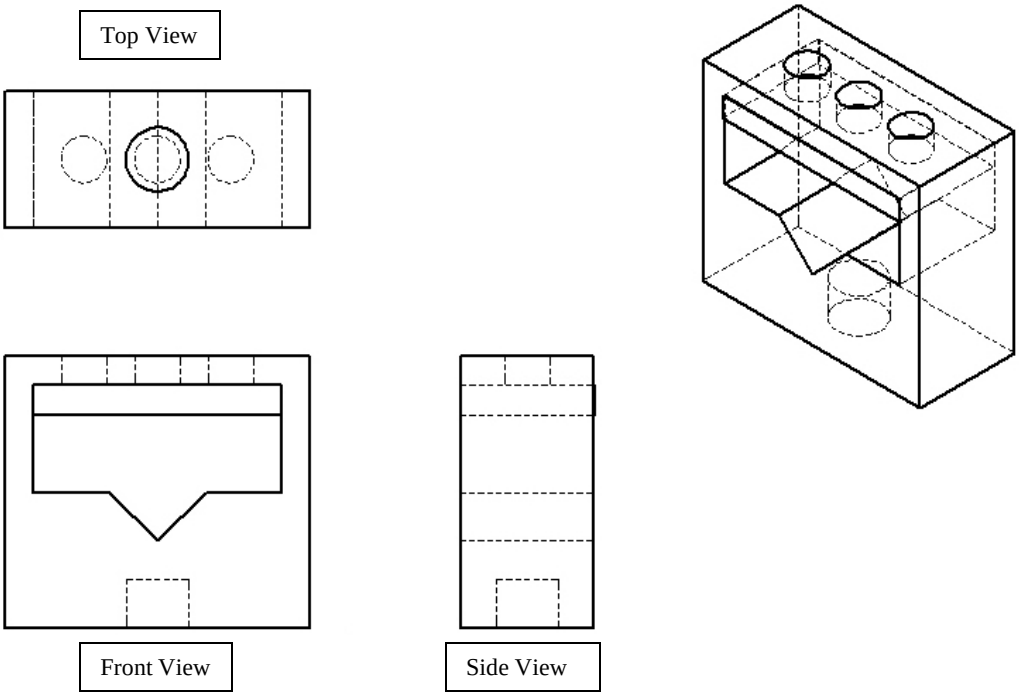


(b)

Figure 3.8: The drawing of clamp; a) 3D drawing and b) orthographic drawing



(a)

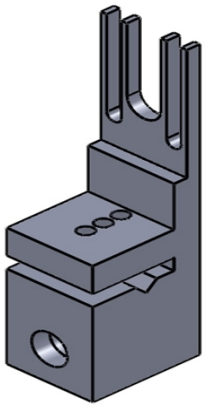


(b)

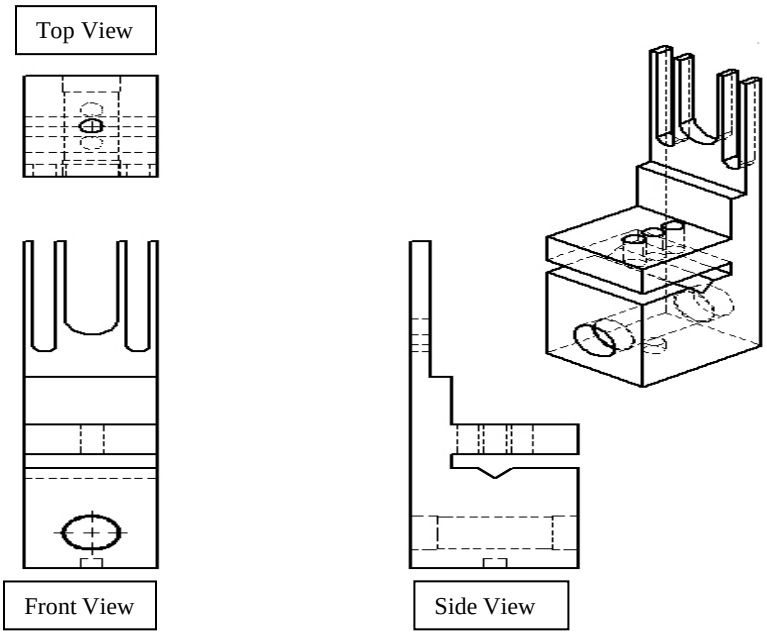
Figure 3.9: The drawing of beam holder; a) 3D drawing and b) orthographic drawing

3.4.4 Design Concept 3

For this concept can hold the various shape of beam and can move the beam out and in easily.

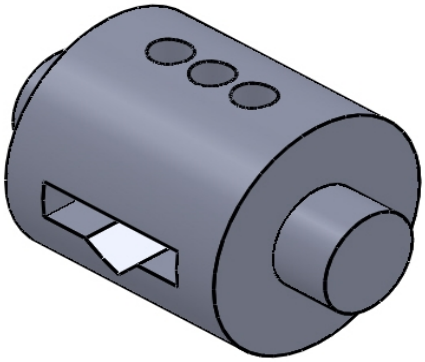


(a)

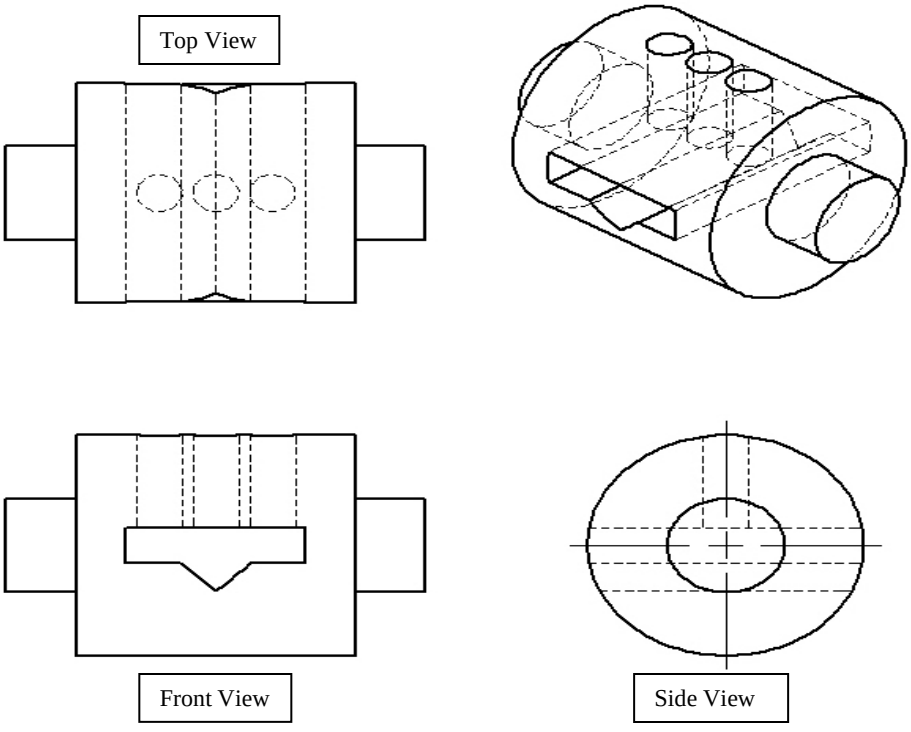


(b)

Figure 3.10: The drawing of unbalance rotator; a) 3D drawing and b) orthographic drawing

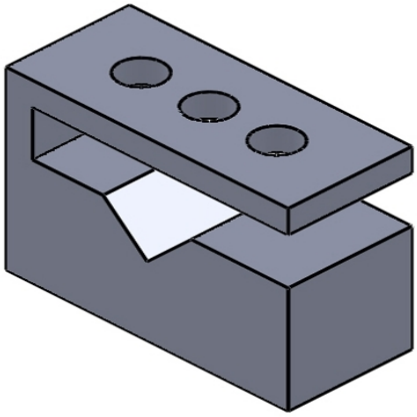


(a)

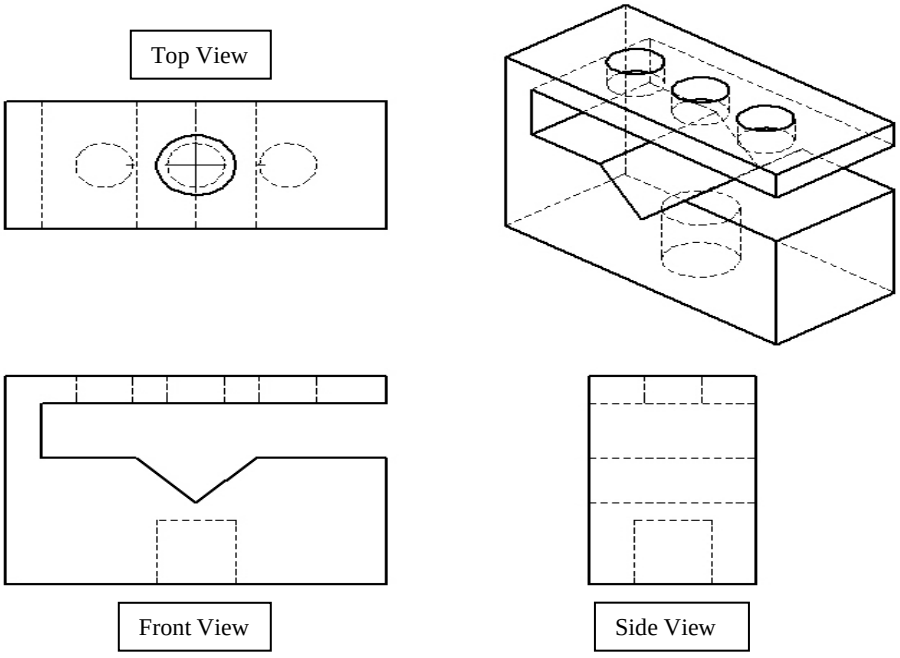


(b)

Figure 3.11: The drawing of clamp; a) 3D drawing and b) orthographic drawing



(a)



(b)

Figure 3.12: The drawing of beam holder; a) 3D drawing and b) orthographic drawing

3.5 PHASE 3 - SELECT FINAL DESIGN

3.5.1 Metric Chart

After the design concept, the best design is studied to relate it with criteria selection. Then make decision which design is the best. Table 3.2 is used to select which criteria is the best.

Table 3.2: Metric Chart

CHARACTERISTIC	DESIGN CONCEPT		
	1	2	3
Easy to use	**	**	*****
Estimate cost	***	***	****
Safety	****	****	****
Lightweight	***	***	****
Aesthetic value	**	***	***
Manufacture	**	**	***
Long lasting	****	****	***
Strength	***	***	***
Total Star	**23**	**24**	**29**

Notes: * = very bad
** = bad
*** = medium
**** = good
***** = excellent

3.5.2 Concept Selection

Table 3.2 compares the rating among all concept design. Based on the table, it shows that concept design 3 has highest rating compare to other designs after considering the criteria selection. As a final design, the fabrication process will be conducted based on design concept 3.

3.6 PHASE 4 - SEARCHING MATERIAL FOR THE PRODUCT

For this project, I plan to use aluminum for all my parts. I plan to use this material because aluminum has very high corrosion resistance and very light material compare to steels. Table 3.3 below is the list of material that needed to fabricate this project. I chose to use all this material because of the safety factor.

Table 3.3: List of material

Part	Material	Dimension (mm)
Unbalance Rotator	Aluminum	40 x 50 x 162
Clamp x 2	Aluminum	60.6 R20
Beam Holder	Aluminum	14 x 32 x 22.9
Allen keys Screw x 9	Steel	30 R2.5
Allen keys Screw x 3	Steel	20 R2.5

3.7 PHASE 5 - FABRICATION OF THE PRODUCT

In order to make the design come to reality, fabrication process needs to be done first. The fabrication process starts from dimensioning the raw material until it is finish as a desired product. In this process, the raw material used is aluminum. Figure 3.13 is the raw aluminum that has been used for this project.

- Aluminum 100mm x 100mm x 170mm
- Aluminum 50mm x 50mm x 20mm
- Aluminum 100mm x R25

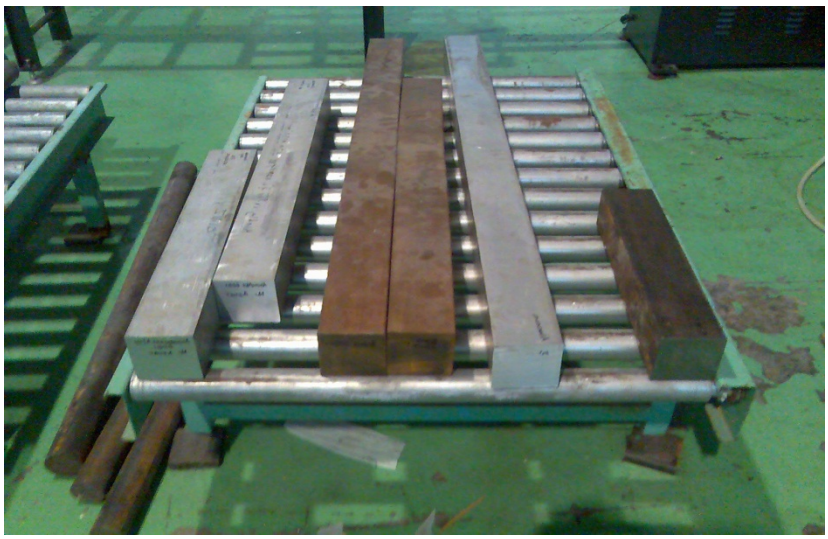


Figure 3.13: Raw Material

The next step is to cut the material into the desired length. This process was done using the Bend Saw Machine. Figure 3.14 shows the process of cutting the raw material.

Figure 3.14: Cutting Process

After cutting the material into its desired length, the next process is discard the chip by using the file. This process must be careful because surface side of material is very sharp. Figure 3.15 shows the process of filing the material.

Figure 3.15: Discard the chip Process

After that, conventional milling machine are used to make the actual dimension of unbalance rotator and beam holder part using facing process. The facing process is using facing tool. Figure 3.16 shows the process of facing using facing tool.

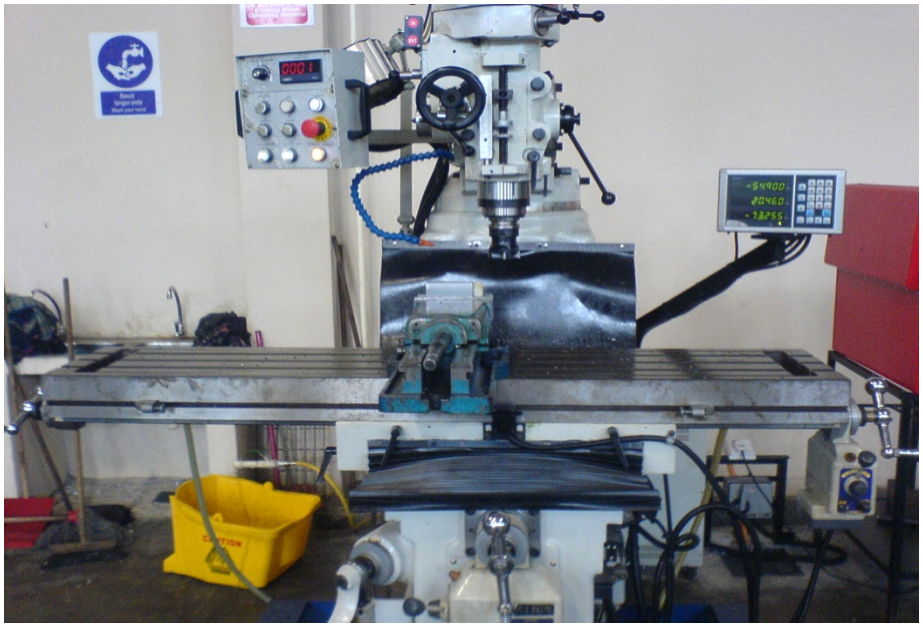


Figure 3.16: Facing process

For the shape on the unbalance rotator part, endmill tools are used to cut to make the shape. For the clamps part, conventional lathe machine is used to cut the actual radius of the clamps.

For the triangle shape on all parts which are unbalance rotator, clamps, and beam holder, EDM wirecut process are used to cut the shape. This machine is used because of small shape of triangle on the parts that cannot be done by other machine. Before that, the projection drawing are draw by Solidworks software in DXF format to run the EDM machine. Figure 3.17 shows the process of material cutting using EDM wirecut.

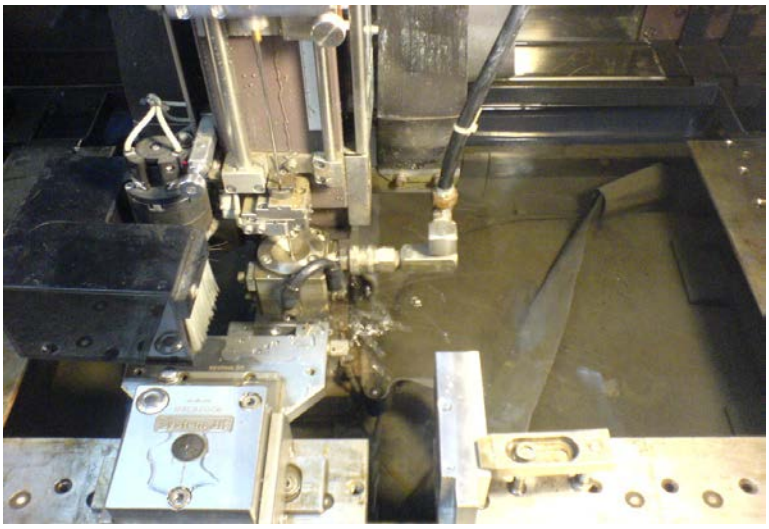


Figure 3.17: EDM wirecut process

After that, drilling processes are used to drill the hole according to the size and hole depth. Drilling tools size D3.5 and D6.7 used to make the hole. Figure 3.18 shows the process of drilling.

Figure 3.18: Drilling Process

Lastly, threading process are used to make the thread of all the parts and done by manual threading. M5 thread tool used for the hole to hold the beam and M8 thread tool used for the hole to hold the rod. Figure 3.19 shows the process of threading and Figure 3.20 shows the final product of this project.

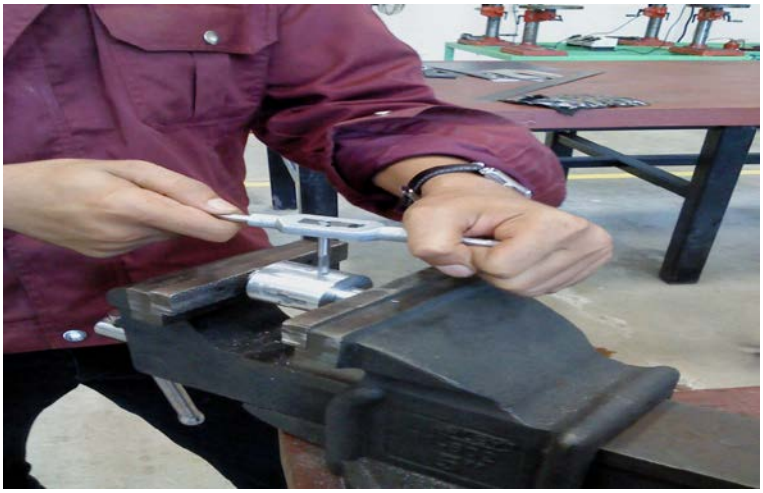


Figure 3.19: Threading Process

Figure 3.20: Final Product

CHAPTER 4

RESULTS & DISCUSSION

4.1 INTRODUCTION

Chapter 4 is the discussion on the results for modification of this project and several problems occur to the project. This chapter also will discuss mainly about the problems encountered during the whole project was been carried out.

4.2 FINAL PRODUCTS

The final design and final product in several views are shown in the Figure 4.1 and Figure 4.2.

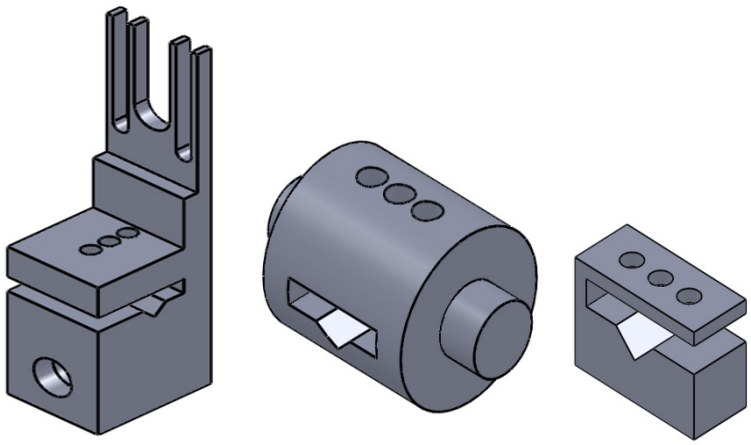


Figure 4.1: Drawing final design

Figure 4.2: Final product

4.2.1 Component of Final Products and Test Rig

All the parts are installed into the test rig neatly and Figure 4.3 shows all the parts for force vibration experiment after installing. Figure 4.4 shows all the parts for free vibration experiment after installing.

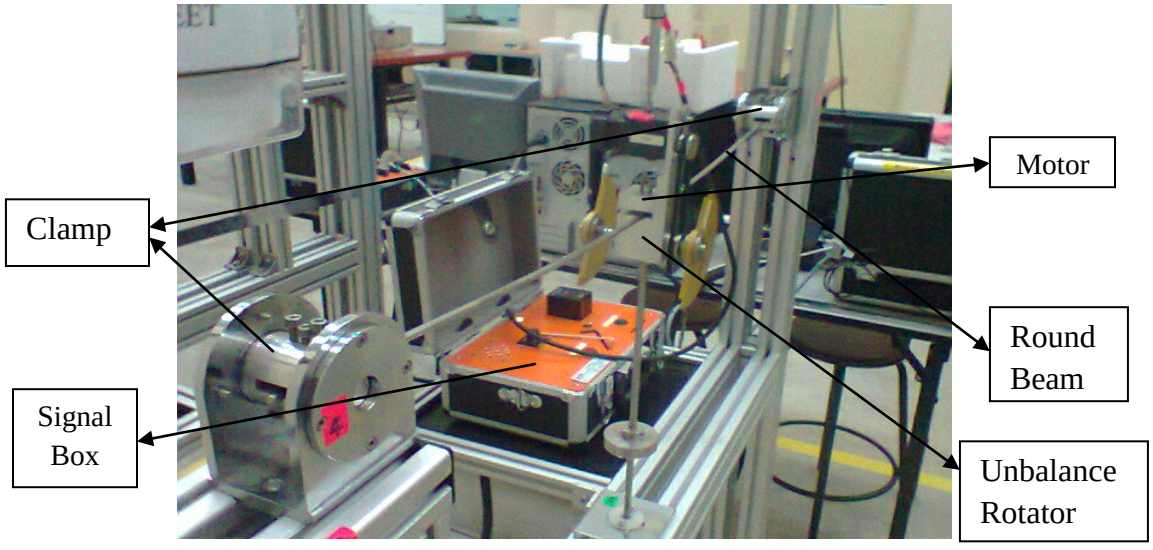


Figure 4.3: Force Vibration Experiment

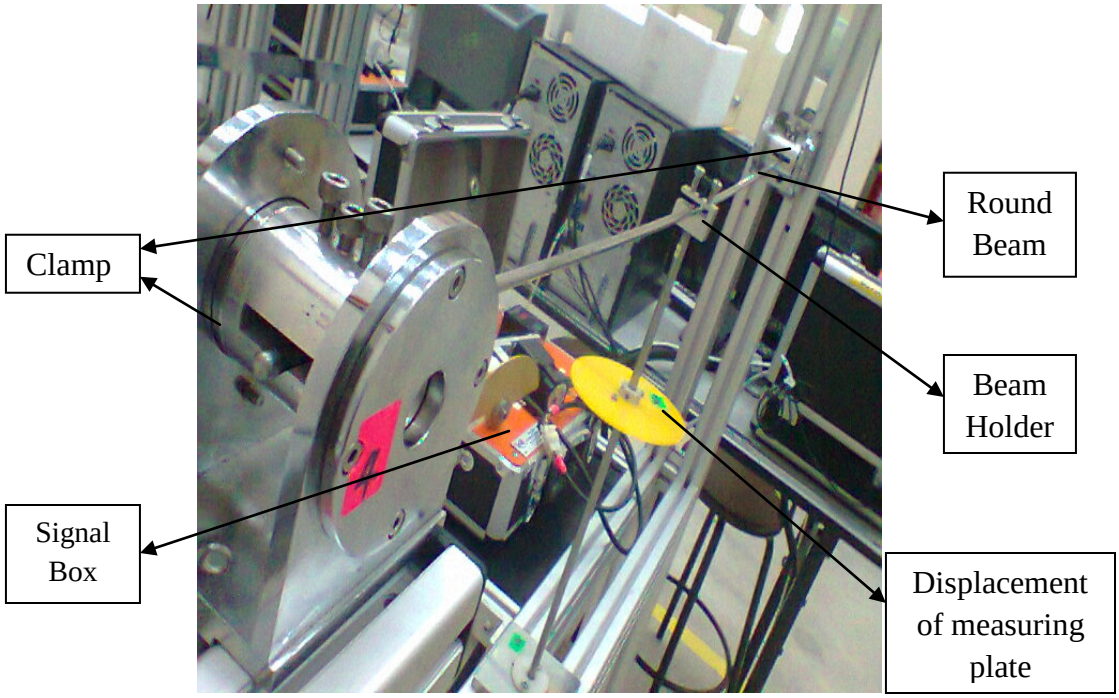


Figure 4.4: Free Vibration Experiment

4.2.2 Function of Final Product Component

Table 4.1 shows the function of every part on the product.

Table 4.1: Function of every part

Part	Function
Clamp	To hold the beam neatly.
Unbalance Rotator	To make the unbalance force on the beam.
Beam Holder	To hold the beam.

4.3 THE PROCEDURES USING THIS COMBINATION OF FREE AND FORCE VIBRATION TEST RIG

These new designs of test rig are combination of free and force vibration test rig. The test rig can operate both experiments using the procedure. The procedures are:

i. Firstly for the force vibration experiment, it has unbalance force on the centre of beam.
ii. Assembly the test rig using clamps, unbalance rotator, beam, and rod.
iii. Make sure the beam is fixed to clamped support.
iv. Make sure the unbalance rotator is centre of the beam.
v. Decide on the RPM for the motor to rotate the unbalance rotating.
vi. Setting the LVDT sensor and make sure computer is ready for record the data.
vii. Start the motor to the given RPM to make the unbalanced force to the beam and repeatedly with different RPM.
viii. Record the data on the computer.
ix. After finish the force vibration experiment, open the unbalance rotator and replace to beam holder and fix it to operate free vibration experiment.
x. The rod also should replace to the rod that have measuring plate.
xi. Decide on the mass to be used for loading the beam. The mass is usually at 5N, 10N and above.
xii. Insert the loading rod through hole at the centre of the mass.
xiii. Setting the LVDT sensor on the displacement measuring plate and make sure computer is ready for record the data.
xiv. Make a force on the centre of the beam and make sure the force is constant when repeat the experiment using different mass.
xv. Record the data on the computer.

4.3.1 Advantages of New Test Rig

For this new design of test rig, it is have a lot of advantages especially for saving the space area to place the test rig. Other than that, it is easier to change from force vibration test rig to free vibration test rig because of parts design. Figure 4.5 and 4.6 shows the advantage of the test rig.

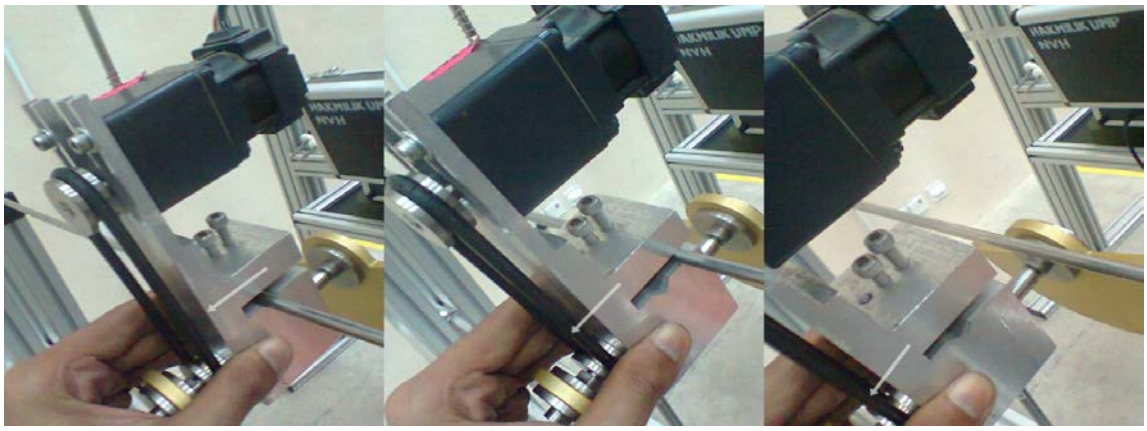


Figure 4.5: Open the Unbalance Rotator

Figure 4.6: Open the Beam Holder

4.4 PROJECT PROBLEMS

4.4.1 Literature Review

The concept and ideas review for this project are not very wide because it is not widely modified by the manufacturer. Students should come with their own ideas on this project.

4.4.2 Designing and Sketching

In the market, there is currently no free and force vibration test rig. So, there are no references that can be referred. All the drawing and dimension need to generate by student itself.

4.4.3 Material Preparation

In the hardware, there are limited resources on type of material. Therefore, I have to change my first plan which is using sink Allen keys screw. So the grade of the final product is lower than the first plan.

4.4.4 Fabrication Process

For the unbalance rotator part, motor holder is quite high and difficult to run the drilling and threading process. So, the solution is used the tool extension that have in hardware shop. Other than that, there have a problem when threading process. The threading tool is easily broke and the pieces of tool are stuck in the hole. So, the solution is drill below the hole and using chisel to bring out the pieces in the hole.

4.5 PROJECT OBJECTIVE ACHIEVEMENT AND PROBLEM STATEMENT SOLVING

The problem statement for this project is need big area to place free and force vibration test rig in the Noise, Vibration and Harshness Laboratory. To solve the problem, idea to produce the test rig is combine both test rigs into one test rig. The combination of test rig can operate free and force vibration experiment easily.

A several new concept designs were come out to solve the problem. Those new concept designs are create by depending on the objective. Then, they were comparing to look, which of them could be the final design and will be fabricate.

Besides that, the space area that want to place the test rig are reduces because of the combination both test rig. That means the objective of the project had been achieved.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

Chapter 5 is about the conclusion and recommendation for this project. In this chapter, it will include the objective of this project is fulfilled and some weakness that need to be improve.

5.2 CONCLUSION

The project is finish and the test rig is able to reduce the space area to place it because of the combination both test rig. The objective of the project is achieved at the end of design and fabrication.

5.3 RECOMMENDATION

The combination of free and force vibration test rig has its weaknesses which will need to be improved to get a better result.

5.3.1 Material Selection

The test rig should be use sink Allen keys screw because of the distance between another screw are too close.

REFERENCES

Singiresu s.rao . 2008 . *Mechanical Vibration 5th Edition* . Pearson.

Masakata Hashimoto . 2002 . *Basic Operation of Lathe* . (Online)
http://www.nmri.go.jp/eng/khirata/metalwork/lathe/intro/index_e.html
(29 November 2011)

Engineers Edge . *Drilling Process and Machines* . (Online)
http://www.engineersedge.com/manufacturing/drilling-machines-process.htm
(3 December 2011)

CustomPartNet . 2009 . *Milling* . (Online) http://www.custompartnet.com/wu/milling
(3 December 2011)

Los Alamos National . 2011 . *Making The Cut Using Wire EDM* . (Online)
http://www.lanl.gov/contour/cut.html (1 December 2011)

Wikipedia . 2010 . *Screw Thread* . (Online) http://en.wikipedia.org/wiki/Screw_thread
(27 November 2011)

APPENDIX A

Gantt Chart