SYSTEM INTEGRATION FOR MECHANISM AND TEST BED OF CONE LAYING SYSTEM

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This report is submitted
in fulfillment of the requirement for the degree of
Bachelor of Mechanical Engineering

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DECLARATION

I declare that this project report entitled "System Intergeration For Mecahnism And Test Bed On Cone Laying System" is the result of my own work except as cited in the references

Signature : ....

Name : ....

Date : ....

APPROVAL

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

Signature	:.	....
Name of Supervisor	:	....
Date	:	....

DEDICATION

To my beloved mother and father

ABSTRACT

This project is aim to design the test bed and to create the system integration between cone laying system. The methodology used to fulfill the project requirements contain of Project Design Specification (PDS), Morphology Chart, Concept Generation and Concept Evaluation. Next, procedure is the design analysis to ensure the standard part will well design using Solidwork and the maximum stress and force calculated using related formula to make sure the project meet the factor of safety required. Then the Finite Eliment Analysis (FEA) in Solidworks software is used to test run to the critical component such as frame, slider and hook. Lastly, the fabrication process such as cutting, grinding, welding and milling held at a workshop at Kompleks Makmal Kejuruteraan (KMK) UTeM. In this project student can show and apply their knowledge and skill in manufacturing, fabricating process, Mechanical Design, Solid Mechanic and Solidwork Software to complete this project. Besides that, the cost and time managements together with good planning is important to make sure the project went smoothly and finish at given deadline. Finally, student need to give full commitment, discipline and good communication to complete this project successfully.

ABSTRAK

Projek ini bertujuan untuk mereka bantuk ruang pengujian dan untuk mewujudkan sistem integrasi diantara sistem pemasangan kon. Metodologi yang digunakan untuk memenuhi keperluan projek mengandungi Spesifikasi Reka Bentuk Projek (PDS), Carta Morfologi, Generasi Konsep dan Penilaian Konsep. Seterusnya, prosedur adalah menganalisis reka bentuk untuk memastikan bahagian standard akan direka dengan baik menggunakan 'Solidworks' dan tegasan maksimum dan daya yang dikira menggunakan formula yang berkaitan untuk memastikan projek itu untuk memenuhi faktor keselamatan yang diperlukan. Kemudian Keadah Unsur Terhingga (FEA) dalam perisian 'Solidworks' digunakan untuk menguji beberapa komponen kritikal seperti bingkai utama, gelansar dan cangkuk. Akhir sekali, proses fabrikasi seperti pemotongan, pengisaran, kimpalan dan pengilangan diadakan di bengkel di UTeM Kompleks Makmal Kejuruteraan (KMK). Dalam projek ini pelajar boleh menunjukkan dan menggunakan pengetahuan dan kemahiran mereka dalam pembuatan, proses fabrikasi, Reka Bentuk Mekanik, Perisian Mekanik dan 'Solidworks' untuk melengkapkan projek ini. Di samping itu, kos dan pengurusan masa dan perancangan yang baik adalah penting untuk memastikan projek berjalan lancar dan selesai pada tarikh akhir yang diberikan. Akhir sekali, pelajar perlu memberi komitmen penuh, disiplin dan komunikasi yang baik untuk menyelesaikan projek ini dengan jayanya.

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LIST OF ABBREVIATION

CAD	Computer Aided Design
PSM	Projek Sarjana Muda
BC	Before Century
PDS	Product Design Specification
QFD	Quality Functional Deployment
HOQ	House of Quality
WBS	Weight Breakdown Structure
SW	Solidworks
GD&T	Geometrical Dimensioning and Tolerances
FBD	Free Body Diagram
FEA	Finite Element Analysis
ANSI	American National Standard Institute
Max	Maximum
Min	Minimum
3D	3 Dimension
2D	2 Dimension
CNC	Computer Numerical Control
CAM	Computer Aided Manufacturing

CHAPTER 1

INTRODUCTION

1.1 Background

Traffic cone are often used to create separation or merge lanes during road construction projects or automobile accidents, although heavier, more permanent markers or signs are used if the diversion is to stay in place for a long period of time. They are usually cone-shaped markers that are placed on roads or footpaths to temporarily redirect traffic in a safe manner and they also call pylons or witches' hats. The material of cone is wire and cable fluff consists mainly of plasticized vinyl, along with other contaminants such as cross-linked PVC, polyethylene, PET, nylon, aluminum, copper, rubber, and fluoropolymers (Adrian, 1987).. The cleanliness of the final workable material depends upon the cleaning processes and normally correlates with the purity of the incoming feed.

The design of traffic cone were invented by Charles D. Scanlon, an American who got the idea while working as a painter for the Street Painting Department of the City of Los Angeles. Traffic cones were first used in the United Kingdom in 1958, when the M6 motorway opened. These traffic cones were a substitute for red lantern paraffin burners being used during construction on the Preston Bypass. David Morgan believes that he constructed the first experimental plastic traffic cones, which replaced pyramid-shaped wooden ones previously used in 1961.

The traffic cone may fill with the flashing light for extra precaution. And traffic cone are usually used at the outdoor during road construction or other situations requiring traffic redirection or advance warning of hazards or dangers. They also can be used for the night time traffic cones are usually fitted with a reflective sleeve to increase visibility (Adrian, 1987).

1.2 Problem Statement

According to the market basically the current cone lifting machines are provided using complex system such as hydraulic system, built with lorry and not compatible with small lorry. The normal method are designed to operate manually with human on it. However, the project is need to design the test bed mechanism that can move lifting cone mechanism left and right. The problem statements are as follow:

i. Casualty of raied workers during laying cone on highway for the purpose of maintenance.
ii. Low efficiency of the manual cone laying system procedure.
iii. To design low cost of semi-automatic cone laying system.

1.3 Objectives

Basically, the purpose of this project is to expose student to complex engineering problems in designing an engineering product/process such constraints as public safety and health, cultural society and environment. Besides, this project is also important to enhance student's skill in project implementation and management. However, the product must have sufficient strength while functioning the require task with reliability. Thus, the aims of the project are all the following:

i. To design the test bed of cone laying system.
ii. To create system integration between cones laying mechanism of the test bed.

1.4 Scope

In this project, we will focus on designing, calculating, analyzing and fabricating a test bed mechanism. Every part of our project will have its own function which are manually fabricate by our hands. The aim is to build the test bed to hang the lifting mechanism and move it left and right with specific position. The scope of the project are all the following:

i. Detailed design for the test bed (CAD)

ii. Detailed design of the system integration.

CHAPTER 2

LITERATURE REVIEW

2.1. Material for Test bed

Material for test bed are the most importance things in building the good structure. The good material give the good result and the good material it not easy to broke or snap while the machine operate with the full power.

2.1.1 Structure of Material

(Becque & Rasmussen, 2009) said that a finite element model was advancement to study the interaction of local and overall buckling in lipped channel columns. The model accounts for the particular material characteristics of stainless steel: non-linear stress strain behavior, anisotropy and increased corner properties because of cold-working.

Moreover, in the analysis of the directional relationship between two different types of bands uncover that few slip system, which can follow the shear strain. This is considered to result from the limited slip systems of the steel and the obstruction of separation of movements by the current band (Kim, Kim, & Shin, 2001). The stronger material the lower banding deformation and it not easy to break.

Furthermore, from (Liu & Young, 2003) stated The design strengths were determine based on the material properties obtained from the complete experiment, which takes into account the enhancement of the material properties due to cold-working. He said that the material properties is importance in order to get high strength.

For the summarization, mostly from the research we should know that the strength of the object is came from the properties of the material that the object used, the stronger the bond the stronger the object.

2.1.2 Structure Bond

The union of two or more masonry units so that the combination acts as a single unit and provides the same structural strength as a single unit of the same material. The modern scientific and technical revolution is responsible for increasing interest and impulse in the search for materials possessing specific and wanted properties (Vajeeston, Ravindran, Ravi, & Asokamani, 2001). In this paper, they said we must responsible of increasing technical revolution in the modern world today our technology must grow faster if not we will miss it.

The combination of high strength, enormous elongation, light weight, high rised temperature strength, and high-strain-rate super plasticity is encouraging for future uses as various kinds of structural materials (Inoue, Kawamura, Matsushita, Hayashi, & Koike, 2001). The combination to make the strong bonding element and can be used as the strong structure material in the industry. It also good for our project to give it stronger bond of material to prevent it from break.

During compaction, an increase in the density of the crystals is obtained if a certain compaction load is applied, supplying the energy needed for diminishing the distance between the ions or molecules in the crystal structure. This effect might be reversible for some materials and irreversible for others, as observed clearly for polyethylene glycol in this study (Adolfsson & Nyström, 1996). The higher compaction will increases the density and the strength of the material and get it stronger.

The summary is, we need the stronger bond to make the strong material and need to be compress to the specific load to make sure the element will not break easily.

2.2 Bending Of the Test bed

Banding is to provide or fit an object with something in form of a strip or ring, for reinforcement or decoration. For the test bed we need to know the banding deflection because the mechanism of lifting need to hang to test bed and the test bed is acting like cantilever beam.

(Bisshopp & Drucker, 1945) said that the solution for large deflection of a cantilever beam1 cannot be obtained from elementary beam theory since the basic assumptions are no longer valid. Specifically, the elementary theory neglects the square of the first derivative in the curvature formula and provides no correction for the shortening of the moment arm as the loaded end of the beam deflects.

The large deflection of a cantilever beam made of Ludwick type material under a combined loading was investigated. The problem involves both material and geometrical non-linearity and a closed-form solution to such problem cannot be obtained (Lee, 2001). In this paper, the deflection of cantilever beam is depend on the material used.

Some problems have been solved by several authors with these theories. They point out that the effects of couple stress in materials become significant when some physical dimension of the body approaches a characteristic length (Kakunai, Masaki, Kuroda, Iwata, & Nagata, 1985). In this paper, the material and the dimension diameter of the beam is most importance to get the stronger beam.

In the conclusion, the strong test bed came from the strong bond material and the good joining. There will be no deflection if used the correct material to build and hang the lifting mechanism.

2.3 Joining of the Structure

There are many type of joining for example to join the steel there using welding or bolt and nut. The meaning of joining is to combine or fasten two things together using joining tool. Joining have two varieties first eternal joining and second can be remove.

2.3.1 Welding joining

A critical temperature was found to exist between the solid and liquid phase line temperature of composite. At the point when welding temperature achieve the critical temperature, the liquid phase matrix would change the holding of fortification of reinforcement into reinforcement matrix by penetrating into the interface of reinforcement (Liu & Young, 2003). In this paper, the high temperature between two sides of steel that need to weld create stronger bonding.

(Martinelli, Scarabelli, & Vedani, 1996) said that there is incredible interest in the application of metal matrix composite (MMC) materials. Potential uses of these materials are various, in industries such as aerospace (satellite struts), defense (electronic instrument racks), automotive (drive shafts and brake discs), sports product (mountain bicycles and golf clubs), and marine (yacht fittings).

Weld interface of the lap joint showed wavy morphology and the intermediate layer was seen along the wavy interface. These microstructures are similar to that of the unstable weld lap joint (Liming, Meili, Longxiu, & Lin, 2001).

Conclusion is the welding using any type of welding will give the strong bond between two steel and it will remain stick together.

2.3.2 Bolt and Nut Joining

According to (Mackerle, 2003) stated that the local contact between the bolt and composite material may induce high stress concentration and break the material. The stress distribution near the region around the bolt joint where the interaction between the bolt and the loaded hole is taken into account, can be determined by finite element analyses.

Moreover, revolution, nuts and bolts become commonplace. The invention of the lathe in 1800 by Henry Maudslay enabled threads of any pitch and diameter to be made with a greater degree of precision and reproducibility (Kenny, Patterson, Street, & Si, 1800). The bolted joints have also been extensively used in various assemblies in recent years (electronic packaging, aircraft industry, automotive industry).

Furthermore, the computed results are based on the assumptions of plane stress behavior of the plate and rigid body representation of the pin, with frictionless contact between the pin and plate (Choo, Choi, & Lee, 1993).

Lastly, the bolt and nut now are widely used in the all sector that are the most compatible fastener. It easy to remove and assemble where you want and it also can stand high pressure depended on the material bolt and nut are used.

2.4 Movement of Test bed

The test bed need to move the lifting mechanism left and right in order to align the cone in curve and start the cone lining from left or right side of the route. The movement of the test bed need to smooth and move fast to make the work more efficient.

2.4.1 Roller Bearing

The complicated roller bearing model has been confirmed experimentally by the requesting case of a cylindrical roller bearing with four flanges under combined radial load and overturning moment. The internal geometry was chosen such that flange contact loads interacted with raceway loads and moments. Great agreement was found between the measured bearing deflection and misalignment and the values predicted by the models (de Mul, Vree, & Maas, 1989). There are many type of ball and roller bearing in the industry we need to choose according to the specification of our project.

The loads are an axial force and a tilting moment. These limiting values are obtained by considering the equilibrium of the forces and moments in the inner ring, and then equating the maximum load to the value obtained from the axial load-carrying capacity of the upper raceway. This cloud of points has been approximated by a straight lined rhombus and a simple closed-form equation has been created to formulate scientifically the acceptance of the bearing (Aguirrebeitia, Abasolo, Avilés, & Fernández De Bustos, 2012).

Misalignment of the inner race causes roller contact to happen on both sides of the cage pocket, again leading to a loss of geometric coupling and causing an increase in instability for littel clearance ratios. This can be avoided by adjusting the axial roller-flange clearance and the roller-cage pocket clearance so that skew control is provided by the race flanges rather than by the sides of the enclosure pocket (Ghaisas, Wassgren, & Sadeghi, 2004). The perfect and accurate dimension bearing is need for the batter performance and long lasting bearing.

The foregoing presents a new and improved method for the forecast of ball and roller bearing weakness lives. We need to culmination of two decades of effort to include in such life prediction all the conditions which influence rolling bearing fatigue life by converting these conditions to an integrated material stress field. The method further enables the utilization of the new ISO standard method for such life computation (Harris & Barnsby, 2001).

The feature extraction is the most important step in roller bearing fault diagnosis. In traditional time domain and frequency domain methods, the mathematical model need to be established or the mechanism need to be studied. However, the related parameters of a complex vibration system are very exceptionally hard to be determined (Junsheng, Dejie, & Yu, 2006). A direct model has been produces for the vibrations of an undamped bearing system caused by ball bearing geometrical defects. The model is valid for low and medium velocity where ball centrifugal action can be neglected. The solution to the non-linear equilibrium equations of the similarity bearing system is anticipated to be known if the bearings are geometrically perfect. For that reason computer programs are available within the bearing industry (Yhland, 1992).

The conclusion, the bearing build and used for the project must be in the correct condition. The bearing must keep the movement smooth and low vibration. The bearing also need to be strong to support the heavy load during working process. The bearing also need to be lubricate with the correct lubricating to maintain the bearing work in the perfect condition.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter explains on the way of this project has been done as shown in Figure 3.1. First, explain on the procedure on how to collect data and the method use in collecting data. The data were obtained from the given product design requirements and specifications and then we used brainstorming method to get the ideas of our product design. Next, followed the engineering design process from sketching concept design to detailed design. Lastly, evaluated and analyzed the data from data collection to choose the best design for my product.

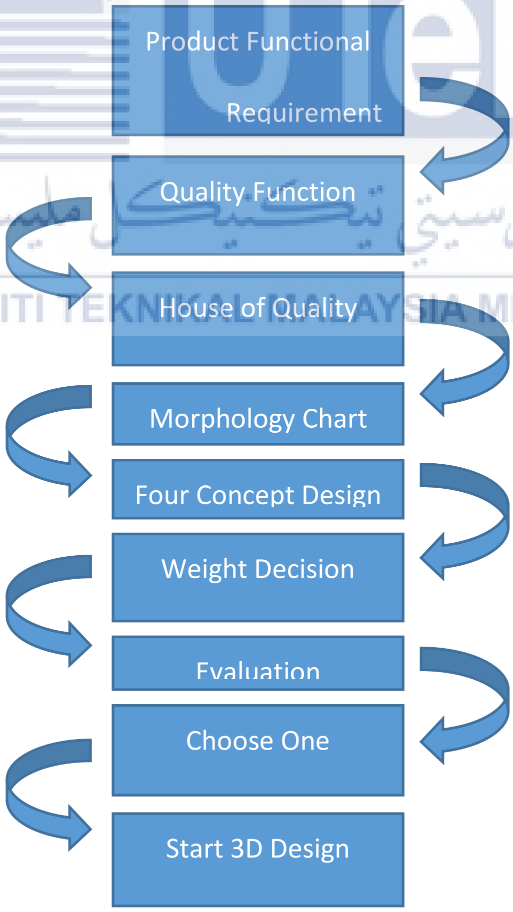


Figure 3.1 Flow Chart

3.2 Project design Specification (PDS)

A product design specification (PDS) is a detailed document that provides the information about the characteristic of a project. Its aim to ensure that the subsequent design and developments of a product meets the needs and to achieve a targeted degree of safety, efficiency and performance.

The product design specification are as below;

1. Performance
   - i. Strong frame
   - ii. Attachment
   - iii. Accuracy in stopping
   - iv. Smooth movement

2. Weight
   - i. Light weight

3. Material
   - i. Light
   - ii. Strong
   - iii. Low cost
   - iv. Easy to fabricate

4. Safety
   - i. Should not harm users
   - ii. Obey the safety requirements

5. Installation
   - i. Easy and quick assemble

6. Manufacturing processes

i. Welding

ii. Grinding

iii. Cutting

iv. Drilling

v. Painting

vi. Fastening

vii. Finishing

7. Aesthetic

i. Shape

ii. Color

iii. Symmetry

8. Environmental friendly

i. Pollution Free

ii. No harmful chemicals or substances

9. Portability

i. Easy to carry around

ii. Light weight and compactness

iii. Mobility

3.3 Project Requirements

The purpose of the project is to build the test bed for the con laying system including the system integration. The test bed is used to hang the con lifting mechanism and need to move left right and controlled by the system integration. The product must have sufficient strength while functioning the require task with reliability. The given project requirements of the product are as follow:

i. To design the test bed of cone laying system.

ii. System integration between cones laying mechanism of the test bed.

3.4 Quality Functional Deployment (QFD)

Quality Functional Deployment is the relationship between customer needs and product requirements.

Table 3.1 Quality Functional Deployment

NO	CUSTOMER NEEDS	IMPORTANCE	PRODUCT REQUIREMENT
1	Strength	5	Sufficient strength with high reliability
2	Easy Handling	5	Easy to assemble and dissemble the Test Bed to the lorry
3	Mobility	4	Used the smooth roller to travel movement left and right
4	Safety Features	5	Functional design concept with safety feature, compactness and finishing quality
5	Functionality	5	Test Bed can stand the higher weight and hold the mechanism in place

6	Appearance	4	Good finishing and high quality of product
7	Environmental Friendly	4	Less noise and less pollution

Table 3.1 show, the customer needs and project requirements are related to gain a functional and relation the suitable engineering specifications of the need test bed with slider mechanism and the integration system. The importance is scaled to get the mathematical benchmark to the relative weight contribution.

3.5 House of Quality (HOQ)

The House of Quality (HOQ) is the relationship between Customer Requirement and Engineering Characteristic. The relative weight is calculated and the high value shows the main consideration of the product.

Table 3.2 House of Quality for Project

PROJECT REQUIREMENT	ENGINEERING CHARACTERISTIC									
	Importance	Type Of Material	No Of Roller	Weight And Height Of The Product	Type Of Movement Of Mechanism	Variety Of Color	No Of Slider	The Angle Of Structure	Type of Structure	Total
Strength	5	9	3		1		9	9	3	170
Easy Handling	5		9	3	3					75
Mobility	4	3								12

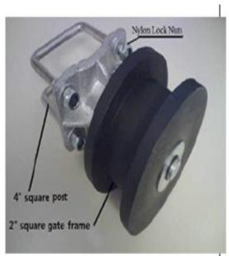
Safety Features	5			9			3	9	3	120
Functionality	5		9		9					90
Appearance	4					9				36
Environmental Friendly	4			1		1				8
Total		57	105	60	65	40	60	90	30	511
Relative Weight		0.11	0.21	0.12	0.13	0.08	0.12	0.18	0.06	1.00

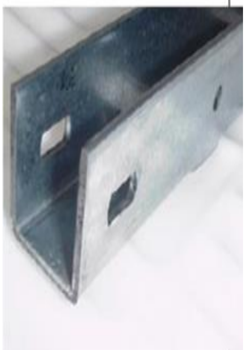
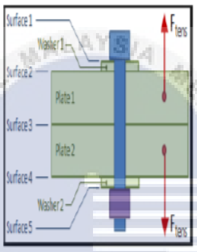
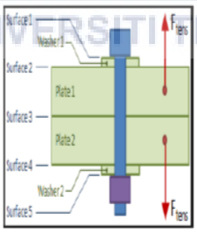
Table 3.2 show, the product with the highest value is the functionality. The product must function well and meets all the project requirements. The number of roller is the highest value in the engineering characteristic. The number of roller is the main criteria that effect to the functionality of the product.

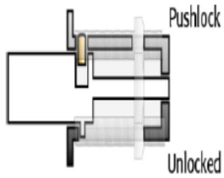
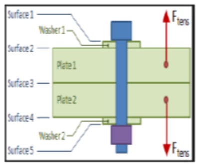
3.6 Morphological Chart

The Morphological Chart for the concept design. Based on Morphology Chart, and generate some different concepts for final design product.

Table 3.3 Morphological Chart

CRITERIA	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Roller	Rubber roller 	Double roller 	Pulley roller 	Shaft slider 

Slider	U- shape channel 	Small u-shape channel 	Pill of u-shape channel 	Shaft slider 
Locking mechanism	Bolt and nut 	Car lock 	Hook lock 	Pin lock 
Type of attachment	Bolt and nut 	Welding 	Flat head bolt and nut 	
Type of steel channel	L- shape 	Rectangle 	Steel rod 	Square channel 

Stopper mechanism control	Sensor 	Push lock 	Gear stopper 	
Type of attachment to lorry	Welding 	Flat head bolt and nut 	Bolt and nut 	

3.7 Concept Generation

The concept designs idea are generated and evaluated to choose the best design that satisfies the customer requirements.

3.7.1 Design 1

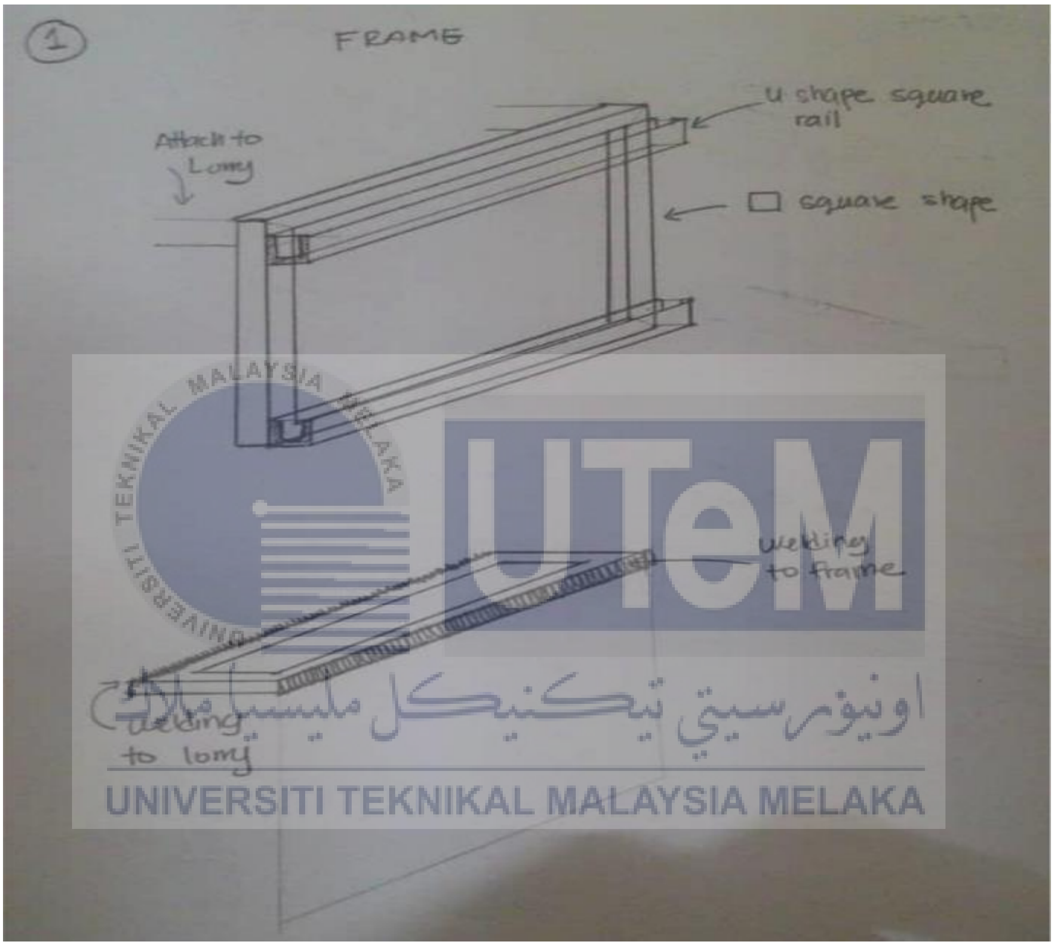


Figure 3.2 Frame Design 1

Table 3.4 Criteria for Design 1

Criteria	Option	Criteria	Option
Roller (upper, middle and down)	1	Stopper mechanism control	1
Slider (upper, middle and down)	1	Type of steel channel	4
Locking mechanism for slider	4	Type attachment at lorry	1
Type of attachment	3		

For the first concept design, as shows in Figure 3.2. The frame design using square shape angle frame design and it is for the stability of the frame. For the roller this design using the rubber roller because it create more friction whole moving. This design using u-shape slider to support the rubber roller and keep it on track. The locking mechanism for the slider is using pin lock mechanism, the lock is easy to used and easy to handle. Next, for the attachment between rail to the frame using the flat head bolt and nut it will easy to assemble and dissemble for services.

In addition, the stopper mechanism control is by using the stopper sensor that will make sure the movement will stop immediately after arrive the stop position. The square channel is used in this design because it is the stronger shape and using the bigger diameter square channel. Type of attachment to the lorry and to the frame is using welding to make sure the attachment stand still while the mechanism working.

3.7.2 Design 2

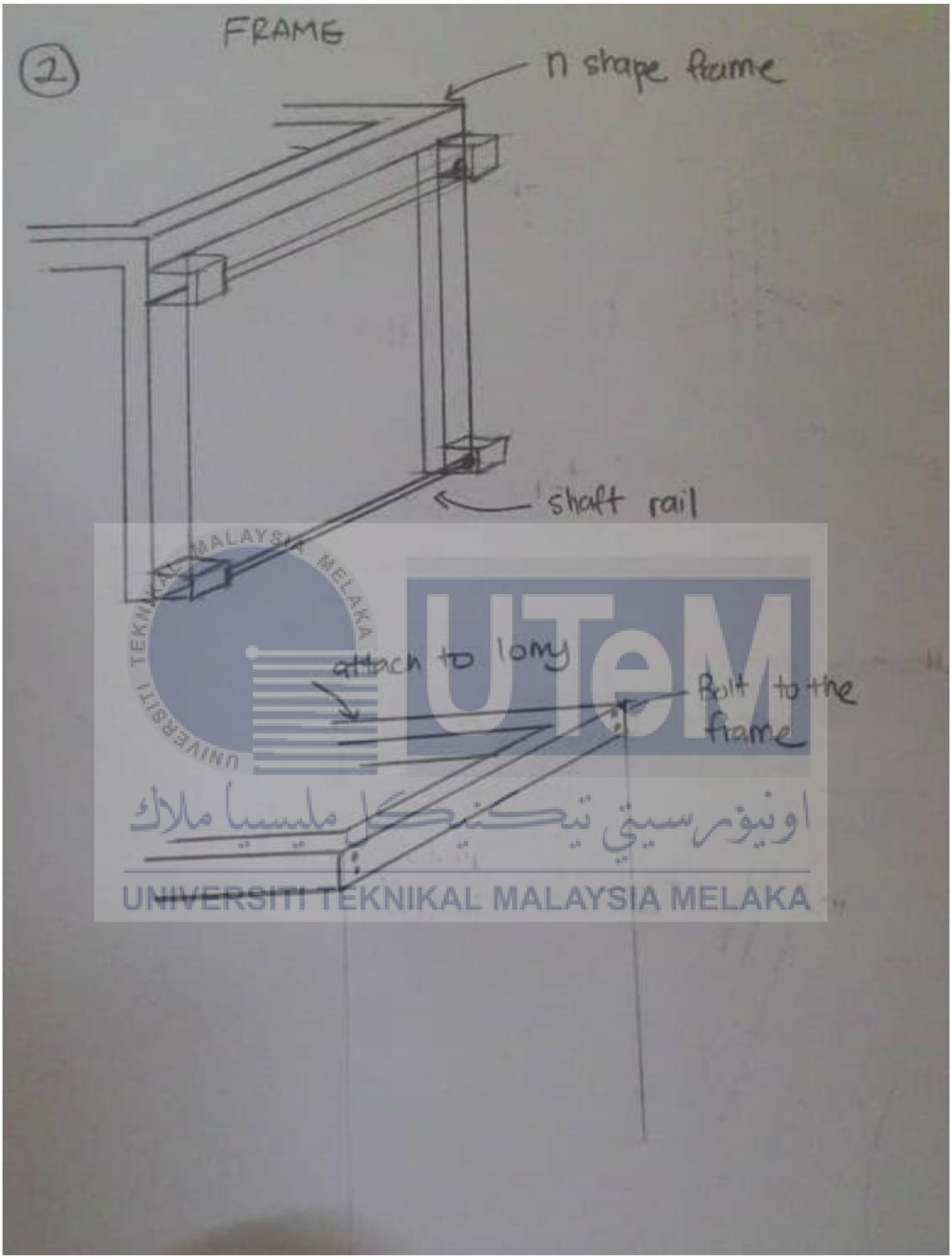


Figure 3.3 Frame Design 2

Table 3.5 Criteria for Design 2

Criteria	Option	Criteria	Option
Roller (upper, middle and down)	4	Stopper mechanism control	2
Slider (upper, middle and down)	4	Type of steel channel	2
Locking mechanism for slider	1	Type attachment at lorry	1&2
Type of attachment	2		

Figure 3.3 shows the second concept design, the frame is using the n-shape because to reduce the material used and the shape is also strong enough to hold the mechanism. For the roller second design is using the cylinder roller for the shaft and it smooth because the roller using the ball bearing. The slider using in this design is shaft slider the shaft slider is smooth easy to used it also can stand the weight. Next, the locking mechanism for the slider is using the bolt and nut as the locker because this design only use the shaft as the slider, we bolt and nut at the each end. For the attachment slider and the frame is using welding, the frame weld to the slider holder and the slider lock by bolt and nut.

Furthermore, for the stopper mechanism this design used push lock mechanism to lock the stopper to the right position. This design we used the rectangle channel to build the frame because it easy in finding at the hardware and have a variety of size. For the attachment to the lorry we used bolt and nut because it easy to remove when the bracket not used.

3.7.3 Design 3

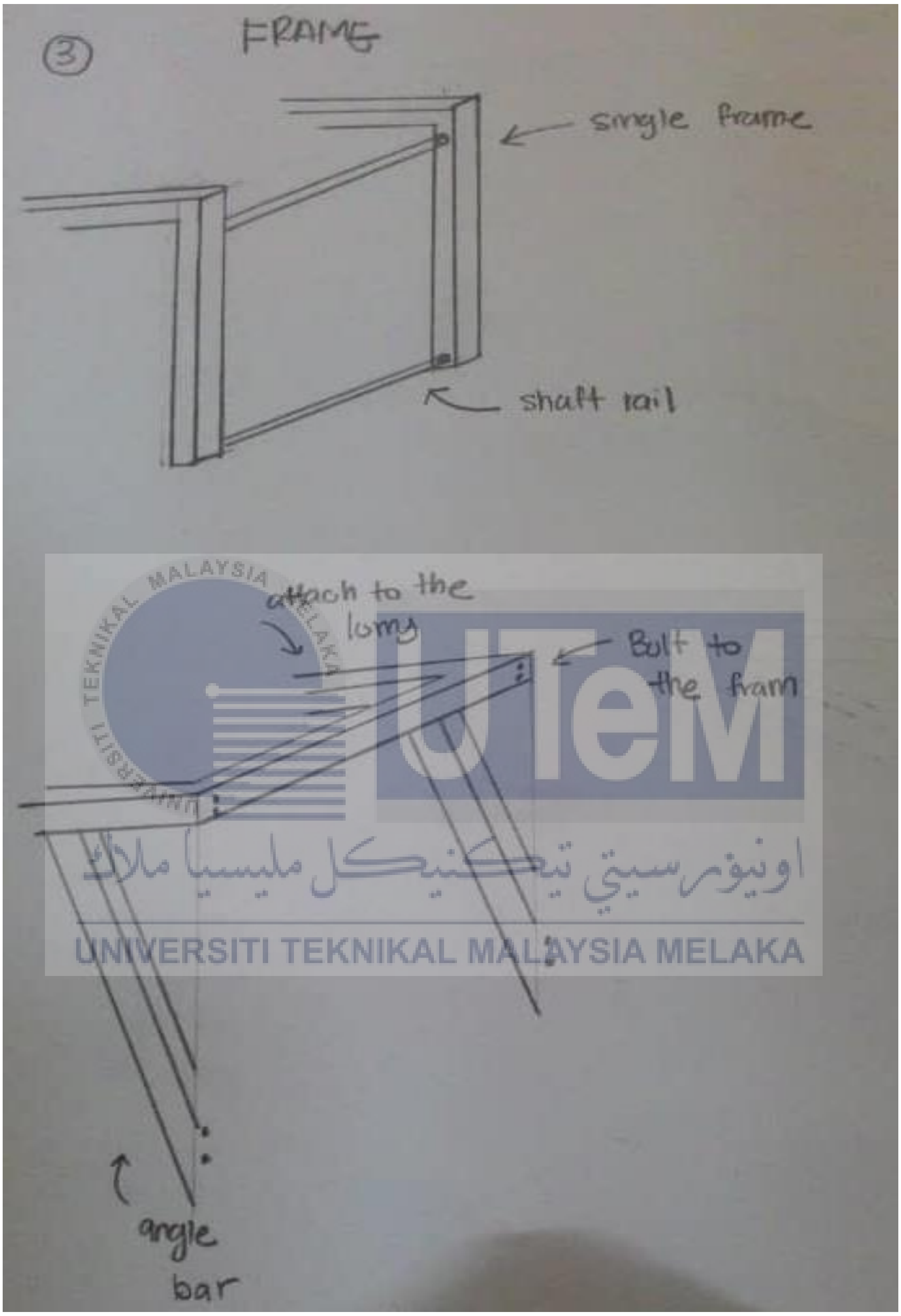


Figure 3.4 Frame Design 3

Table 3.6 Criteria for Design 3

Criteria	**Option**	**Criteria**	**Option**
Roller (upper, middle and down)	4	Stopper mechanism control	
Slider (upper, middle and down)	4	Type of steel channel	
Locking mechanism for slider	4	Type attachment at lorry	
Type of attachment	3		

Third concept is shows in Figure 3.4, the frame is L-shape frame and strengthen by the rail shaft and also the attachment at the lorry using triangle shape angle bar to hold the test bed. This design using cylinder roller attach to the shaft slider the roller is have the smooth movement. For the slider in this design shaft slider is using at the upper and lower slider and also act as to strengthen the frame. Locking mechanism used in this design is pin lock system it easy to used and secured lock from the roller to derail. The type of attachment used is flat head bolt and nut to attach the frame and the rail.

Sensor are using as the stopper mechanism for this design because the sensor is the most accurate system can be used. Type of channel used by this design is square channel because the stronger shape is square and it easy to handle. Attach to the lorry using bolt and nut it easy to assemble and dissemble and the lorry cam be used for other purpose.

3.7.4 Design 4

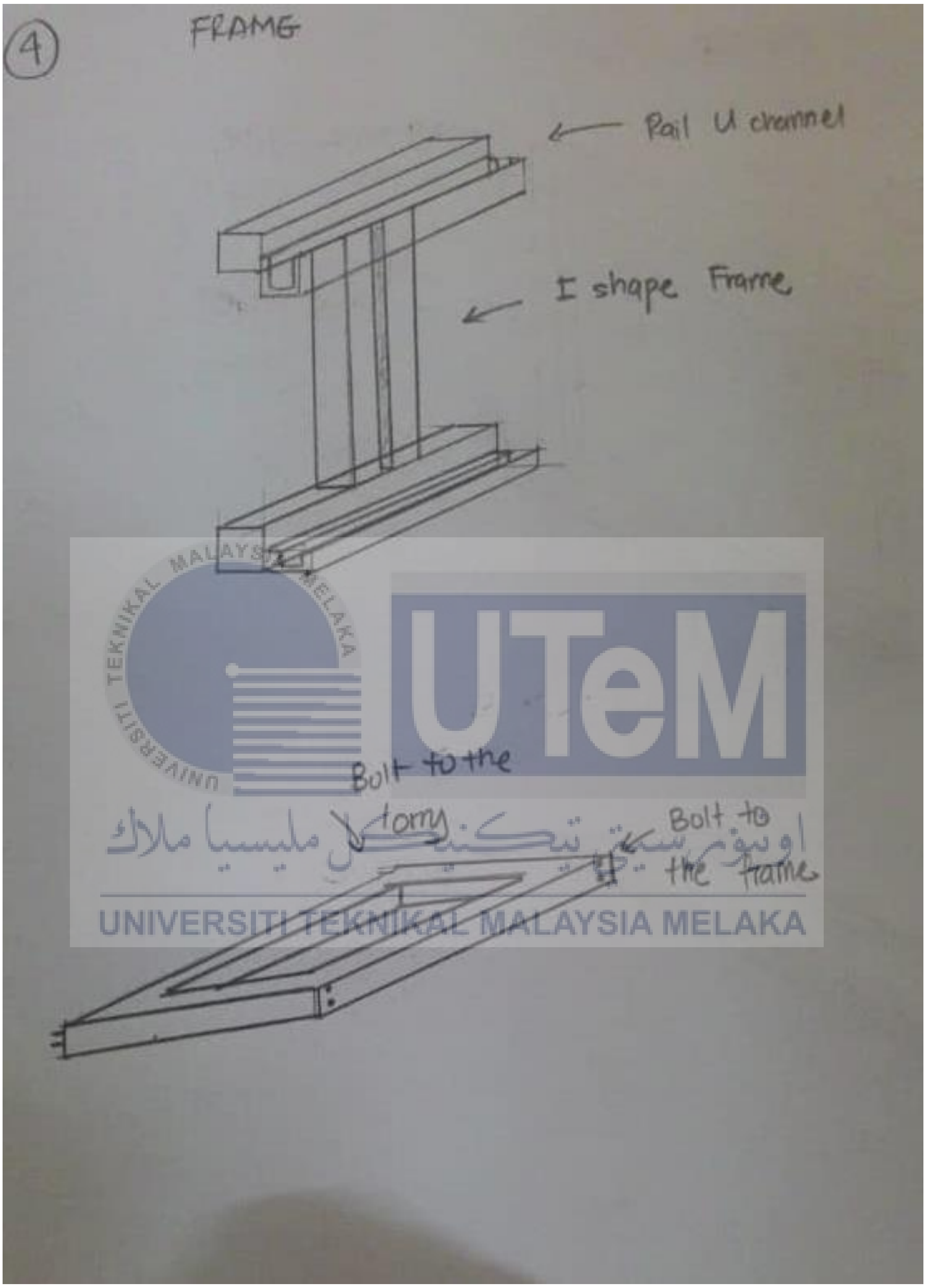


Figure 3.5 Frame Design 4

Table 3.7 Criteria for Design 4

Criteria	Option	Criteria	Option
Roller (upper, middle and down)	3	Stopper mechanism control	3
Slider (upper, middle and down)	1 & 2	Type of steel channel	4
Locking mechanism for slider	4	Type attachment at lorry	3
Type of attachment	1		

Figure 3.5 shows the concept design this design using I-shape frame concept it inspiration by the I-beam shape. The roller used is pulley roller to keep the roller on the track and give the smooth movement. For the upper slider this design used u-shape rail and for the lower rail this design used small u-shape. For the locking mechanism for the rail system this design used pin lock it was the easy and faster lock and unlock system and completely secured. Attachment frame and rail is using the bolt and nut mechanism because it easy to assemble and dissemble.

Stopper system for this design is using gear stop system and the system is operate using motor and control the movement of the lifting mechanism. Type of steel channel is square channel for the frame and the lorry attachment steel it easy to handle and much stronger. Type of attachment at the lorry is using bolt and nut.

3.8 Concept Evaluation

3.8.1 Weight Decision Matrix

Weight decision matrix shows in Table 3.10 is done in order to choose the final concept that suitable to the costumer requirement.

Table 3.8 Weighted Decision Matrix

Rating	Unsatisfactory	Just Tolerable	Adequate	Good	Very Good
Value	0	1	2	3	4

		Concept Alternative							
		Design 1		Design 2		Design 3		Design 4	
Criteria	Importance Weight (%)	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
Strength	20	4	0.80	4	0.80	4	0.80	2	0.40
Easy Handling	15	4	0.60	3	0.45	3	0.45	4	0.60
Mobility	10	4	0.40	4	0.40	4	0.40	3	0.30
Safety Features	20	4	0.80	4	0.80	4	0.80	3	0.60
Functionality	15	3	0.45	4	0.60	4	0.60	4	0.60
Appearance	10	4	0.40	3	0.30	3	0.30	4	0.40
Environmental Friendly	10	3	0.30	3	0.30	3	0.30	3	0.30
Total	100		3.75		3.65		3.65		3.20

3.8.2 Evaluation

The concept designs are presented in terms of weighted decision matrix shows in Table 3.8, the best design out of the four concept designs is selected. The evaluating processes is done and to what degree does the concept satisfies the criteria defined in the house of quality as well as the weighted decision matrix.

There are seven main criteria that project should work perfectly which is strength, easy handling, mobility, safety feature, appearance and environmental friendly. The main functionality where the Test Bed frame must hook tightly and strong to make sure the mechanism can attach to the Test Bed. Next is easy handling, easy to assemble and dissemble the Test Bed to the lorry. Then the mobility, the roller in this project used the smooth roller to travel movement left and right easily. Third is safety features, the movement part is covering for example the sprocket and chain is cover by aluminum steel. Nice appearance is importance so the project look nice and neat. Other than that, the project must environmental friendly it will reduce harm and pollution to the environment.

The conclusion for weighted decision matrix the first concept design dominant in almost the criteria and received the highest rating which is 3.75, thus make it the best concept design to be fabricated and commercialized out of the four designs.

3.8.3 Conclusion of Selected Design

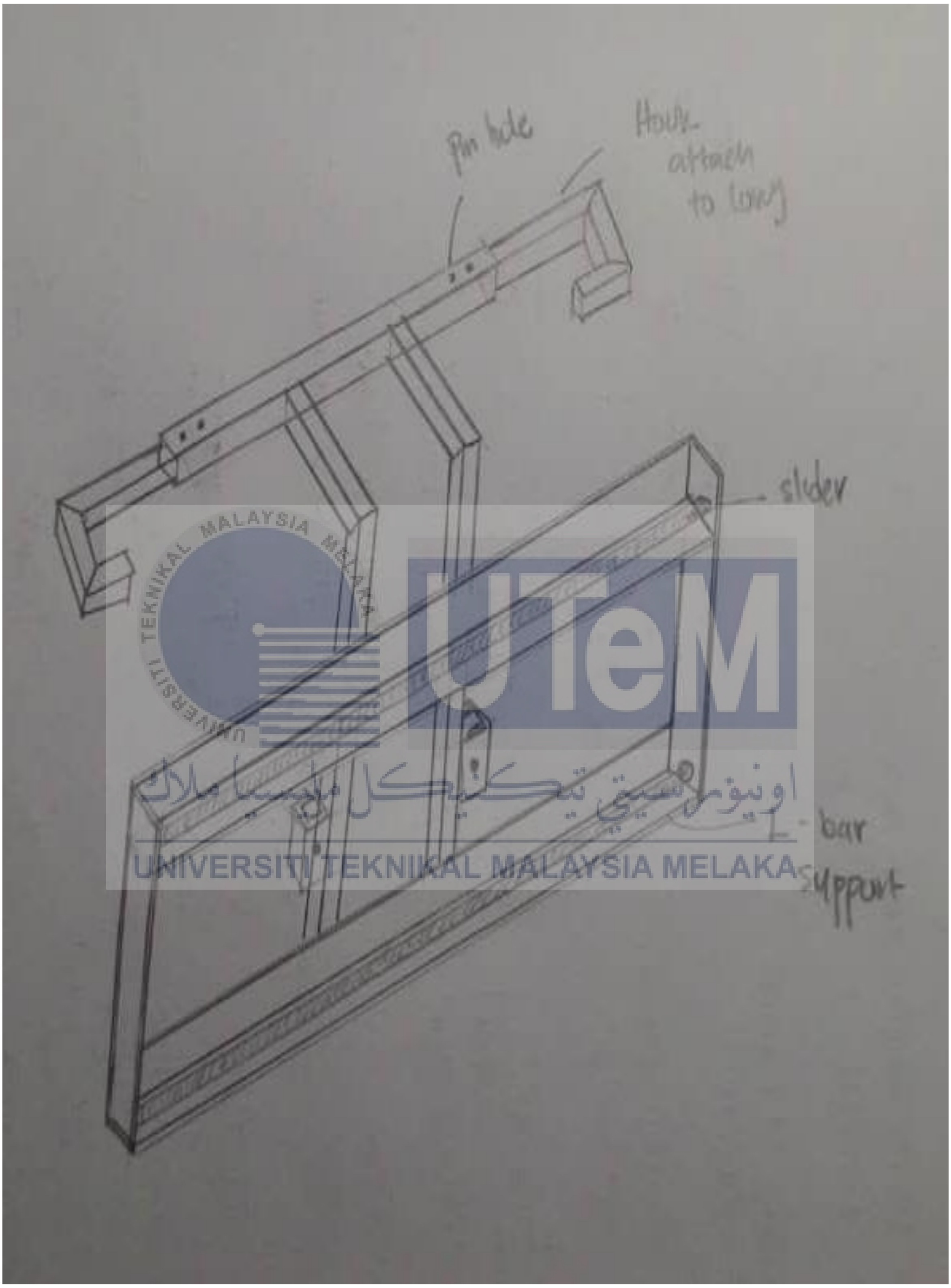


Figure 3.6 Final Design

Table 3.9 Criteria Final concept

Criteria	Option	Criteria	Option
Roller (upper, middle and down)	3	Stopper mechanism control	1
Slider (upper, middle and down)	4	Type of steel channel	4
Locking mechanism for slider	3	Type attachment at lorry	3
Type of attachment	2		

Figure 3.6 shows the final design product, the frame for the final design is combining of all the design before the frame is made of square, rectangle and triangle shape. For upper and lower roller is use rubber pulley roller and ball bearing to smooth the movement. The slider for this design using shaft slider of rail same goes to upper and lower part it will make sure the movement keep in track. The locking mechanism for slider using hook locking system it will easy the user to lock and unlock the slider because to remove the lifting mechanism. Type of the attachment used to attach the slider to the frame is welding. The welding used because the roller in the slider can move freely without stuck to the anything.

Furthermore, the stopper mechanism control for this design we used sensor because it more accurate than other mechanism and the movement controlled by motor. The type of steel channel for the final design are use square channel with the thicker diameter to keep the steel stand the heavy weight and strong bond after welding. For attachment at lorry this design used bolt and nut to attach the huge frame to the lorry by using the original pole at the lorry as the base.

CHAPTER 4

WORK MANAGEMENT AND COSTING

4.1 Flow Chart

Figure 4.1 shows a process of the project has been done from the beginning until finishing.

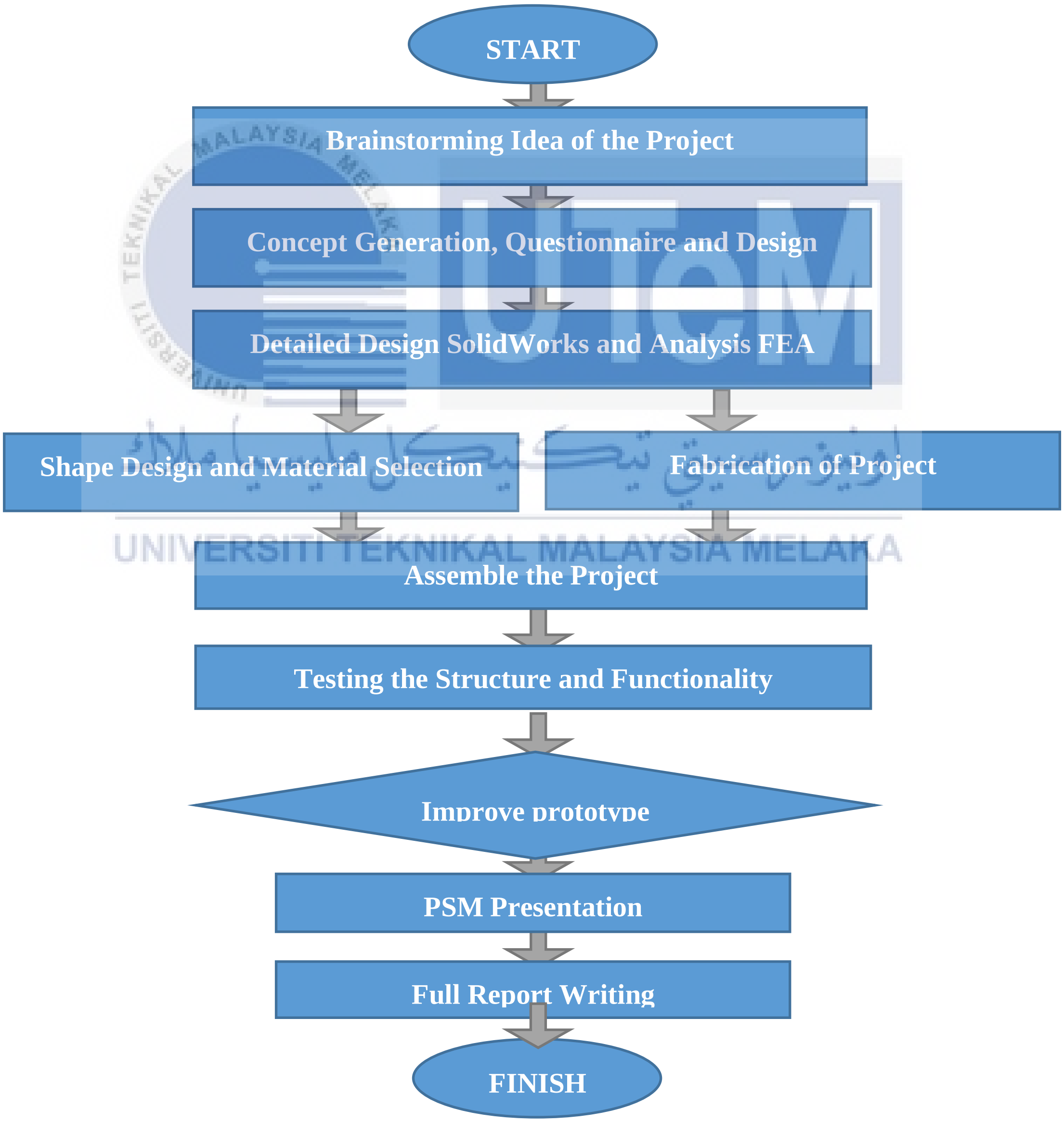


Figure 4.1 Flow Chart

4.2 Work Break Down Structure (WBS)

Figure 4.2 shows a Work Breakdown Structure of the project. It defines the relationship of the final deliverable of the project to its sub deliverables, and their relationships to work packages.

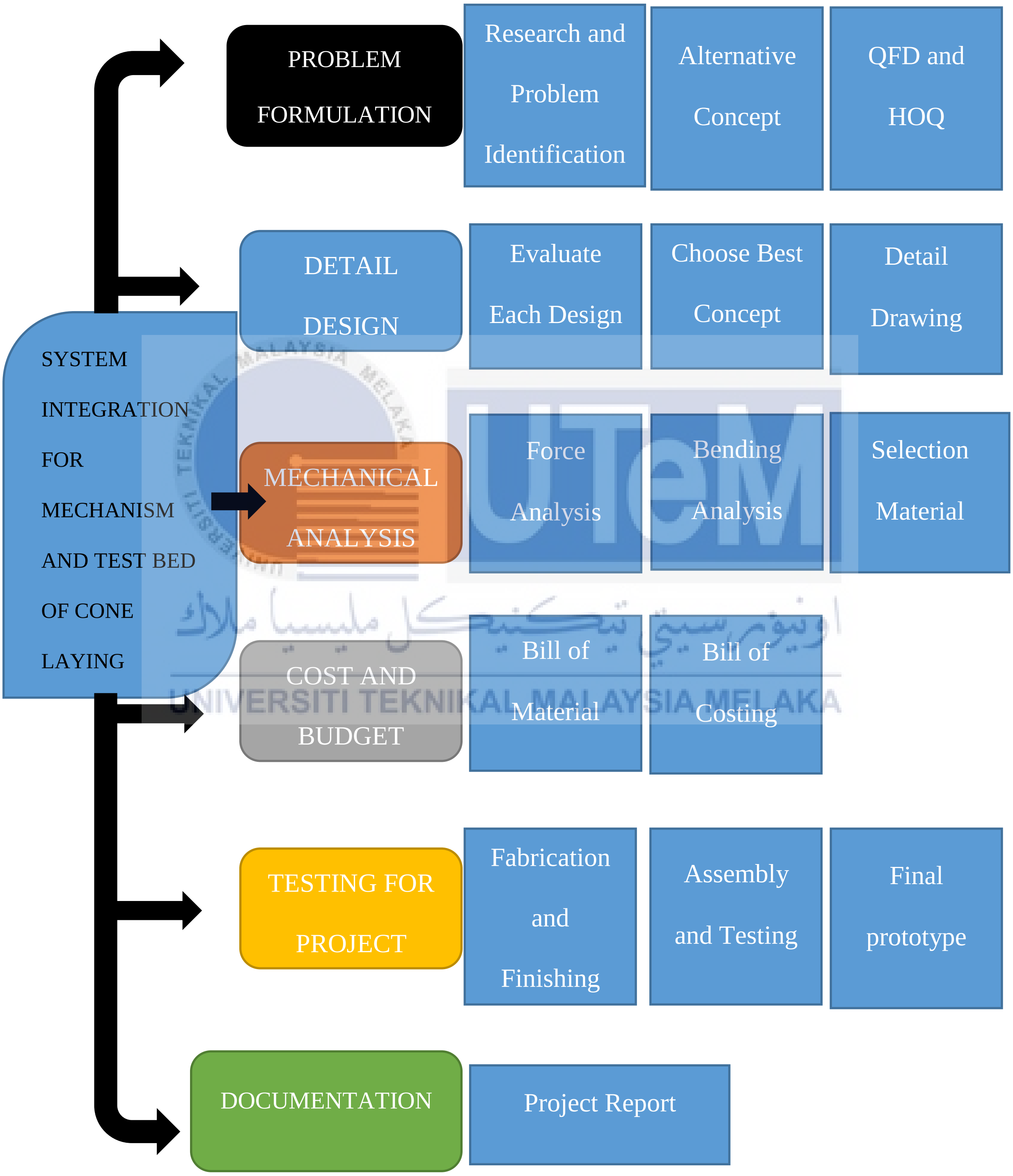


Figure 4.2 Work Breakdown Structure

4.3 Time Planning

Gantt chart is shown in Table 4.1. It is otherwise called visual presentation of a project where the activities are broken down and displayed on a chart which makes it is easy to understand and interpret.

Table 4.1 Gantt Chart

Task	Weeks															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Project briefing and appoint SV																
Project proposal and concept generation																
Methodology (Progress report 1)																
Detail design																
Survey and material selection																
Analysis (FEA)																
Measure, mark and cutting the steel																
Welding and fasten bolt and nut to the project																
Test fitting project to the lorry																
Assemble to the main body																

Full testing with the lifting mechanism											■	■	■			
Finishing													■	■		
Presentation															■	
Report Submission																■

4.4.1 Project Costing

Table 4.2 shows the Project Cost which is the total funds needed to complete the project or work that consists of a direct and indirect cost. The cost estimation and budgeting of the project to design and manufacture the product.

Table 4.2 Costing

No.	Item	Unit	Quantity	Unit Price (RM/feet)	Subtotal (RM)
1.	1.1 inch x 1.1 inch Square Channel	Inch	1	21.60	21.60
2.	1.5 inch x 1.5 inch Square Channel	Inch	4	26.20	104.80
3.	1.5 inch x 0.5 inch Square Channel	Inch	1	15.40	15.40
4.	2 inch x 2 inch L-shape Bar	Inch	2	24.50	49.00
5.	20 mm hollow steel rod	Meter	2	8.50	17.00
6.	8 mm aluminum rod	Meter	1	5.60	5.60
Total					213.40

For the project, the budget sponsored by faculty is RM 200. So, the cost estimation must not be more than the budget cost. Table 4.2 shows the list of materials used in this project together with their prices. The total cost used in this project is RM 213.40 and it exceed the budget given by RM13.40.

CHAPTER 5

DESIGN SPECIFICATION AND FABRICATION PROCESS

5.1 Detail Design

5.1.1 Product Design Using SOLIDWORK 2017

For this Test Bed project was detailed drawing for each part is create by using SOLIDWORK software before it been fabricate to the actual product. The Test Bed system is inspired by looking at hook and release trailer the system is easy to handle and not complicated. The design is slightly different from the conceptual design has been selected it has some improvement to provided better function. Figure 5.1 shows the 3D assemble drawing for the Test Bed system.

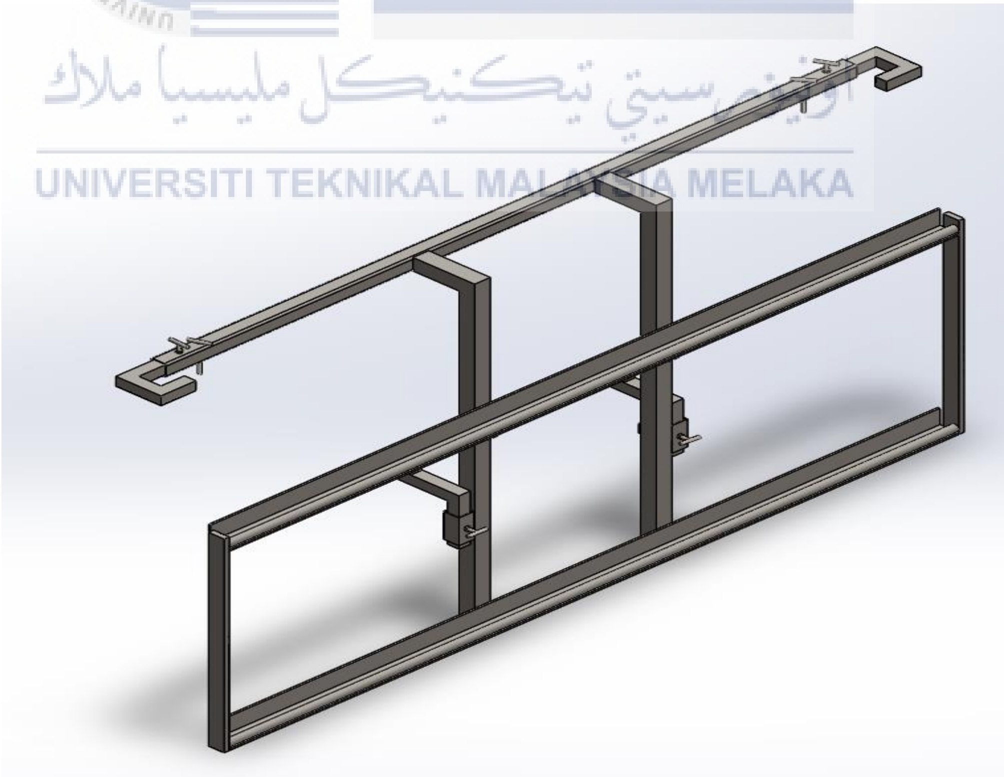


Figure 5.1 Solidworks 3D Design

5.1.2 Sizing

The design size for the Test Bed is (1800.40mm X 960mm) it suitable to attach at the three ton lorry which have (1800mm) width and (1200mm) height from ground until the top of lorry rear. It also only able to attach properly if the lorry move at the low speed. The rail for mechanism attachment is design it will have some space clearance from the road and able to lift the mechanism.

5.1.3 Engineering Drawing

The engineering drawing contain of assembly view, exploded view and orthographic view which consist of front view, top view, right view and isometric view. The orthographic drawing attached in Appendix.

5.1.4 Bill of Material

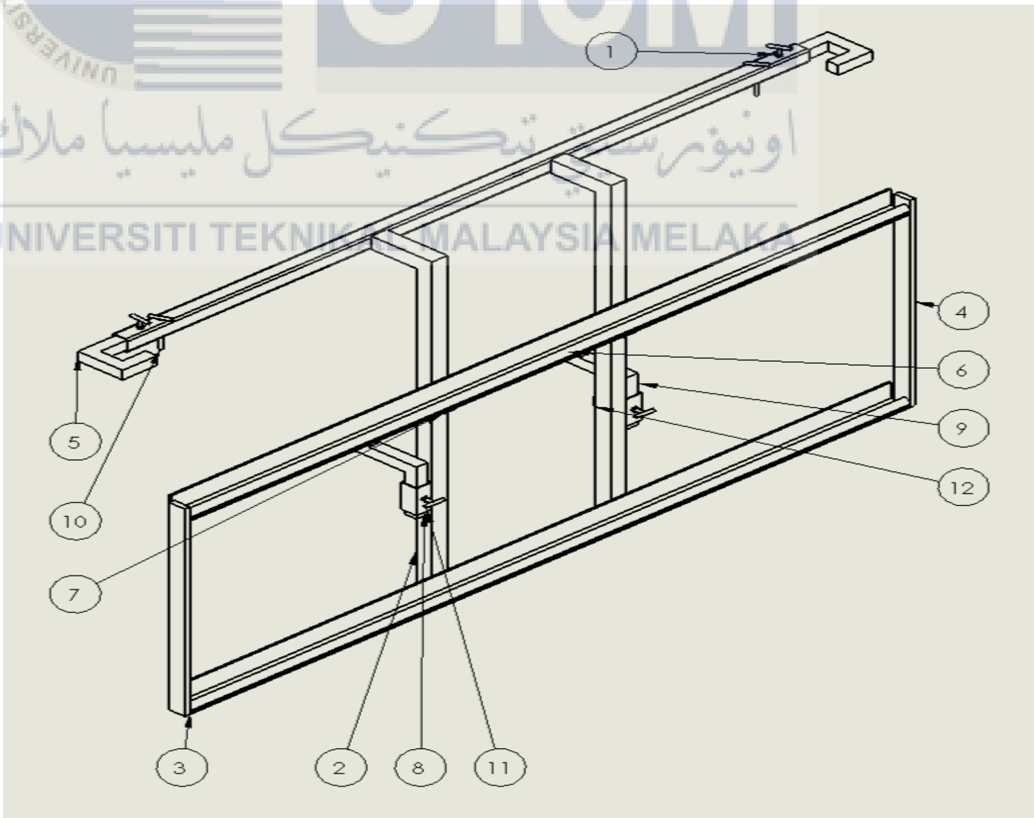


Figure 5.2 Solidworks 2D Design

Figure 5.2 and Table 5.1 show the Solidwork 2D Design of the project with a list of Bill of Materials of each part of test bed system.

Table 5.1 Bill of Material

ITEM NO.	PART NO	DESCRIPTION	QUANTITY
1	Part 5	Steel (1.5 x1.5 inch) 1680mm	1
2	Part 2	Steel (1.5 x1.5 inch) 960mm	2
3	Part 4	L-Bar (2 x 2 inch) 1775mm	2
4	Part 6	Steel (1.5 x0.5 inch) 600mm	2
5	Part 1	Steel Hook (1.1 x1.1 inch) 330mm	2
6	Part 3	Steel Rod (20mm diameter) 1775mm	2
7	Part 7	Steel (1.1 x1.1 inch) 25mm	2
8	Part 8	Steel (1.5 x1.5 inch) 78mm	2
9	Part 9	Steel (1.1 x1.1 inch) 122mm	2
10	Part 10	T-Pin (8mm diameter) 90mm	2
11	Part 11	T-Pin (8mm diameter) 30mm	4
12	Part 12	Steel (1.1 x1.1 inch) 10mm	4

5.2 Dimensioning Techniques

Geometric dimensioning and tolerance, often referred as GD&T, is a symbolic language used on engineering drawings and models to define the allowable deviation of feature geometry. The language of GD&T consists of dimensions, tolerances, symbols, definitions, rules, and conventions that can be used to precisely communicate the functional requirements for the location, orientation, size, and form of each feature of the design model. Thus, GD&T is an exact language that enables designers to convey it with regard to their design models. Production can then use the language to understand the design intent and inspection looks to the language to determine set up requirements. All of the drawing attached in Appendix used dimension unit of Millimeter (mm).

5.3 Fabrication Process

Fabrication is the process used to manufacture steelwork components that will, when assembled and joined, form a complete frame. Most modern steelwork fabrication factories have computer aided design and detailing (CAD) which is linked directly to factory floor computer numerically controlled (CNC) machinery creating a genuine CAD/CAM environment. The accuracy of the computer generated details being transmitted directly to the computer aided manufacturing (CAM) machinery increases the quality standards of production.

5.3.1 Measuring

Measuring process is estimating process to determine the value or measurement of the raw material before assemble become final product. This is in order to ensure that measurements are accurate. In this project, the measuring process is in unit length, Millimeters. The device use while measure is the measuring tape shows in Figure 5.3(a). A scriber shows in Figure 5.3(b) is used to do marking on the metal.

(a) (b)

Figure 5.3 (a) Measuring Tape and (b) Scriber

5.3.2 Cutting

Cutting is the partition of item into at least two or more portions. The devices utilized in this project to cut are plier cutter, disc-cutter machine and grinder. Figure 5.4(a) shows the plier cutter that used to cut the sharp edge for aluminum sheet. Disc-cutter machine shows in Figure 5.5(b) is used to cut most of the steel used in the project frame.

(a) (b)

Figure 5.4 (a) Plier Cutter and (b) Disc Cutter

5.3.3 Drilling

Drilling is a cutting process into a hole or round cross-area of metals. In this task, we used pillar type driller machine to make hole to our product particularly a hole for the shaft that connect the wheels. Figure 5.5 shows the potable driller machine.

Figure 5.5 Potable Drill

5.3.4 Welding

Welding is a process to join the materials, typically metals by heating them using electricity or a heat so that they melt and stick together permanently. For test bed project, all the parts of body frame structure fasten using welding Figure 5.6 shows the welding machine.

Figure 5.6 Welding Machine

5.3.5 Grinding

Grinding is used to complete work pieces that show high quality surface of product. The machine tools used for grinding is the type of machining used an abrasive wheel as a cutting device. Grinder machine used in this project is bench grinder and portable grinder. The portable grinder shows in Figure 5.7 used to remove the excess welded part and to grind the sharp edge on the Test Bed frame body.

Figure 5.7 Portable Grinder

5.3.6 Fastening

Fastening is the procedure of precisely joins at least two of mechanically joins or more object together. Different from welding, fastening is used to create non-permanent joints that can be evacuated or disassembled without harm the joining parts. In this project, we used stainless steel bolt to join two sections together.

5.3.7 Finishing

Finishing is a process to change, remove and reshape the project to improve appearance, safety features and surface erosion. In this project, the finishing process involve are grinding, sanding and painting. The grinder used for finishing is to remove the rust on product as shown before and curve the sharp edge. Sanding is used to rub the abrasive particles against the surface of project before start painting. Lastly is painting to give a better appearance of the product and make it long lasting.

5.3.8 Testing

In general, testing is discover how well something functions. In terms of human beings, testing tells what level of knowledge or skill has been acquired. In this project, the model was tested to test the strength and functionality. Firstly, the project must stand the lifting weight without bending. For the movement, the project must delivered the perfect and smooth rail for the lifting move left to right. Then, we fixed the miss fitting to the lorry during assemble. The project can fit after drill more hole and have the tighten screw to make sure the locking system is fully secured before the actual test. However, for this project, we only tested the functionality and strength but do not need the time taken the time tested through lifting part only. The testing session have proven that the project is safe and stiff enough to be used.

5.4 Product Function

Table 5.2 below shows the main part in Test Bed with their function. Each parts have their own function to make sure the project function well. The product function is as below;

Table 5.2 Function of Parts

No.	Main Part	Function
1.	Main Hook 	To hook and secured the upper part of the frame to lorry from the vibration and fall.
2.	Thighten Bolt 	To make sure the hook not loose cause by vibration and while the mechanism operate.

3.	Pin 	To make the hook stay in place while the operation for extra safety.
4.	Bottom Hook 	Bottom hook is to lock the position of the frame while the lorry is moving.

5.	Roller 	Using the pulley roller shape it will move easily along the cylinder rod.
6.	Slider Frame 	The frame have two line of slider it will support all the weight of the mechanism.

5.5 Design Summary

The Test Bed frame shows in Figure 5.7 is the structure that will integrate with the lifting mechanism and it will hold and move the mechanism left and right while operate. It design to easy the workers to a line the cone on the road. There are 12 parts are assemble together the most of them are fasten using welding processes. The safety features is added in this product to make the product user friendly and safe to use. The light weight frame make it easy to transport and lift.

Figure 5.8 Test Bed Frame

CHAPTER 6

RESULTS AND DISCUSSION

6.1 Product Weight

The Test Bed has total mass approximately 32.96 kg while be considering all parts and fastener, the total weight is 323.34 N. This weight has great consideration in determine the stability and safety of the product. The formula used for this project is as bellows:

6.1.1 Stress:

Stress is defined as the force per unit area of a material is shown in Equation 6.1 below..

$$\sigma = \frac{force}{cross\ section\ area} = \frac{F}{A} \tag{6.1}$$

Where, $\sigma =$ Stress in units of Nm^{-2} or Pa, $F =$ Force applied and $A =$ Cross Section Area of the project meter.

6.1.2 Strain:

Equation 6.2 below shows an equation of Strain. Strain is define as extension per unit length.

$$\varepsilon = \frac{extension}{original\ length} = \frac{e}{\iota o} \tag{6.2}$$

Where $\varepsilon = strain$, Lo = the original length, e = extension and l = stretched length. Strain has no units because it is ratio of lengths.

6.1.3 Factor of safety:

Express how much stronger a system is than it need to be for an intended load. The equation of factor safety is shown in Equation 6.3.

$$factor\ of\ safety = \frac{yield\ stress}{working\ stress} = \frac{\sigma_y}{\sigma_{y,all}} \quad (6.3)$$

Where σ_y = yield stress and $\sigma_{y,all}$ = working stress.

6.2 FEA Analysis

This FEA Analysis is prepared as a structural analysis of the Test Bed component. The aim is to design the test bed of cone laying system using SOLIDWORK and design the system integration between cones laying mechanism of the test bed. The 3D CAD model of the Test Bed component was developed using SOLIDWORK CAD software. Later, finite element analysis was performed using SOLIDWORK simulation under various boundary conditions (restraints) and loading condition (force) to determine the maximum displacement and maximum stress generated at the component due to the given load.

Material used in this project is ASTM A36 Steel. ASTM A36 Steel has a density of 7,800 kg/m^3. Young's modulus for A36 steel is 200 GPa. ASTM A36 Steel has a Poisson's ratio of 0.26, and a shear modulus of 75 GPa. The thickness of ASTM A36 Steel is less than 8 in (203 mm) has a minimum yield strength of 36,000 psi (250 MPa) and ultimate tensile strength of (400–550 MPa). Plates thicker than 8 in have a (220 MPa) yield strength and the same ultimate tensile strength of (400–550) MPa.

The results from the analysis will be further applied as a reference to gain improvement for the Test Bed. Safety factor values can be thought of as a standard way to compare strength and reliability between systems. The use of a factor safety does not imply that the design is safe. Many quality assurance, installation, manufacturing and end-use factors may be influences for a safe design.

6.2.1 Assemble Full Body

Figure 6.1 show the 3D model of Assemble Body of the test bed and Table 6.1 shows the model information. The material used for the part is ASTM A36 Steel. The total force acting on this part is 1434.04N including lifting mechanism (141.181kg) and cone (6kg).Total mass is 146.181 Kilogram. For the safety factors the value is 5.209 shown in Table 6.5. FEA result in Table 6.4 shows the strain of the rail which is minimum 9.34x 10^{-12} and maximum 1.705x10^{-4}. For displacement the value is 5.592 x 10^{-1} mm shows in Table 6.3. Table 6.2 stated at FEA result of stress which is minimum 3.478 x 10 N/m^2 and maximum 4.622 x 10^{7} N/m^2.

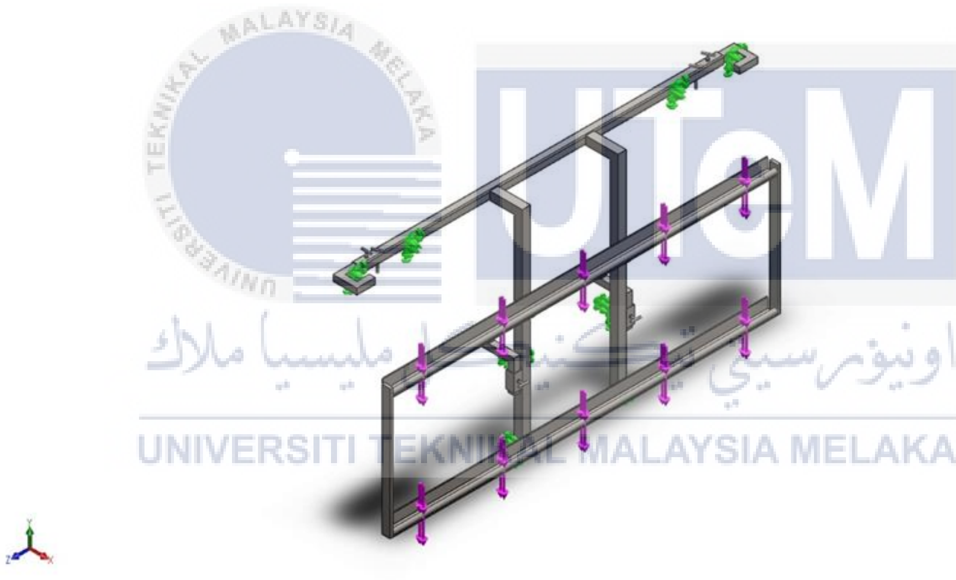


Figure 6.1 Assemble Parts

Table 6.1 Assemble Parts Properties

Volumetric Properties	
Mass	32.95893 kg
Volume	5.17976e-005 m^3
Density	7850 kg/m^3
Weight	3.98479 N

Table 6.2 Assemble Stress Analysis

Name	Type	Minimum	Maximum
Stress	VON: von Mises Stress	3.478N/m^2 Node: 74086	4.622×10^{7}N/m^2 Node: 6460

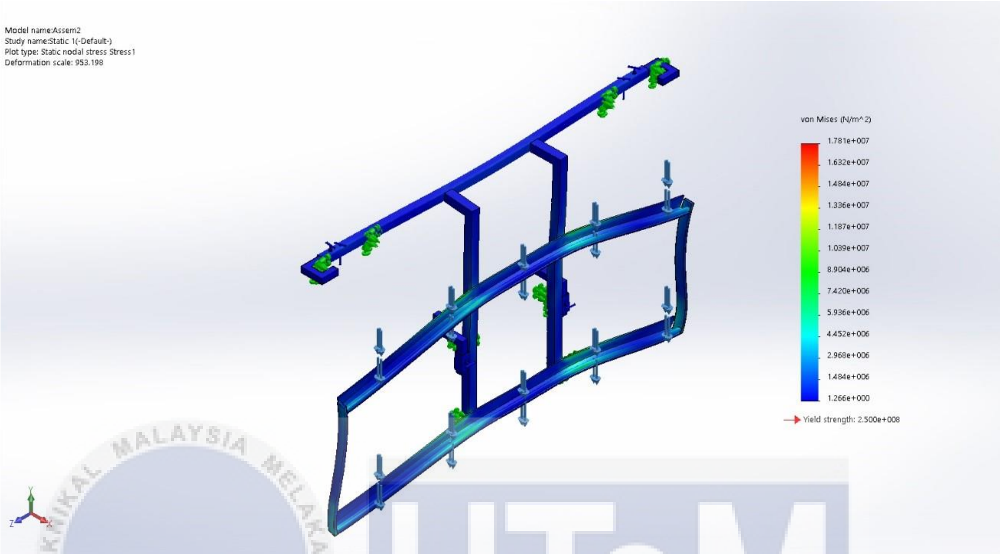


Table 6.3 Assemble Displacement Analysis

Name	Type	Minimum	Maximum
Displacement	URES: Resultant Displacement	0.000mm Node: 8	5.592×10^{-1}mm Node: 70656

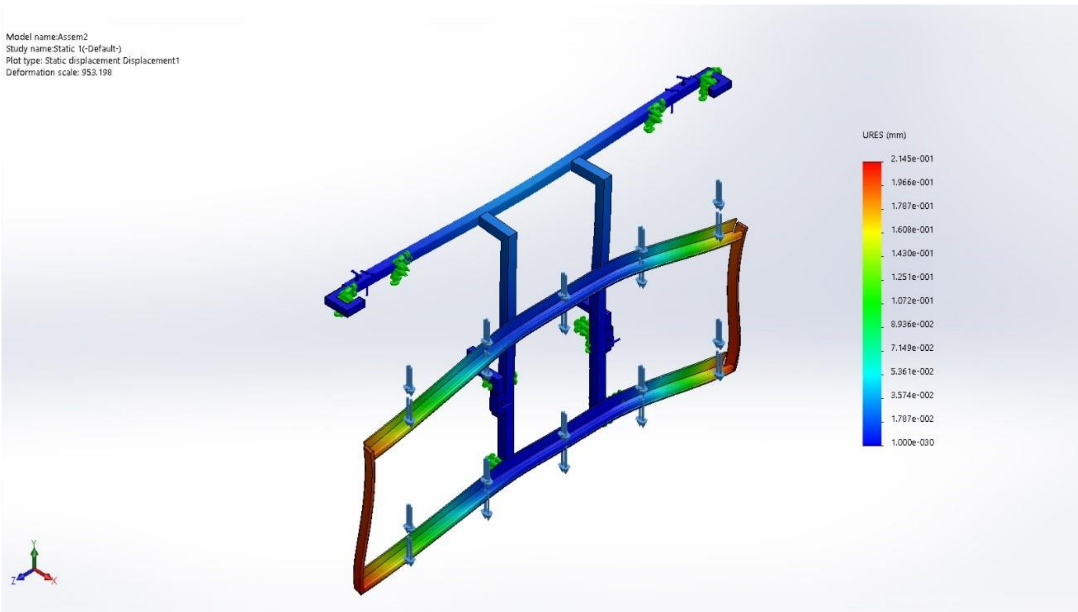


Table 6.4 Assemble Strain Analysis

Name	Type	Minimum	Maximum
Strain	ESTRN: Equivalent Strain	9.340×10^{-12} Element: 38140	1.705×10^{-4} Element: 3437

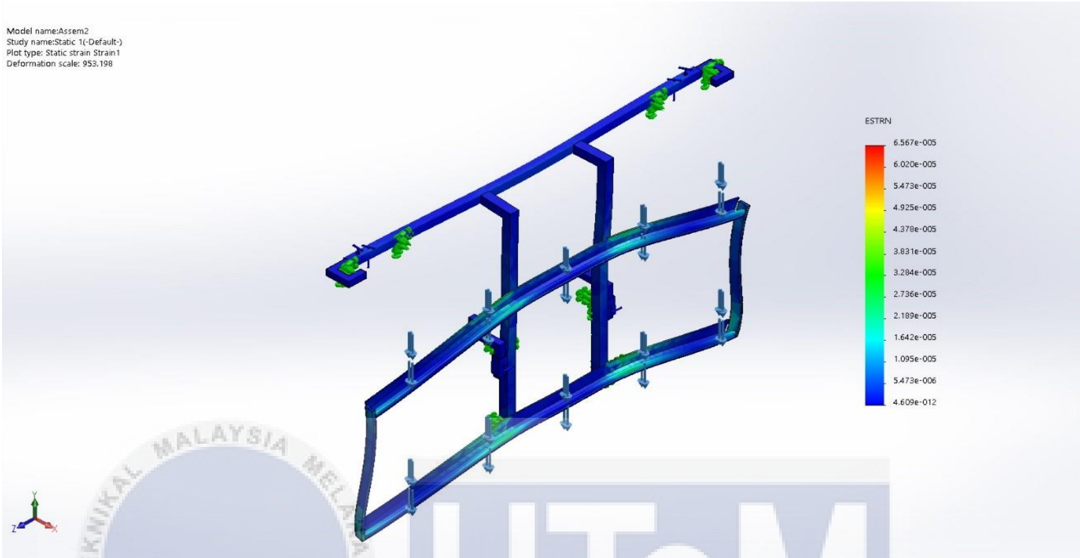
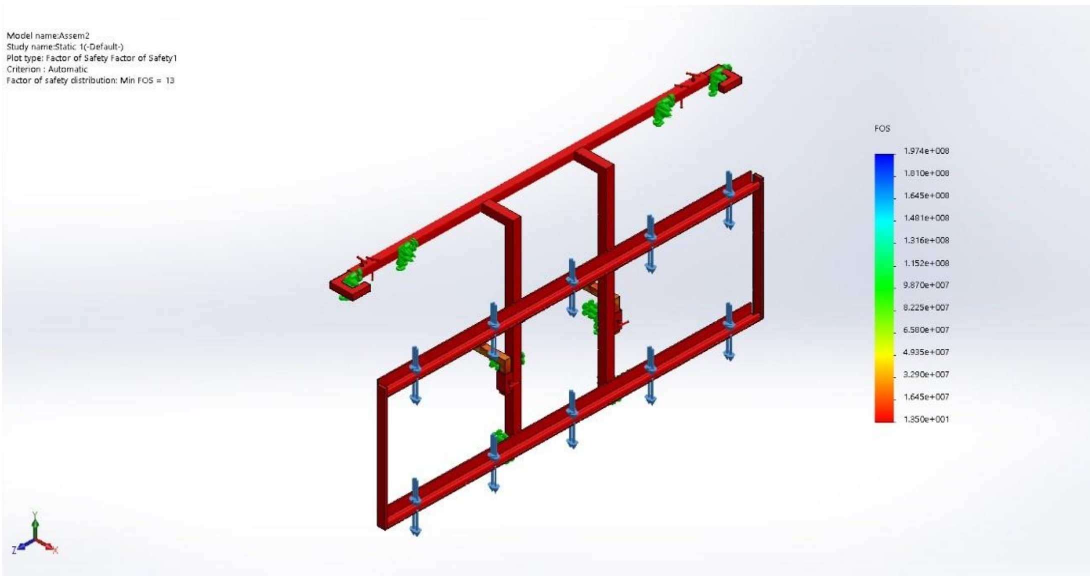


Table 6.5 Assemble Factor of Safety Analysis

Name	Type	Minimum	Maximum
Factor of Safety	Automatic	5.209×10^{0} Node: 6399	7.188×10^{7} Node: 74086



6.2.2 Part 1

Figure 6.2 and Table 6.6 shows 3D model for locking mechanism of the test bed and also the properties. The material used for the part is 1 hollow ASTM A36 Steel (38.1mm X 38.1mm). The total force acting on this part is 874.68N including body, lifting mechanism (140.181kg) and cone (6kg). Total mass is 178.32Kilogram. Table 6.7 shows that FEA result of stress which is minimum 4.038x 10^{2} N/m^2 and maximum 1.484x 10^{8} N/m^2. For displacement the value is 1.411 mm shown in Table 6.8. For the safety factors the Table 6.10 shows the value is 1.685. FEA result shows in Table 6.9 is the strain of the rail which is minimum 1.673 x 10^{-9} and maximum 5.814x10^{-4}.

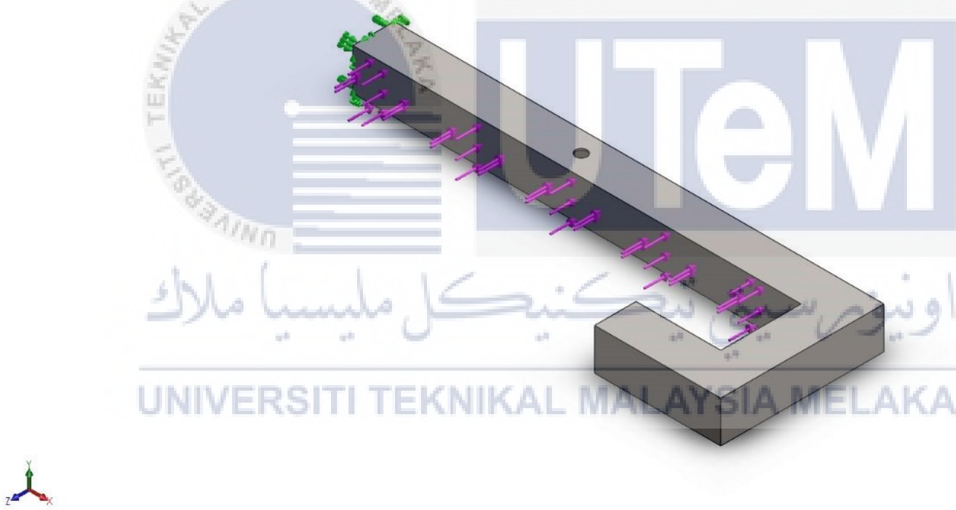


Figure 6.2 Locking Mechanism (Part 1)

Table 6.6 Part 1 Properties

Volumetric Properties	
Mass	0.406611 kg
Volume	5.17976e-005 m^3
Density	7850 kg/m^3
Weight	3.98479 N

Table 6.7 Part 1 Stress Analysis

Name	Type	Minimum	Maximum
Stress	VON: von Mises Stress	1.080×10^{4}N/m^2 Node: 11435	3.332×10^{7}N/m^2 Node: 29

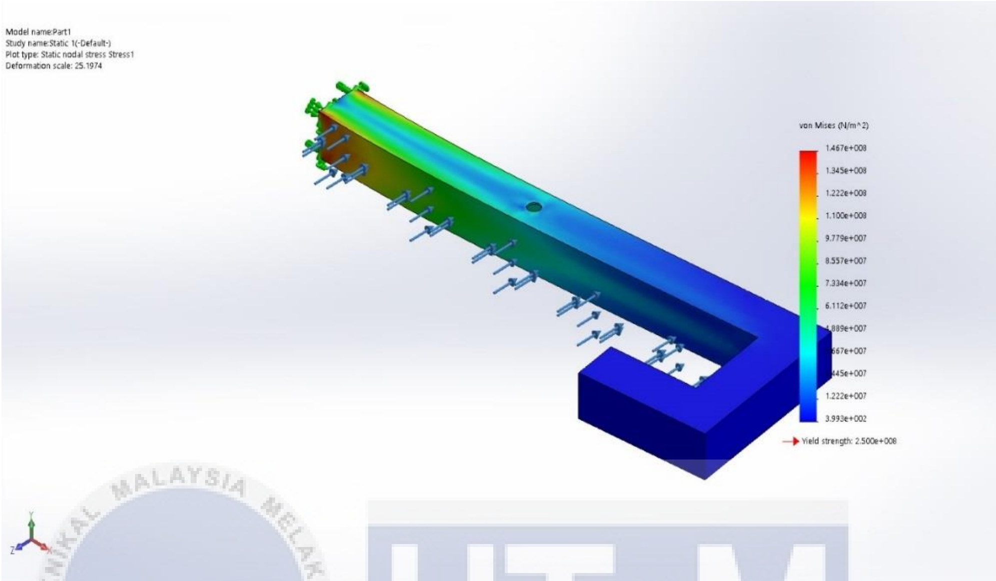


Table 6.8 Part 1 Displacement Analysis

Name	Type	Minimum	Maximum
Displacement	URES: Resultant Displacement	0.000mm Node: 29	1.382mm Node: 418

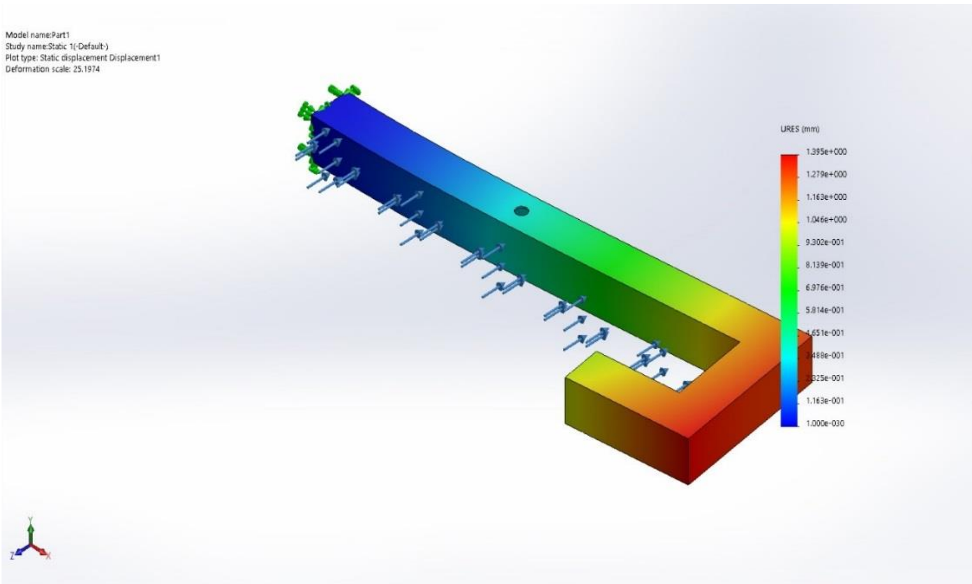


Table 6.9 Part 1 Strain Analysis

Name	Type	Minimum	Maximum
Strain	ESTRN: Equivalent Strain	5.528×10^{-8} Element: 5994	1.245×10^{-4} Element: 1685

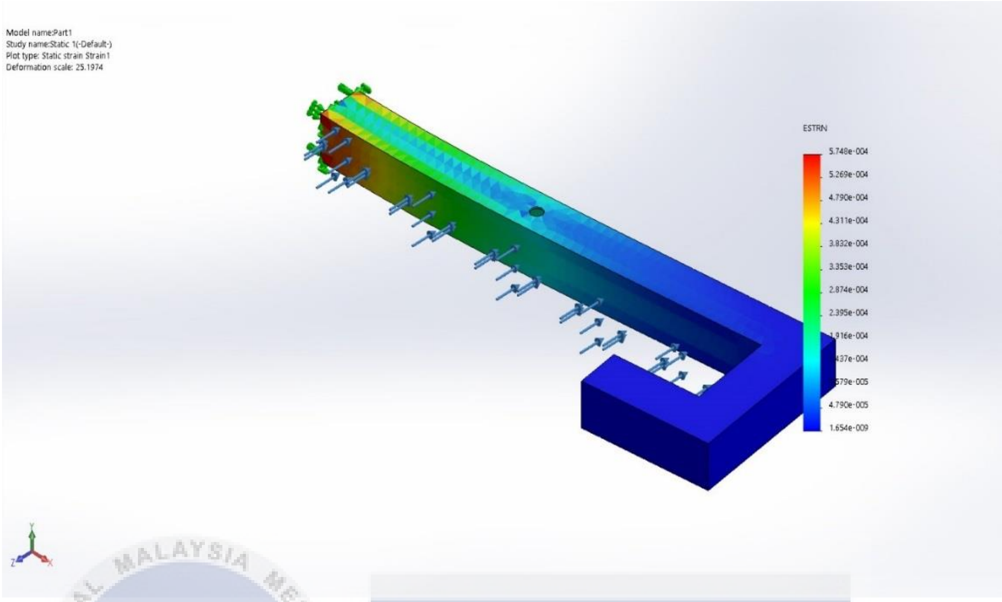
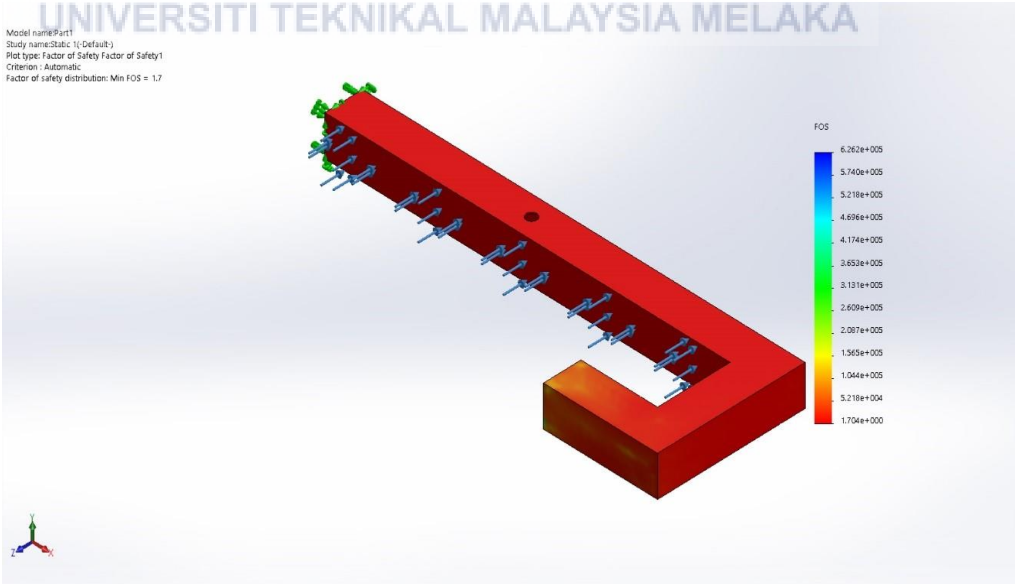


Table 6.10 Part 1 Factor of Safety Analysis

Name	Type	Minimum	Maximum
Factor of Safety	Automatic	7.502 Node: 29	2.315×10^{4} Node: 11435



6.2.3 Part 2

Figure 6.3 and Table 6.11 shows the 3D model for holding the rail to lorry for the test bed and its properties respectively. The material used for the part is 1 hollow ASTM A36 Steel (38.1mm X 38.1mm). The total force acting on this part is 856.25N including body, lifting mechanism (140.181kg) and cone (6kg). Total mass is 174.56 Kilogram. For displacement the value is 1.382mm as shown in Table 6.13. Table 6.12 shows the FEA result of stress which is minimum 1.080 x 10^4 N/m^2 and maximum 3.332 x 10^7 N/m^2. Table 6.15 shows the safety factors the value is 7.502. Table 6.14 shows the strain of the rail which is minimum 5.528 x 10^{-8} and maximum 1.245x10^{-4}.

Figure 6.3 The Holding (Part 2)

Table 6.11 Part 2 Properties

Volumetric Properties	
Mass	3.59268 kg
Volume	0.000568279 m^3
Density	7850 kg/m^3
Weight	43.7177 N

Table 6.12 Part 2 Stress Analysis

Name	**Type**	**Minimum**	**Maximum**
Stress	VON: von Mises Stress	1.080×10^{4}N/m^2 Node: 2021	3.332×10^{7}N/m^2 Node: 345

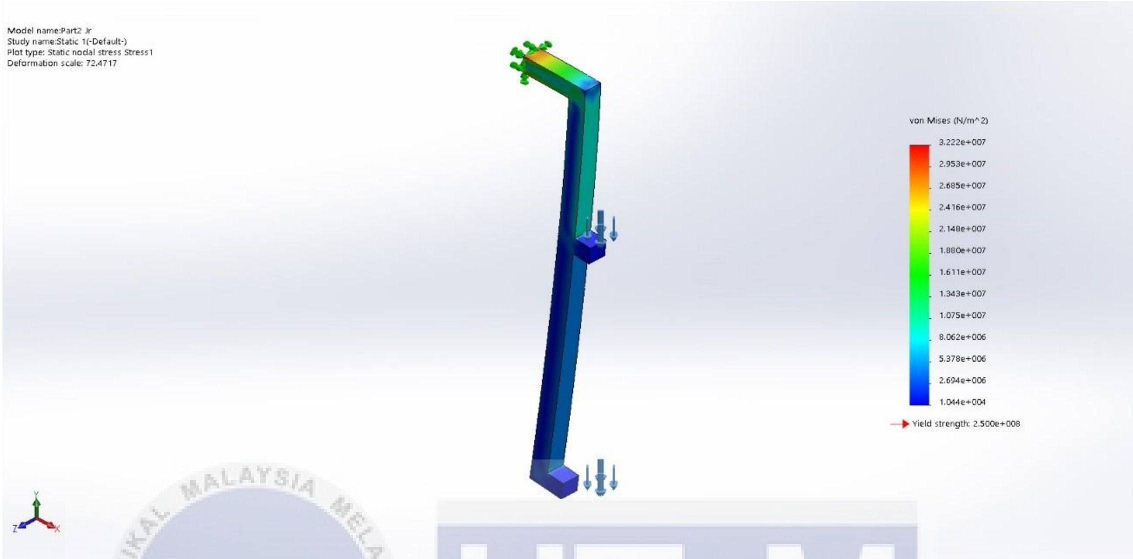


Table 6.13 Part 2 Displacement Analysis

Name	**Type**	**Minimum**	**Maximum**
Displacement	URES: Resultant Displacement	0.000mm Node: 333	1.382mm Node: 735

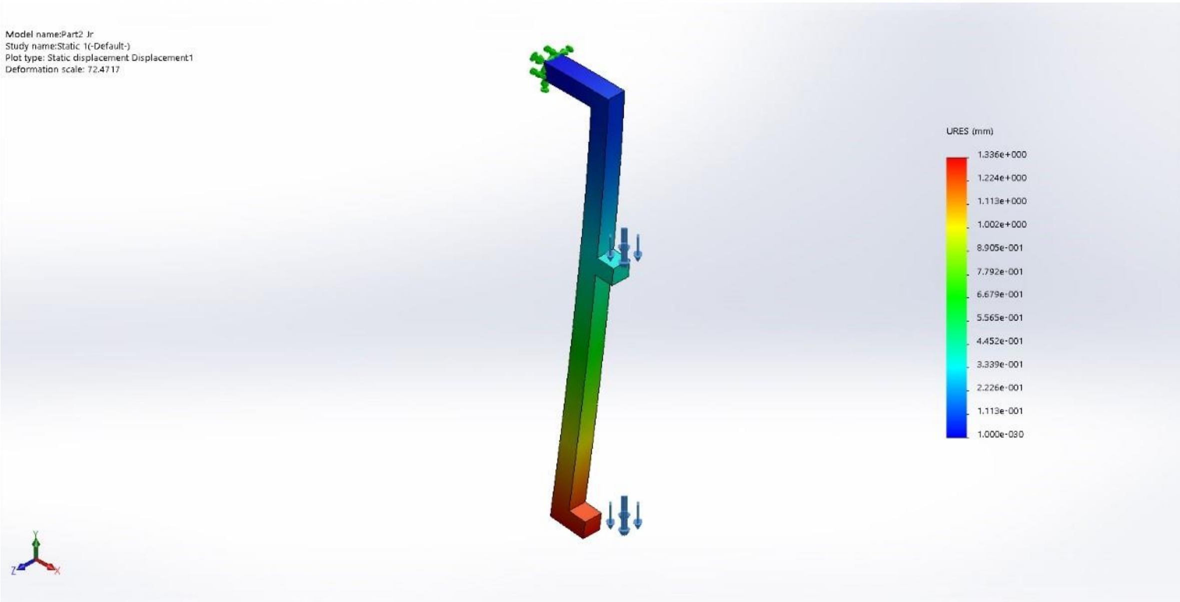


Table 6.14 Part 2 Strain Analysis

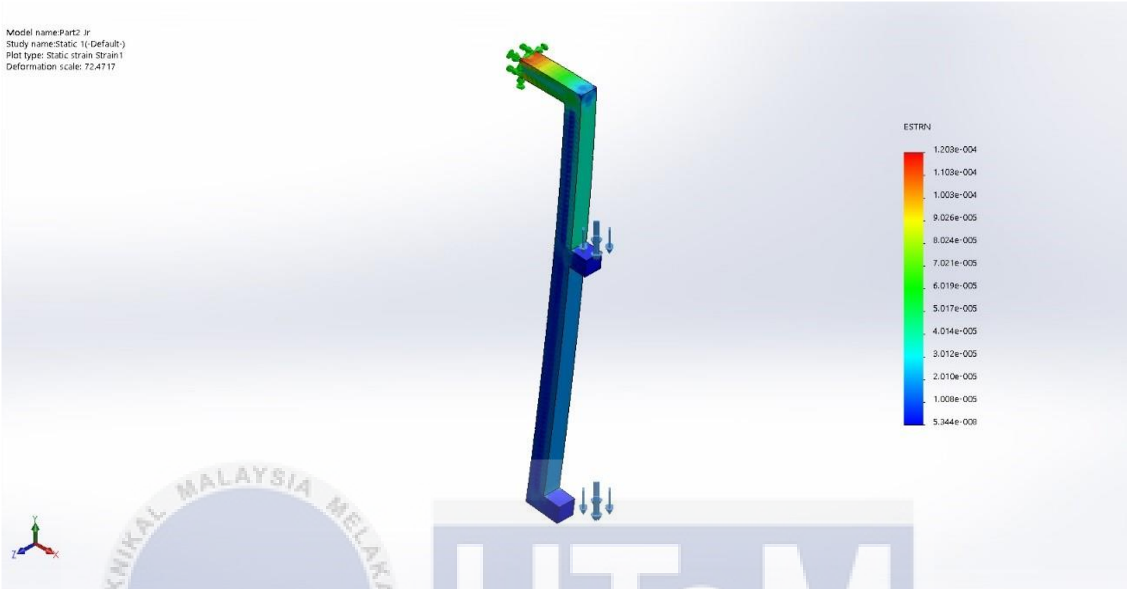
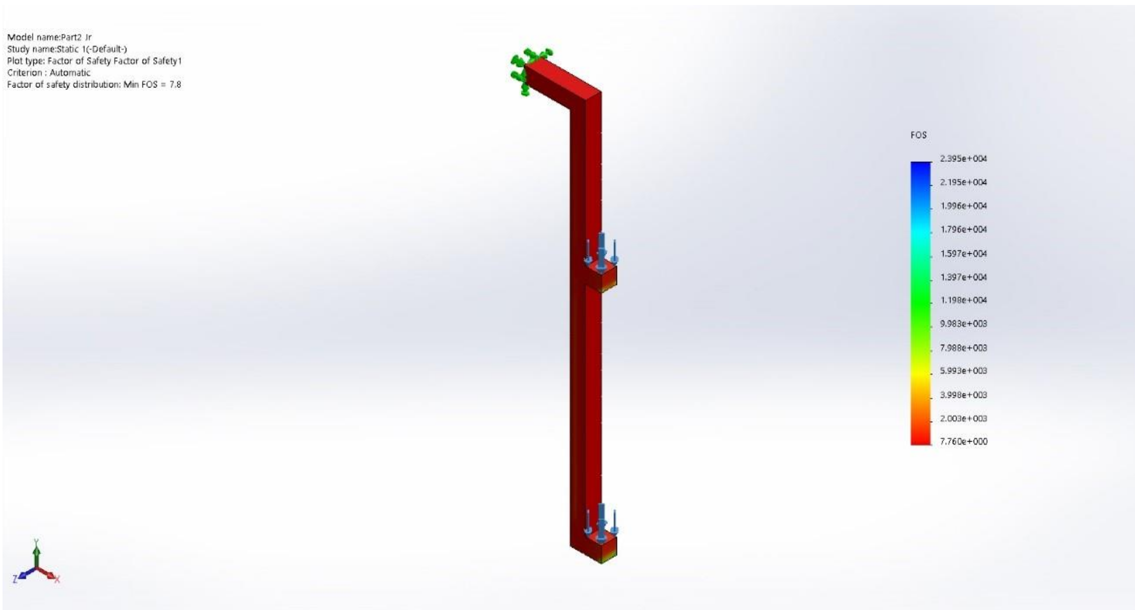
Name	**Type**	**Minimum**	**Maximum**
Strain	ESTRN: Equivalent Strain	5.528×10^{-8} Element: 4589	1.245×10^{-4} Element: 7139
			

Table 6.15 Part 2 Factor of Safety Analysis

Name	**Type**	**Minimum**	**Maximum**
Factor of Safety	Automatic	7.502 Node: 345	2.315×10^{4} Node: 2021
			

6.2.4 Part 3

Figure 6.4 and Table 6.16 show the 3D model for railing of the lifting mechanism for the test bed and its properties respectively. The material used for the part is 1 hollow cylinder ASTM A36 Steel (diameter 20mm). The total force acting on this part is 824.93N including lifting mechanism (140.181kg) and cone (6kg). Total mass is 168.181 Kilogram divided to two because the load hang on two different part. Table 6.17 shows the FEA result of stress which is minimum 3.082 x 10^5 N/m^2 and maximum 3.168 x 10^8 N/m^2. Figure 6.20 shows the safety factors the value is 7.892. Figure 6.18 shows the displacement the value is 14.65mm. FEA result shows the strain of the rail which is minimum 1.988x 10^{-6} and maximum 1.190x10^{-3} shown in Table 6.19.

Figure 6.4 Railing (Part 3)

Table 6.16 Part 3 Properties

Volumetric Properties	
Mass	1.13291 kg
Volume	0.000144319 m^3
Density	7850 kg/m^3
Weight	11.1025 N

Table 6.17 Part 3 Stress Analysis

Name	Type	Minimum	Maximum
Stress	VON: von Mises Stress	3.082×10^{5}N/m^2 Node: 13379	3.168×10^{8}N/m^2 Node: 2181

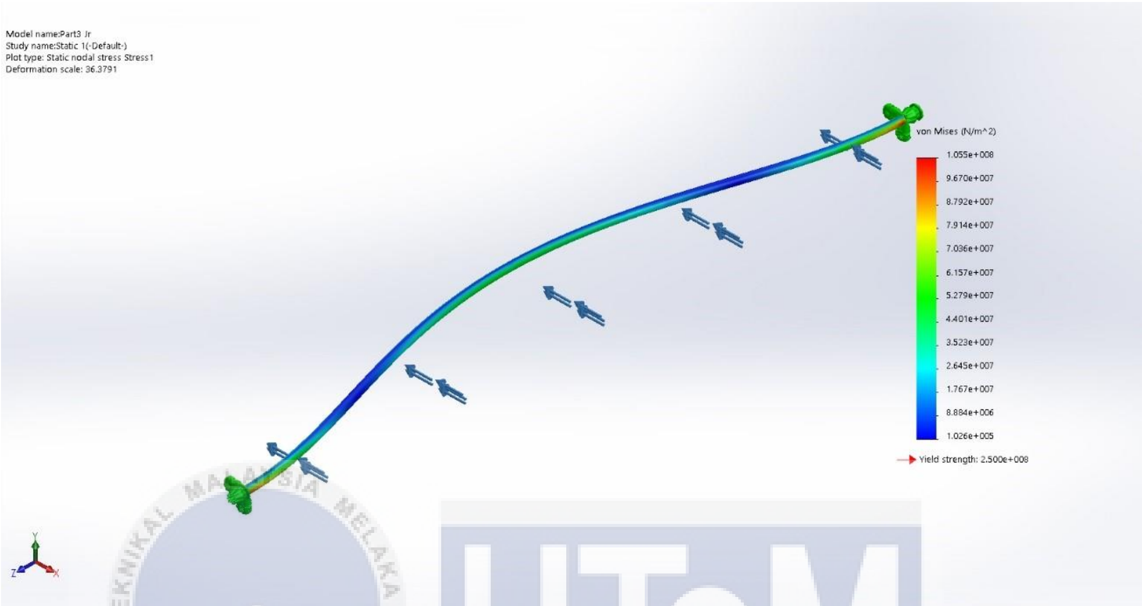


Table 6.18 Part 3 Displacement Analysis

Name	Type	Minimum	Maximum
Displacement	URES: Resultant Displacement	0.000mm Node: 1	14.65mm Node: 1388

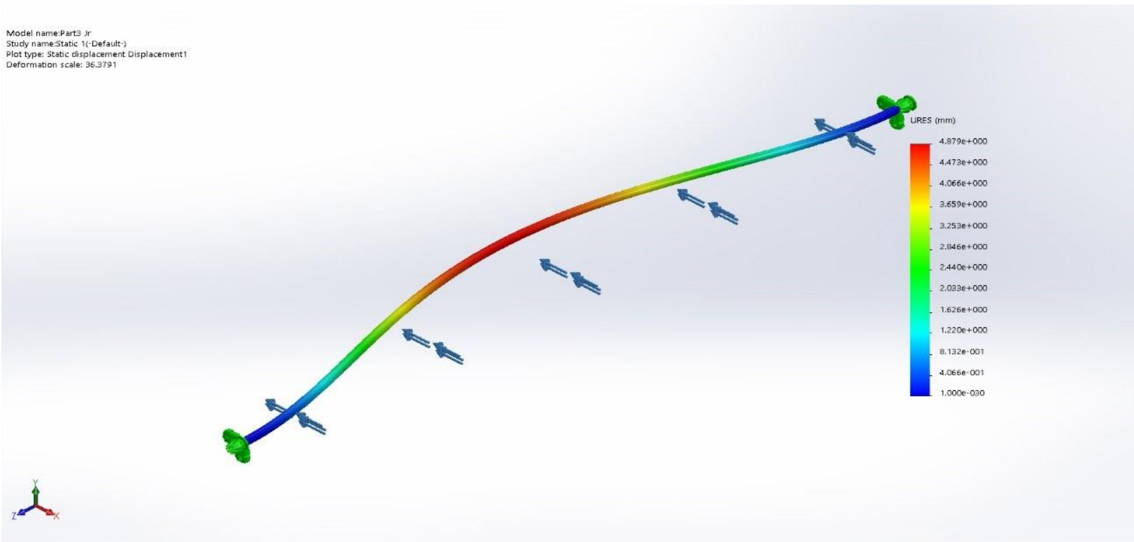


Table 6.19 Part 3 Strain Analysis

Name	Type	Minimum	Maximum
Strain	ESTRN: Equivalent Strain	1.988×10^{-6} Element: 3394	1.90×10^{-3} Element: 22

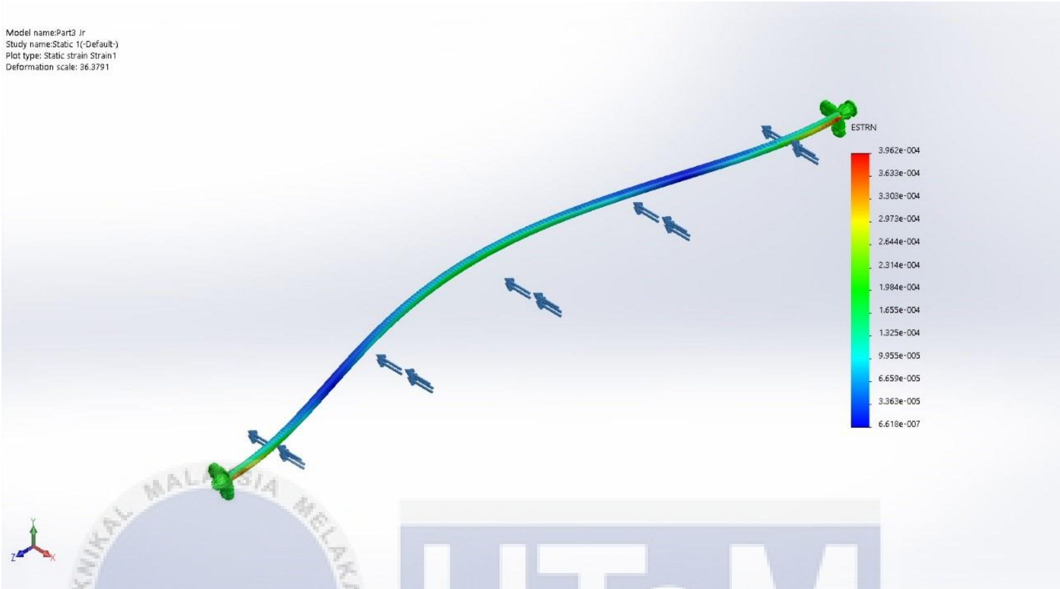
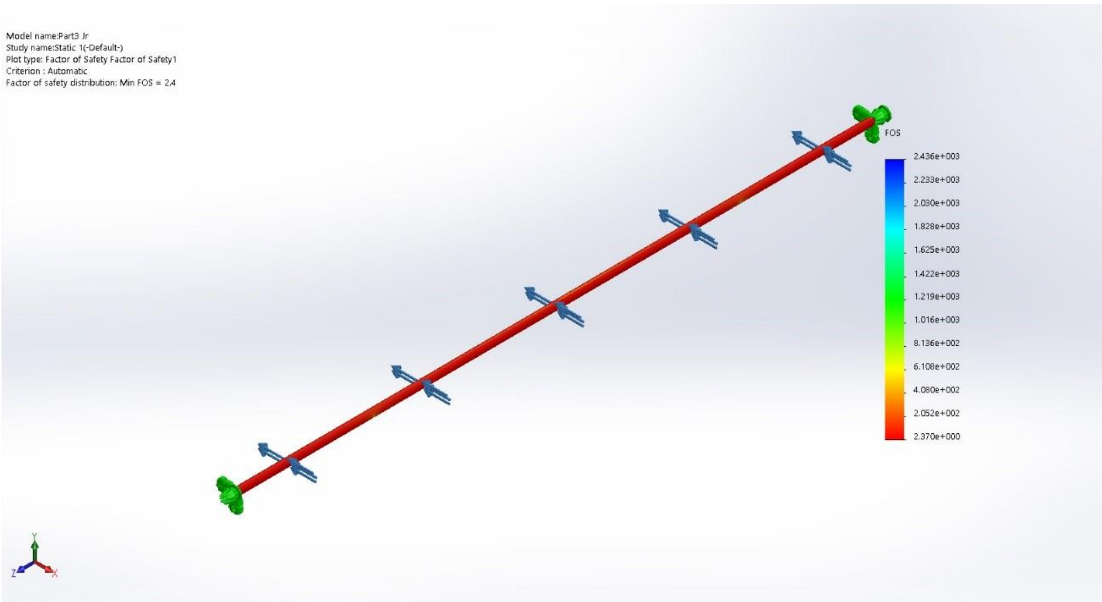


Table 6.20 Part 3 Factor of Safety Analysis

Name	Type	Minimum	Maximum
Factor of Safety	Automatic	78.92 Node: 2181	8.111×10^{2} Node: 13379



6.2.5 Part 4

Figure 6.5 and Table 6.21 shows the 3D model for rail support of the test bed and its properties. The material used for the part is L shape ASTM A36 Steel (50.8mm X 50.8mm). The total force acting on this part is 824.93N including lifting mechanism (140.181kg) and cone (6kg). Total mass is 168.181 Kilogram divided to two because the load hang on two different part. For the safety factors the value is 3.827 shown in Figure 6.25. Figure 6.22 shows the FEA result of stress which is minimum 1.477×10^5 N/m^2 and maximum 6.532×10^7 N/m^2. FEA result in Figure 6.24 shows the strain of the rail which is minimum 5.766×10^{-7} and maximum 2.204×10^{-4}. For displacement the value is 1.520 mm as shown in Table 6.23.

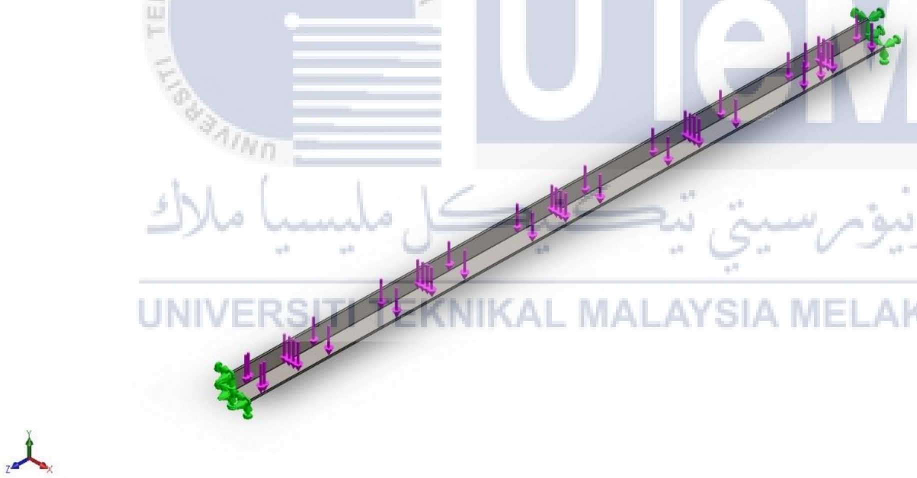


Figure 6.5 Rail Support (Part 4)

Table 6.21 Part 4 Properties

Volumetric Properties	
Mass	6.73 kg
Volume	0.000857325 m^3
Density	7850 kg/m^3
Weight	65.954 N

Table 6.22 Part 4 Stress Analysis

Name	**Type**	**Minimum**	**Maximum**
Stress	VON: von Mises Stress	1.477×10^{5}N/m^2 Node: 6572	6.532×10^{7}N/m^2 Node: 14195

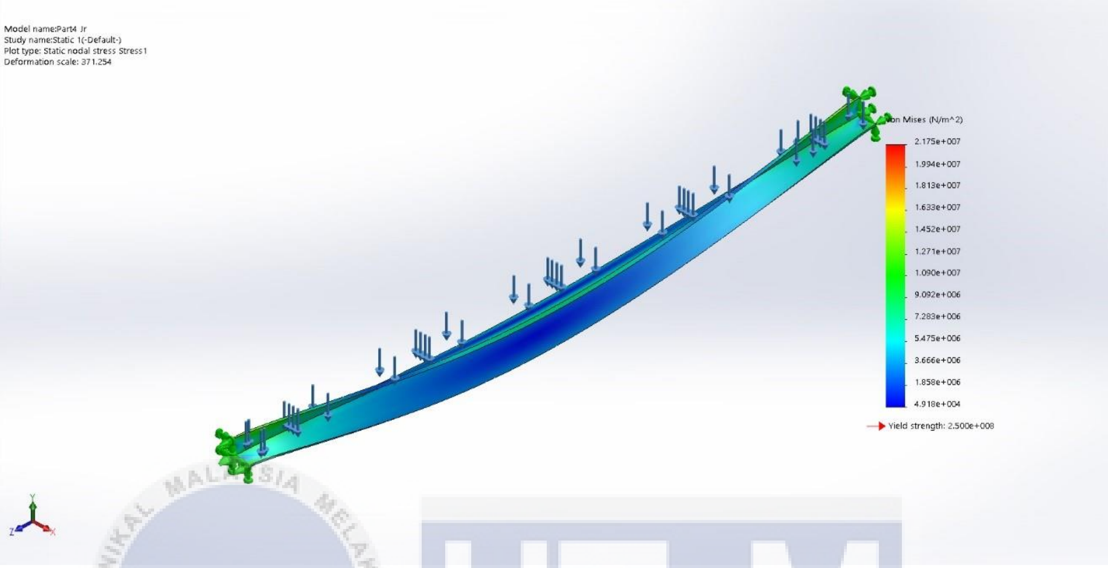


Table 6.23 Part 4 Displacement Analysis

Name	**Type**	**Minimum**	**Maximum**
Displacement	URES: Resultant Displacement	0.000mm Node: 1	1.520mm Node: 975

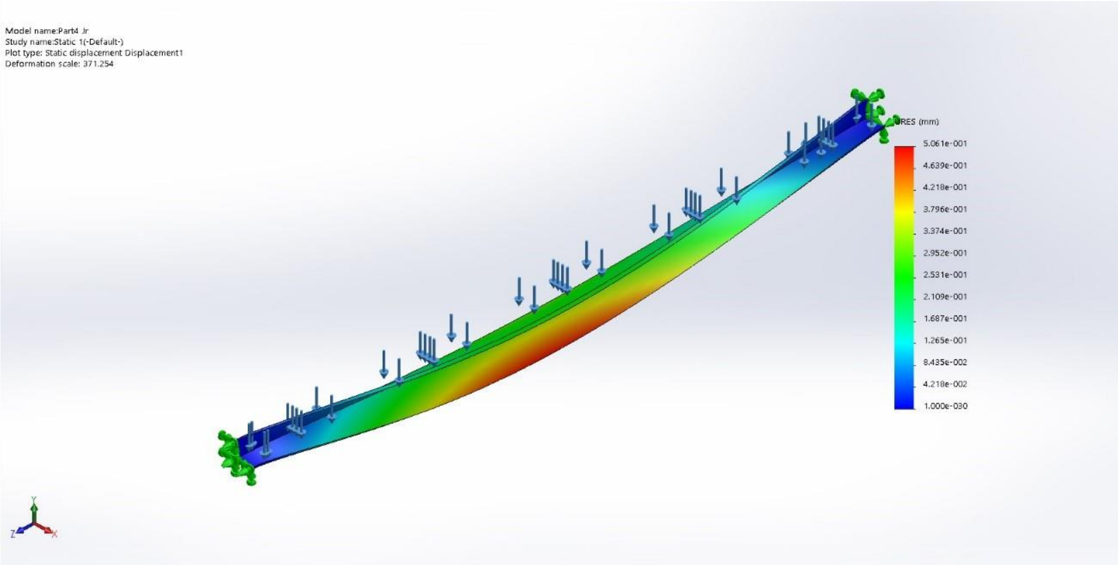


Table 6.24 Part 4 Strain Analysis

Name	Type	Minimum	Maximum
Strain	ESTRN: Equivalent Strain	5.766×10^{-7} Element: 2272	2.204×10^{-4} Element: 5265

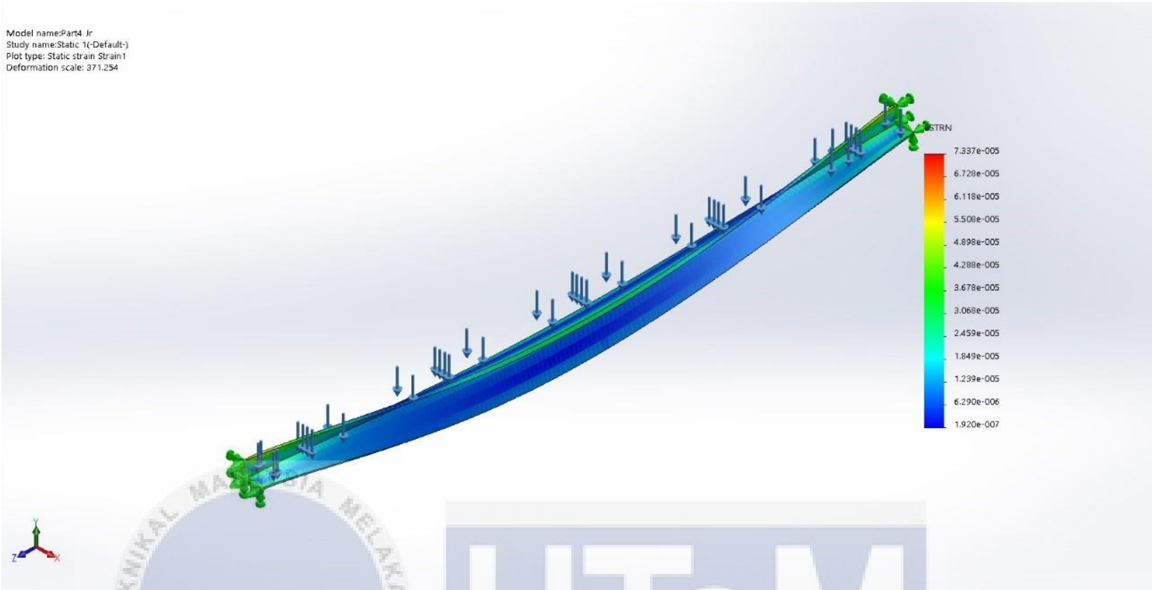
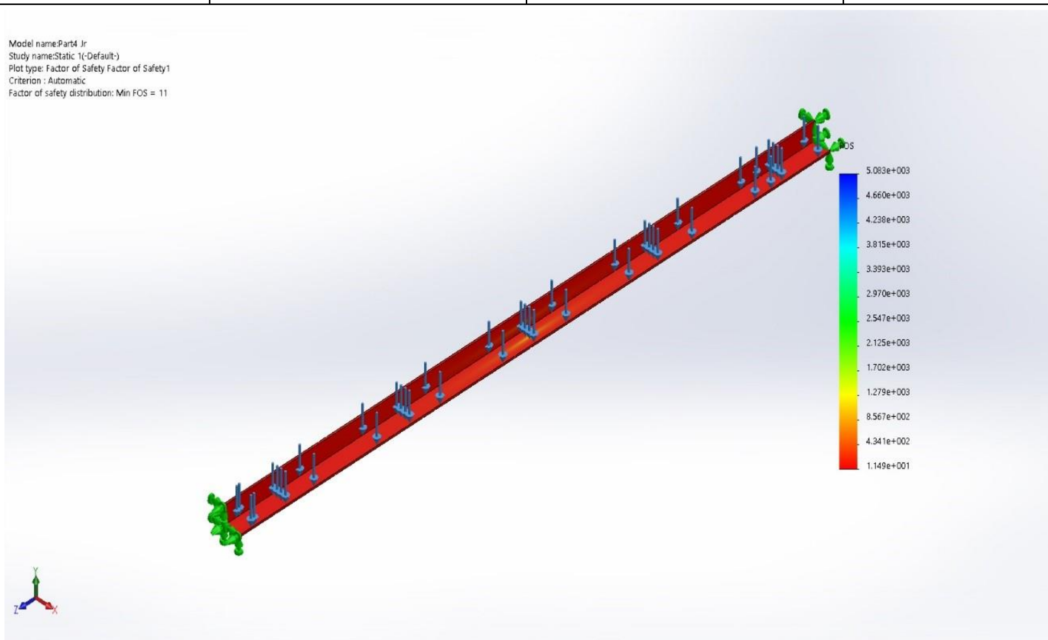


Table 6.25 Part 4 Factor of Safety Analysis

Name	Type	Minimum	Maximum
Factor of Safety	Automatic	3.827 Node: 14195	1.693×10^{3} Node: 6572



6.2.6 Part 5

Figure 6.6 and Table 6.26 shows the 3D model for holding the rail support of the test bed and the properties. The material used for the part is 1 hollow ASTM A36 Steel (38.1mm X 38.1mm). The total force acting on this part is 1748.22N including body, lifting mechanism (140.181kg) and cone (6kg). Total mass is 178.21Kilogram. The FEA result in Table 6.27 shows the stress value which is minimum 1.429 x 10^5 N/m^2 and maximum 1.163 x 10^8 N/m^2. For displacement the value is 3.008mm in Table 6.28. Table 6.30 shows the safety factors the value is 2.150. FEA result in Table 6.29 shows the strain of the rail which is minimum 3.499 x 10^{-6} and maximum 4.249 x10^{-4}.

Figure 6.6 Part 5

Table 6.26 Part 5 Properties

Volumetric Properties	
Mass	3.62867 kg
Volume	0.000543832 m^3
Density	7850 kg/m^3
Weight	41.837 N

Table 6.27 Part 5 Stress Analysis

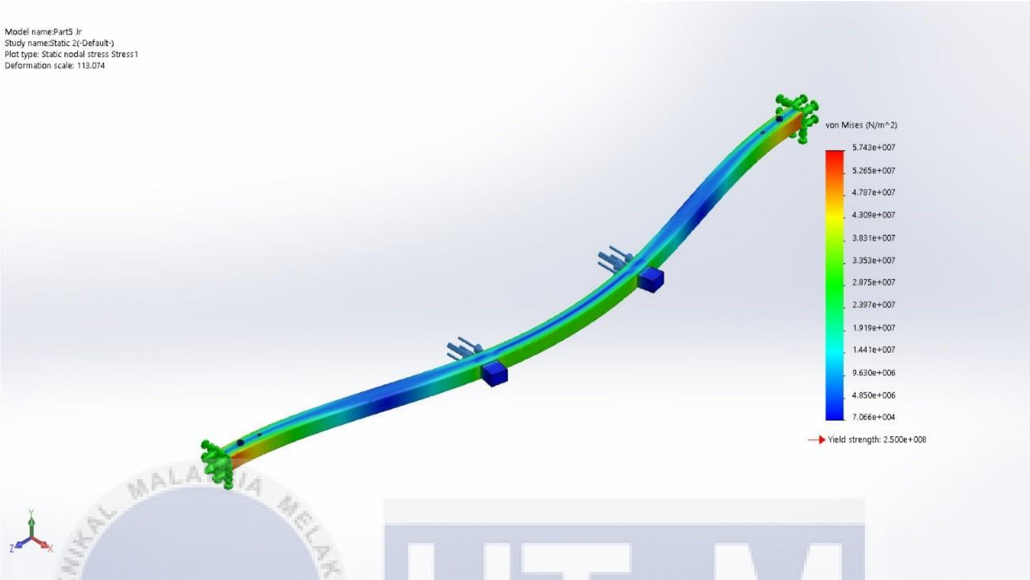
Name	Type	Minimum	Maximum
Stress	VON: von Mises Stress	1.429×10^5N/m^2 Node: 10079	1.163×10^8N/m^2 Node: 1158
			

Table 6.28 Part 5 Displacement Analysis

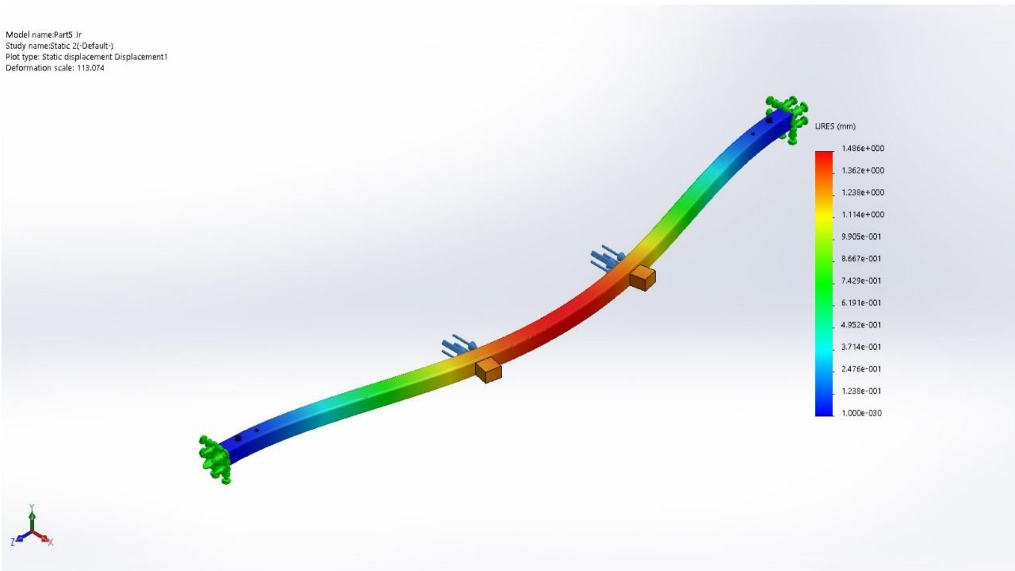
Name	Type	Minimum	Maximum
Displacement	URES: Resultant Displacement	0.000mm Node: 224	3.008mm Node: 1562
			

Table 6.29 Part 5 Strain Analysis

Name	Type	Minimum	Maximum
Strain	ESTRN: Equivalent Strain	3.499×10^{-6} Element: 9375	4.249×10^{-4} Element: 5817

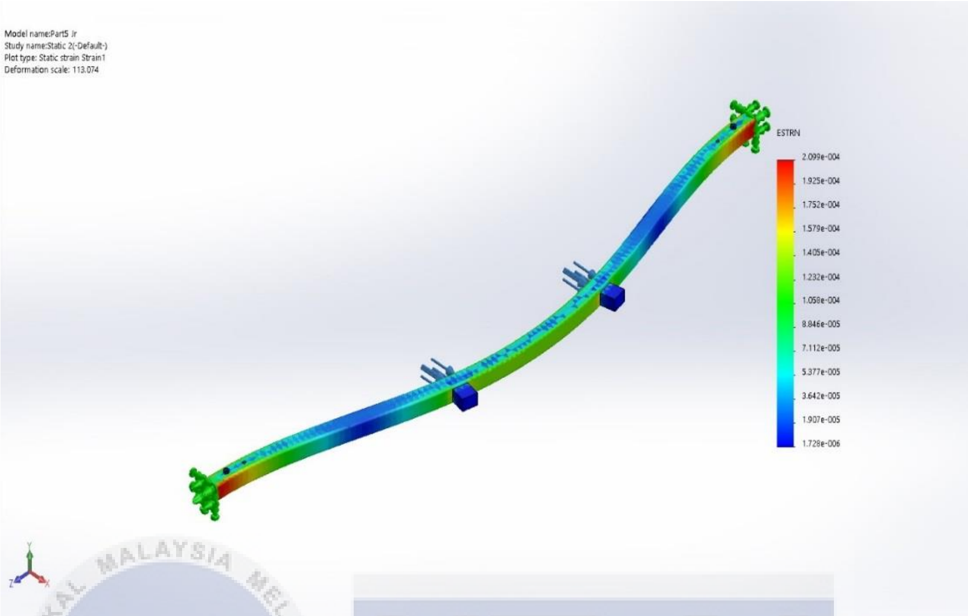
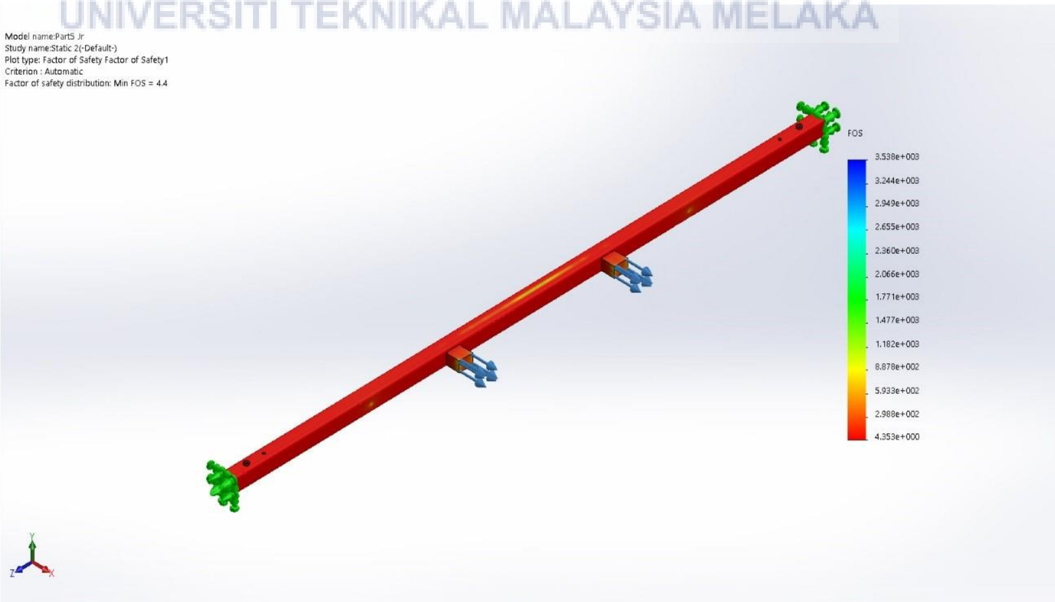


Table 6.30 Part 5 Factor of Safety Analysis

Name	Type	Minimum	Maximum
Factor of Safety	Automatic	2.150×10^{0} Node: 1158	1.750×10^{3} Node: 10079



6.3 Discussion

The Test Bed project is contain about 12 parts are assemble together to make the complete structure. For the FEA analysis the five most crucial part are choose the part is consist Part 1, Part 2, Part 3, Part 4 and Part 5. FEA for the full assemble frame body show the structure only have small bending and the structure not yielding.

However, the Part 1 was the small part but have a importance job hook the frame to the lorry and the part had less bending and stress. Next, Part 2 is the base structure because it connect the slider and the part that hook to the lorry and this part make a lot of bending compare with other part. Then, for Part 3 is shaft slider for the mechanism and the part should hold mechanism in place while operate and has it has less bending force because supported by Part 4. Other than that, Part 4 is the L- shape bar that hold the shat slider and give the batter support. Lastly, Part 5 is the hollow steel that attach with Part 1 and 2. This part has added dummy steel box to make the point position for the force acting on the part 5 and it show higher displacement from original place.

CHAPTER 7

CONCLUSION AND RECOMMENDATION

7.1 Conclusion

The project of System Integration for Mechanism and Test Bed of Cone Laying System is aimed to design the Test Bed of cone laying system and the system integration between cone laying system and the Test Bed. After did some research on the project it show that the project already exist in the other countries highways company. Then after study more detail about this project on how the mechanism attach to the lorry using support and frame. The idea from all research and study about this project were proposed into several 2D and 3D sketching than choose the final design. The 3D model was design using software (SOLIDWORKS) to find the advantage and improve the disadvantage from the project. The all parts of project was detailed design and dimensions before continue with fabrication process. Stress analysis and Finite Element Analysis (FEA) has run and calculated to ensure that the product meets safety requirements.

This project purposed is to develop and design the Test Bed, this project needed to build the prototype for collecting the data from the on the road testing and the result found to be satisfactory. The system integration is to integrate between test bed and the mechanism by using human force to push the mechanism and a line it through the cone. During the testing, the test bed is function smoothly and perform the perfect outcome. In the nut shell, the project have achieve its designed function which is to fully integrate with the mechanism and perform the smooth movement. The all objective in this project are achieved.

7.2 Recommendation

The future works to be done for the project to perfectly functioned, it come with a few recommendations. Firstly, the student should consider more in safety feature in this project and for the recommendation the student should fine the strong support at the lorry to make the slider frame stiffer. The current support would experience a bending and will rupture when the heavy mechanism operate. If can fine the better support it will make the product stronger and stable while operate.

Furthermore, should be consider is the locking mechanism between the slider and the roller to make it more secure when operate. In order to have the smooth movement the high quality bearing must use in the roller. It will result the better quality and reduce the man power to sliding it. The recommendation is to have the rubber finish at the roller and it will make the roller and the slider more friction and will not slip easily.

Lastly, student recommended in the future project to make sure do have the proper planning before start the fabrication process it will easy and smooth the fabrication process. Make sure the dimension is correct because the wrong dimension will trouble student while fabricate.

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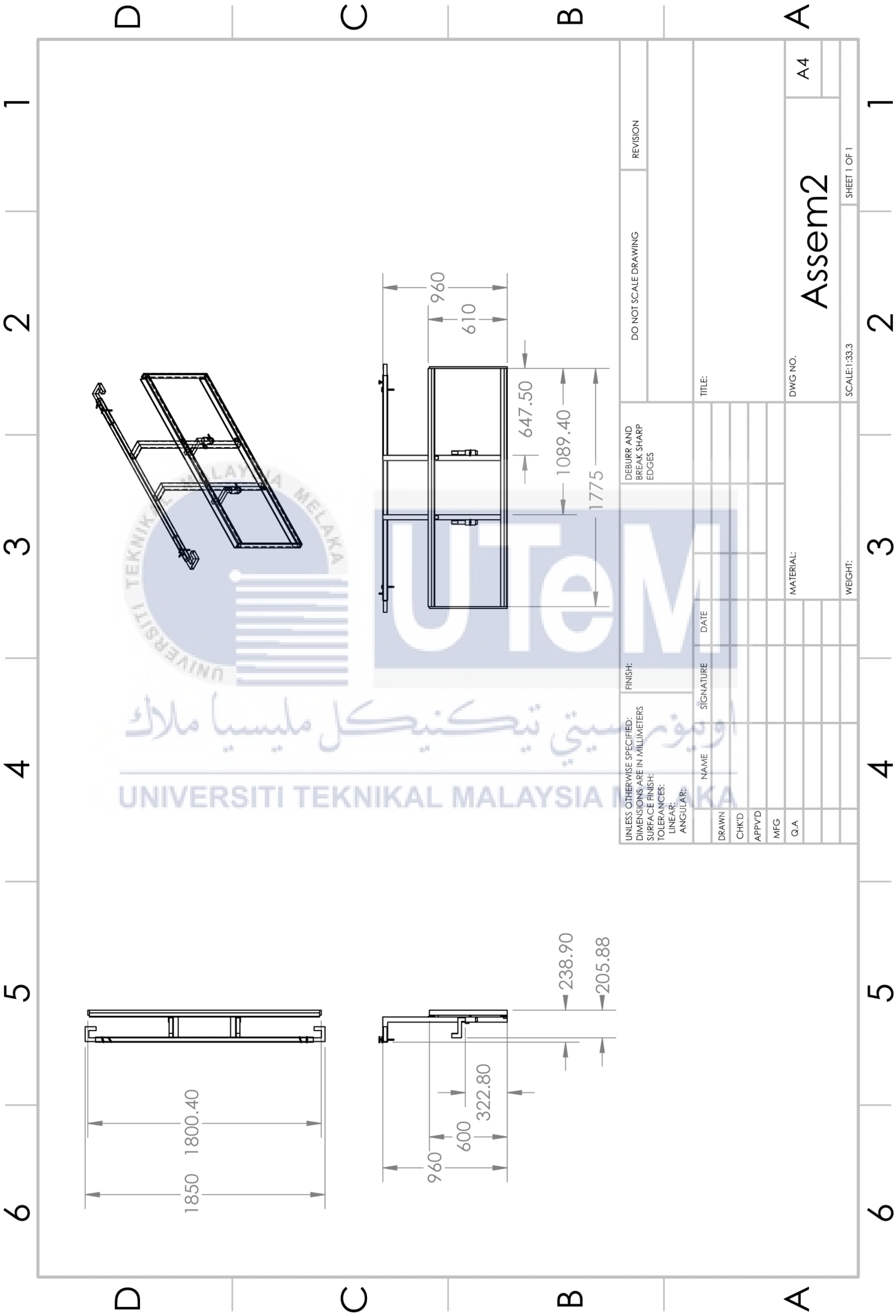
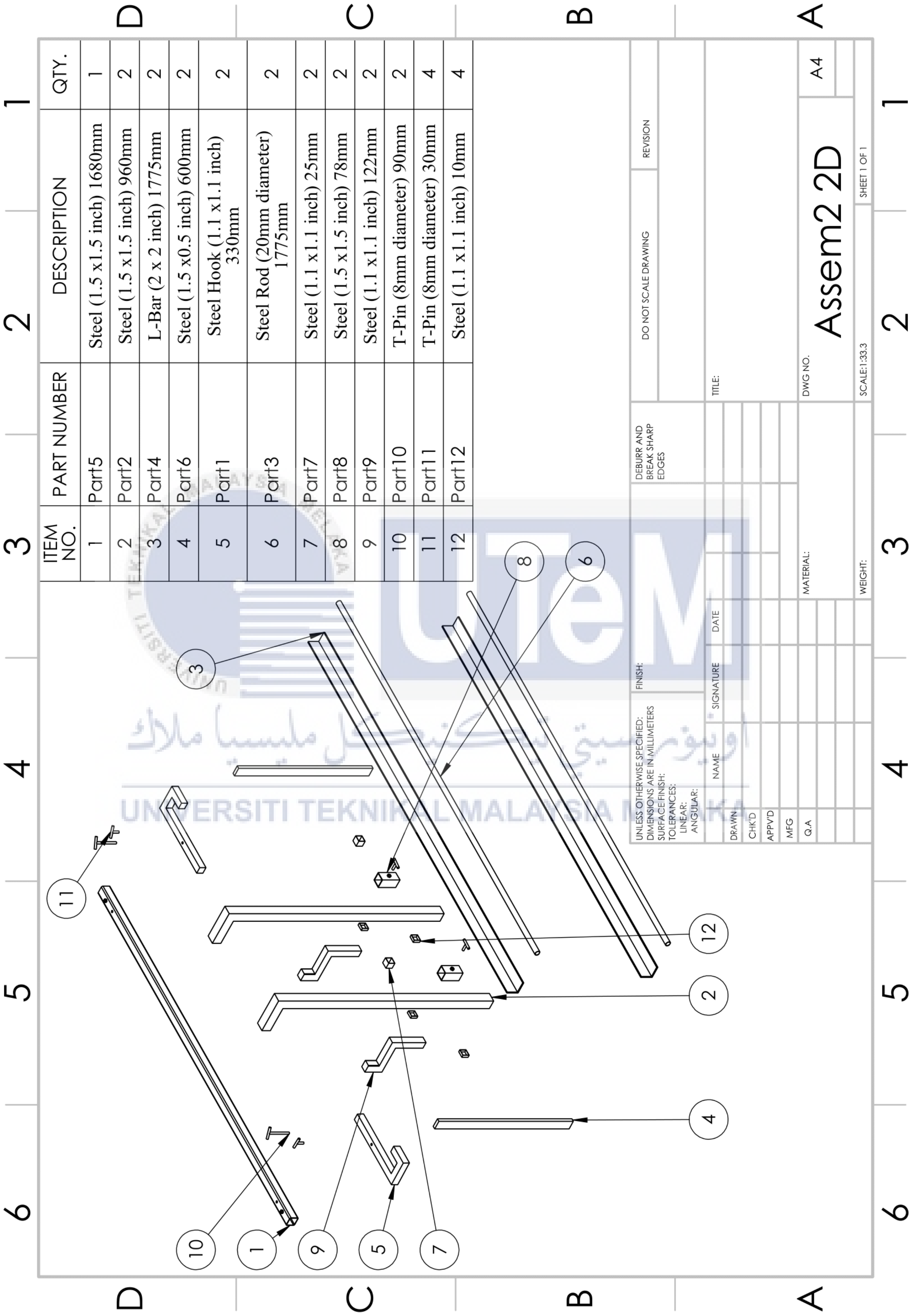
APPENDIX A (ASSEMBLY 2)

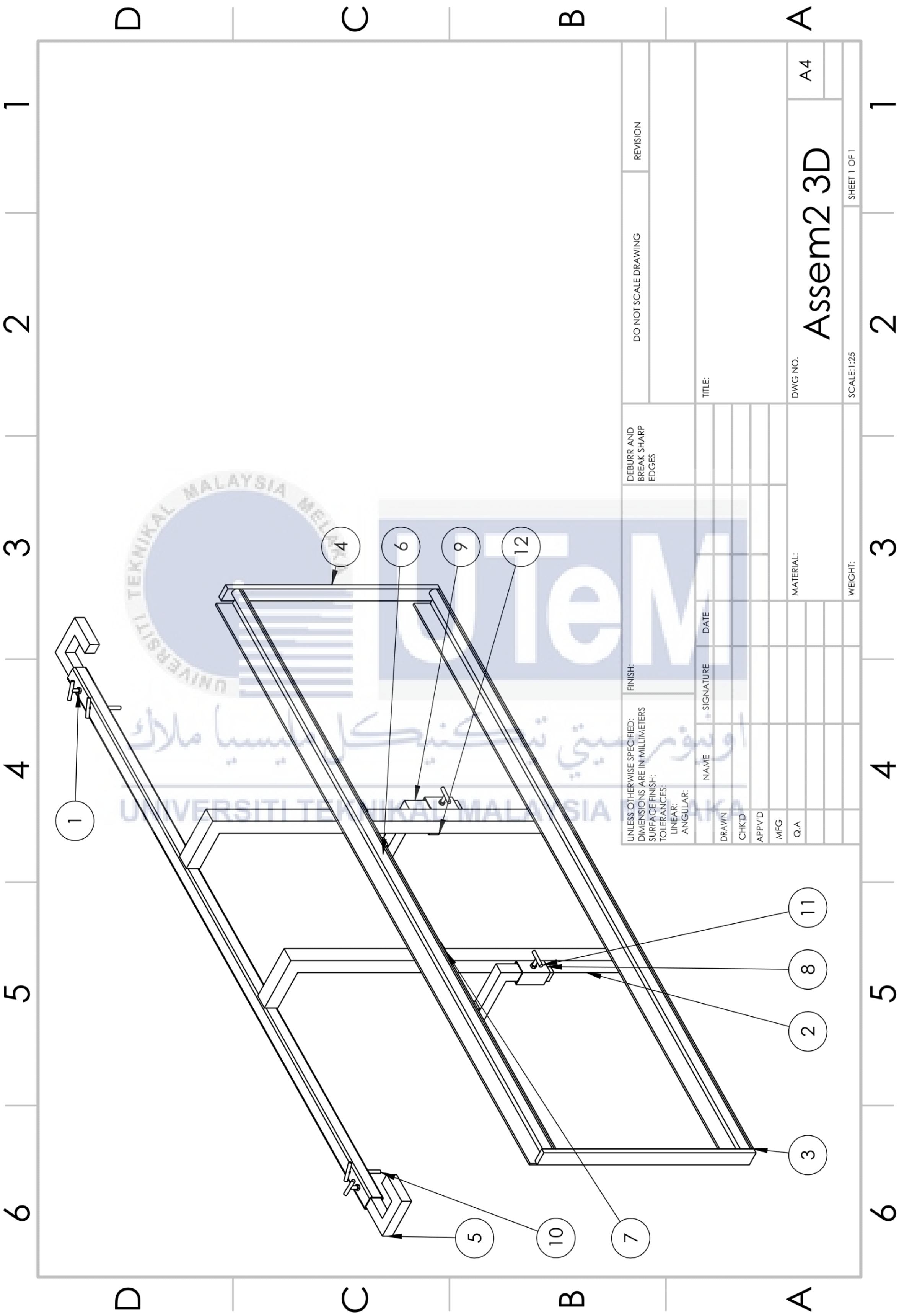


APPENDIX B (ASSEMBLY 2- 2D)



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Part5	Steel (1.5 x1.5 inch) 1680mm	1
2	Part2	Steel (1.5 x1.5 inch) 960mm	2
3	Part4	L-Bar (2 x 2 inch) 1775mm	2
4	Part6	Steel (1.5 x0.5 inch) 600mm	2
5	Part1	Steel Hook (1.1 x1.1 inch) 330mm	2
6	Part3	Steel Rod (20mm diameter) 1775mm	2
7	Part7	Steel (1.1 x1.1 inch) 25mm	2
8	Part8	Steel (1.5 x1.5 inch) 78mm	2
9	Part9	Steel (1.1 x1.1 inch) 122mm	2
10	Part10	T-Pin (8mm diameter) 90mm	2
11	Part11	T-Pin (8mm diameter) 30mm	4
12	Part12	Steel (1.1 x1.1 inch) 10mm	4

APPENDIX C (ASSEMBLY 2-3D)



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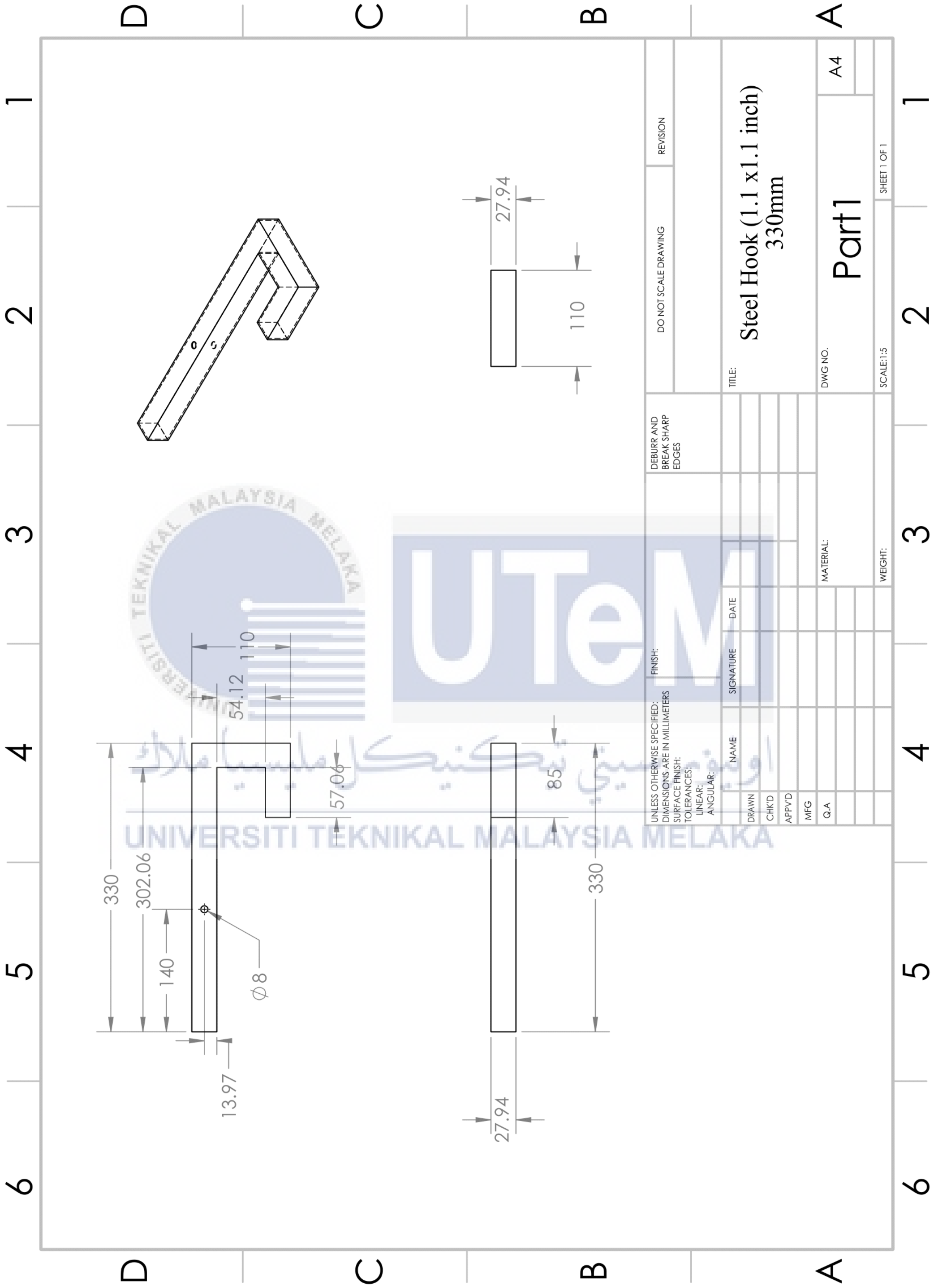
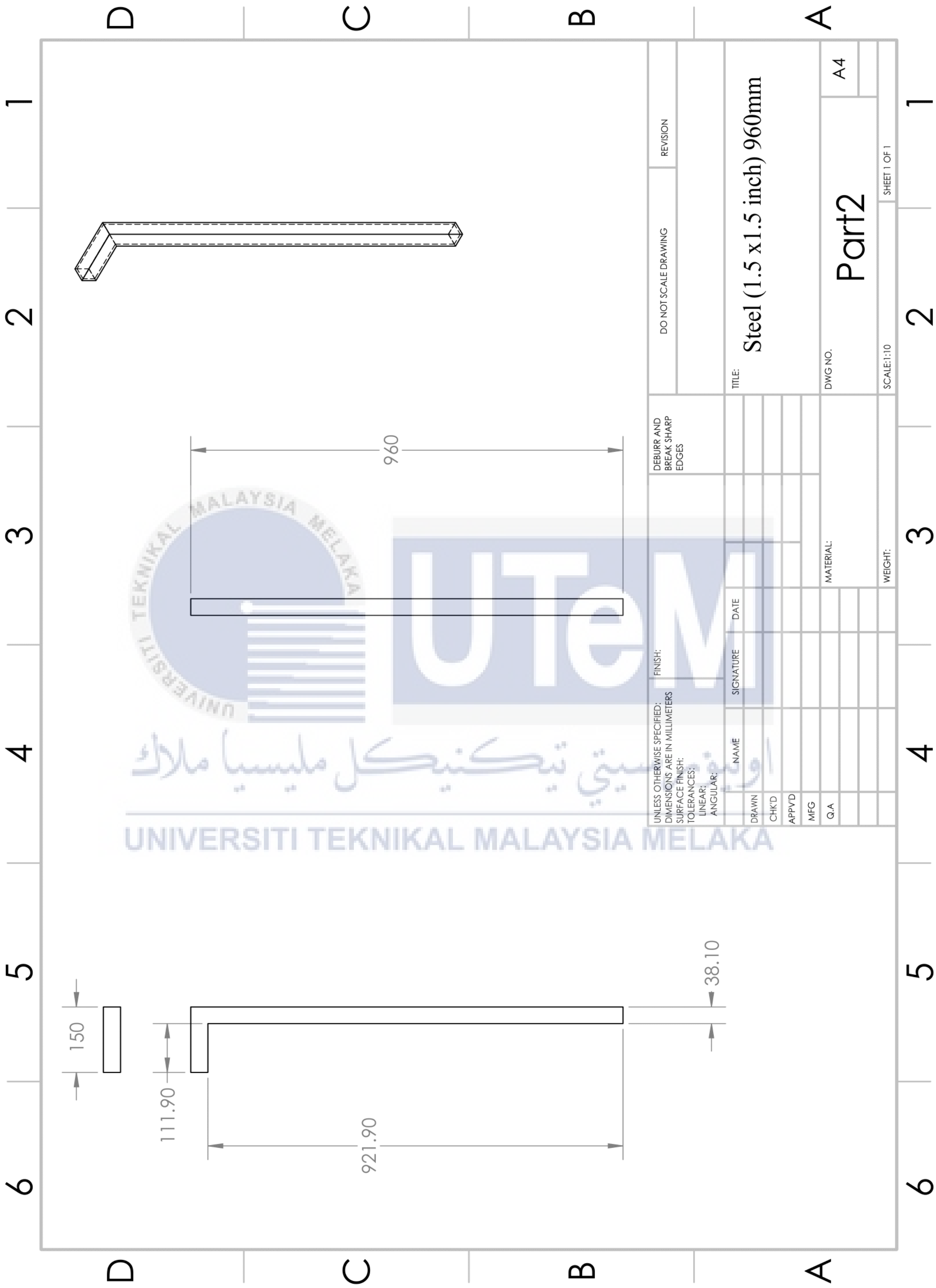


APPENDIX E (PART 2)



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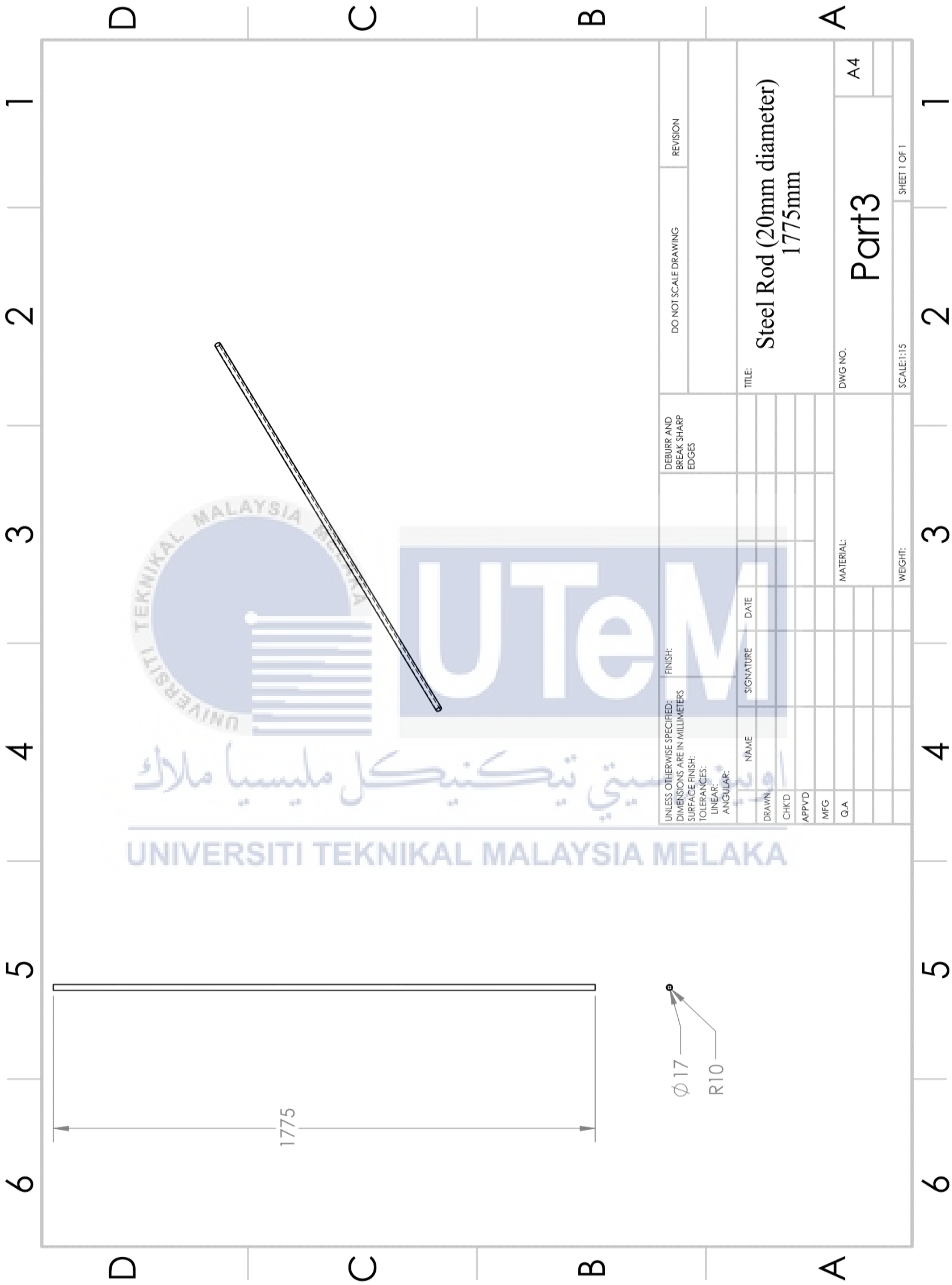
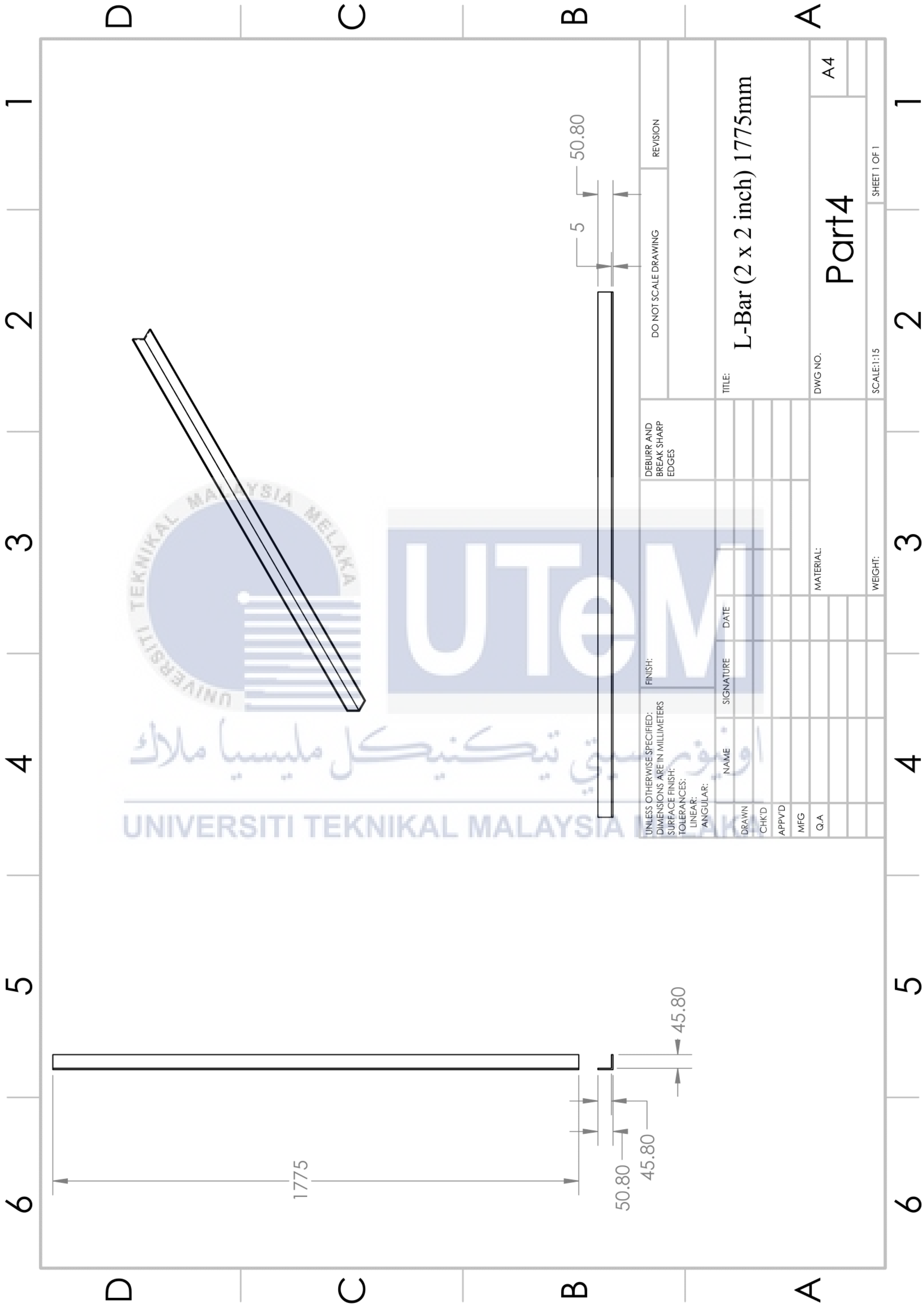
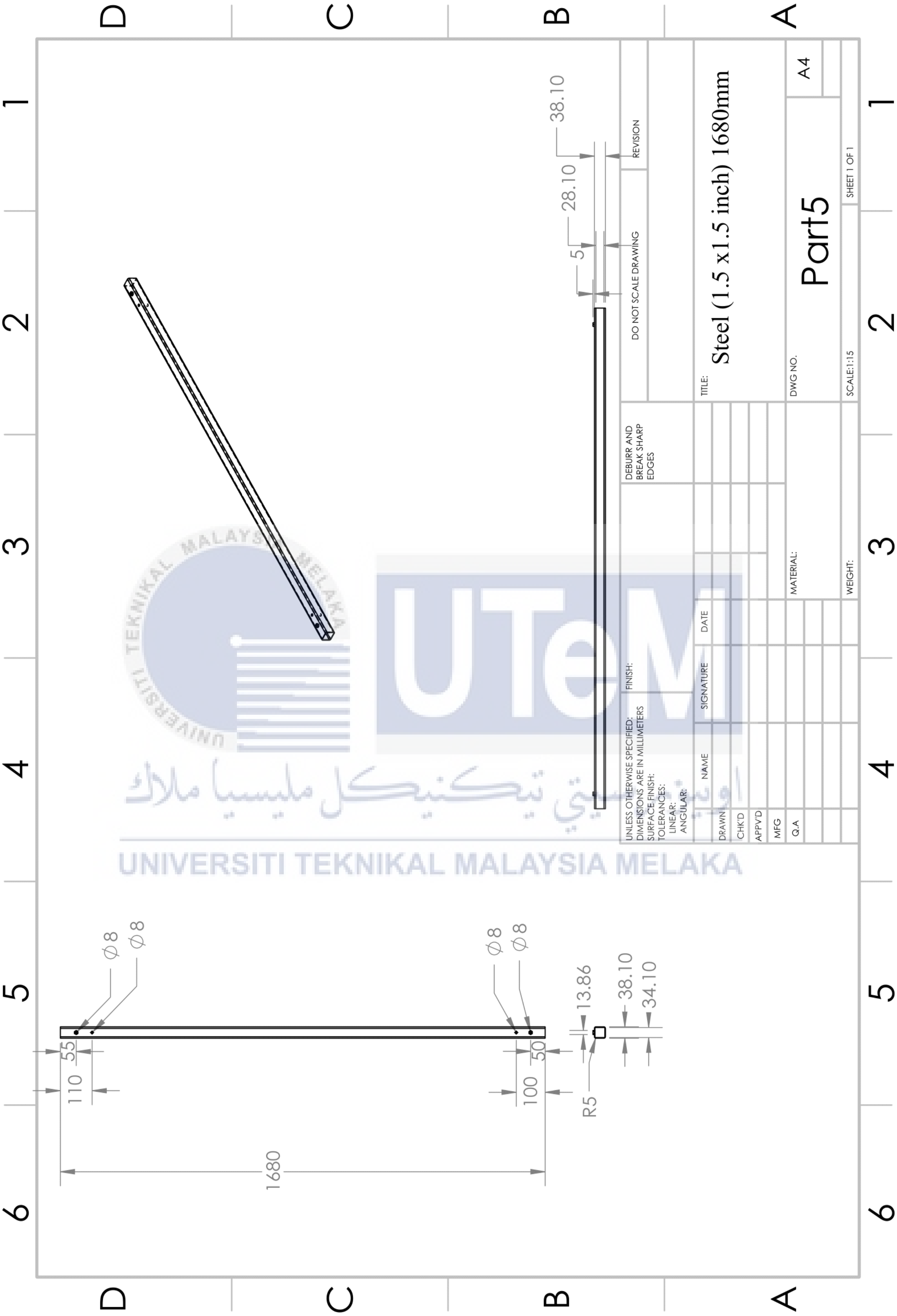


APPENDIX G (PART 4)



APPENDIX H (PART 5)


Steel (1.5 x1.5 inch) 1680mm
Part5
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DWG NO.
A4
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SHEET 1 OF 1
MATERIAL:
WEIGHT:
DO NOT SCALE DRAWING
REVISION
DEBURR AND BREAK SHARP EDGES
FINISH:
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
NAME
SIGNATURE
DATE
DRAWN
CHK'D
APPV'D
MFG
Q.A
38.10
28.10
5
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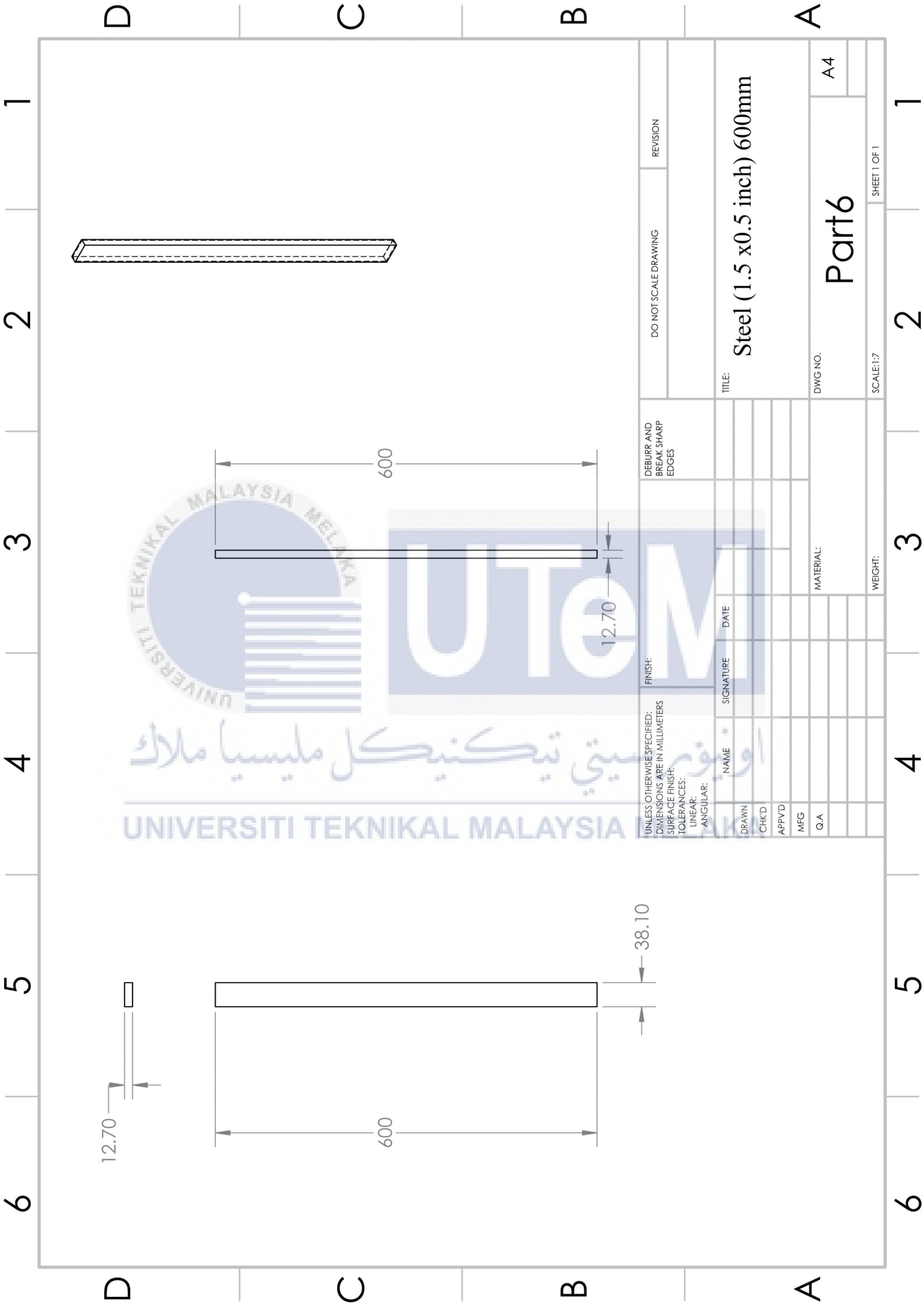
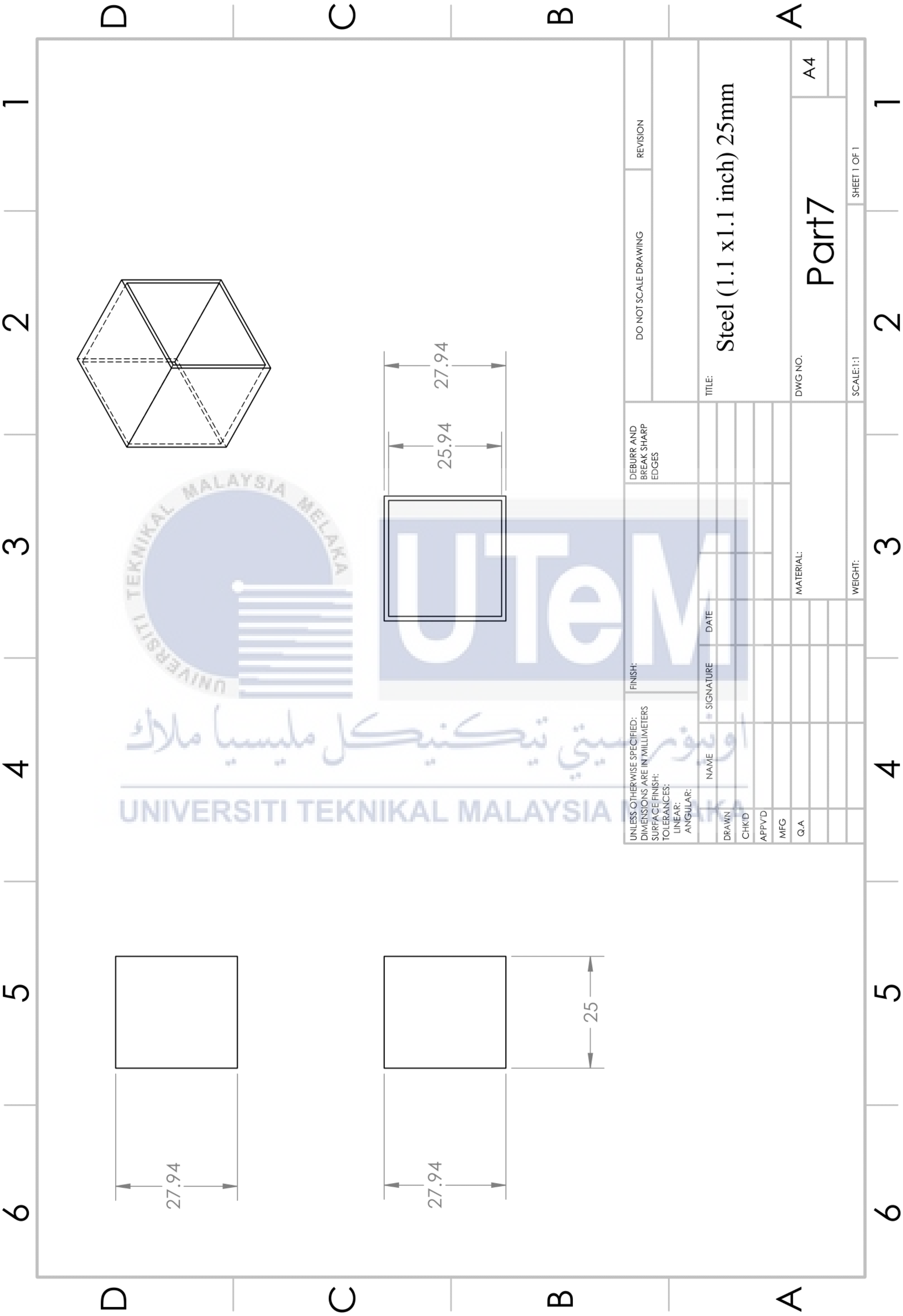
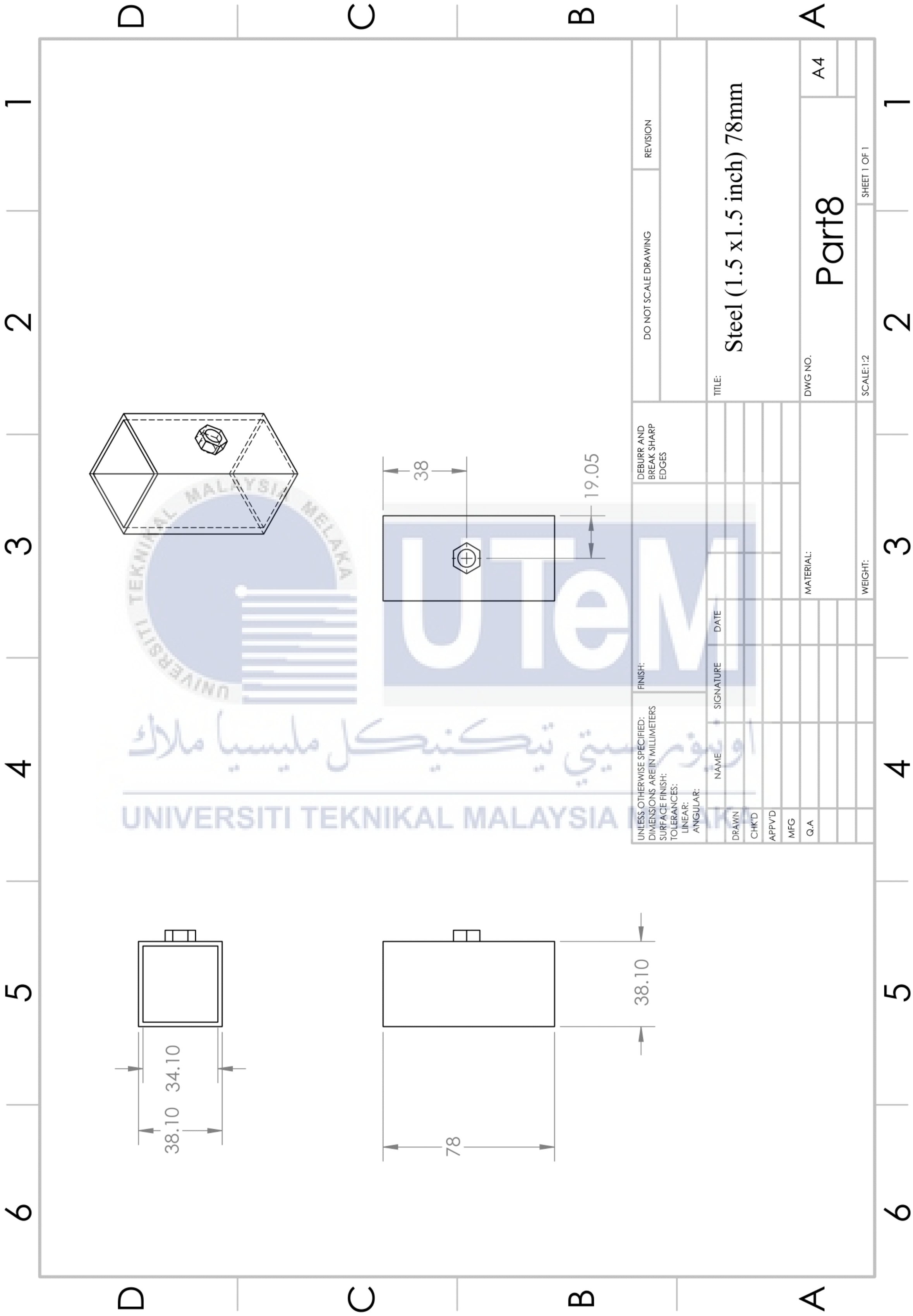
APPENDIX I (PART 6)



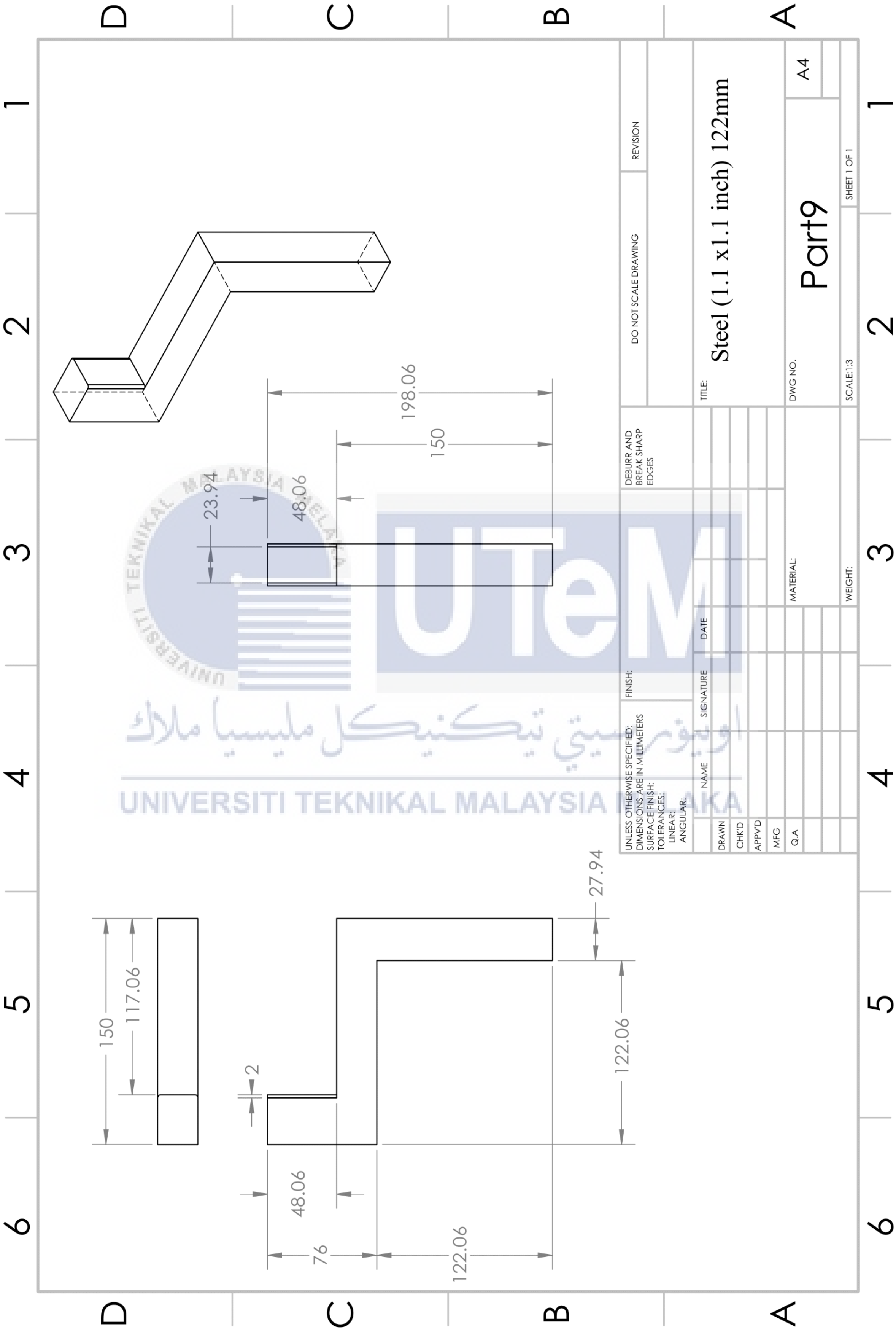
APPENDIX J (PART 7)



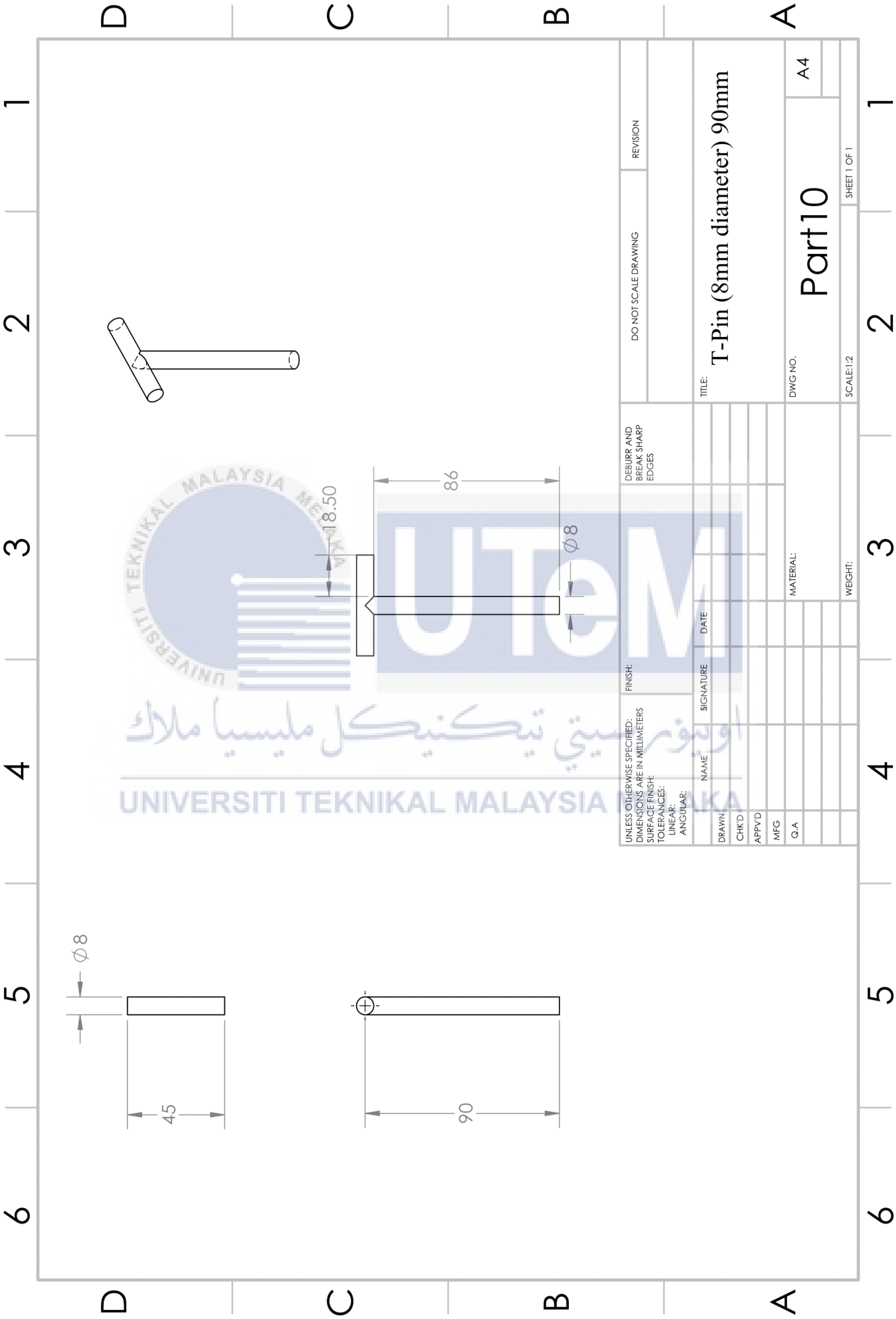
APPENDIX K (PART 8)



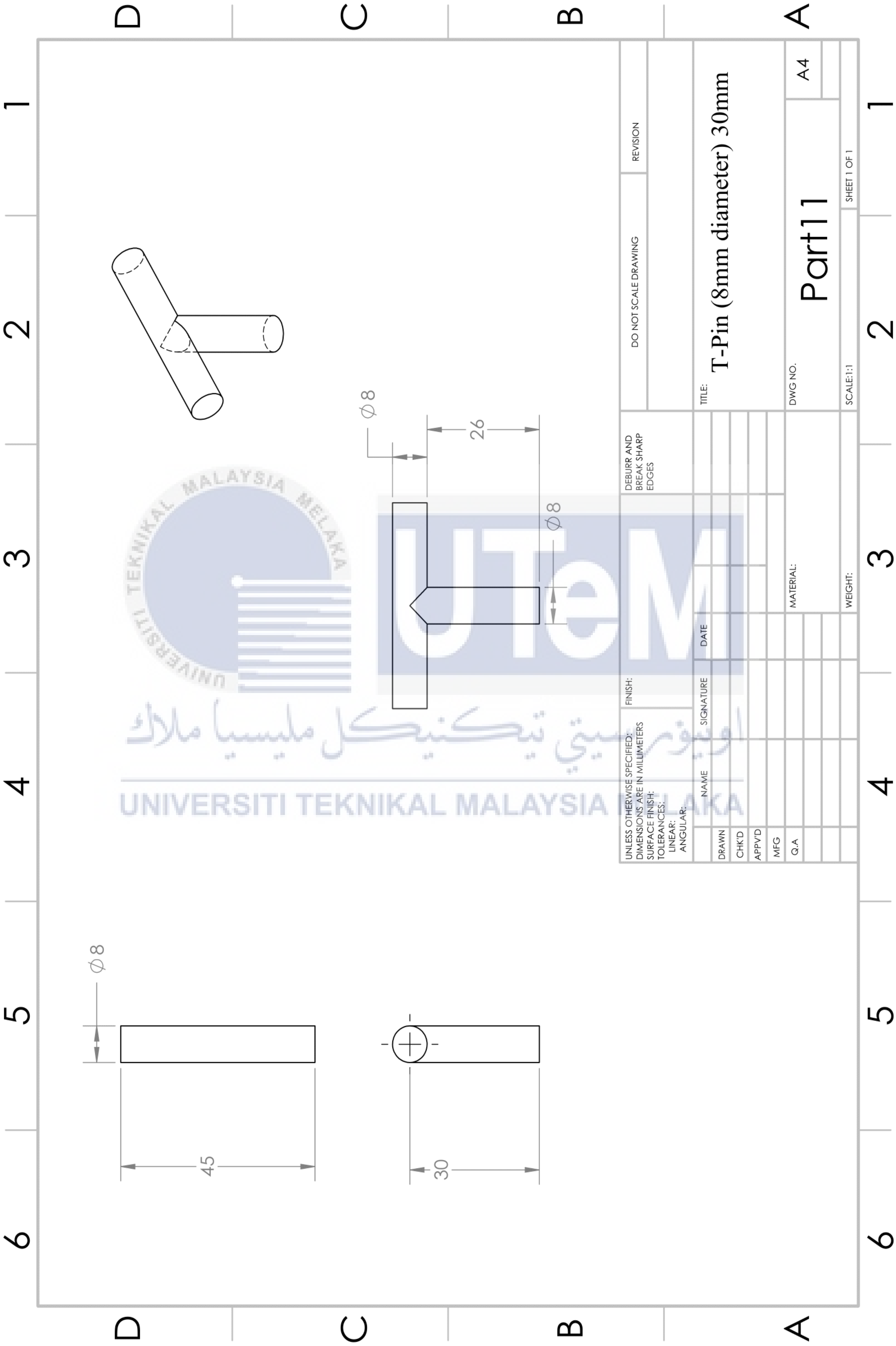
APPENDIX L (PART 9)



APPENDIX M (PART 10)



APPENDIX N (PART 11)



APPENDIX O (PART 12)