DEVELOPMENT OF MULTIFUNCTION LADDER

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DEVELOPMENT OF MULTIFUNCTION LADDER

NURUL JASMIE BINTI CHE AHAMED

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

Faculty of Mechanical Engineering
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NOVEMBER 2009

SUPERVISOR'S DECLARATION

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

Signature

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STUDENT'S DECLARATION

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

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ABSTRACT

The objective of this thesis is to develop and fabricate the multifunction ladder and to minimize the manufacturing cost. Ladder is equipment that can easier consumer's daily activities at higher place. It is stable and safe to use. The concept of this project is based on student's creativity. The characteristics of material to fabricate this ladder are lightweight, longer life span, corrosion resistance and can take maximum load. Thus, the suitable material that accomplished those characteristics is aluminium alloy. In this thesis, we'll also be having more to the fabrication of this ladder.

ABSTRAK

Laporan ini membentangkan tentang tangga yang sering digunakan untuk melakukan kerja-kerja yang berada di tempat yang tinggi. Tangga merupakan satu platform untuk memudahkan lagi pengguna melakukan kerja-kerja dengan selamat dan ia juga adalah satu cara yang betul. Idea pembentukan tangga ini berdasarkan kreativiti pelajar sendiri. Pemilihan bahan yang sesuai untuk digunakan bagi pembentukan tangga ini merupakan bahan yang mempunyai berat yang ringan. Jangka hayat yang lama, tidak berkarat dan yang penting boleh menampung beban yang berat. Bahan yang dicadangkan untuk pembentukan tangga ini merupakan jenis bahan aluminium alloy. Dalam laporan ini juga akan lebih memfokuskan kepada pembentukan tangga.

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LIST OF ABBREVIATION

AL	Aluminum
ANSI	American National Standard Institute
CAD	Computer Aided Design
CRES	Corrosion-resistance Steel
MIG	Metal Inert Gas Welding
OSHA	occupational Standard and Health Administration
UMP	Universiti Malaysia Pahang

LIST OF SYMBOL

Symbol	Unit
Area(A)	m^2
Force(F)	N
Mass(m)	kg
Meter	m
Millimetre	mm
Stress(σ)	Pa

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter can explain the background of project, problem statement, scope of work, objective and project Gantt chart

1.2 PROJECT BACKGROUND

The project involves designing and fabricating a Multifunction Ladder. This ladder would be entirely different from existing ladder. As the Diploma final year project allocates the duration of 1 semester, this large man-hour project therefore requires significant efforts of the students to participate. Basically the entire Multifunction Ladder could be divided into 3 stages, which are concept review and development, designing and fabrication.

The Multifunction ladder is equipped by using all necessary items and method for instance sheet metal, rectangular hollow steel, aluminium plate, rivet, skills in manufacturing process by perform to cutting the material. The advantages of the proposed ladder to be developed can be seen in its flexibility to be moved such that, man are offered to make their task easier since the ladder will facilitate them to painting, climbing for easily, wall and etc.

The process of development is initiated from designing the shape of the ladder by considering the function as well. In order to produce user friendly product that is suitable to the consumer, consideration to the ergonomic factor is taken into account. It involves the measurement process before the materials are cut into pieces before joined together.

My project title is Development of Multifunction Ladder. The project involves small analysis of the Multifunction Ladder chassis or frame body and fabrication of the ladder itself with concerns regarding strength, durability, ergonomic factor, dynamic resistance and convenience. New concept of ladder is required to improve its durability and functions. Test need to be done to verify the strength of the ladder right before the fabrication process to avoid material and fund wasting. The projects prerequisites are Static, Dynamic and Strength of Material. Overall, the project will meet acquire skills of design, analysis, and fabrication.

1.3 PROBLEM STATEMENT

There are problem statement in my project

1.3.1 Consumer are facing problem to save for many place
1.3.2 Consumer is also difficult to move the ladder from place to place.
1.3.3 Existing ladder in the market only has limited function.

1.4 OBJECTIVE

The project objectives is develop and fabricate the Multifunction Ladder and to minimize the manufacturing cost

1.5 SCOPE

The scope of this project had been establish as

1.5.1 The maximum load of ladder is 150 kg.

1.5.2 The maximum height or the ladder can stand at 2.5 meters.

1.5.3 Multifunction ladder and portable use.

CHAPTER 2

LITERATUR REVIEW

2.1 INTRODUCTION

The ladder is a mechanism that allowed man to do activities in daily life. This chapter can explain about the type of ladder, what is suitable material use to fabricate the ladder and what equipment need to use.

2.2 TYPE OF LADDER AND FUNCTION

2.2.1 Rolling Step Ladder

This type of ladder allows for easy access to products and stocks stored on high industrial shelves in warehouses. They are also equipped with wheels to allow for easy manoeuvrability from shelf to shelf. There are some key factors to look for when buying rolling step ladders for industrial use. The first thing to look for is that it meets the strict regulations and safety standards set by the American National Standards Institute (ANSI) and the Occupational Safety and Health Administration.

Figure 2.1: Rolling step ladder

Source : Google image

Another important feature to look for is its ability to hold a 450lbs load. This is essential as rolling ladders are used not only for carrying people but also heavy stock items. The ladder should also be constructed of thick steel (such as 13 gauge) to ensure that it is strong and sturdy. Wheel locks, a braking system or spring-loaded casters (which retract when there is weight on the device) should be fitted to the step ladder so that it is unable to move while in use. A non-slip coating is also recommended for the steps and top platform.

2.2.2 Step Ladder

Step ladders are an essential tool to have around the home to help with getting to those hard to reach places. Whether it be getting something down from the pantry, cleaning cupboards or hanging a picture on the wall, step ladders make life easier for most. Step ladders are designed with large flat steps on them (rather than rungs) which makes for easy placement of the foot. Many feature a large extended frame from the top of the steps which allows the user to hold onto so they can balance themselves and prevent falls from the ladder.

Figure 2.2 :Step ladder

Source :Google image

This type of ladder comes in a wide range of materials to suit the style of a home. Wooden step ladders are ideal for a country style home that has a lot of wood finishing in it such as benches and doors, whereas aluminium step ladders would be best suited to a modern and contemporary apartment. These feature only one or two steps, and no frame handle, and unlike their ladder counterparts, users can stand on top of these stools.

2.2.3 Extension Ladder

Extension ladders are designed to be used for a vast number of tasks at high levels in outdoor environments. They are adjustable so that users can set them at just the right height for the job they are doing – whether that be painting a house or clearing the gutters.

Figure 2.3: Extension ladder

Source: Google image

This type of ladder features sliding sections (usually two sections, although very long designs feature three sections) and the top part of the ladder is extended using a rope and pulley system. These sections are both the same length, and when extended they must over lap by at least 0.4572m (and the longer the ladder, the bigger the overlap).

Other features fitted to these ladders include a locking device that stops the extended section from moving and sliding back down when it is in use; end caps that prevent the structure from being damaged by the ladder and also from it moving.

2.2.4 Folding Ladder

People with limited storage space whether it be in their home, business or vehicle will appreciate the design attributes of folding ladders. As the name suggests, folding ladders do just that they fold up. They were specifically designed to be compact to cater for various types of people such as builders with limited room on their trucks, apartment dwellers, and etc.

One of the more common types of folding ladder is the adjustable A-frame aluminium design. This can be sectioned into four main pieces and folded like a concertina or collapsed down where it looks like one long piece of metal. These are also great to use for accessing your attic space. One thing to make sure of when buying a ladder that folds is that the locks are made of aluminium rather than steel, otherwise they are at risk of rusting, making the ability to fold the ladder either difficult without oiling.

Figure 2.4: Folding ladder

Source : Google image

A folding platform ladder is ideal if you need a step up around the house. This ladder is about a foot high and features two sets of legs with integrated steps and a flat platform for the user to stand on. The legs fold away under the platform when it is not in use. Larger ones are also manufactured for commercial and industrial use.

2.2.5 Articulate Ladder

Versatility is the key to this type of ladder, as it can be used not only as a step ladder, but also as a straight ladder, scaffolding or a table. Articulated ladders feature a series of hinges or joints, meaning that they can be manipulated into various positions for different types of jobs. Its construction is similar to that of a step ladder, except that it has three sets of hinges – one in the centre of the ladder, and two on either side (effectively dividing the ladder into four equal folding sections).

Figure 2.5: Articulate ladder

Source : Google image

Two important features to look for in this ladder are decent stabilizers on the feet and also sturdy locks on the hinges/joints. A good set of stabilizers will help to stop the ladder moving around when it is in a difficult or skew position, whereas tough locks that hold the joints in position and stop the ladder from collapsing when in use.

Articulated ladders are best constructed from either aluminium or fibreglass, as these are the two toughest materials for ladders to be made from. Depending on the length, duty rating (load capacity) and materials used to make the ladder.

2.2.6 Telescopic Ladder

Telescopic ladders are compact and lightweight, making them the perfect option for people who need a portable ladder but have limited storage space (such as the trunk of their car) available to them.

Figure 2.6:Telescopic ladder

Source :Google image

This type of ladder is designed to extend out from its storage height of a couple of feet through to approximately 3.6576m (this varies depending on the brand and size of each ladder). Most designs extend upwards in 1ft increments from the ladders closed state. As each section goes up, it is locked in using spring-loaded bolts in each rung. It is extremely important to check that each rung is secure before using this type of ladder otherwise users are susceptible to a nasty fall. Each ladder is fitted with a release mechanism to close the ladder back into its condensed state.

2.2.7 Platform Ladder

Platform ladders are a painter and decorator’s best friend as they not only hold the worker themselves, but they also hold their work tools and products. Not just the sole domain of painters alone, this type of step ladder can be used in any type of environment where they are exposed to extended periods of elevated standing.

Figure 2.7: Platform ladder

Source : Google image

There are two main types of platform ladders – the first is where the platform is integrated into the top of a single ladder, whereas the second type involves two separate ladders that hold a large platform supported between both ladders. They are commonly constructed with aluminium or steel. The two-ladder design is more commonly used in commercial applications and also comes as a rolling option. An important feature to look for when buying this type of ladder is to get a platform that has a slip-resistant surface so that neither the user nor their tools can slip off easily.

2.3 LADDER ACCESSORIES

2.3.1 Ladder Platform

Clips onto a rung to provide a convenient area for tools and materials at the top of the ladder.

Figure 2.8: Ladder platform

Source : Diydata

2.3.2 Ladder Tray

This attachment holds bucket and tools in a high position. A stout 'S' hook may also be used to suspend a bucket or paint can, but is less versatile.

Figure 2.9: Ladder tray

Source :Diydata

2.3.3 Ladder Stay

One end locks onto the top two rungs of the ladder and the other end rests against the wall so the ladder is held off a small distance from the wall. It allows the underside of the eaves and guttering to be worked on without having to lean back.

Figure 2.10:Ladder stay

Source :Diydata

2.4 BASIC PART

Standard part of ladder which are below

2.4.1 Main body : to stand the body with the rungs and required full strength of body.
2.4.2 Rung : step to climb from bottom to top.
2.4.3 Plate : to put the tin of paint
2.4.4 Rubber feet : can stabilizer giving 100% grip to floor surface

2.5 TYPE OF MMATERIAL

2.5.1 Aluminium alloy

Aluminium alloys are mixtures of aluminium with other metals (called an alloy), often with copper, zinc, manganese, silicon, or magnesium. They are much lighter and more corrosion resistant than plain carbon steel, but not as corrosion resistant as pure aluminium. Bare aluminium alloy surfaces will keep their apparent shine in a dry environment due to the formation of a clear, protective oxide layer. Galvanic corrosion can be rapid when aluminium alloy is placed in electrical contact with stainless steel, or other metals with a more negative corrosion potential than the aluminium alloy, in a wet environment. Aluminium alloy and stainless steel parts should only be used together in water-containing systems or outdoor installations if provision is made for either electrical or electrolytic isolation between the two metals

2.5.2 Stainless Steel

In metallurgy, stainless steel, also known as inox steel or inox, is defined as a steel alloy with a minimum of 11% chromium content by mass. Stainless steel does not stain, corrode, or rust as easily as ordinary steel (it stains less, but it is not stain-proof). It is also called corrosion-resistant steel or CRES when the alloy type and grade are not detailed, particularly in the aviation industry. There are different grades and surface finishes of stainless steel to suit the environment to which the material will be subjected in its lifetime. Common uses of stainless steel are cutlery and watch cases and bands.

Stainless steel differs from carbon steel by the amount of chromium present. Carbon steel rusts when exposed to air and moisture. This iron oxide film (the rust) is active and accelerates corrosion by forming more iron oxide. Stainless steels have sufficient amounts of chromium present so that a passive film of chromium oxide forms which prevents further surface corrosion and blocks corrosion from spreading into the metal's internal structure.

2.6 RIVET

A rivet is a permanent mechanical fastener. Before it is installed it consists of a smooth cylindrical shaft with a head on one end. The end opposite the head is called the buck-tail. On installation the rivet is placed in a punched or pre-drilled hole. Then the tail is "upset" (i.e. deformed) so that it expands to about 1.5 times the original shaft diameter and holds the rivet in place. To distinguish between the two ends of the rivet, the original head is called the factory head and the deformed end is called the shop head or buck-tail.

Figure 2.11 : Rivet Pop

Figure 2.12 : Rivet Handle

Because there is effectively a head on each end of an installed rivet it can support tension loads (loads parallel to the axis of the shaft); however, it is much more capable of supporting shear loads (loads perpendicular to the axis of the shaft). Bolts and screws are better suited for tension applications. [14]

Fastenings used in traditional wooden boat building like copper nails and clinch bolts work on the principle of the rivet but they were in use long before the term rivet was invented and, where they are remembered, are usually classified among the nails and bolts respectively. The rivet body normally manufactured from one of three method:

Table 2.1: Method of Rivet Body

Name	Description
Wire	the most common method
Tube	common in longer length, not normally as strong as wire
Sheet	least popular and generally the weakest option

Source: Wikipedia

2.7 RUBBER FEET

Rubber feet is one accessories of the ladder. The function is to can stabilizer giving 100% grip to floor surface. It most important to look the ladder in tidy. It make from rubber and suitable to use as cover. [1]

2.7.1 Type of Rubber Feet

2.7.1.1 Non-slip articulating rubber feet

- Our most popular ladder feet
- Ideal for increased safety in most situation-indoors and outside
- Large heavy-duty rubber feet are rectangular

- Excellent grip even on grass and rough ground
- Swivel action ensures full contact whatever the ladder angle
- Designed to fit virtually all ladders. All fixing supplied (6 nuts and bolts)

Figure 2.13 : Non-slip Articulating

Source : westernrubbers.tradeindia

2.7.1.2 Rubber Section-Cut Feet

- Provide increased safety on smooth surface such as factory floors
- Domed metal casings house the 95mm diameter rubber cups which are replaceable
- Swivel action ensures full contact whatever the ladder angle
- Designed to fit virtually all ladders

Figure 2.14 : Rubber Section-cut Feet

Source : westernrubbers.tradeindia

2.7.1.3 "Trim 2 Fit" ladder Bungs

- Simply cut them down to the length require
- Made from solid rubber and are already marked with cutting guides for the following ladder sizes.

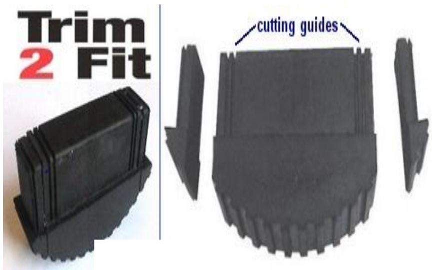

Figure 2.15 : Trim 2 Fit

Source : Westernrubbers.tradeindia

2.7.1.4 Rubber Bungs for Ladder

- It is important that rubber bungs are maintained in good condition and we stock for easy replacement of worn and broken ones

Figure 2.16 : Rubber bungs

Source : Westernrubbers.tradeindia

2.7.1.5 Rubber Feet for Steps

- It is important that stepladder feet are maintained in good condition and we keep a stock for easy replacement of worn and broken ones. [1]

Figure 2.17 : Rubber Feet for Step

Source : Westernrubber.tradeindia

2.8 SHEARING PROCESS

Shearing is a metalworking process which cuts stock without the formation of chips or the use of burning or melting. Strictly speaking, if the cutting blades are straight the process is called shearing; if the cutting blades are curved then they are shearing-type operations. The most commonly sheared materials are in the form of sheet metal or plates; however rods can also be sheared. Shearing-type operations include: blanking, piercing, roll slitting, and trimming. [8]

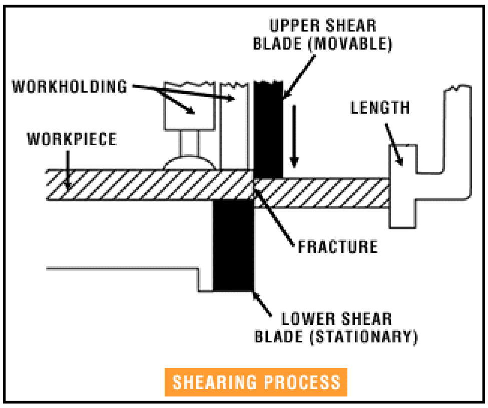

Figure 2.18: Shearing Process

Source : efunda/ shearing.cfm

Materials that are commonly sheared include Aluminium, Brass, Bronze, Mild steel and Stainless steel. The shearing process uses three types of tool systems. They are used for shearing:

- Sheet metal and plate using a squaring or bow tie shear
- Angle materials using and angle shear, and
- Bar stock using a bar shear.

Figure 2.19: Shearing Machine.

2.9 BENDING PROCESS

Bending is a process by which metal can be deformed by plastically deforming the material and changing its shape. The material is stressed beyond the yield strength but below the ultimate tensile strength. The surface area of the material does not change much. Bending usually refers to deformation about one axis.

Bending is a flexible process by which many different shapes can be produced. Standard die sets are used to produce a wide variety of shapes. The material is placed on the die, and positioned in place with stops and/or gages. It is held in place with hold-downs. The upper part of the press, the ram with the appropriately shaped punch descends and forms the v-shaped bend.

Bending is done using Press Brakes. Press Brakes normally have a capacity of 20 to 200 tons to accommodate stock from 1m to 4.5m. Larger and smaller presses are used for specialized applications. Programmable back gages, and multiple die sets available currently can make for a very economical process. [9]

Figure 2.20: Bending Machine

2.10 DRILLING

Drilling is easily the most common machining process. One estimate is that 75% of all metal-cutting material removed comes from drilling operations. Drilling involves the creation of holes that are right circular cylinders. This is accomplished most typically by using a twist drill, something most readers will have seen before. The chips must exit through the flutes to the outside of the tool. As can be seen in the figure, the cutting front is embedded within the work piece, making cooling difficult. The cutting area can be flooded, coolant spray mist can be applied, or coolant can be delivered through the drill bit shaft. [10]

2.10.1 DRILL PRESS

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

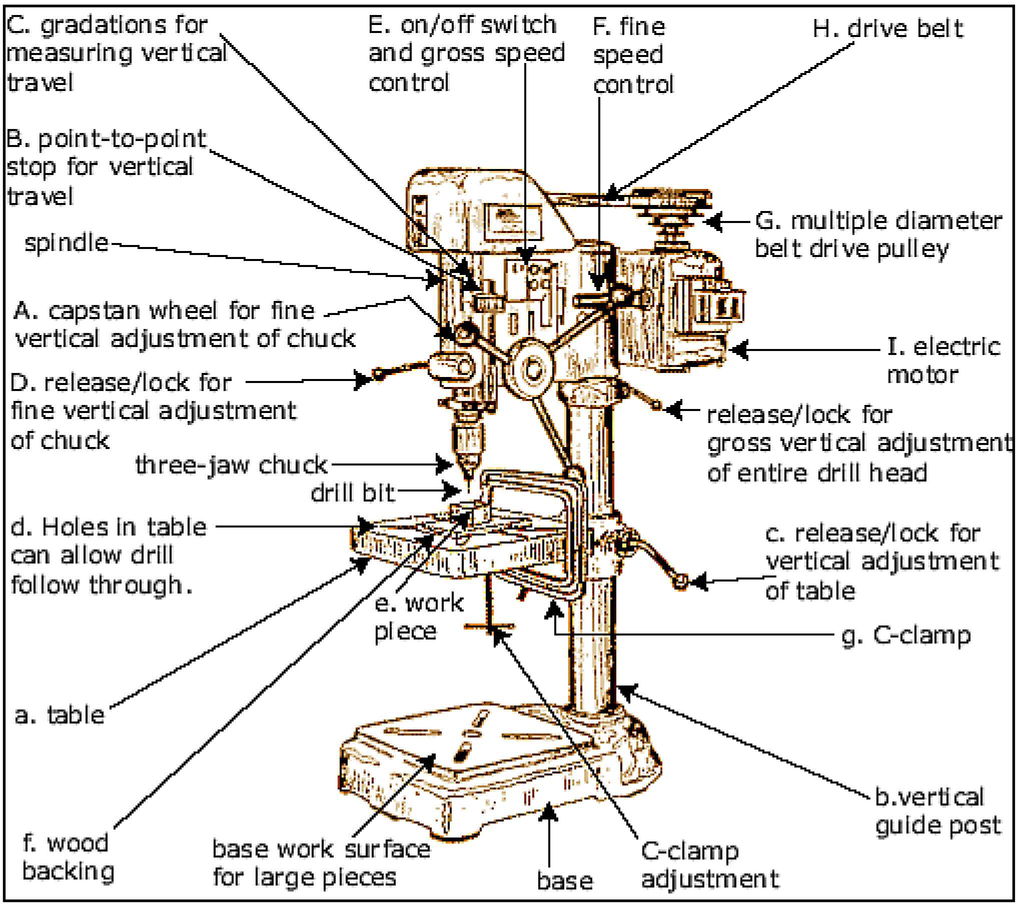

Figure 2.21: Drill Press Machine

Source : Efunda/ drill.cfm

2.11 GRINDING PROCESS

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

In grinding, an abrasive material rubs against the metal part and removes tiny pieces of material. The abrasive material is typically on the surface of a wheel or belt and abrades material in a way similar to sanding. On a microscopic scale, the chip formation in grinding is the same as that found in other machining processes. The abrasive action of grinding generates excessive heat so that flooding of the cutting area with fluid is necessary.[11]

Figure 2.22: Grinder

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Project methodology is a body of practices, procedures and rules used by those who work in a discipline or engage in an inquiry and a set of working methods. In this chapter, we will explain about the process that involved during the fabrication process. I also will explain about the design and analysis that had been chosen to be as the final idea to be producing or fabricate. All the fabrication process in this project is going to be explained in details with flow chart.

3.2 DESIGN

The Design of the Ladder must be compliance to several aspects. The design consideration must be done carefully so the design can be fabricated and the parts are all functioning. The aspects that must be considered in designing the ladder are:

3.2.1 Strength: Must have certain strength to ensure that it can load heavy items.
3.2.1 Ergonomic Factors: Ladder must be user friendly as easy and convenience.
3.2.3 Suit to environment: The ladder must be suitable to be use in factory area

3.3 DRAWING

The drawings are divided into two categories, which are:

3.3.1 Sketching: All the ideas for the ladder fabrication are sketched on the paper first to ensure that idea selection can be made after this.

3.3.2 CAD Drawing: The final idea is drawn into the CAD drawing format with details features.

3.4 DESIGN SPECIFICATION

The design of the Ladder must be considered that it can endure several specifications,

Table 3.1: Design specification

No	Specification	Parameter
1	Overall maximum load	150kg
2	Height maximum	2.5 meter
3	Main body 25.4mm × 63.5mm ×1.0mm	2.5 meter
4	Rungs/step 19.05mm × 38.1mm× 1.0mm	4 meter
5	Support CF1191	3.5 meter
6	Ladder tray 32cm × 35cm	1 plate
7	Brusher cylinder Ø6×11cm	1

3.5 SKETCHING DRAWING SELECTION

From the existing ideas, only three concepts that had been chosen to be considered as the final ideas, which are:

3.5.1 Concept 1

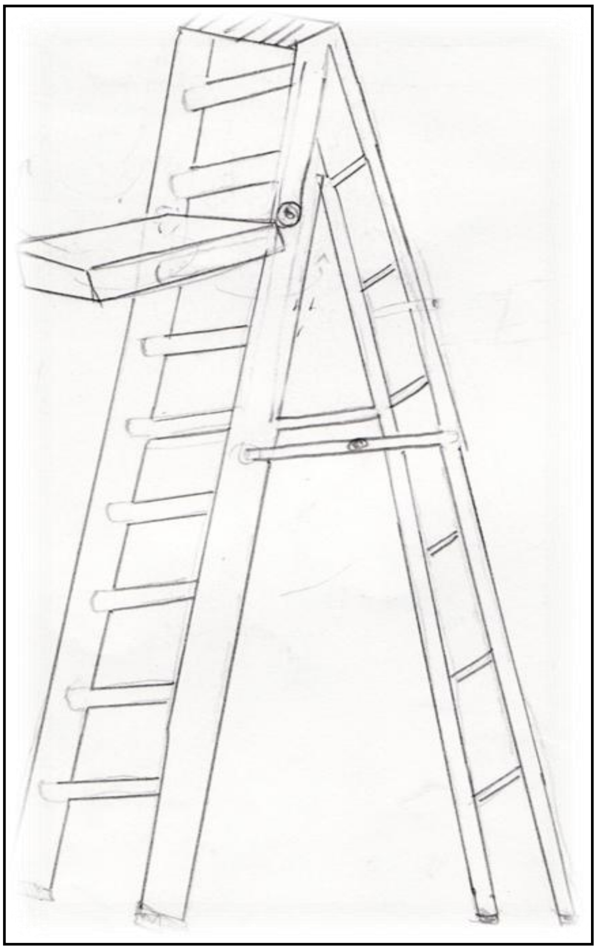

Figure 3.1 : Sketching 1

This sketching same body frame with existing ladder. Have plate to put tin of paint. The max load is 150kg and max height is 2.5m. This ladder made from aluminium alloy. The advantage are stable, can folding and easy to keep. The disadvantage cannot save in small space.

3.5.2 Concept 2

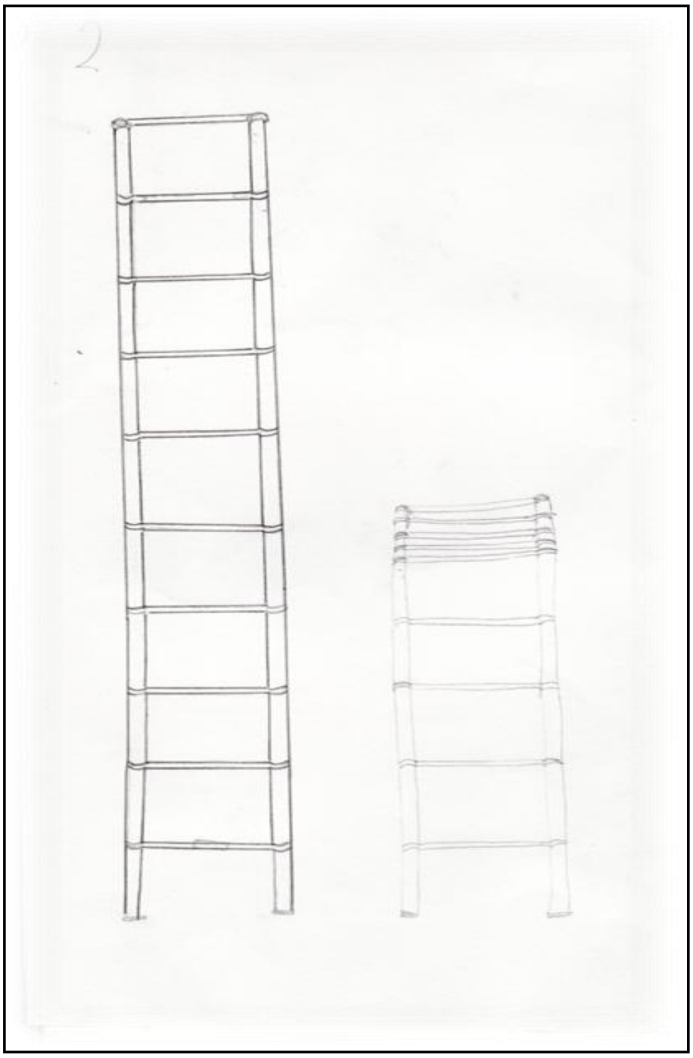

Figure 3.2 : Sketching 2

This is new concept. The max height is 2 meters and made from hollow round steel. Can adjust the high with the consumer need. This not longer life span because its hollow. The size of hollow steel not same. Size at top more small than size at bottom. The advantage is to easy keep in small place like boot car and the disadvantage is not strength like other ladder.

3.5.3 Concept 3

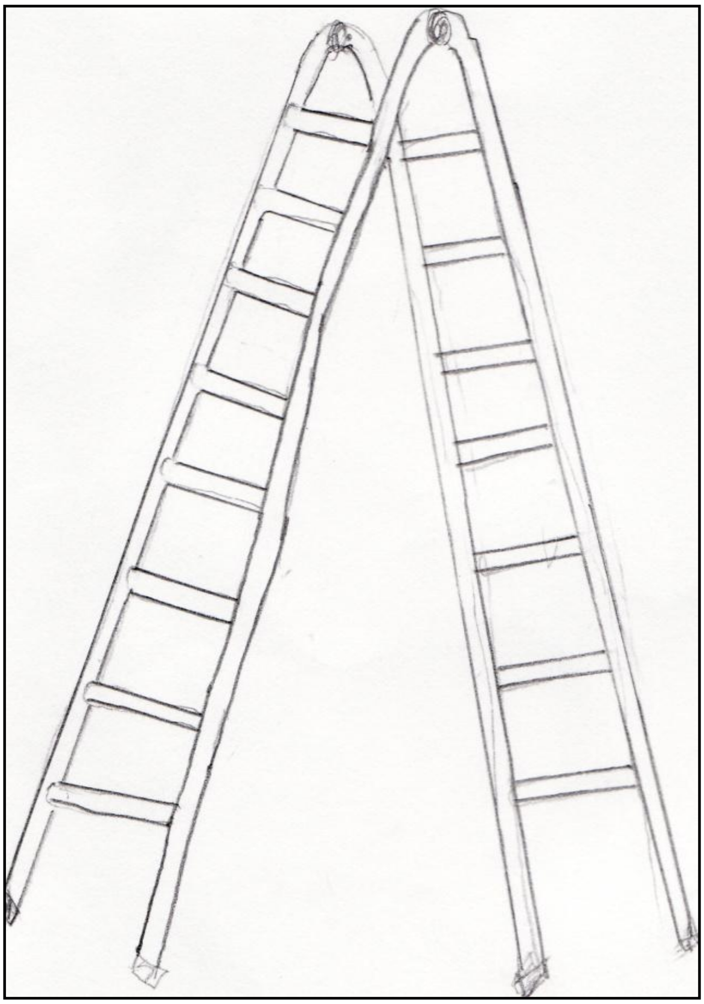

Figure 3.3 : Sketching 3

This concept is simple. The max height is 2 meters and made from fibreglass. This ladder can stand 2 meters and 1 meter. When to use 1 meter the ladder can stand normally with lock and when 2 meter the ladder need to hold at wall. The advantage is electrically nonconductive, great value, and strong. The disadvantage is expensive because use fibreglass more expensive than other material.

3.6 CONCEPT SELECTION

3.6.1 Final concept

Figure 3.4 : final selection

I'm choosing this sketching as my project concept is because it is simple but yet convenience. Thus, the support bar was located on the right spot of the pressure point.

3.7 COMPUTER AIDED DESIGN DRAWING

After a design has been selected, the next step in the designing process is dimensioning. The dimensioning is base on relevant dimensions and also referring to the existence ladder so that the design is fit into others part.

After dimensioning, the engineering drawing of the design is drawn using AutoCAD application, at this stage CAD modelling method is used. Part by part Cad modelling created according to the dimension done before, after all part created, the 3D model is assembled with each other base on the design.

3.8 OVERALL VIEW OF THE DESIGN

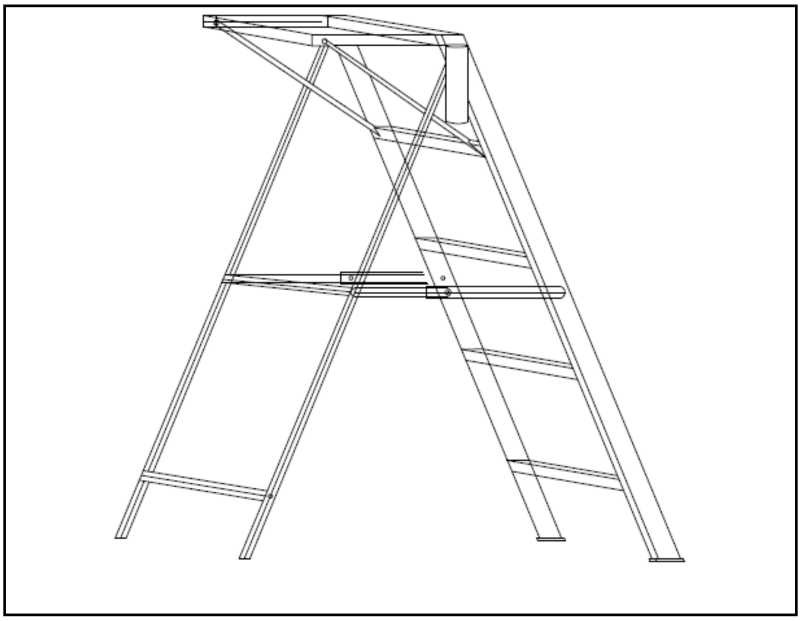

Figure 3.5: CAD Drawing

3.9 FABRICATION PROCESS

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

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. The processes that involved are:

- **Measuring**: Materials are measured to desired dimensions or location.
- **Marking**: All measured materials need to be marked to give precise dimension.
- **Cutting**: Marked materials are then cut into pieces.
- **Drilling**: Marked holes are then drilled to make holes for bolts.
- **Joining**: Materials joined by the method of rivet and using bolt and nut.
- **Finishing**: Put all accessories like rubber feet and grind all surface with smooth and no chip

3.10 MATERIAL PREPARERATION

Material of the project is totally using aluminum alloy according it is suitable for fabricate the ladder. Aluminum alloy is high strength and can patching the heavy load.

3.10.1 Aluminum Rectangular Hollow :

- 19.05mm × 38.1mm × 1500mm – 2pieces

Figure 3.6:Main body

- 25.4mm × 63.5mm ×360mm - 2 pieces

Figure 3.7: Rung / steps

3.10.2 Aluminum CF1191

Figure 3.8: Support

3.10.3 Stainless Sheet Metal

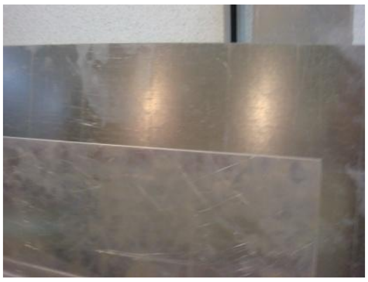

Figure 3.9: Plate

3.10.4 Aluminum Cylinder

Figure 3.10: Brusher cylinder

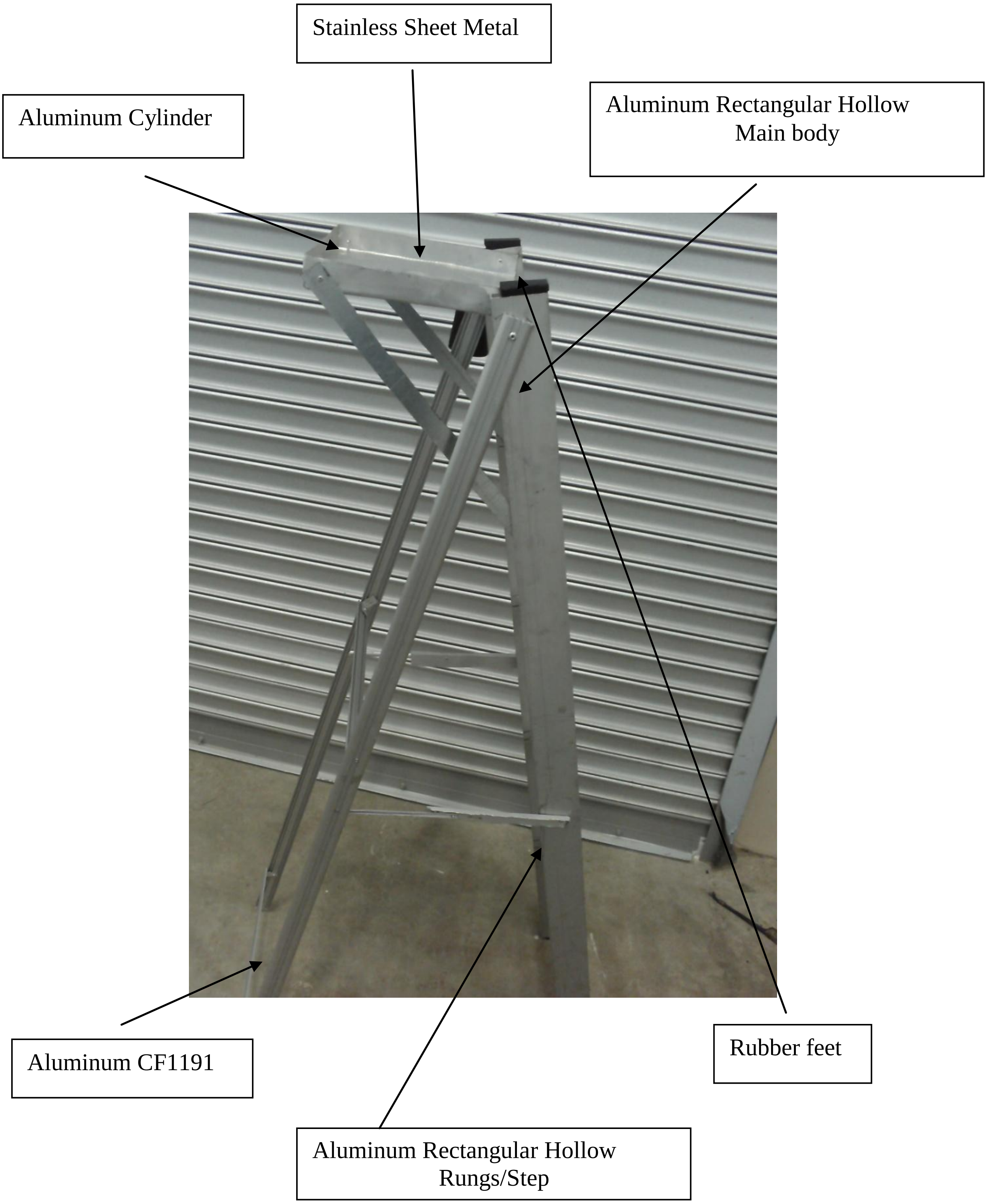

Figure 3.11: Actual Product (Ladder)

Table 3.2: Description of ladder safety

NO	DESCRIPTION	MATERIAL
1	Accommodation Ladder	Al-alloy or steel
2	Top rail & Stanchion	Al-alloy or Steel
3	Turntable & Upper Platform	Mild Steel
4	Brusher cylinder	Aluminium
5	Rungs/step	Al-alloy or Steel
6	Support	Al-alloy or Steel
7	Rubber Feet	Rubber

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

In this chapter, I will explain about the final fabrication of the ladder is done from only limited times due to several problems occur to the project. In this chapter will discuss mainly about the problems encountered during the whole project was been carried out and simple analysis.

4.2 PROJECT PROBLEMS

4.2.1 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 ideas on the project.

4.2.2 Designing & Sketching: Because of the idea were from the student directly, so there are no references that can be referred. All the drawing and dimension need to generate by student itself.

4.2.3 Fabrication Process: Students need to be given more time to finish fabricating their product because of slackness of skill and training, the joining finishing was not so god but yet can still reliable.

4.2.4 Material Preparation: Some of the needed material needs to buy at the city. University should prepare the material or either provides the place where the material can be obtained from.

4.2.5 Budget Preparation: It is not so effective to use student’s money to get the materials. University should provide budget at first stage so that student’s expenses are not interfere

4.3 CALCULATION

4.3.1 Stress analysis

$$\sigma = \frac{P}{A} = \frac{F}{A}$$

$F = ma$

Area formula for rungs

$A = H \times L$

$= 0.35m \times 0.0635m$

$= 0.022225m^2$

If weight

$weight = 50kg$

$a = 9.81$

We can calculate the force

$f = ma$

$= (50)(9.81)$

$= 490.5N$

Then calculate the stress

$\sigma = \frac{F}{A}$

$= \frac{490.5N}{0.022225m^2}$

$= 22kPa$

That is follow with weight 80kg,100kg, and 150 kg

Table 4.1: Data stress analysis

Weight (kg)	F (N)	σ (kPa)
50	490.5	22
80	784.8	35
100	981	44
150	1471.5	66

Then make a graph

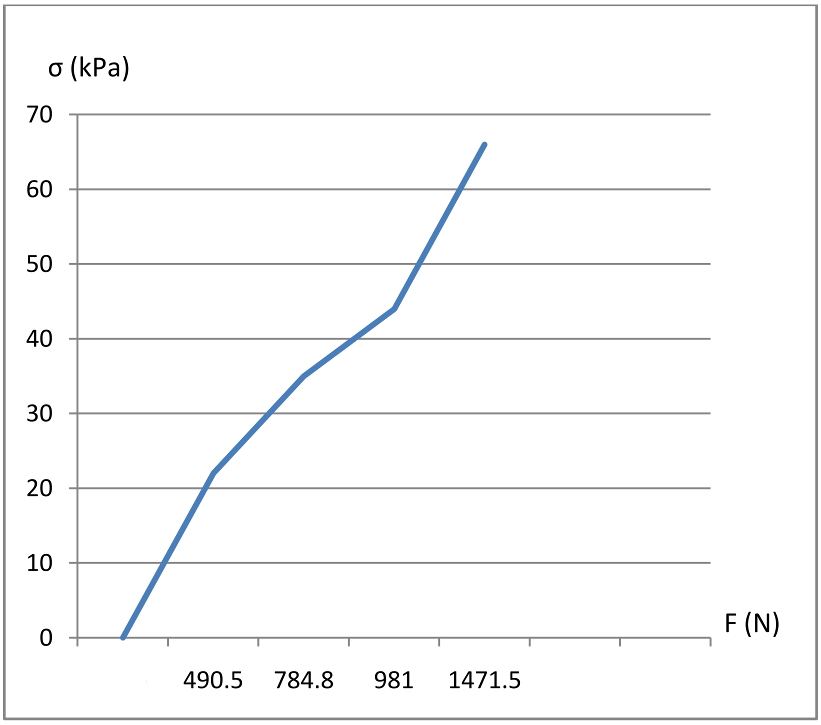

Figure 4.1: Graph stress analysis

4.4 LADDER SAFETY

4.4.1 Before even picking up the ladder, check that it meets the safety standards set by the OSHA and also its load capacity duty rating, so that it is able to handle the work it is about to be used for. Also check that all the parts are secure and not damaged.

4.4.2 When positioning the ladder, make sure it extends at least three feet past the landing point.

4.4.3 In order to stabilize the ladder, secure the top of it to the landing point if possible.

4.4.4 For step ladders – make sure the spreader is secure before use, and also never stand on the top of the ladder.

4.4.5 For extension ladders – Don't stand on the top three rungs of the ladder and also don't try and move it while in use.

4.4.6 If the ladder is being used near power lines or for electrical work, made sure that it is a fibreglass, not an aluminium ladder as they conduct electricity.

4.4.7 For every four feet that the ladder rises up, the bottom of the ladder should be placed 0.3148m from the resting point. For example if the ladder is 4.8768m high, the base should be placed 1.2192m from the object it is leaning against.

4.5 MAINTAINING LADDER

Very little maintenance is required for aluminium or fibreglass ladders. Check that the hinges of step ladders are not binding and that the sections on extensions ladders slid freely - aluminium to aluminium friction can weaken the material over a period of time. On extension ladders, check where rope is used, that it is in sound condition and the fixing positions are secure undamaged. Fit new rope as soon as there is any sign of fraying.

4.6 COSTING

All material to fabricate the ladder must buy at hardware because at lab not prepare this material.

Table 4.2: Costing

MATERIAL	UNIT	PRICE
Aluminum Rectangular Hollow	19.05mm × 38.1mm × 6.1m	RM31
	25.4mm × 63.5mm ×6.1m	RM23
Aluminum CF1191	6.1m	RM31
Rubber feet	4	RM4
	TOTAL	**RM81**

Source : Receipt

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

In this chapter the problems encountered during the whole project are discussed. Then it goes to conclusion of the project and recommendation.

5.2 CONCLUSION

As a conclusion we think my project had been practice me before start the practical. It is because we had learned a lot of skills and method of using several of machines. We also had using internet to search a lot of things that connect with my project. Based on this literature review, we have found many types of ladder and with different design. Beside that, we also can gain knowledge about the material type, structure and others else. Within a short time to finish the project, there are a lot of problems quickly because there is no enough time if we delay to settle it. This project also generates my capabilities as a responsibility person. This is because we had to take care and take a look for my project. Beside that, we also have made a private meeting with my supervisor for a discussion about my progress of work and the progress of report. So by the time we also can make some improvement and learn how to share others opinion and idea to make my product better.

Finally for the last, we can conclude that final year project is very important because it can make our self more discipline and be punctually on time in whatever work we do. We also have achieved my objective and a scope of project about design and fabricate a ladder using my idea.

5.3 RECOMENDATION

5.3.1 Facilities

Based on the progress of the project that we had done, so many things in facilities aspects can be improved especially in welding process. The MIG welding machine doesn't have enough quantity for the student user. So the faculty especially must provide more welding machine for the student user because amount of student is increase by a year.

5.3.2 Student Budget

Some of the materials also need the student to buy such the things that doesn't have in mechanical laboratory. For the budget, the faculty should provide the budget to student at first. Precise planning of the work progress will make sure that the project can be done in a shorter time. Have a good time management can guaranty that any of student task to complete in a good ways and also give more time to focus on others subject.

5.3.3 Design

Based on consumer needs, design the ladder must more portable. The design in the future can design the ladder with adjustable high. Then can propose with the sit site on the ladder for easier to consumer when use it. If the project like this give more time to fabricate all the needs can achieved with more research.

5.4 FUTURE WORK

The final year project is a most important subject that must be learns in the final semester. It is because this project can make the student practice their skill of machining process since semester one. Its include using shearing machine, bending machine, drilling machine, CAD software, and others else. So for my ladder project, I think a lot of things can be improved in the future. This improvement can help us in the characteristics and functioning of the existed ladder. Besides that, the financial is very important to develop this ladder sophisticated and could be produce to the market in the future.

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APPENDIX

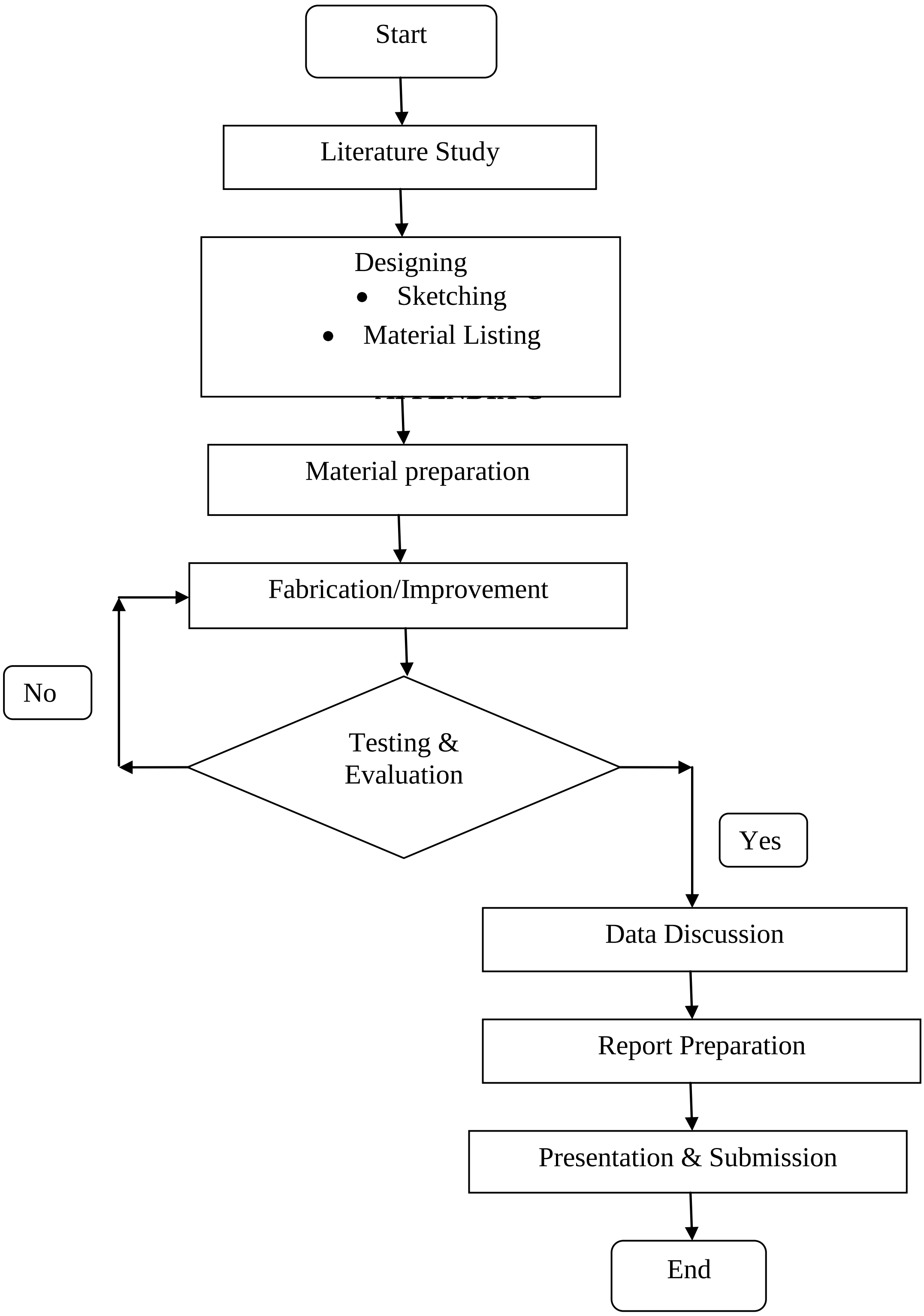
APPENDIX A

GANTT CHART

ACTIVITIES		WEEK														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Literature Review	Planning															
	Actual															
Objective of the study	Planning															
	Actual															
Scope of the study	Planning															
	Actual															
Design specification	Planning															
	Actual															
Material selection	Planning															
	Actual															
Fabrication / improvement	Planning															
	Actual															
Testing and evaluation	Planning															
	Actual															
Data discussion	Planning															
	Actual															
Report preparation	Planning															
	Actual															
Presentation	Planning															
	Actual															
Report submission	Planning															
	Actual															

APPENDIX B

FLOW CHART



APPENDIX C1

SKETCHING DRAWING

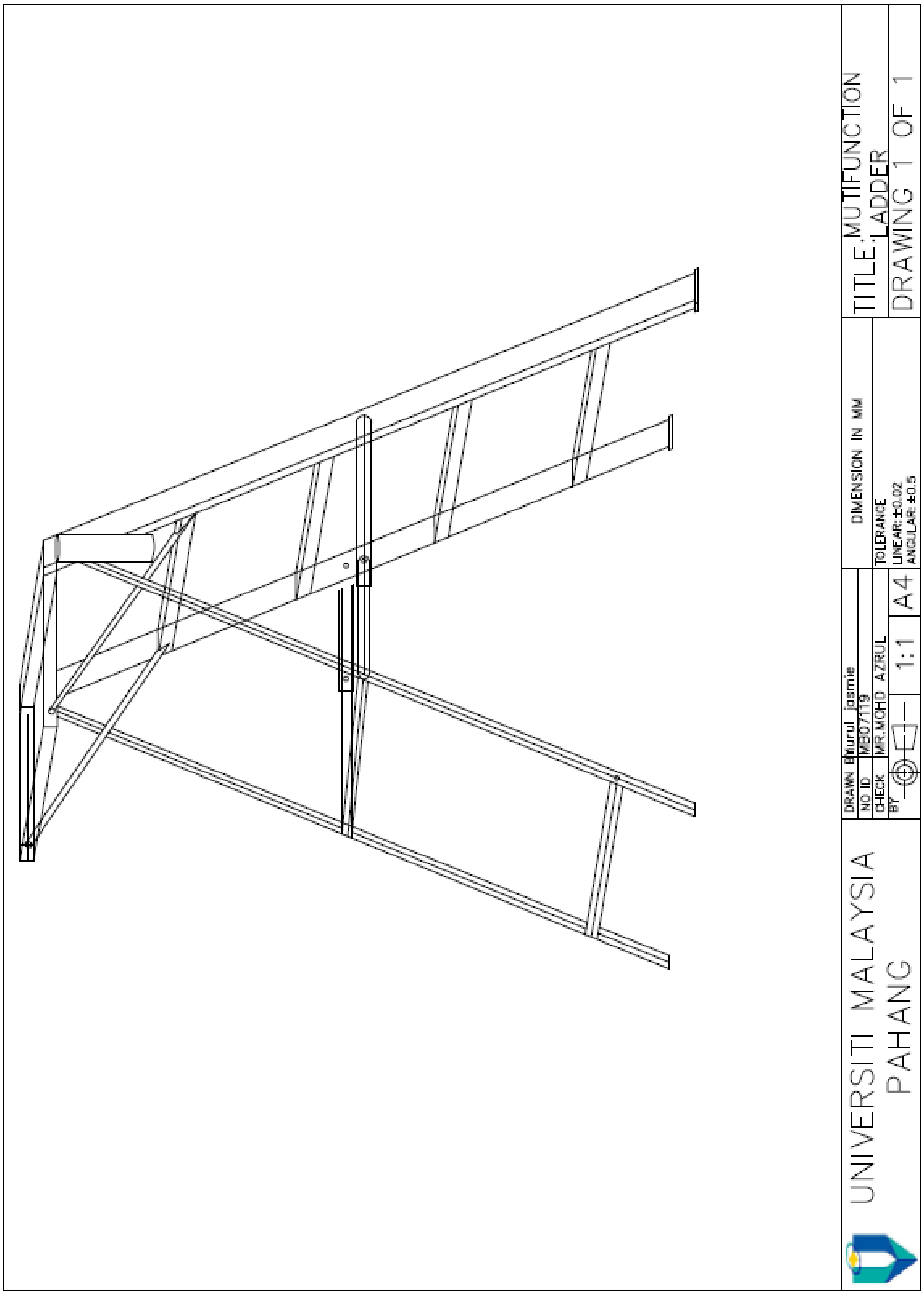
CONCEPT 1

CONCEPT 2

CONCEPT 3

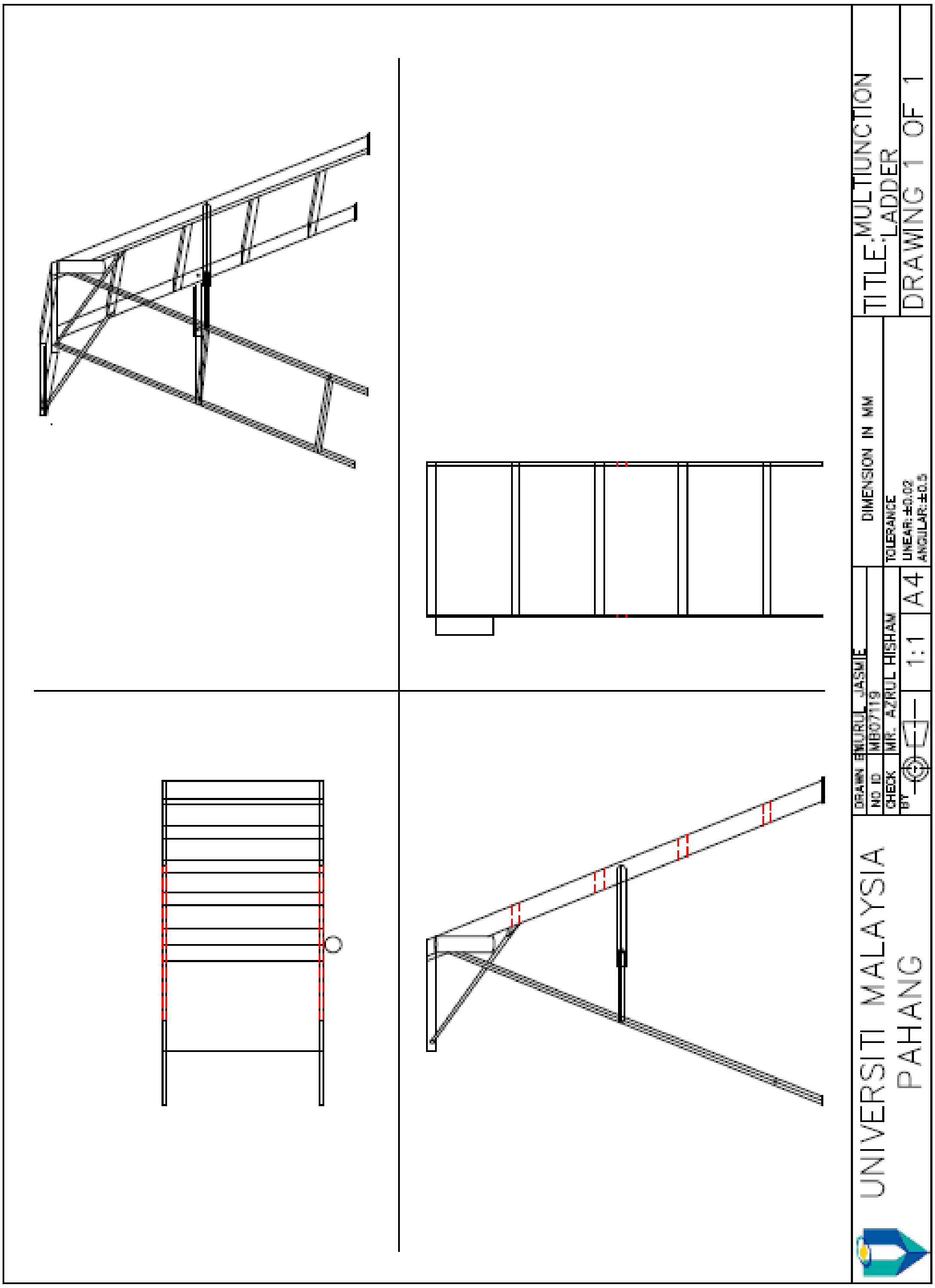
APPENDIX C2

ISOMETRIC DRAWING



APPENDIX C3

ORTHOGRAPHIC DRAWING



APPENDIX D

TYPICAL YIELD STRENGHT

Material	Yield strength (MPa)	Ultimate strength (MPa)	Density (g/cm³)
Structural steel ASTM A36 steel	250	400	7.8
Steel, API 5L X65 (Fikret Mert Veral)	448	531	7.8
Steel, high strength alloy ASTM A514	690	760	7.8
Steel, prestressing strands	1650	1860	7.8
Steel Wire			7.8
Steel (AISI 1060 0.6% carbon) Piano wire	2200-2482 MPa		7.8
Stainless steel AISI 302 - Cold-rolled	520	860	
Cast iron 4.5% C, ASTM A-48	276 (??)	200	
Titanium alloy (6% Al, 4% V)	830	900	4.51
Aluminium alloy 2014-T6	400	455	2.7
Copper 99.9% Cu	70	220	8.92
Cupronickel 10% Ni, 1.6% Fe, 1% Mn, balance Cu	130	350	8.94
Brass	approx. 200+	550	5.3
Tungsten		1510	19.25
Glass		50 (in compression)	2.53
E-Glass	N/A	3450	2.57
S-Glass	N/A	4710	2.48

Basalt fiber	N/A	4840	2.7
Marble	N/A	15	
Concrete	N/A	3	
Carbon Fiber	N/A	5650	1.75
Spider silk	1150 (??)	1200	
Silkworm silk	500		
Aramid (Kevlar or Twaron)	3620		1.44
UHMWPE	23	46	0.97
UHMWPE fibers (Dyneema or Spectra)		2300-3500	0.97
Vectran		2850-3340	
Pine Wood (parallel to grain)		40	
Bone (limb)	104-121	130	
Nylon, type 6/6	45	75	
Rubber	-	15	
Boron	N/A	3100	2.46
Silicon, monocrystalline (m-Si)	N/A	7000	2.33
Silicon carbide (SiC)	N/A	3440	
Sapphire (Al_2O_3)	N/A	1900	3.9-4.1
Carbon nanotube (see note above)	N/A	62000	1.34