DESIGN OF PEEL TEST FIXTURE FOR ADHESIVELY BONDED JOINTS

WONG YEW SHENG

DESIGN OF PEEL TEST FIXTURE FOR ADHESIVELY BONDED JOINT

WONG YEW SHENG

A report submitted
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DECLARATION

I hereby, declared this report entitled “Design Of Peel Test Fixture For Adhesively Bonded Joints” is the results of my own research except as cited in references.

Signature : ……..

Author’s Name : WONG YEW SHENG

Date : 15 MAY 2018

APPROVAL

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

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

ABSTRACT

The purpose of this project is to design a suitable jig to carry out peel test on a Universal Tester Machine (UTM). Adhesive joint is widely used in today industry. Peel test is the test carried out to test the strength of an adhesive joint. Therefore, peel test is one of the important tests run for the advancement in adhesive technologies. In this project, the jig designed is focuses on 90 degree peel test to test the adhesive strength of adhesive tape on different type of materials. The peel test standard follows the standard of ASTM D3330/D3330M, 2010. Engineering design process is used in order to design a suitable jig for this project. The jig is designed and analyzed through CATIA software where the conceptual design is selected using the Pugh's selection method. After final selection, the functional prototype of the jig is manufactured using rapid prototyping process. Manufactured jig is tested on UTM machine and the sample result is recorded. Different material can be attached to the specimen plate of the jig to carry out peel test with different specimen. The jig designed in this project can be improved and modified in future similar studies for better peel test jig for UTM.

ABSTRAK

Objektif utama projek ini adalah untuk mereka bentuk sebuah jig yang sesuai untuk menjalankan ujian kupas atas Universal Tester Machine (UTM). Bahan pelekat merupakan suatu bahan yang selalu digunakan untuk mencantumkan bahagian mekanikal dalam industri hari ini.. Ujian kupas pula merupakan suatu ujian untuk mengkaji kekuatan bahan pelekat. Ujian ini sangan penting untuk perkembangan dan kemajuan dalam teknologi pelekat. Dalam projek ini, jig yang direka adalah bagi tujuan membantu UTM untuk menjalankan ujian kupas 90 darjah ke atas permukaan bahan yang berlainan. Ujian kupas ini mengikut standard ASTM D3330/D3330M. Proses reka bentuk kejuruteraan telah digunakan dalam proses mereka jig ini bagi tujuan menghasilkan satu jig yang sesuai untuk digunakan. Perisian CATIA telah digunakan untuk menghasilkan lukisan CAD jig dan menganalisa struktur jig yang telah dilukis. Kaedah Pemilihan Pugh pula digunakan untuk memilih konsep yang telah direka. Selepas pemilihan akhir dibuat, prototaip yang berfungsi dalam projek ini telah dibuat menggunakan kaedah 'rapid prototyping'. Jig yang telah siap dibuat telah dicuba-guna atas UTM dan hasil ujian telah dicatatkan. Permukaan yang berlainan boleh dilampirkan ke atas plat spesimen untuk menjalankan ujian kupas yang berkaitan. Walaubagaimanapun, jig yang direka dalam projek ini masih boleh ditambahbaik pada masa akan datang dengan memperbaiki atau megubahsuai reka bentuk jig.

DEDICATION

To my beloved family,

Mrs Chiang Lan Heong

Ms Serrine Chiang Mee Heong

Mr Cheong Mee Khuan

My Supervisor,

Dr. Mizah Bt Ramli

My friends especially to Mr. Tan Chee Teck

All lab assistant that had guided me throughout my time in the lab

ACKNOWLEDGEMENT

First of all, I am very grateful that I am able to complete my final year project in time. There are a lot of help in term of guidance and advice that had come to me when I needed them. I would like to take this opportunity to extend my gratitude to all the parties that had involve in this project.

Firstly, I would like to thank University Teknikal Malaysia Melaka (UTeM), for providing me this chance to gain my knowledge and experience through this final year project. I did learn a lot and gain a lot of knowledge while completing this project. Next I would like to sincerely thank my Supervisor, Dr Mizah Bt Ramli for her guidance and patience throughout my final year project. My design will never be able to complete without her guidance. I also would like to thanks my panels who corrected my mistake and taught me things that I never learn.

Not forget to mention my friends and lab assistants who also provided help when I needed. Last but not least, I want to thank my single-parent mother, Mrs Chiang Lan Heong and others relatives for their moral and financial support not just in this project, but also throughout my life in university. Their inspirational and courageous talk had walked me through the hard time completing the final year project.

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CHAPTER 1

INTRODUCTION

1.1 Background

Adhesive technology is an application that has been widely used worldwide. It can mechanically assemble parts without altering the structure and mechanical properties of the parts. Adhesive peel test is the mechanical test to test the strength of adhesive on chosen specimen.

However, improving the peel tester for the adhesive will directly contributes to the advancement of adhesive technologies.

Therefore, jig is components of machine tool installations, specially designed in each case to position the work piece, hold it firmly in place, and guide the motion of the power tool(Hamad Mohammed Abouhenidi, 2014). Jig plays a vital role to the efficiency and

accuracy of a peel tester. Installing a suitable jig design on adhesive peel tester can significantly enhance its performance.

Design of jigs and fixture must satisfy the following conditions which are reduction of idle time, provision of coolant, hardened surface, safety, fool proof and indexing type of jigs. (Lakshmi Kumari, G.Prsasnna Kumar, 2015)

The fixture and jig is to be designed for peel test for adhesively bonded joint. The fixture is to be installed onto a universal testing machine (UTM) and 90 degree peel test is conducted on the machine with the aid of the fixture. The adhesively bonded specimen to be tested on the machine is metal. The standard of this peel test on metal follows the standard of ASTM-B571-97.

The test is of the standard DIN EN 50461 and ASTM D3330M. However, test with other standard is also possible to be used with the universal testing machine.

1.2 Problem Statement

The problems emerged from the peel tester used to test adhesive today are weak specimen gripping and bad positioning of specimen on the peel tester during the test. Universal Testing Machine is used in order to carry out the 90 degree peel test of adhesively bonded joint.

The accuracy of the adhesive peel test tested on the UTM is not precise because the specimen is not static while the adhesively bonded joint is peeled. The bonded joint peels irregularly and hence decrease the accuracy of the result of peel test. When the specimen is not static, the specimen also tends to move around which also indirectly decreases the result of the peel test.

1.3 Objective

The objectives of the project are as follows:

1. To understand the method and steps of peel test on adhesively bonded joint using Universal Testing Machine.
2. To design a suitable jig or fixture to be added onto the Universal Testing Machine using mechanical designing software.
3. To design jig that can carry out 90-Degree Peel Test.
4. To fabricate and install the designed jig or fixture to the Universal Testing Machine and do an analysis onto the efficiency and accuracy of the peel test.
5. Design of jig that fulfills the design requirement.
6. Design a functional jig at minimal cost.

1.4 General Methodology

Below are engineering design method involved to carry out the objectives of the project :

1. Literature review

   Studying journals, researches, articles and others peel test and jigs related material

2. Studying peel test and the capabilities of Universal Testing Machine

   Observe and understanding the mechanism of the UTM machine and hands-on to learn doing peel test using UTM machine. Measure the size of jig or fixture required

3. Design Requirement

   Determine the requirement of the jig design.

4. Conceptual Design

   Generate ideas by morphological chart.

5. Concept Selection

   Selection of best design using appropriate method.

6. Detailed Design

   Create a CAD drawing of the designed jig.

7. Fabrication of jig

   Fabricate the designed jig using 3D printer.

8. Analysis of peel test performance of UTM machine with jig designed.

   Test the jig or fixture fabricated to achieve the objective of the project.

9. Report writing

   Prepare post-project report at the end of the project.

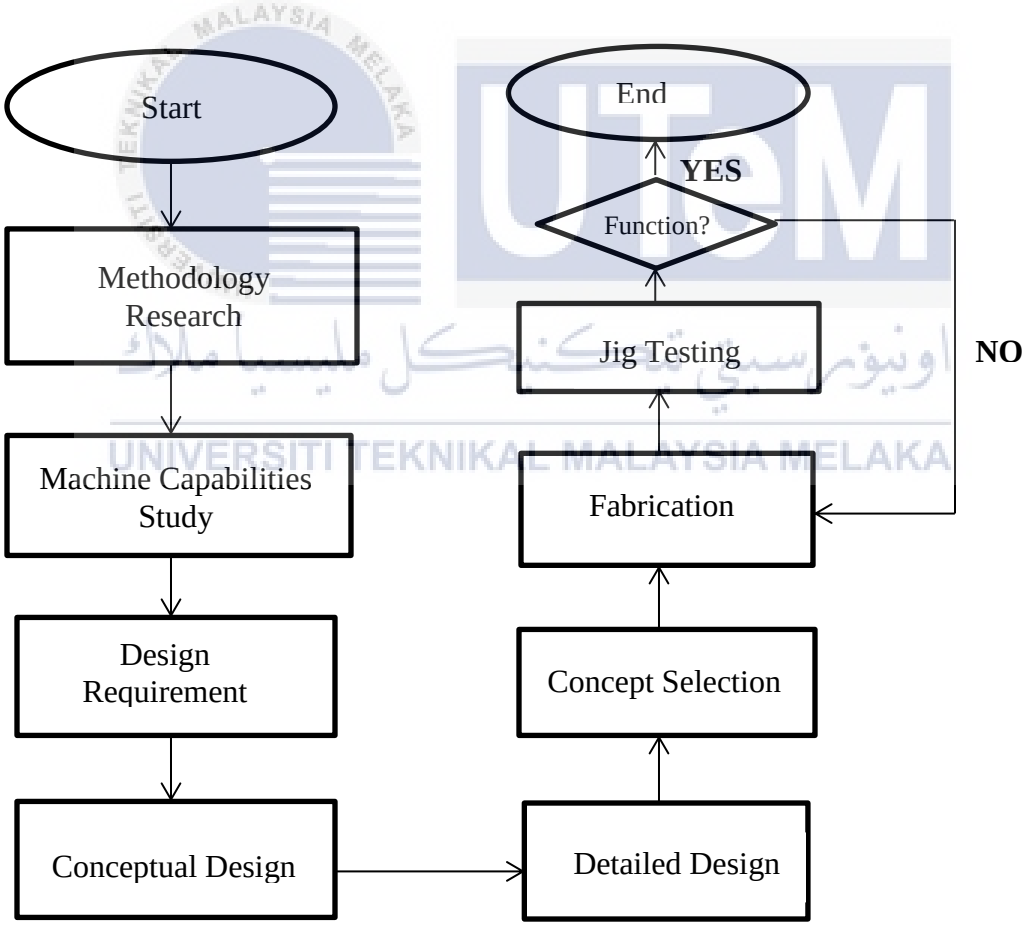


Figure 1.1 : Flow Chart of the methodology

CHAPTER 2

LITERATURE REVIEW

2.1 Adhesives Technologies

Adhesive is widely being used in mechanical field because of its ability to join parts and withstand high stress and strain. There are lots of researches done regarding to adhesive shear stress and strain. Example, Peretz experimented the shear behavior information using specially designed torsion gadget which measures the shear moment-displacement for adhesive layers.(R.D Adams, F.J Guild, F Kadioglu,2000[1]). Dolev and Ishai carried out experiment on bulk in-situ adhesives specimen with a view to characterize mechanical behavior under various load and stress.[1] Lilleheden extends his researches to investigate the mechanical properties of adhesive specimen in bulk and thin-film form to prove the reasons for above discrepancies.[1]

An adhesive must not be chosen only according to its strength but also with regards to its suitability for the environmental conditions and the loading type. In the 1990s a new generation of toughened epoxy adhesives called crash-resistant adhesives, arrived on the

market with good strength at high strain rates and large energy absorption capabilities (Adams, 2005).

In aeronautics and automobile industry, the light weight and complex structures normally used adhesive in mechanical structure bonding (Da Silva, 2011a). Use of adhesive in mentioned industry can drastically reduce the weight of vehicles (M.R.G Silva, E.A.S Marques, Lucas F.M Da Silva, 2016). On the other hand, for high strain rate application, adhesive is not recommended. Adhesives only provide high static strength.

2.2Adhesive Peel Test

Peel test is a mechanical test to measure the strength of an adhesive. It generally tests how strong can the adhesive hold a joint or object together. There are 3 common types of parameter used to measure peel test which are tensile strength, shear strength and peel force. The most frequently used result parameter of a peel test is peel force. (Yue Wang, 2014). The variables which affect the peel force are the geometry (size of specimen, thickness of adhesive), properties of the adhesive and specimen and environmental interference. (M.D. Thouless, Q.D. Yang, 2008). The general equation for peel force, P_r is stated as below depending on geometrical and material parameters based on study done by M.D. Thouless and Q.D. Yang:

$$\frac{P_f}{\Gamma_I} = f\left(\frac{\bar{E}h}{\Gamma_I}, \frac{\Gamma_{II}}{\Gamma_I}, \theta, \frac{\sigma_Y}{\bar{E}}, n, \frac{\hat{\sigma}}{\sigma_Y}, \frac{\hat{\tau}}{\sigma_Y}, \frac{\bar{E}_s}{\bar{E}}, \nu, \nu_s\right)$$

Peel test general equation (M.D. Thouless, Q.D. Yang 2018)

The analogy of a peel test can be illustrated using Dr.K. Kendall's model. The model illustrated an elastic film peeled from a rigid specimen and it explains the relationship of

elastic modulus and other variables that affect the peeling strength. Peeling adhesive layer from substrate required energy. However, this peeling process can use energy conservation law for analysis purpose. (Yue Wang, 2014). We can set up a peeling system shown in Figure 2.1 below:

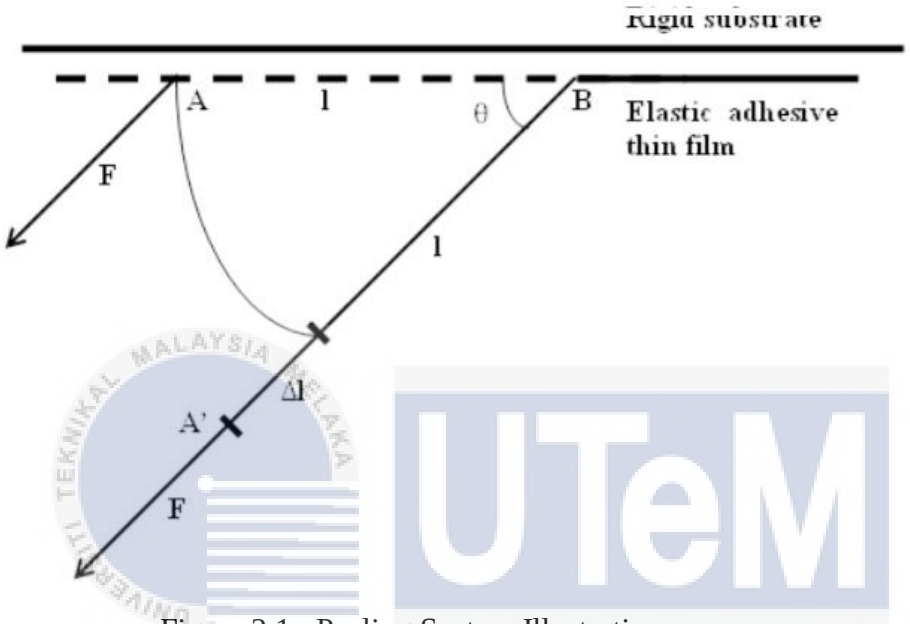


Figure 2.1 : Peeling System Illustration.

The Adhesive Layer Has A Thickness Of D, Width Of B And Elastic Modulus B (Yue Wang, 2014) However, the geometries of peel were divided into 3 main types, 90^{o} peel, 180^{o} peel and T-peel. The degree of the peel refers to the geometry of a peel test.

2.3 Mandrel Peel Method

A mandrel peel method is peeling test where the peel curve is controlled by a roller with radius. (L.F Kawashita, D.R Moore, J.G Williams, 2005[2]) By neglecting the frictional force, the setup of Mandrel peel test is as shown in Figure 2.2:

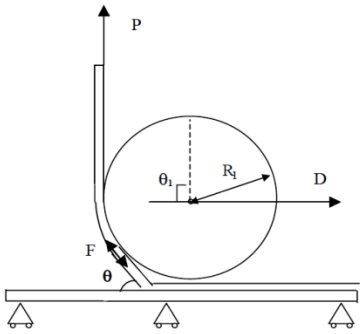


Figure 2.2 : Mandrel peel test[2]

The general governing equation for Mandrel peel test is: [2]

$$FR=PR \text{ or } F=P$$

The horizontal equation, D is given by: [2]

$$D=P(\cos\theta+\cos\theta_1)$$

If $\theta=90^{o}$ then the equation is as follows:[2]

$$G=(G_A+G_P)=\left(\frac{P-D}{b}\right)$$

2.4 Jig and Fixture

A jig or fixture is created to hold workpiece and guide the cutting tools. In peel test, a fixture is designed to be used to hold the adhesive and specimen in place for peeling. Although the test can be carried out without a jig, but with the aid of a well-designed jig, the test can be simplified and the accuracy of the test can be improved. Figure 2.3 and 2.4 below show few examples of jig designed to be used in peel test.

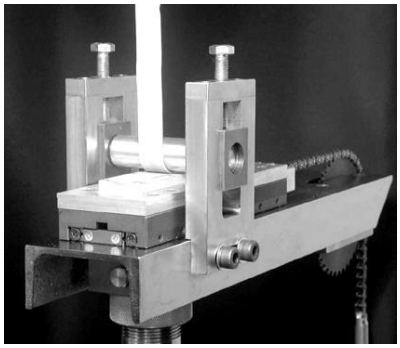


Figure 2.3

Figure 2.4

In this project, the design of jigs and fixture follows the standard of ASTM D3330/D3330M. The method is referred as Method F in the standard. Test Method F is a 90° peel. A strip of tape is taped onto a test platform and then peeled from the platform at a 90° angle at a certain rate while the time and the force required to peel the tape off is recorded. (ASTM D3330/D3330M, 2010). The maximum load of the peel test is 10kN and the standard speed of the peel is 300mm/min.

There are many designs of jig in the market that are suitable to be made as reference in this design project. Figure 2.5 and 2.6 show the design of peel test jig from Shimadzu Company with sample results which can be referred as to design a jig for peel test in this project. (Shimadzu Data Sheet no.18) This design of jig is very close and similar to the jig design in this project because this jig is also specially designed for the use on UTM machine of Shimadzu Company. The laboratory uses also used the same UTM machine by Shimadzu.

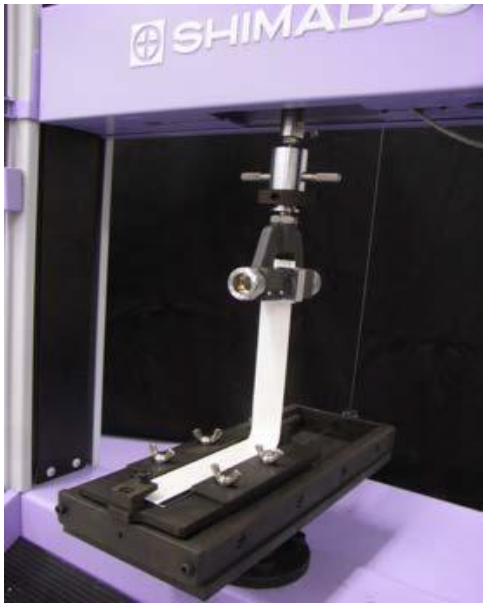


Figure 2.5 : Shimadzu Coporation Jig AGS-X

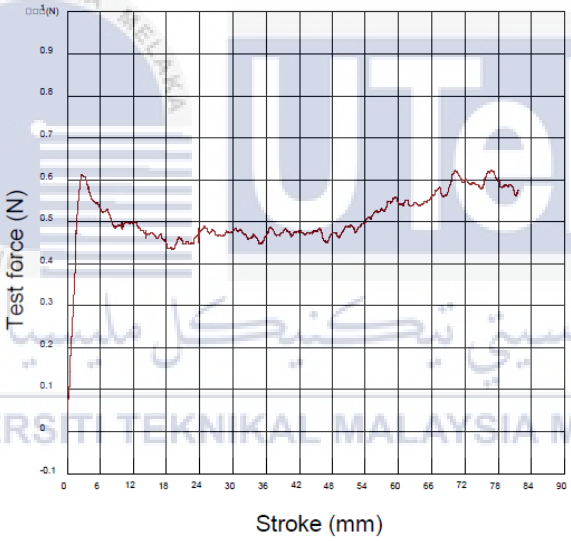


Figure 2.6 : Sample result of the test ran with AGS-X

CHAPTER 3

METHODOLOGY

The methodology of this project will begin from title selection until the testing of designed jig on UTM machine. At the beginning of this final year project, the information about adhesive and peel test is studied thoroughly. Research journals and articles are reviewed to understand the adhesive, peel test and jig design for peel test. There are a number of suitable designs that can be used for peel test, but only the most suitable design of jig will be chosen and modified so that it compatible with UTM machine.

3.1.Methodology Researchs

At the beginning, major amount of time are used in case study, research paper study and article study related to the title of this project. Previous research paper on uses of adhesive, strength of adhesive, peel test, type of peel test, design of jigs for peel test are referred and reviewed to understand peel test as well as designing a jig to aid peel test. Throughout the time during methodology research, there are several designs of jig that are

compatible to the UTM machine, but most of them required further improvements. All others related topics about the research and study of this PSM title are as stated in Chapter 2. The capabilities of UTM machine is also studied to aid the design of jig so that it suits the machine.

3.2 Determine the capabilities of the Universal Tester Machine

The ultimate purpose of the jig design is to assist the UTM machine to carry out the peel test. However, to begin the design process of the jig, the capabilities of the UTM machine must be studied so that the jig design can fit perfectly onto the UTM machine. The size of the grip of the UTM machine is measured to ensure that the jig design can fit the grip. The mechanical motion of the UTM during a peel test is also observed to gather more information to assist the design process. To conclude, the best way to install the jig onto the UTM machine is to fix the jig onto the grip of the machine. The top grip of the machine is use to grip on the tape while the bottom grip is use to grip on the jig.

3.3 Design Requirement

The design requirements are determined to produce the desired design of jig for peel test on UTM machine. Design requirements are mainly determined from the capabilities of machine and jig design of other researches. Customer survey is not suitable to be done on this design because the suitable sample of survey is very small. The design requirement determined is as below:

- Able to assist the UTM machine to perform peel test
- Able to fit perfectly onto the grip of the UTM machine

- Size and weight must be sustainable by the UTM machine
- Structure and material must be strong and stiff enough to carry out peel test
- User-friendly design to add convenience to user
- High mobility and low weight and size. Easy to install and remove

3.4 Generation of Ideas and Conceptual Design

The majority ideas to design the jig are generated from reference to the product design available in the market and previous researches. The concept of jig design in this project is peel test jig with a specimen plate and assisted by a roller. The idea of roller is inspired by the research done on the mandrel peel method. The roller is able to assist the jig to peel the specimen from the specimen plate consistently. The locomotion of the specimen plate is however very simple compared to the design available in market. Majority design of peel test jig in the market used roller or slider to move the specimen plate. In this design, a simple concept of slider will be used to slide the specimen plate along the platform during peel test.

3.5 Detailed Drawing of Design

After significant study on the topic, the project proceeds with design process in PSM 1 which included generation of jig design part drawing using CATIA software. The best design was chosen from the conceptual design and each and every part of the jig designed follows appropriate standard and modified according to its need. However, there are analyses that need to be done in design process especially the dimension and tolerance analysis to ensure that the

design can be assembled perfectly in next process. After drawing the design in CATIA, the design is also used for simulation so that it can work well when assembled.

The dimension tolerance of the jig is analyzed and checked before fabrication test through simulation in CATIA to ensure that the jig can be assembled properly as shown in Figure 3.5 when all the parts are fabricated.

3.6 Selection of Concept

After generation of ideas and conceptual design, the designs will be rate and the better concept is selected to be fabricated. Stuart Pugh's method of selection is used to determine the best design.

3. 7 Fabrication planning

In this project, the preferred manufacturing process is using rapid prototyping. However, other manufacturing process can also be used in order to fabricate desired jig. Rapid prototyping is preferred because it can provide good prototype at a low cost.

3. 8 Analysis Of The Performance Of Jig On UTM Machine

After fabrication and assembly of the jig, the performance and the functionality of the jig will be tested with peel test on UTM machine. The objective of this analysis is to determine whether the jig is able function to the peel test on UTM machine or not. If the design is successful, this project can be used for reference for improvement purpose on design of jig for peel test as if the design is a failure, the problems which caused the failure will be identified and amended. The specimen used for peel test will be musking tape. The specimen will be adhered onto different material of specimen platform in this design and peeled by the UTM machine with the aid of the jig roller.

CHAPTER 4

RESULTS

4.1 Conceptual Design

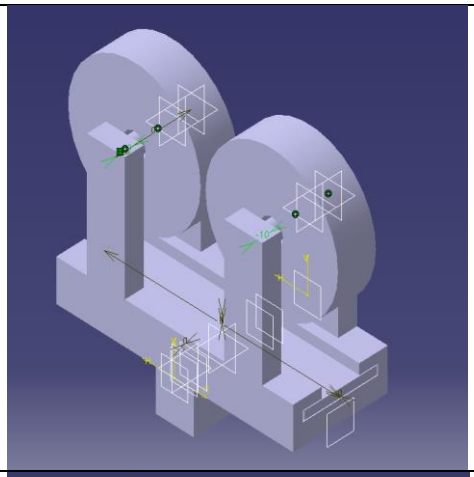
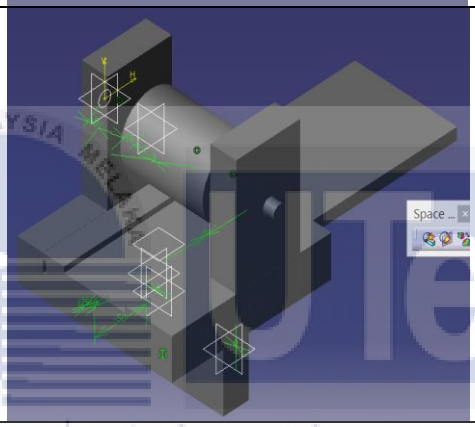
First, to start generating conceptual design, there are few things that need extra attention to ensure the manufacturability and functionality of the jig. First, to manufacture the jig using rapid prototyping, the design must not be over-hanged. Deliberately fabricating an over-hanged design will result in low quality and rough surface finish onto the jig.

Secondly, due to the capabilities of 3D-printers, it is hard to obtain precision of dimension of the hollow part. The imprecise dimension in hollow part will cause the movement of the plate to be inconsistent during the peel test.

Thirdly, the space for the peel specimen of previous design is limited. However, the size of the platform is modified so that it satisfied the ASTM-D6862 standard test method for 90-degree peel resistance of adhesive.

There are 2 concept design generated in this design project. The details of the designs are shown in Table 4.1.

Table 4.1 : Concept Design

Concept	Design	Details
A		Jig design with 2 rollers to assist the peel. It has greater size. Specimen move along the platform by sliding.
B		Jig design with 1 roller only. Relatively smaller in size. Wider specimen plate. Simple installation and working mechanism

The design available in the market which follows the same standard is able to fit a standard specimen width of 55mm and others specimen sizes up to 260mm. Therefore, this modified jig can up to 80mm specimen width which satisfied the standard width of 55mm.

4.2 Detailed Design of Jig

The detailed design of the final jig design is produced using CATIA. The jig will be assembled parts by parts after all the parts are fabricated using 3D-printer. Basically, the mechanism of the design is very simple. The adhesive tape will be adhered to the specimen plate and the specimen plate will be fitted onto the platform. One end of the adhesive will

be gripped by the top grip of the UTM machine and the bottom grip will grip on the platform. During peel test, the adhesive tape will be pulled along with the top grip and the roller will roll along with the movement of the adhesive tape upwards. Figure 4.1 – 4.5 showed the drafting of each part of the jig and the assembled jig of concept A while Figure 4.6 – 4.11 showed drafting of every part in Concept B.

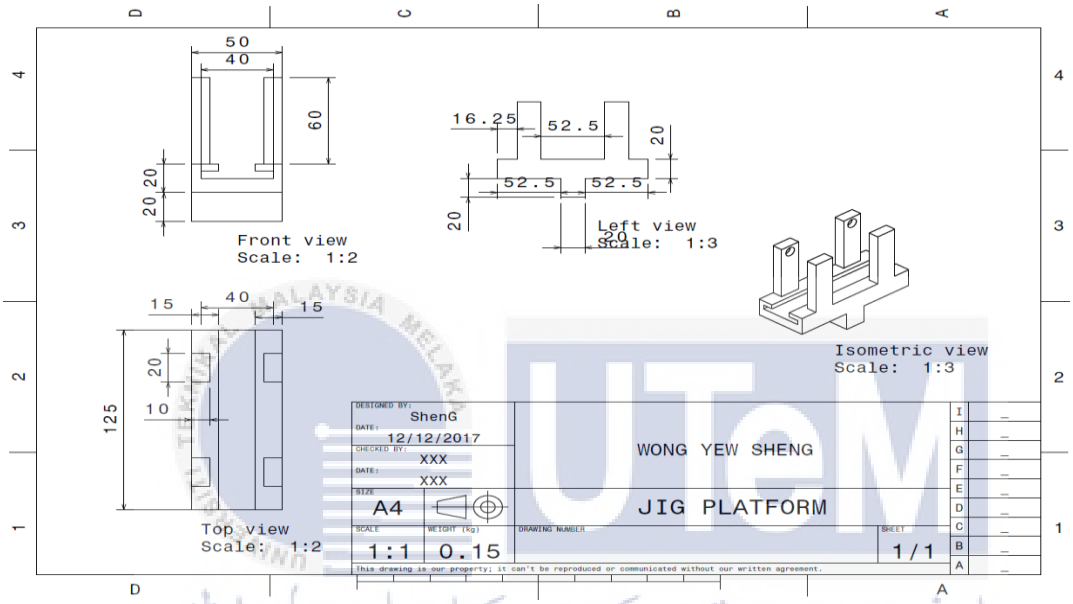


Figure 4.1 : The draft of jig platform

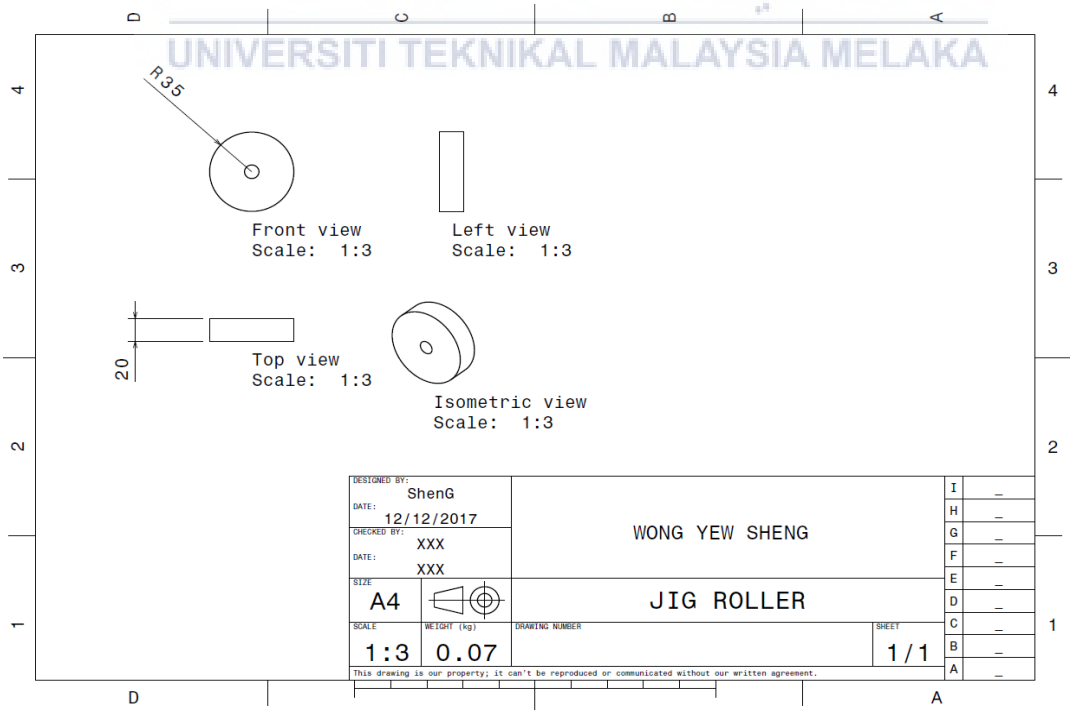


Figure 4.2: The draft of jig roller

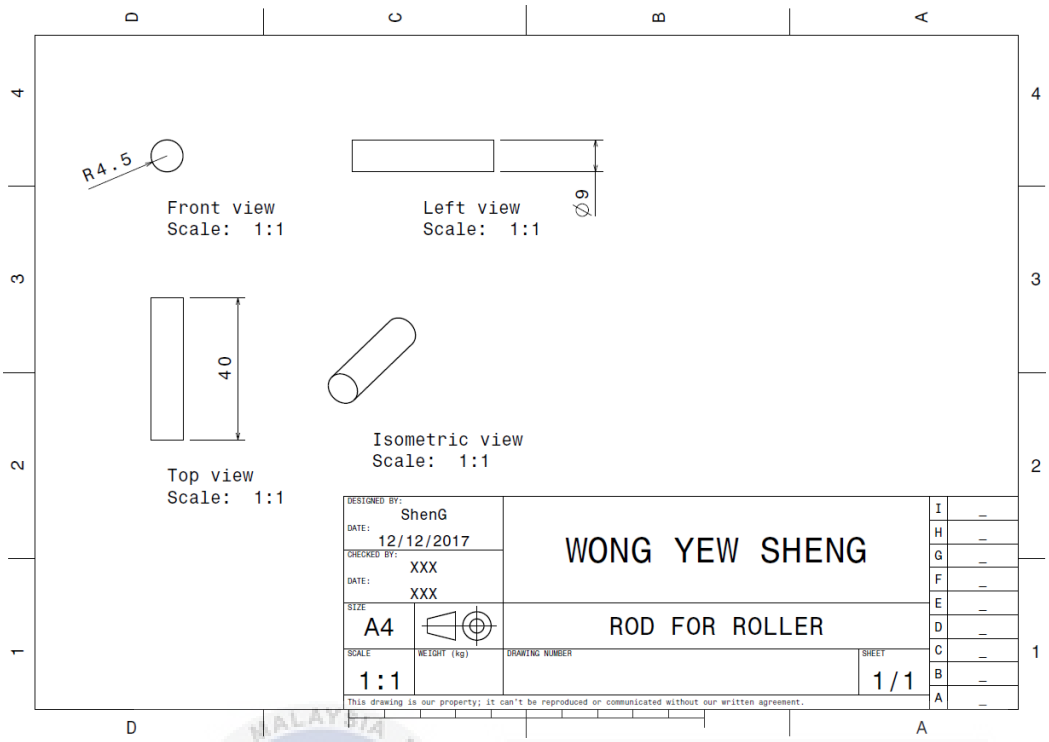


Figure 4.3: The draft of rod for roller

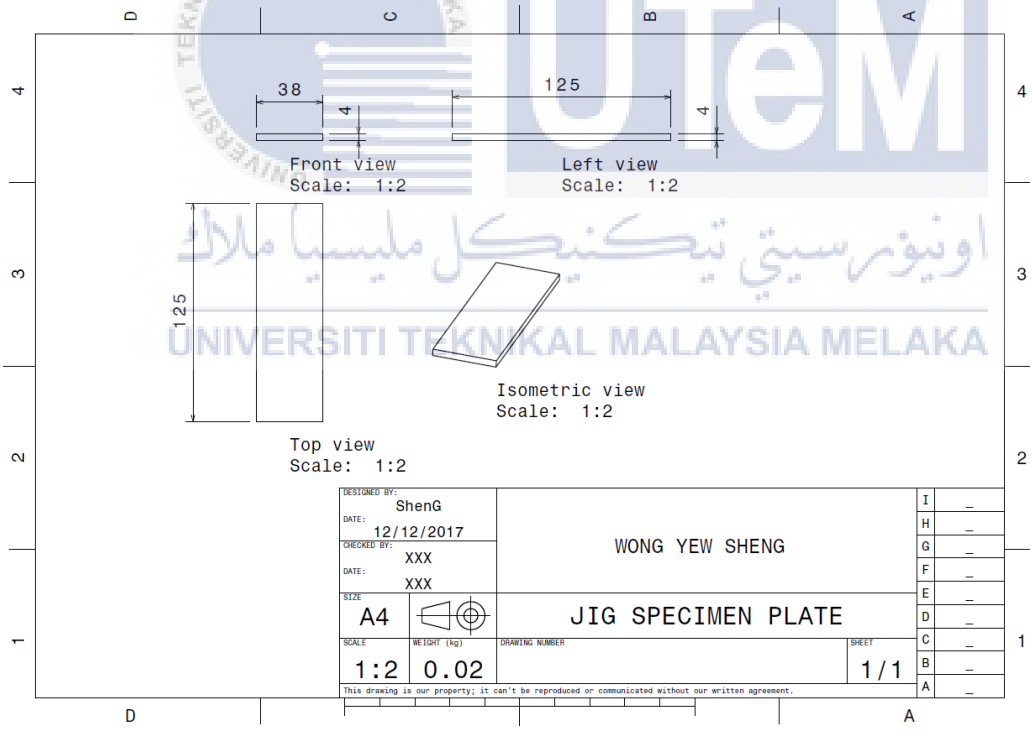


Figure 4.4: The draft of specimen plate

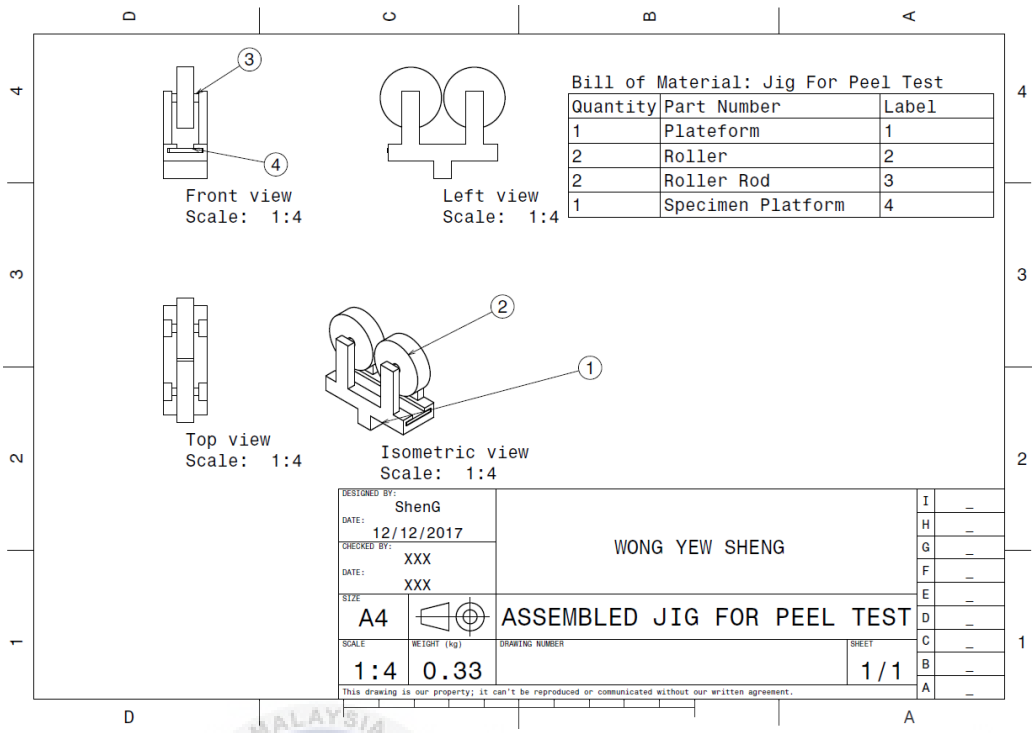


Figure 4.5: The draft of assembled jig

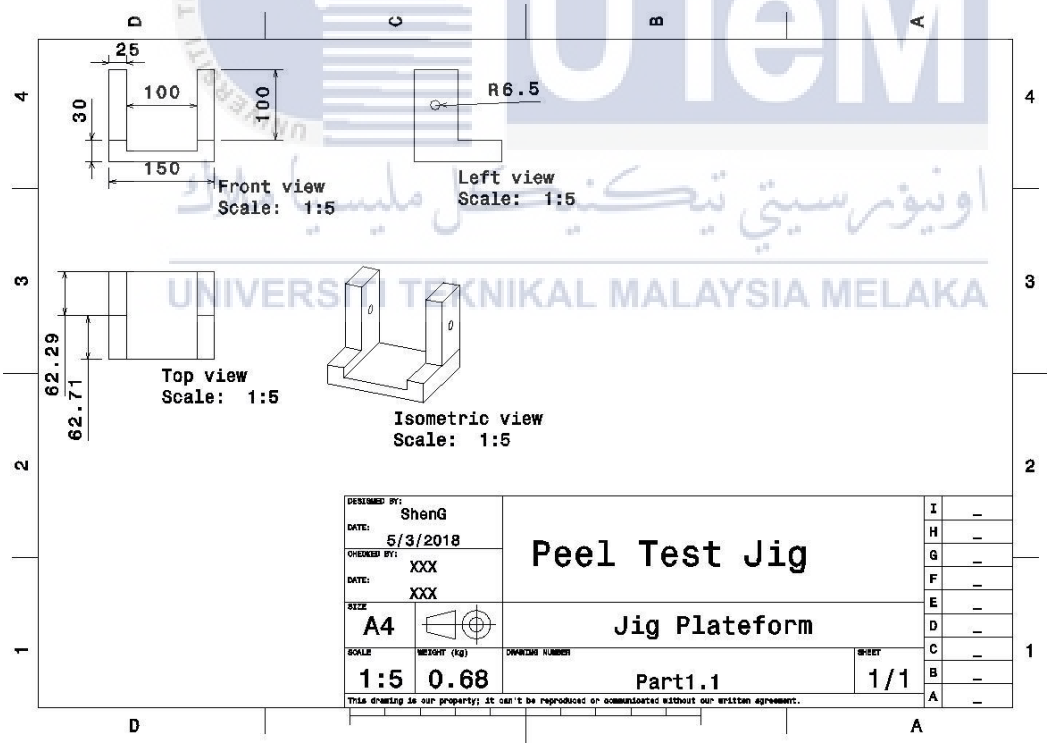


Figure 4.6: Jig Plateform Drafting

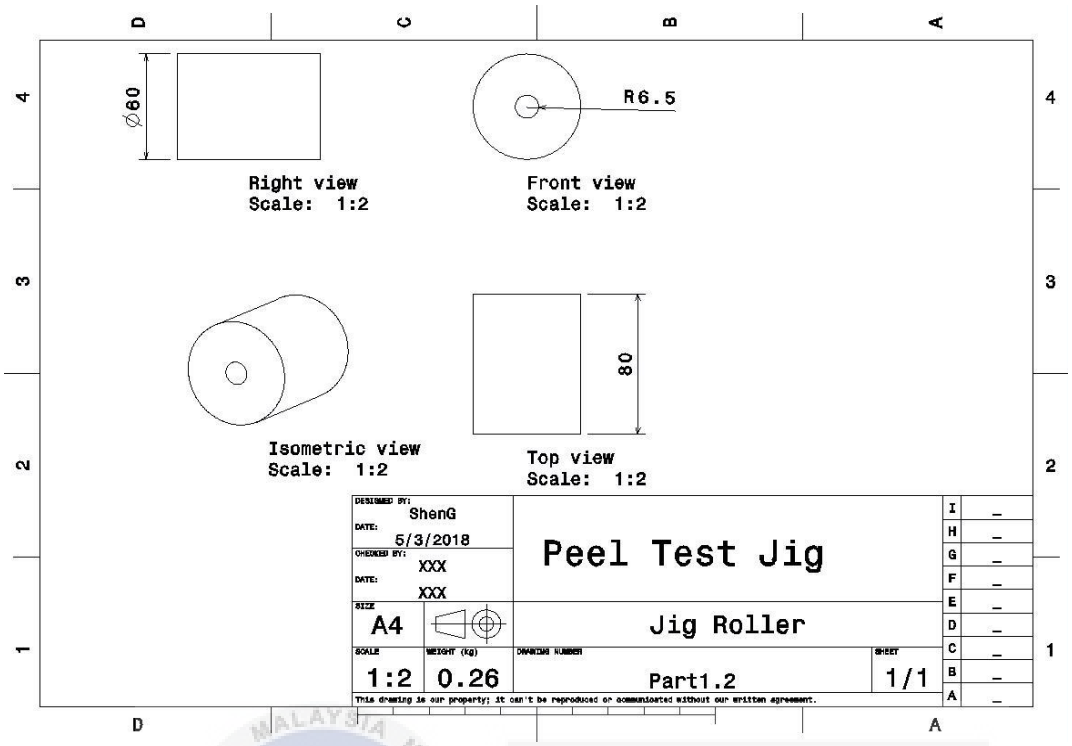


Figure 4.7 : Jig Roller Drafting

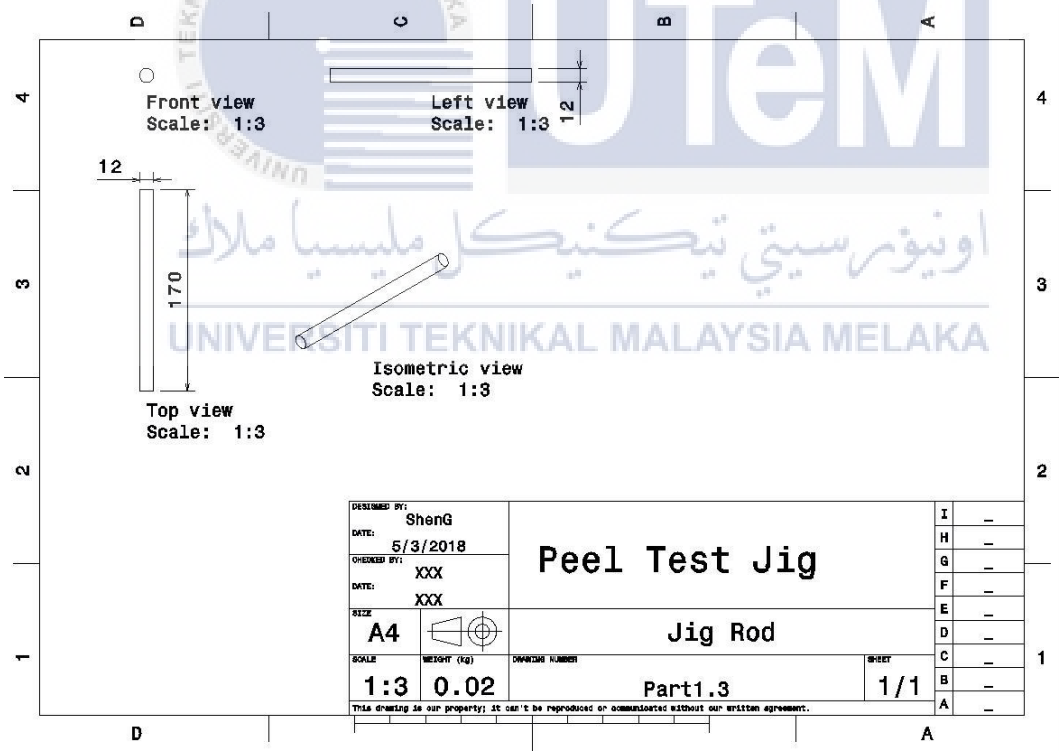


Figure 4.8 : Jig Rod Drafting

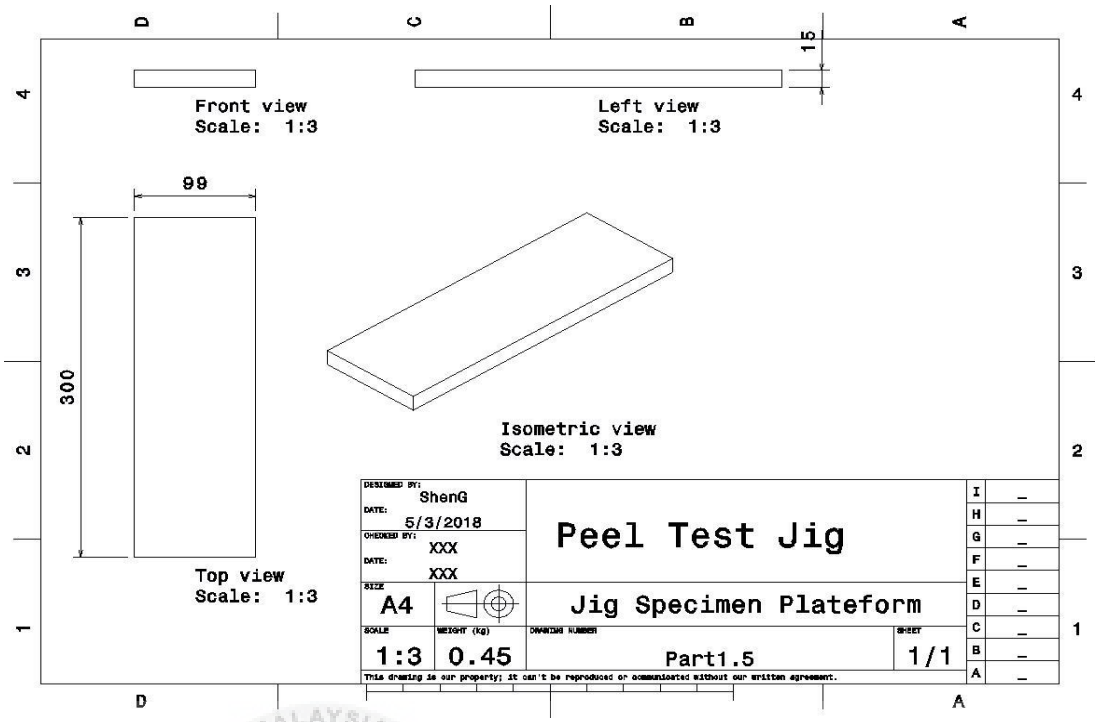


Figure 4.9 : Specimen Plate Drafting

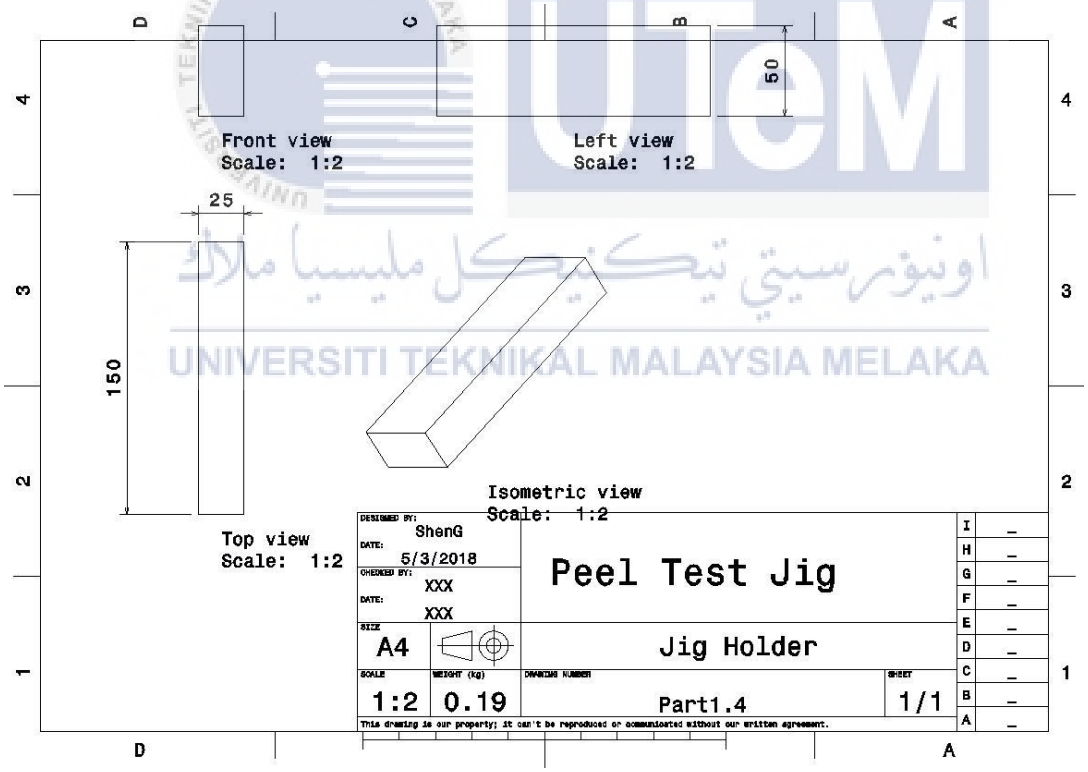


Figure 4.10 : Jig Holder Drafting

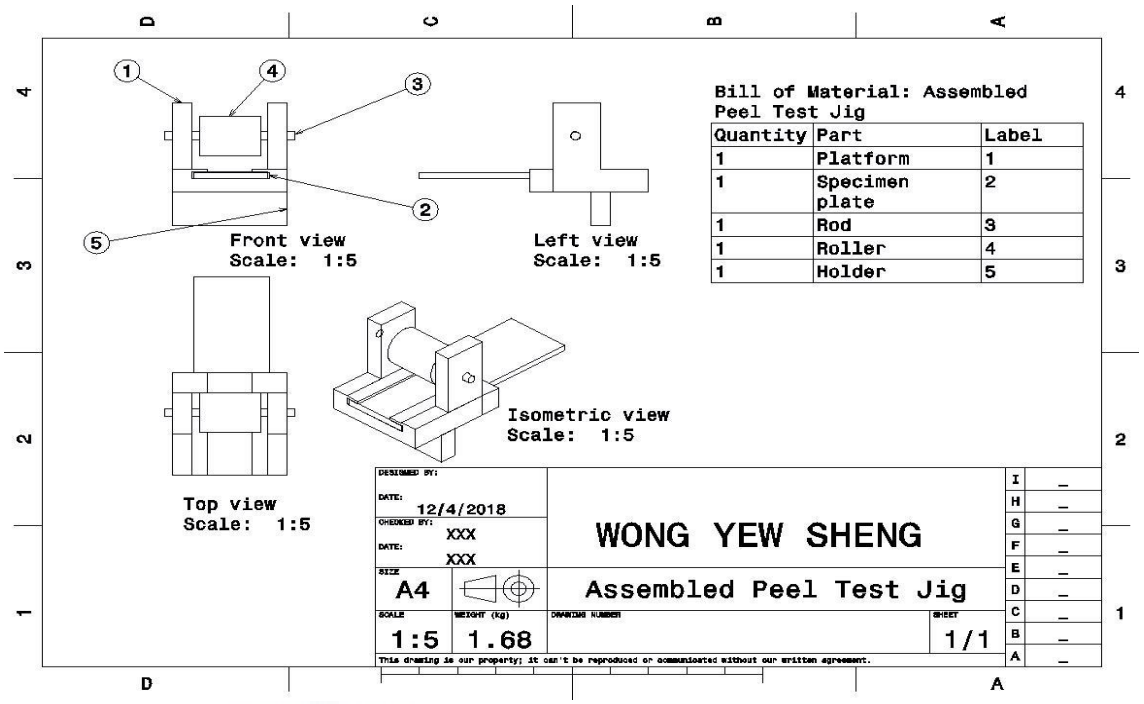


Figure 4.11 : Assembled Jig Drafting

4.2 Concept Selection

The concept is selected using Pugh's selection method. Criteria for the selection of jig design are considered by referring the design requirement of this project. The concepts are compared with peel test jig available in market, the G50 peel test table by TestResources Inc. G50 peel test table is a jig installed onto Universal Tester Machine to carry out peel test which is very similar to the jig design required in this project. Table 4.2 shows the Pugh's method matrix for the selection of concept.

Table 4.2 : Pugh Method Matrix

Criterion	Concept A	Concept B
Fit UTM	0	0
Good Strength	+	-
Smaller size	-	+
High efficiency	+	+
User-friendly	-	+
High mobility	+	+
+	3	4
0	1	1
-	2	1
Net score	1	3
Rank	2	1

According to the design requirement, the criteria of the desired jig design for this project are that it fit onto UTM, have good strength, small in size, high efficiency, user-friendly and high mobility.

Concept A fits perfectly on the UTM. It has relatively higher strength due to its design structure with the support of 4 pillars. It also functions at high efficiency during peel test with the assist of the rollers. However, due to the design of pillars and 2 big rollers, its big size cause inconvenience to the user to setup the jig for peel test.

Concept B also fits perfectly on the UTM. It has low strength due to its design structure. The design of Concept B is relatively smaller in size and it is user-friendly especially when setting up for peel test on UTM. It also has high mobility due to its size.

The results of the matrix showed that Concept B is ranked 1 with net score of 3 while Concept A is ranked 2 with net score of 1. From the result of Pugh's method matrix, concept design B has a higher rating compared to concept design A. Therefore, Concept B is selected to be the final design of this project. Mechanical analysis will be done onto Concept Design B to analyze the stress that will act onto the structure when load is applied.

4.3 Mechanical Analysis of Jig

A stress analysis is done onto the part where load is distributed, the rod of the jig. The load acting onto the rod of the jig is set to 10kN which follows the 90 degree peel test for adhesive tapes standard No.ISO 29862:2007 (T.Murakami) done by Shimadzu Corporation. The results of the analysis are shown in Figure 4.12 and Figure 4.13

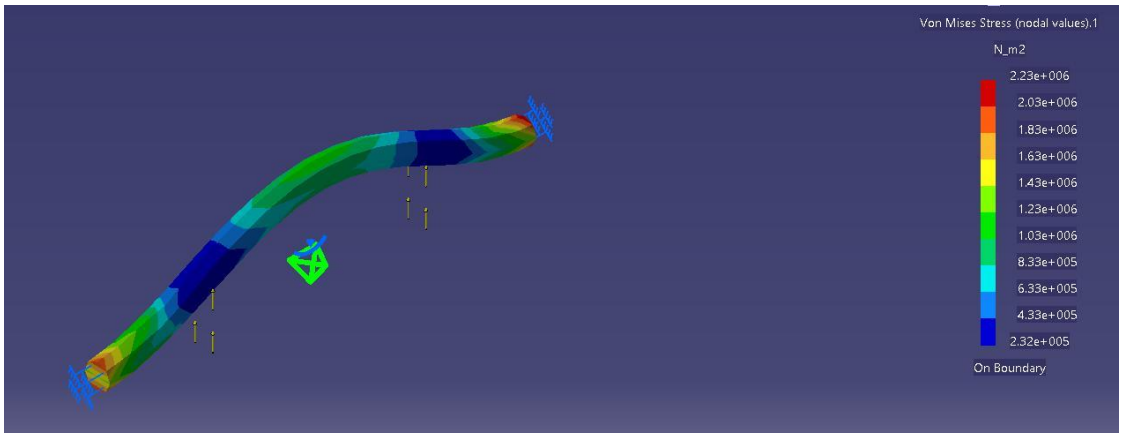


Figure 4.12 : Von Misses Stress Distribution

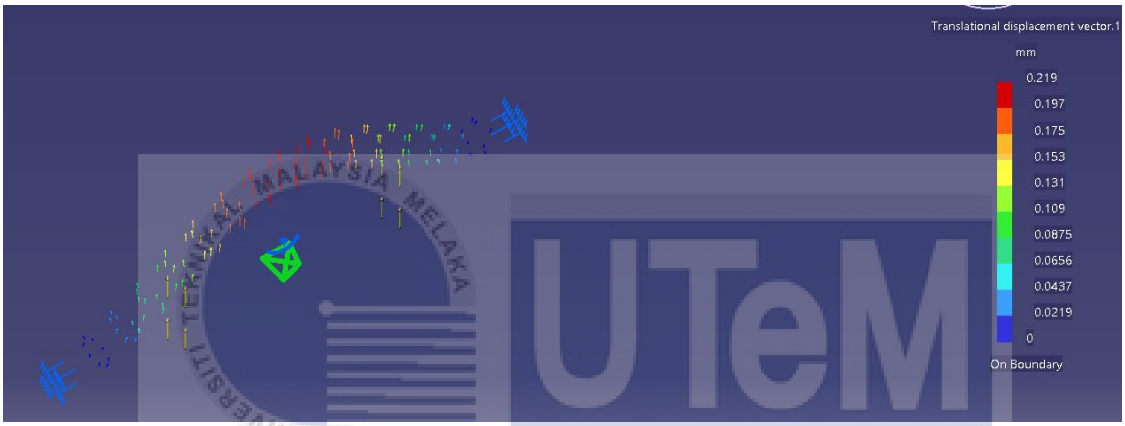


Figure 4.13 : Translational Displacememt

The analysis showed that the maximum von misses stress is located at the red-colored region of the rod which is $2.23e^{6}$ N/m^{2}. The maximum translational displacement for the rod is 0.219mm which located at the middle of the rod. The factor of safety of this rod in the jig is therefore calculated to be 16. The high value of safety factor is most probably due to over-design. This analysis showed that the jig is able to carry out peel test at a minimum 10kN and up to of load without failure. From the analysis, for 10kN of load, the safety factor is calculated using formulation:

$$\text{Safety Factor} = \frac{Actual\ Stress}{Allowable\ Stress}$$

$$= \frac{35.9Mpa}{2.23Mpa}$$

$$= 16$$

4.4 Manufacturing of the Jig

First and foremost, to plan for the manufacturing of jig designed, the consideration must include the possibility, capabilities and cost of each and every manufacturing process taken into consideration. The manufacturing process needed to fabricate this jig must be cost-saving, able to produce the desired shape in accurate dimension and with minimum defects.

Eventually, the manufacturing process decided to be used is rapid-prototyping process using 3D-Printer. This manufacturing process is low-cost and able to fabricate the shape designed with accurate dimension as well as sustainable product strength. 3D-printed product also has low weight which satisfies the product design requirement. Figure 4.14 and 4.15 shows the manufacturing of the jig.

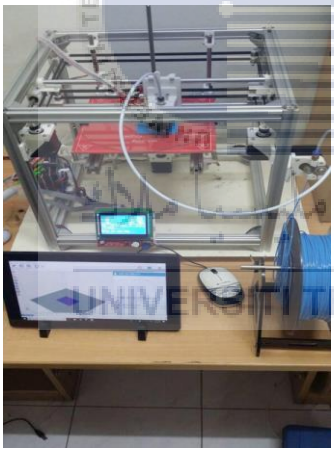


Figure 4.14

Figure 4.15

The jig is manufactured part by part and assembled after fabrication is completed. There are some problems encountered during the manufacturing process which required some parts that needed to be reprinted. First, the 3D printer is not capable to print jig size as big as the actual draft in detailed design. However, the printing is scaled down by 0.5 so that the prototype can be produced.

Second, the product will shrink a little in size during 3D-printing. This cause the dimensional tolerance set at 0.3mm too small to be assembled. However, during the

reprint, the dimensional tolerance is adjusted to overcome the situation. The completed jig assembled is shown in figure 4.16.

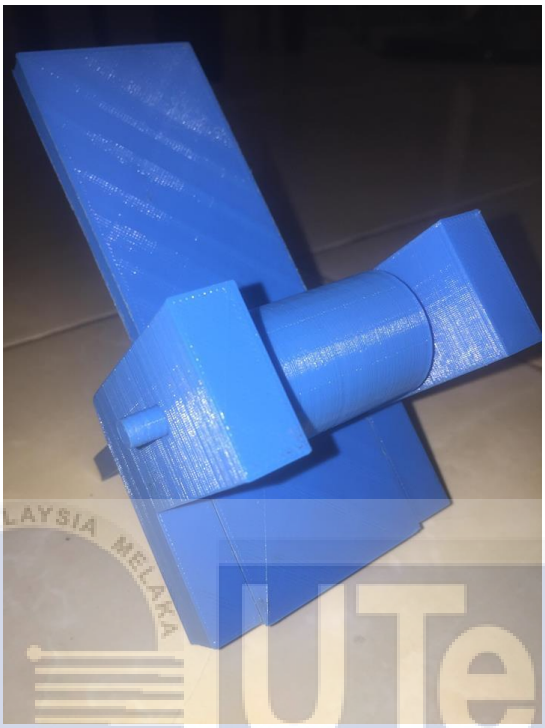


Figure 4.16: Assembled Jig after Fabrication

4.5 Testing and Result of the Jig

Upon completion of the fabrication of the jig, the peel test jig is tested on the UTM. The purpose of the test is to determine the capabilities and functionality of the jig to carry out peel test on the UTM. The parameters of the test are the force required to peel the musking tape off and displacement along the specimen plate. The peeling speed is set at 300mm/mins. The setup of the test before adhering musking tape on the specimen plate is as shown in figure 4.17.

Figure 4.17 : Peel Test Setup

The test is carried out for 3 times with musking tape adhered on 3 different surfaces. The first peel test includes peeling the musking tape off the original surface of the specimen plate. In second test, the specimen plate is wrapped with aluminium foil while in third test the specimen plate is wrapped with rubber covered with rubber sheet. The data recorded in by the computer is taken as the result of the test. It recorded the graph of load against displacement. Figure 4.5.2 shows the graph obtained in test.

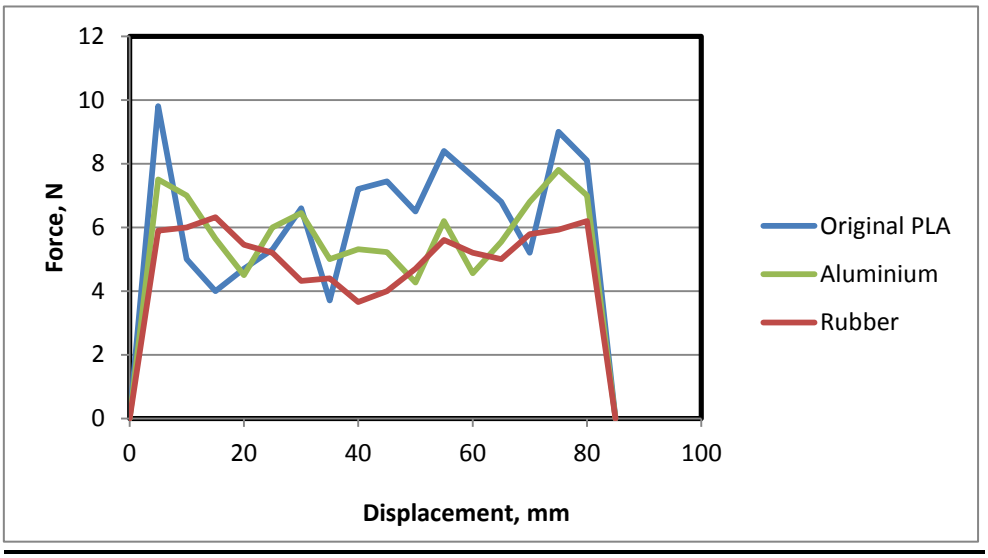


Figure 4.18 : Graph Force Against Displacement

4.6 Discussion

The maximum load recorded among 3 of the test is around 9.8N. The original surface of the specimen plate required maximum force 9.8N to peel the musking tape from the surface. The average peeling force required to peel the musking tape off the original surface is also highest among the 3 different surfaces.

The aluminium surface required lower force followed by rubber surface which require lowest force. Maximum force recorded to peel the musking tape from the aluminium surface is 7.5N. As for the rubber surface, the maximum force recorded to peel the musking tape from it is 6.32N. The adhesive strength is greatest on the original plastic surface and weakest on rubber surface.

As a brief footnote, the jig design is functioning well, but after using it for some time, it revealed some imperfection which had reduced the efficiency and the accuracy of the test. When the specimen plate is used for several times, the dimensional tolerance on the specimen plate which is in-contact-sliding with the platform tends to wear off. This causes the specimen plate to become loose along the platform. Since the specimen plate is loose, the plate will sometimes move slightly upwards during peel test which cause inaccuracy to the test.

Other than that, it is also very important to say that if we do not neglect frictional force acting against the sliding specimen plate during the peel test, the test will also not be accurate because the slider is indeed affected by the friction as it slide along the platform.

Improvement can be done onto the jig in the future to solve all the problems encountered and stated above. The suggestion to solve the problems will also be attached in the future recommendation part in this project.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

To conclude, the concept of the design of this peel test jig is very similar to the jig referred in the journal in literature review. The ideas and concept to design the jig mainly come from the current design available in the market and with the assist of some previous research papers.

The jig designed is able to carry out peel test as desired although that the efficiency and accuracy of the jig is still not as good as desired. The detailed and final design of jig in this project is not perfect as desired. There are unexpected errors encountered throughout the design process and testing. These errors encountered are all recorded in this project and could be the room of improvement for future research on this same topic.

Due to limited cost and time, this jig design is simple in design and working mechanism compared to peel test jig found in the market. However with greater budget or source of fund in the future, this jig can be improved in terms of design, material, working mechanism and size.

5.2 Recommendation

In mere future, it is highly recommended that the specimen plate of this jig is to be designed so that it can only move in X-Y direction and not Z-direction. This can be done by creating a slot-like space to insert the specimen plate so that it doesn't move in Z-direction. However it is also recommended that slot-like space for the specimen is designed in a greater length in future to provide accuracy to the test. Figure 5.2.1 and 5.2.2 showed the drafting of suggested jig design modification for future research.

It is also recommended that in future, the specimen plate can be designed in various lengths so that different length of peel test can be carried out with the jig. In addition, slider is not the best moving mechanism of the specimen platform. The moving mechanism can still be improved so that the friction while the specimen plate moves along the platform can be reduced and the result of the peel test will be more accurate.

Last but not least, the jig must be optimized so that the factor of safety of the design is not too high. According to the past researches on design of jigs and fixture, the standard factor of safety is set at 3-5 which is the optimum range of safety factor for jig design. However, before manufacturing the jig, in order to reduce the safety factor of the jig, the design can be optimized by removing the unwanted or non-functional part of the design. Other materials can be used to adjust the allowable stress to optimize the safety factor of the jig design.

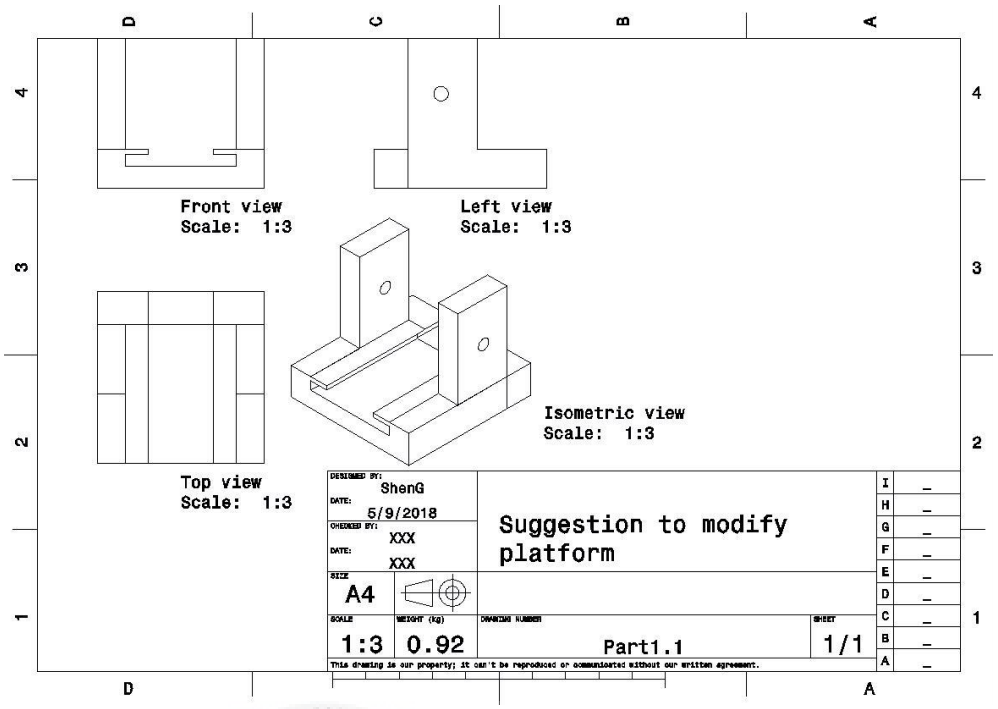


Figure 5.1: Drafting of Platform after Suggested Modification

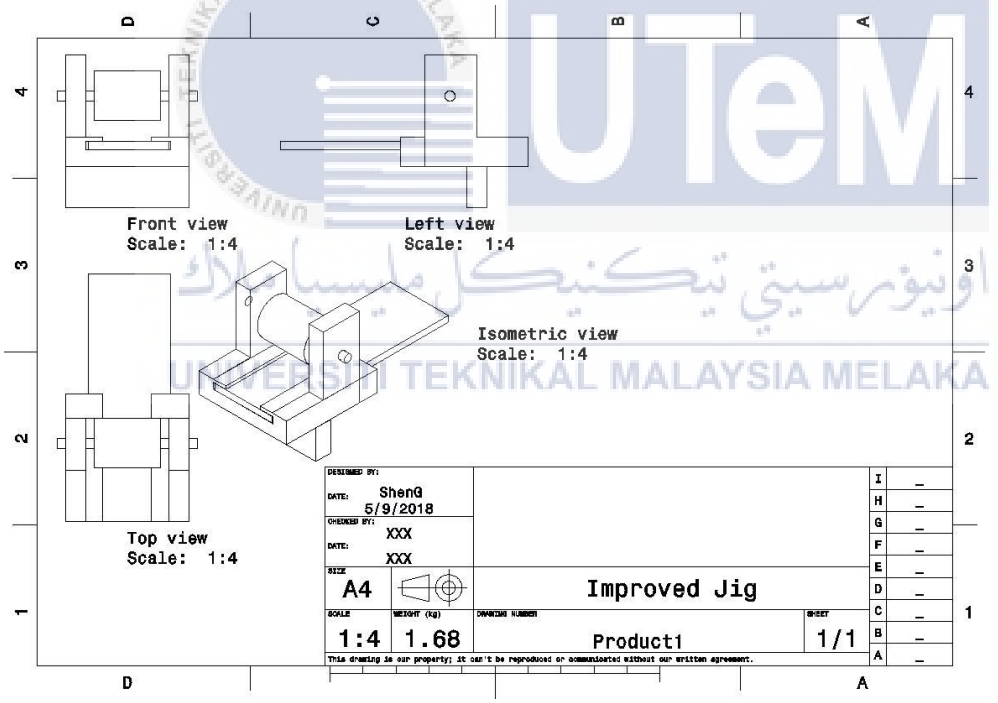


Figure 5.2: Drafting of Assembled Jig after Suggested Modification

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