MODULAR STUDY TABLE

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JUDUL: MODULAR STUDY TABLE

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MODULAR STUDY TABLE

WAN MOHD FIRDAUS BIN WAN MOHD NOR

A report submitted in partial fulfillment of requirements
for the award of degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

MAY 2009

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

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STUDENT DECLARATION

I declare that this thesis entitled *modular study table* is the result of my own research except cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	: ……………………….
Name	: WAN MOHD FIRDAUS BIN WAN MOHD NOR
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Date	: ………………………..

Dedicated to my beloved:

Father,

Mother,

Younger brother

ACKNOWLEDGEMENT

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Praise to Allah S.W.T, the Most Merciful and the Most Compassionate. Peace upon him Muhammad S.A.W, the messenger of Allah.

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ABSTRACT

The problem to the existing table nowadays is it is fix or limited to number of person that can use it in the same time. The space for it cannot be adjusted to accommodate more people then it supposed to. The user has to find other solution such as providing another table if the current table cannot fulfill the number of people. The purpose of this project is to design and develop a study table that can be manipulated in term of the space that the table can provide according requirement. In this project, the table would be able to support amount of user from single person till four person max at a time. The use of the table can be modulated from a single person to a group of four people. Single person would use smaller space compared to a group of four people. The variable condition makes the usage requirement varies from time to time. The objective of this project is to design, analyse the structure and lastly to fabricate the flexible table that can fill the needs from user. The scope of work is to draw the parts for the table by using Solidworks software, assemble all the parts into a table in the Solidworks, build the real structure of the table (by parts), and use the ALGOR software to analyse the structure. In the analysis, it is mainly to determine the value of maximum yield stress the table can support for each case from single person study table to maximum four person study table. In the analysis, the maximum value from software analysis is 107.866MPa, happens in the four person usage case. The value is acceptable due to the yield strength of the material used, aluminum, is 325MPa. Displacement for the structure can also be observed in ALGOR analysis for all three cases. Displacement of 9.4mm is observed in simulation for four person usage and this value is still acceptable for construction. The table did form the shape planned but the surface of the table tend to bend even without the load. The deformation can clearly spotted visually relative to a straight object.

ABSTRAK

Masalah yang timbul dengan meja sedia ada pada masa sekarang ialah jumlah pengguna yang boleh menggunakan meja tersebut pada suatu masa yang sama adalah terhad. Ruang yang sedia ada tidak boleh diubah suai untuk membolehkan lebih ramai pengguna menggunakannya pada masa yang sama. Pengguna terpaksa mencari jalan penyelesaian lain seperti menyediakan meja yang lain sekiranya meja yang sedia ada tidak boleh menampung jumlah pengguna. Tujuan utama projek ini ialah untuk merekabentuk dan membangunkan sebuah meja belajar yang boleh dimanipulasikan dari segi keluasan ruang sepertimana yang diperlukan. Dalam projek ini, meja tersebut dapat menampung jumlah pengguna dari seorang hingga empat orang. Ruang yang diperlukan bagi seorang pengguna adalah lebih kecil jika dibandingkan dengan empat orang pengguna. Kepelbagaian keadaan menyebabkan tahap penggunaan berubah dari semasa ke semasa. Objektif projek ini adalah untuk merekabentuk, menganalisis struktur dan seterusnya membina sebuah meja fleksibal yang boleh memenuhi kehendak pengguna. Skop projek ini adalah melukis bahagian – bahagian meja dengan menggunakan perisian Solidworks, menyantumkan semua bahagian meja dalam Solidworks, membina struktur sebenar meja (mengikut bahagian), dan menggunakan perisian ALGOR untuk menganalisis struktur. Di dalam analisis, tujuan utamanya ialah untuk menentukan nilai maksimum stress yield yang boleh ditampung untuk setiap kes dari penggunaan persendirian sehingga maksimum empat orang. Mengikut analisis, nilai maksimum yang diperolehi dari perisian ALGOR ialah 107.866MPa, iaitu pada kes empat pengguna. Nilai tersebut boleh diterima kerana nilai kekuatan yield untuk material aluminium adalah 325MPa. Sesaran untuk struktur juga boleh dilihat melalui perisian ALGOR untuk ketiga – tiga kes. Menurut perisian ALGOR, sesaran sebanyak 9.4mm berlaku pada kes empat pengguna dan nilai ini masih lagi boleh diterima bagi tujuan pembinaan struktur sebenar. Meja tersebut dapat dibina sepertimana dirancangkan tetapi permukaan meja melengkung walaupun tanpa sebarang beban dikenakan keatasnya. Lengkungan tersebut dapat dilihat dengan jelas berpandukan objek yang lurus.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Table is very important furniture in today's life. From application in office to household usage, it is widely used all over the world. Its contribution to men kind cannot be denied at all.

Nowadays, tables are widely used. From office usage to household item, table is important to us. At office, it used as a tool to put items and as a workplace to work at, and as for home, as a dining table, studying table and etc.

But the usage of that thing is not limited for placing item of the floor or eating session, it usage has spread. It even has been acknowledge as a collectable item, object for decoration, and other usages. Some of the table has high value and considered a fine piece of art, collected as an antique collection. [4]

Although the usage of table are huge, there still some adjustment can be done to the current table to make that it is even more flexible and versatile then current table. In other word, table that have the senses of nowadays life.

1.2 PROBLEM STATEMENT

Firstly, the table is hard to be stored if it didn't be used due to its flexibility is limited. The table is useful only when the user needed to use it, but if the user done with it, he or she cannot or hard to store it away. Due to its size and shape, it is difficult to store it. Nowadays living space like houses and condominium are getting more and more expensive. Not all people can afford to stay in a huge home. Due to this problem, space is important to manage. [5]

Second, the size of the table is fixed and cannot be change according to event involving it. It cannot be change following the occasion needed by its owner. For example, for dining purposes, it is only proper to be used for dining occasion only, other function also can be done but it would be awkward. "Tables come in a wide variety of shapes, height, and materials, depending on their origin, style, and intended use." [5]

Third problem involving table is it cannot balance itself if the floor surface isn't smooth. The table will shake and become imbalance. This will disturb the situation at that time.

Problem number four that involve the table is it is fix or limited to number of person that can use it in the same time. The space for it cannot be adjusted to accommodate more people then it supposed to. The user has to find other solution such as providing another table if the current table cannot fulfill the number of people.

These problems cannot totally be eliminated but surely can be minimized. A lot of work must be taken to overcome the problem regarding the table.

The table that will be developed will be able to solve the fourth problem that has been stated in the project background. The products which uses the concept of modular, is an approach aiming to subdivide a system into smaller parts (modules) that can be independently created and then used in different systems to drive multiple functionalities. The current table has several same characteristic which is made from a piece of material that cannot be fold or flip and certainly cannot be added the length of its surface.

The length of the table limit the application can be handled by the table. Small table cannot be used to put a lot of things at the same time. The space for the application is limited. This makes the user must find another table to support the current table for the certain function. That will cause the user to spend unnecessarily for another table.

For the normal table, the table has problem when it is tried to be move from one room to another. It must be torn apart before any movement can be done. The normal table are not meant to be taken to pieces will eventually damaged if the process done several time. It will cause the product to shorten its durability.

The normal table are not meant to be stored after used but this would bring problem to people that has no or limited space in their home. The space that has been occupied by the table is quite large and if the table can be stored after it's been used, the space would be able to be used for other purposes.

So, we can see that this problem can cause some serious problem to all users and must be solve to make sure all people life in better life. This problem surely can be solved by replacing the old table with this newly improved modular based table.

1.3 PROJECT OBJECTIVES

In the course of completing this project, there are a few objectives to be fulfilled. These are:

I. To analyze the structure by using analysis software
ii. To design and develop a flexible-area table.

1.4 PROJECT SCOPE

i. Design a study purpose table using the concept of modularity.

ii. Draw the parts for the table by using Solidworks software.

iii. Assemble all the parts into a table in the Solidworks

iv. Build the real structure of the table (by parts)

v. Use the ALGOR software to analyse the structure

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will explain the development process of a table. Brief information about the history, types, design and material used will be explained. This chapter will also discuss about the previous project that is related to the topic. Lastly, a modular design for a study table will be discussed.

2.2 MODULARITY

Modularity is a concept that can be applied in huge area. From the aspect of biology [2] to the aspect of engineering [1], the concept of modularity can be applied. The modularity concept is not limited to any aspect. It can come in many forms such as for an example the light bulb in figure 2.1

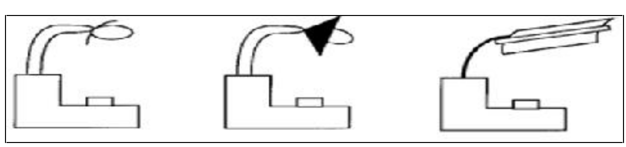

Figure 2.1: Modularity in light bulb

All three lamps is the same type but it can be changes due to needs and function. The modularity concept gives the user the power to decide the needs and requirement they wanted. By this concept also, the user can save their money because of modular products, designing and assembly of the item is at a low cost. [1]

2.3 MODULAR TABLE

Modularity is an approach aiming to subdivide a system into smaller parts (modules) that can be independently created and then used in different systems to drive multiple functionalities. Besides reduction in cost (due to lesser customization, and less learning time), and flexibility in design, modularity offers other benefits such as extension (adding new solution by merely plugging in a new module), and exclusion.

As for table, it is a form of furniture made of a surface and supported by a base, usually four legs. It is often used to hold objects or food at a convenient or comfortable height when sitting.

When both of the terms combined together, it give the meaning of a form of furniture that capable to be subdivide into smaller parts that can be independently created and then used in different systems.

2.3 FUNCTION OF TABLE

A table can be used temporarily for objects such as food and eating utensils during a meal, cups for drinks, a book, a spread-out map, writing paper during writing, and anything that requires having several objects at hand, including various hobbies. Tables are frequently used to place small items on such as key chains or pens until further use. Things also can be put permanently on a table, for example a TV, computer, decoration and etc. Table settings of food are laid out in a traditional arrangement.

2.4 HISTORY OF TABLE

Some very early tables were made and used by the Egyptians and the design in that time just basic. They were not used for seating people. Food was put on large plates deposed on a pedestal for eating. The Egyptians made use of various small tables and elevated playing boards. The Chinese also created very early tables in order to pursue the arts of writing and painting.

The two ancient empires, the Greeks and the Romans, widely use the table in their daily life, especially for eating, although Greek tables were pushed under a bed after use. The Greeks created a piece of furniture that similar to the guéridon (a small, often circular center table supported by one or more columns, or sculptural human, or mythological figures). Tables were made of marble or wood and metal (usually bronze or silver alloys). Later, the larger rectangular tables were made of separate platforms and pillars. The Romans also introduced a large, semicircular table to Italy, the *mensa lunata*.

Furniture during the middle Ages is not as well-known as that of earlier or later periods, and the luxury design table was used by the nobility. In the Eastern Roman Empire, tables were made of metal or wood, usually with four feet and frequently linked by x-shaped stretchers. Tables for eating were large and often round or semicircular. A combination of a small round table and a lectern (a reading desk with a slanted top, usually placed on a stand or affixed to some other form of support, on which documents or books are placed as support for reading aloud) seemed very popular as a writing table. In Western Europe, the invasions and intestine wars caused most of the knowledge inherited from the classical era to be lost. As a result of the necessary movability, most tables were simple trestle tables, although small round tables made from joinery reappeared during the 15th century and onward. In the Gothic era, the chest (furniture) became widespread and was often used as a table.

Refectory tables first appeared at least as early as the 16th century, as the evolution of the trestle table; these tables were typically quite long and capable of supporting a sizeable banquet in the great hall or other reception room of a castle.

2.5 TYPES OF MODULAR TABLE

2.5.1 The Modular Concrete Picnic Table [6]

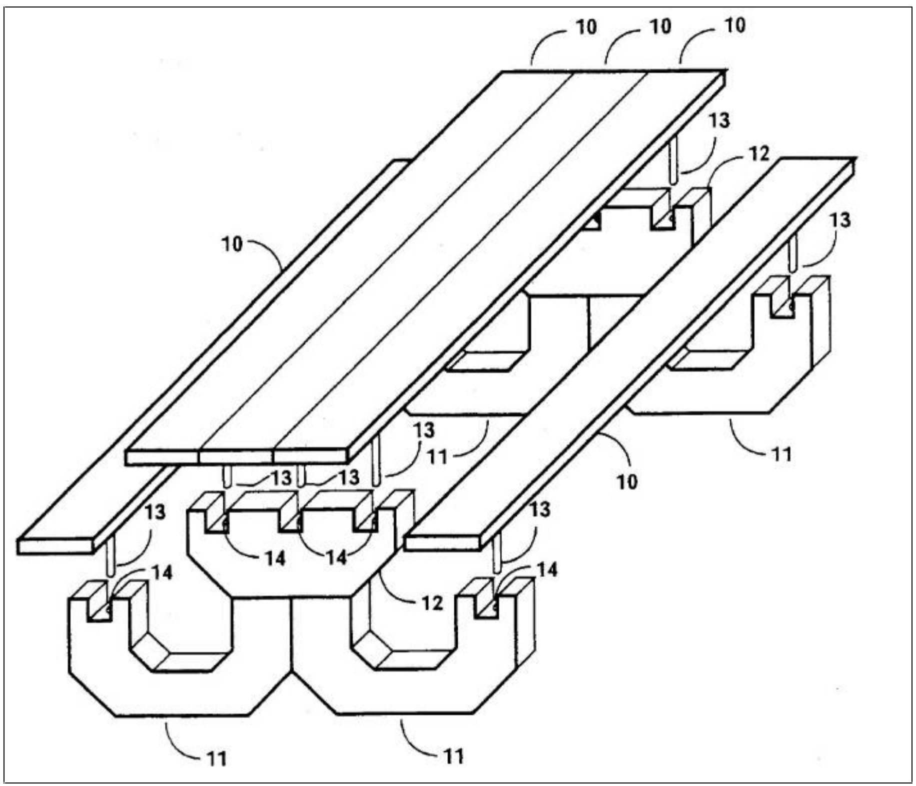

Figure 2.2: Modular Concrete Picnic Table

According to this table inventor, Roesner, Dean G, he claims that the table in figure 2.2 (dimension units in inch) is a modular pre-cast concrete picnic table (United States Patent 5752450) which can be firmly assembled and disassembled into sections comprising two end sections.

He also claims that this design has some advantages over the old model of picnic table. For an example, compared to the previous art, this table is a unique combination of stability, durability, portability, maintainability and cost effectiveness of materials, as well as being remarkably simple to assemble and disassemble. He also claims that the modular, eleven piece constructions lends itself to easy transportation, even to the point that all parts can be easily carried by two or fewer people, which make it even more unique considering the structure of the table, were made out of concrete. The table also able to be repair if any of the components is damage; the design allows easy replacement of damaged parts through ease of assembly and disassembly and commonality of parts as well as the feature of person portability of all parts.

2.5.2 Self-Leveling Modular Table [9]

In this invention, the inventor (United States Patent 6382109), Leon Novikoff, has design a table that has the capability to form into various shapes and sizes. It is also capable to self leveling. It is the renovation of the current table but the modular table is easy to use and it is economical. It reflects the beauty and professionalism once it is put together.

His invention is due to problems that faced in restaurant and office where sometimes having problems to join the available table to have a bigger area that can support more people at a time. So, he uses the concept of modularity to design the table. He claims that even though there are a lot ready-to-assemble table in the current market, but sometimes the table doesn’t as good as factory-assemble table. The ready-to-assemble table tends to loosen up or come apart after extended use.

2.5.3 Articulated Modular Table [7]

Whitesitt, Scott W. is the pattern holder for articulated modular table (United States Patent 6497184) in figure 2.3 (dimension units in inch). His design are based on the reason of the versatility of a normal table are limited. He also said that modular table is a table that able to be arranged and locked in different configuration or design. The shape of the table isn't fixed and can be change according needs and function.

These are advantages that he claims for his articulated modular table. Firstly, the table able to provide an articulating arrangement of two coplanar works surfaces of next tables that can be moved into various positions. Next, he said that the table able to be moved to different location by only one person without much difficulty. Then, the table is said able to be arranged to various geometry arrangements so that it can maximize the usage of provided room.

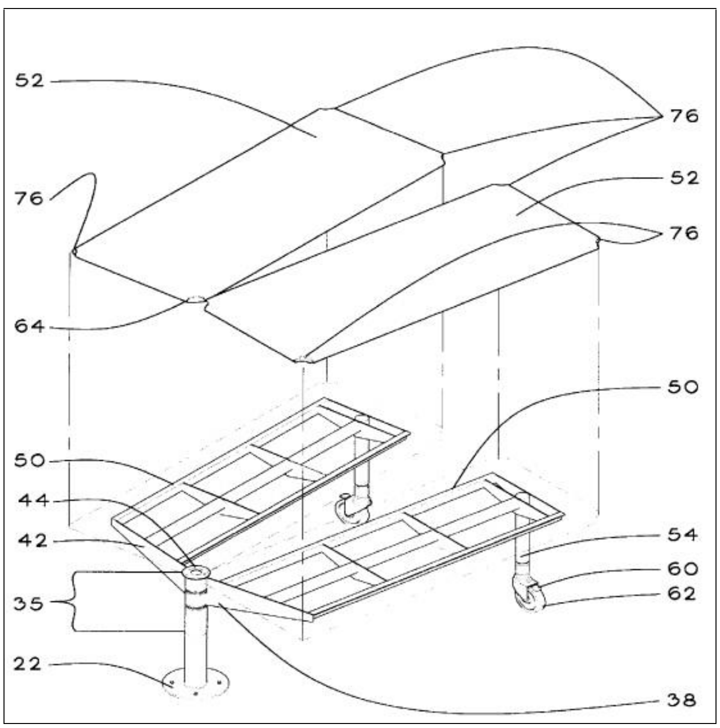

Figure 2.3: Articulated modular table

2.5.4 Modular Picnic Table [8]

The inventor of this product shown in figure 2.4 (dimension units in inch) (United States Patent 6978723), Dodd, Dolphus A., claims that it is essential for a picnic table to use modular design in the product because with a modular design, the table is able to be stored easily when it is not been used. The reason for this inventor wanted his table able to store easily is because he wanted to avoid the factors that can shorten the durability of the table such as sun's ray, rain, wind, and others.

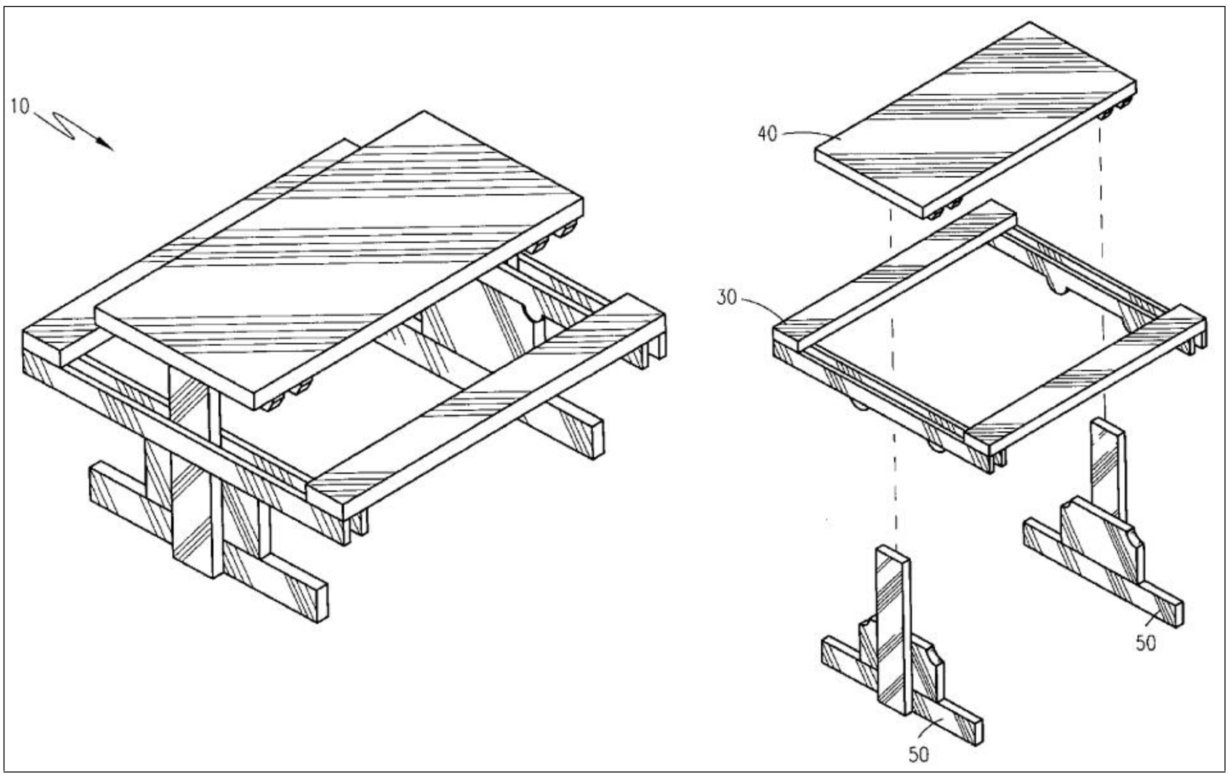

Figure 2.4: Modular Picnic Table

2.6 MODULAR STUDY TABLE

In this project, the basic idea is to create a table that specifically for studying purpose that uses the concept of modularity, in this case, it's surface size can be adjusted from time to time depending on the amount of user that want to use it. Its surface can be expand or shrink.

Limited space provided by normal table didn't give the user flexibility to use the table. The user is bounded to limited workspace. He or she cannot exceed the space provided when putting item, books, or event tools required for the studying session.

Limited space also means that the number of person allowed to be at the table is limited. For a small study table, it may be possible to support one or two user at a time, but as the amount of user increases, it is impossible to provide a proper studying area for the users. Much larger table required to support the amount of user.

The fix amount of area that provided by the normal table couldn't give the user the flexibility to use it. The user may not experiencing any problem if the studying session only involve books, but if the user desire to included something larger than the books, for an example, a drawing board. If the table area is big, it wouldn't be a problem but if the area is just only for normal study, it also can bring a little bit problems in the studying process.

That's why this modular studying table ware proposed. Its purpose is to minimize the entire above problem. The concept of modularity itself in this project allows the user to determine the condition of the table, the size of the table and the purpose of the session, whether it is for personal study or it is a discussion session. The modular study table can provide the required condition for above problems

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this chapter, all the procedure from designing to finishing process for the modular study table is discussed briefly. The whole process is shown in a flowchart which in figure 3.1 which acts as a guideline for the reader to understand the flow of the project. From the flowchart, there are six processes to accomplish the project. All the processes are discussed in the next section.

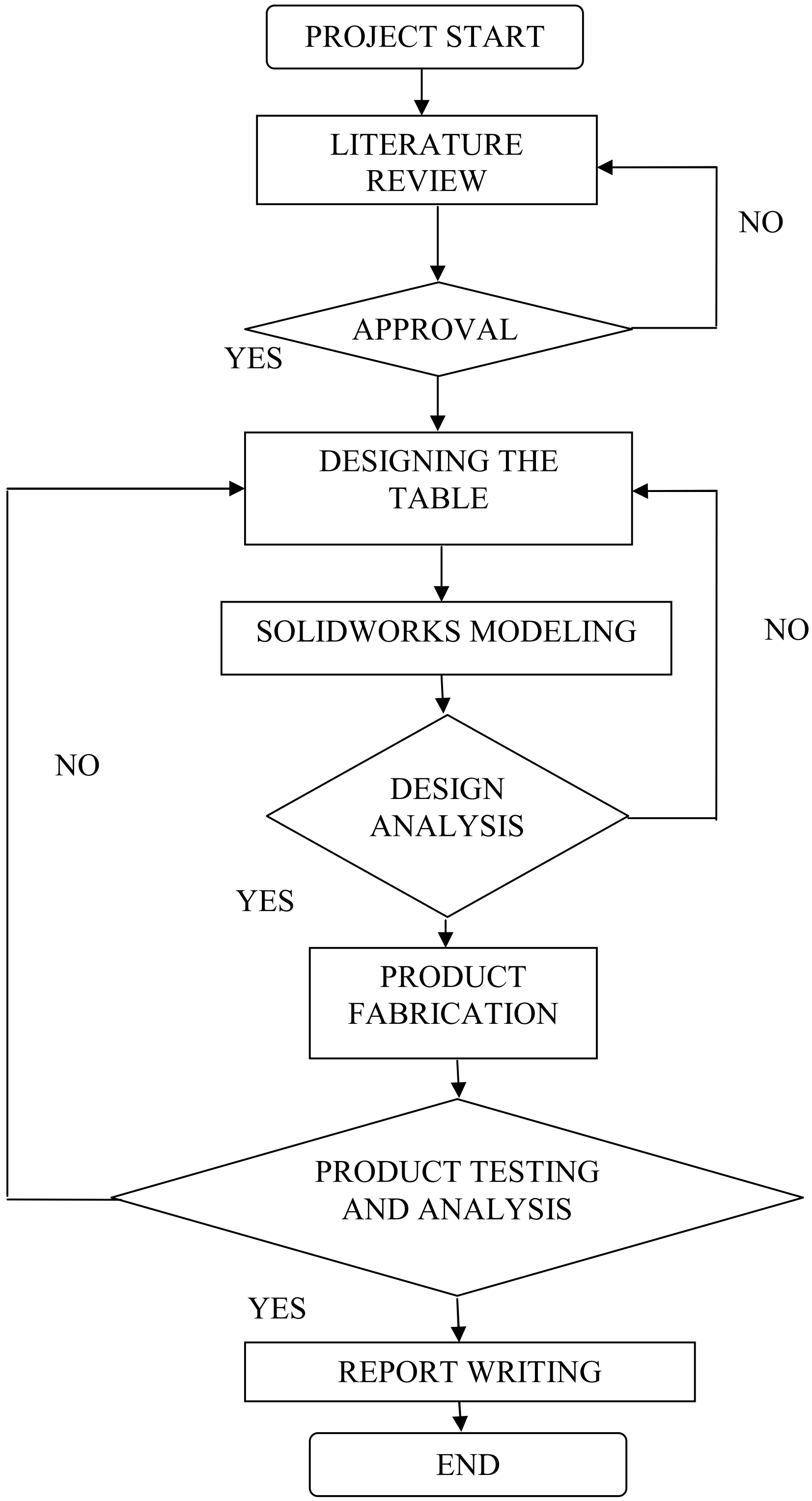

Figure 3.1: Flowchart of the project

3.2 LITERATURE REVIEW

All material related to the project in literature review is been study and understand. All the information regarding general information on table to previous related study stated in the review. This is important as a reference point for this project

3.3 DESIGNING THE TABLE

In this stage, early design for the table was proposed. It is to find the most suitable and possible design that can be done by using all the equipment and facilities available at the laboratory. It includes all the possible geometry, space, and material factor which mean the shape possible for fabrication, the amount of space can be provided by the table and the material would be chosen.

3.4 SOLIDWORKS MODELING

All information obtained in the designing process then will be used in the Solidworks modeling process. Compared with designing process, this process details the information by giving a 3D design visual. It also helps to improve the design by giving clearer detail which hardly can be seen in the design process, thus if there were any flaw detected in the modeling process, designing process must be done all over again.

The main objective of the software is to generate the 3D visual for the planned table as shown in figure 3.2 for later usage in ALGOR. By using Solidworks, any flaw that present on the design can be detected and will be eliminated by improving the previous design with new and improved design.

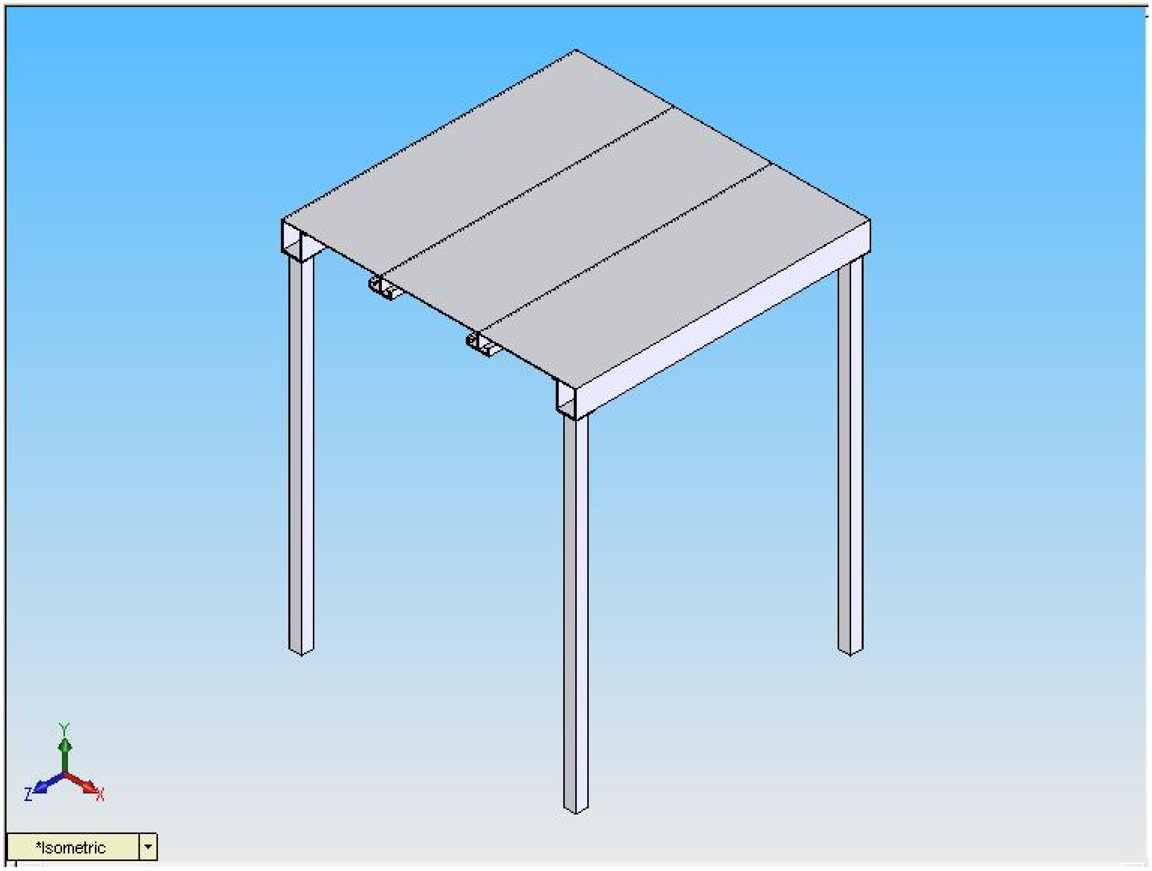

Figure 3.2: General idea of modular table

The main criteria considered as flaw in the modeling process for this project such as design that cannot be draw in Solidworks which means the design is too complex, the dimension that cannot be made into real product due to several factor such as capability of the machine or the limitation due to material available and others.

The Solidworks modeling is saved in format of .IGES as in figure 3.3 to ensure that it can be imported for the next process, the analysis process.

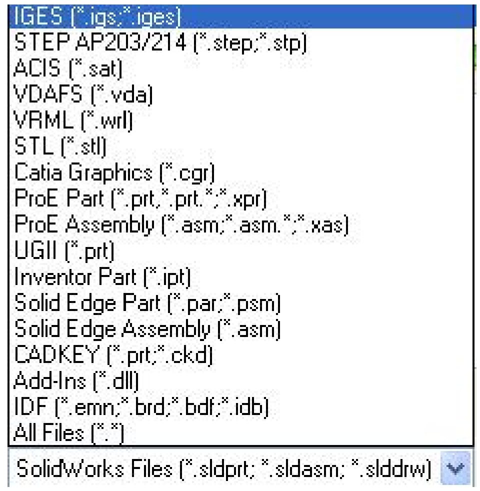

Figure 3.3: File type in Solidworks

The entire unit for dimension in this project is in millimeter (mm)

3.5 DESIGN ALANYSIS

In this project, after the design is completely done by using the Solidworks software, it will be tested by using analysis software, which in this case, ALGOR software.

The modeled design is imported from Solidworks to ALGOR by selecting the proper saved .IGES file as in figure 3.4.

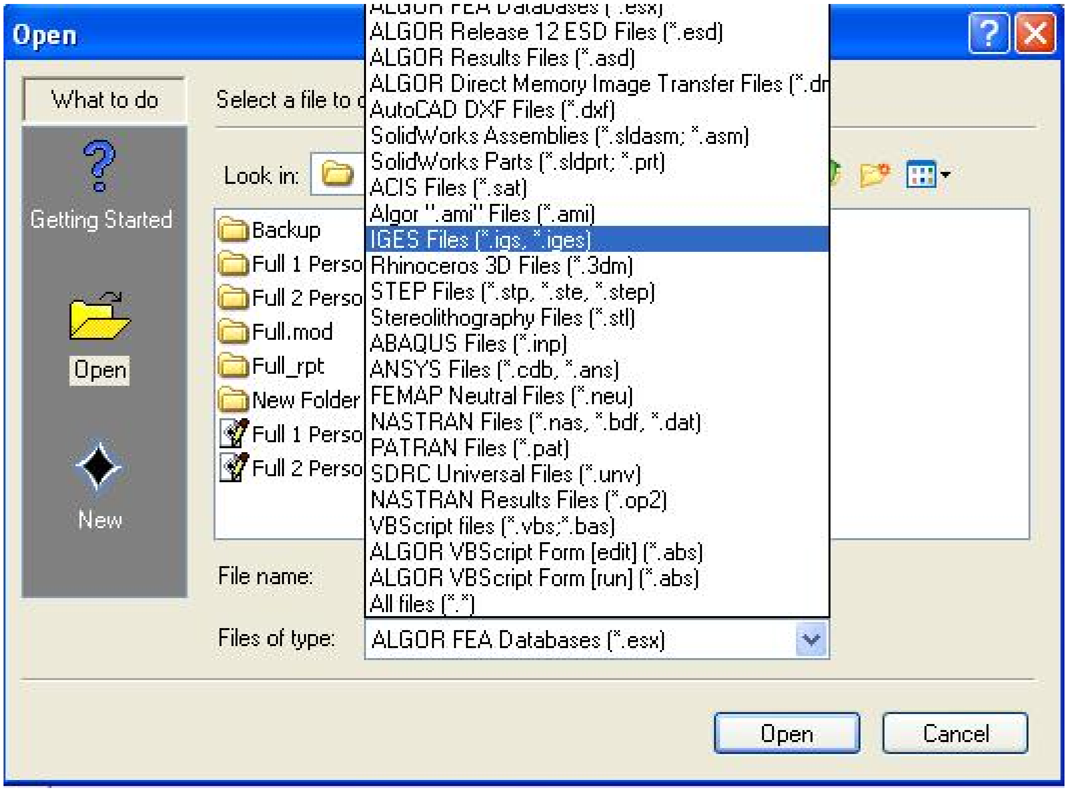

Figure 3.4: File type in ALGOR

3.5.1 Meshing

After importing the file into ALGOR, the process of meshing the structure is done in figure 3.5. It is to ensure that the ALGOR software can work properly during the analysis process. Finer mesh size will resulting higher accuracy value but as a result, the analysis process will take a longer time

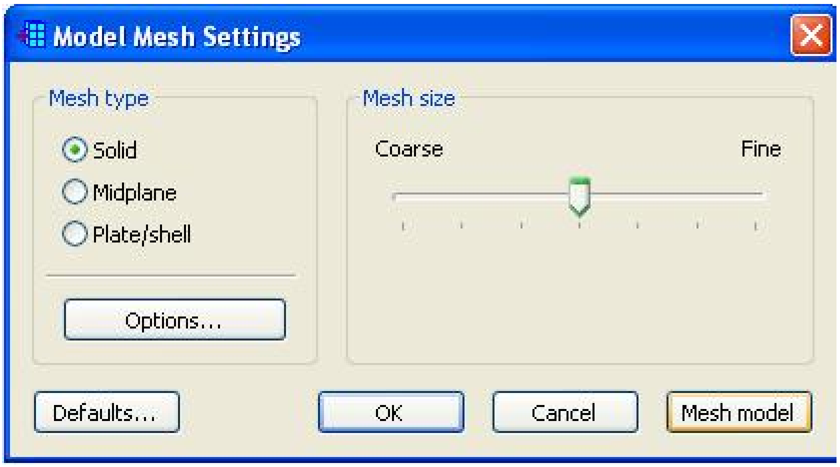

Figure 3.5: Mesh setting

The structure will eventually turn into meshed structure as shown below in figure 3.6

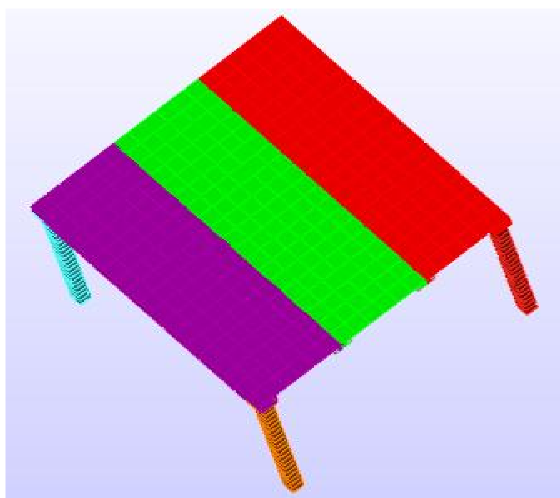

Figure 3.6: Meshed design

3.5.2 Analysis information

For the analysis to work, proper information about the material, boundary condition, and value of force that been exerted on the material must be inserted.

3.5.2.1 Material

In ALGOR, after the design is completely imported from Solidworks, the material of the work piece has to be defined. Huge selection of material from ALGOR material library is available for analysis purposes.

In this project, aluminum was the materials choose as the material for analysis as shown in figure 3.7 due to reason will be explains later. From the library, Aluminum 2024-T4 matches the actual material used for fabrication process.

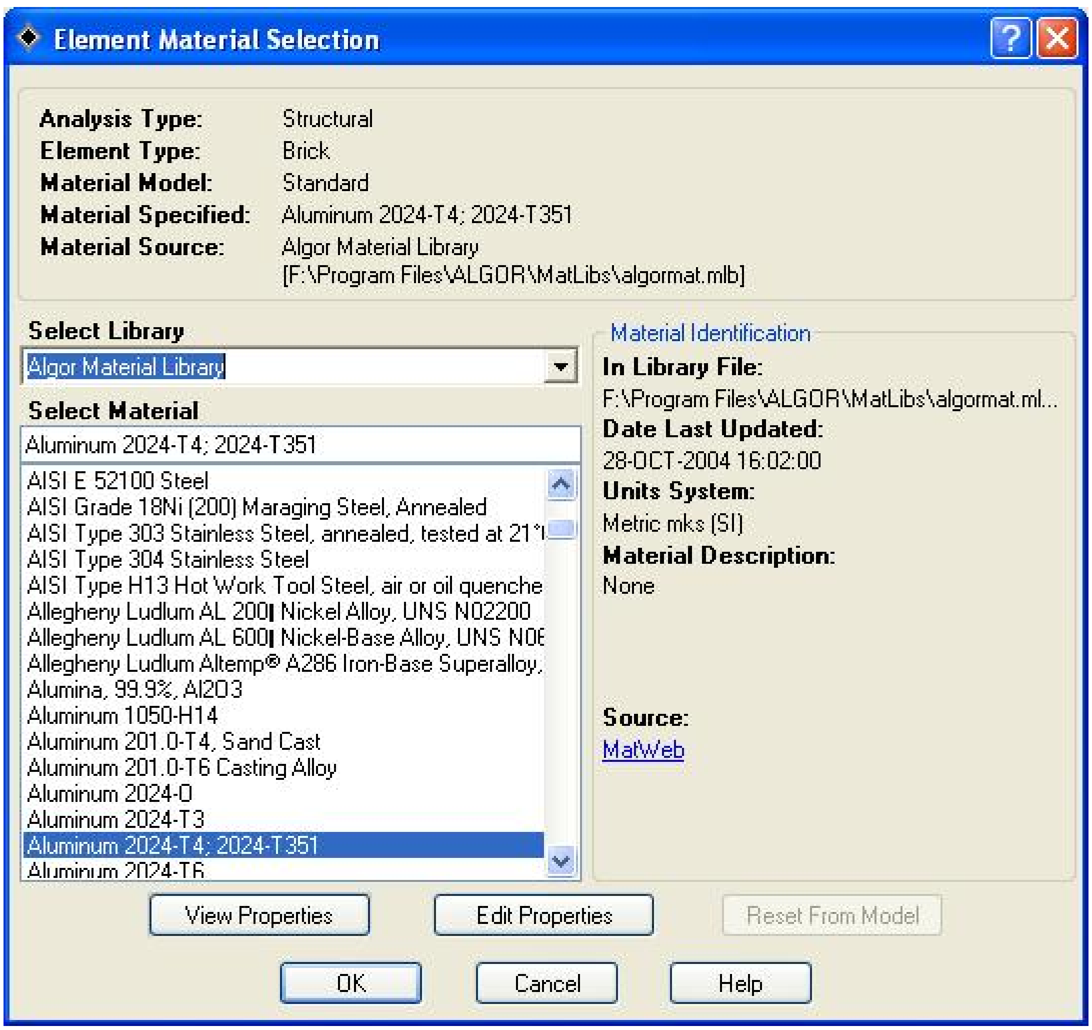

Figure 3.7: Element material selection

3.5.2.2 Boundary condition

Boundary condition will ensure that the analysis result is according to required condition. It will simulate the actual situation for the work piece. The boundary condition for this project is fixed under the table at the legs position. As in figure 3.8 and the setting to acquire the condition is as in figure 3.9

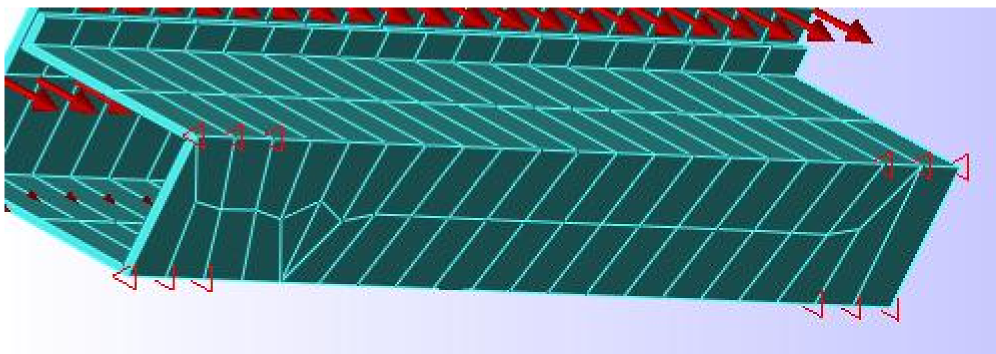

Figure 3.8: Fixed point

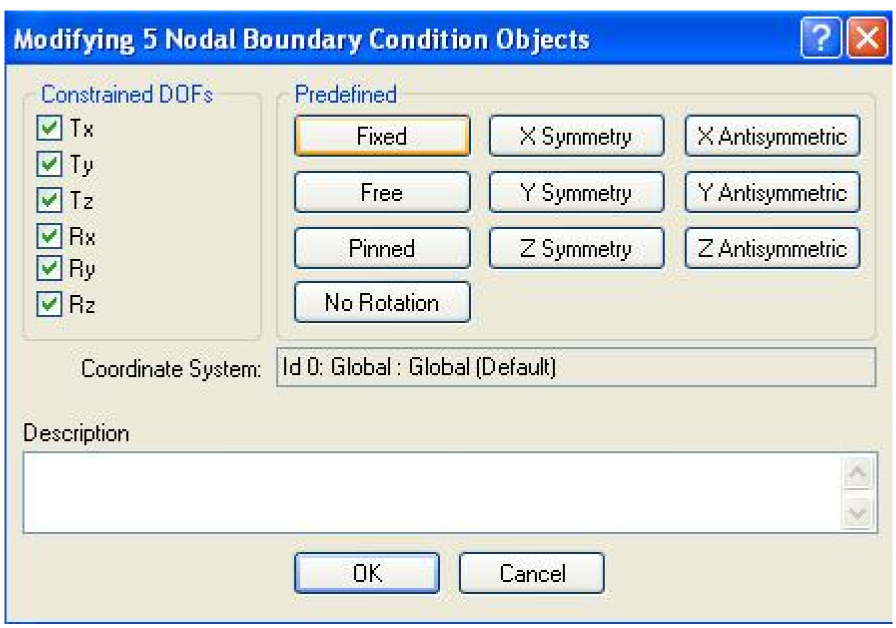

Figure 3.9: Setting boundary condition

3.5.2.3 Force exerted

Force exerted in this analysis is evenly distributed throughout the entire work piece. By using the "Select Surface" shown function in figure 3.10 in ALGOR, the force of 100N is pressed by using force distribution "Surface Force" type as can be seen in figure 3.11

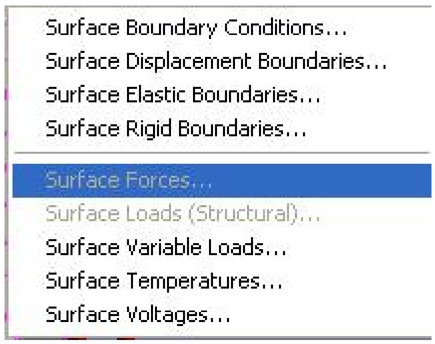

Figure 3.10: Surface force

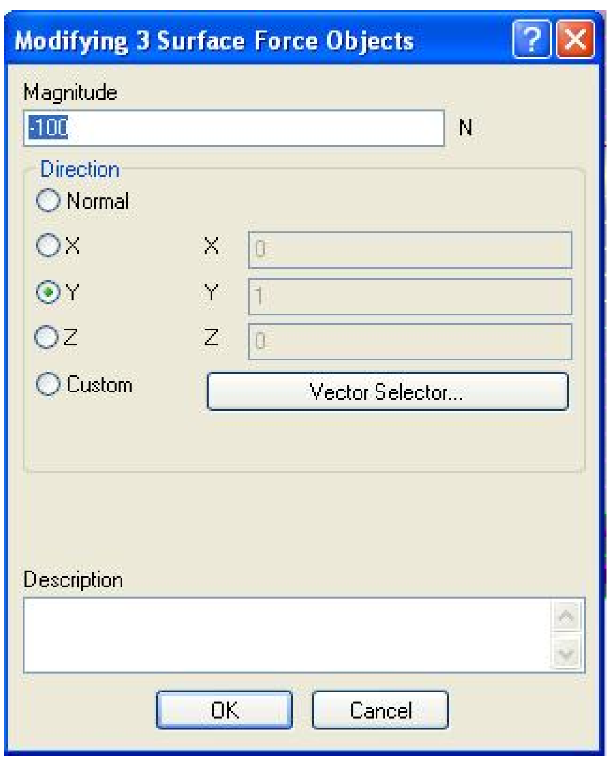

Figure 3.11: Surface force value

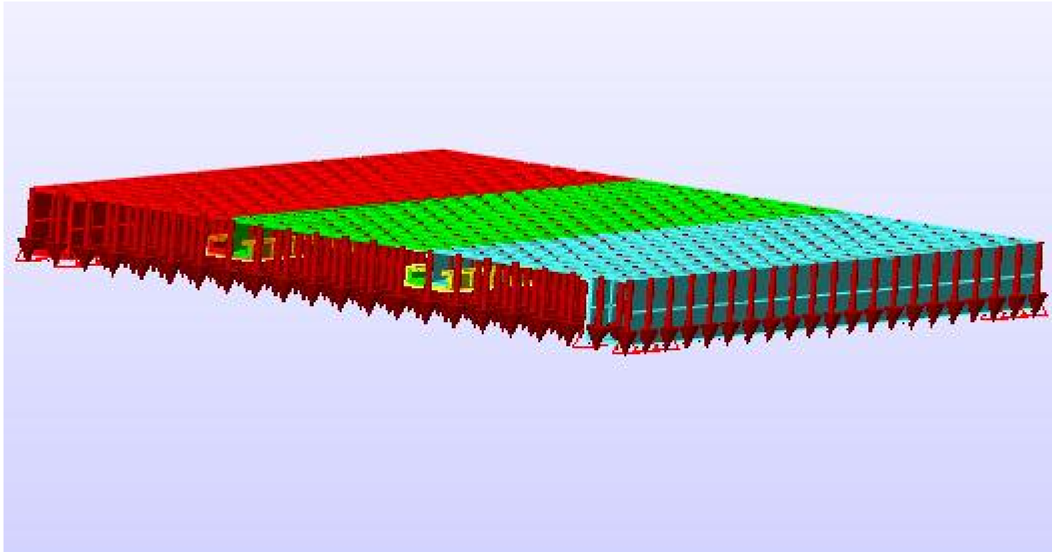

Figure 3.12: Surface force direction

Figure 3.12 is the result due to earlier setting of surface force and surface force value.

3.6 PRODUCT FABRICATION

The fabrication process will proceed after the analysis process. For this project, there were two main machine used, the Hydraulic Shear and TrumaBend V85S. Hydraulic Shear machine used for cutting sheet metal process and as for the TrumaBend V85S, it used for bending process.

3.6.1 Material selection

In the early stage of the project, there was no specification on the material will be used for the project. As for starting, there were three materials considered as a possible material for the project. The first material was galvanic iron. It was choose considering the strength of the material itself. Second, due to large amount of zinc available at the laboratory, it considered as a possible material also. Lastly, there was aluminum sheet metal. Not as tough as galvanic iron but still considered as a possible material due to its weight is not as heavy as galvanic iron and doesn't rust like zinc. All the material has a thickness of 2mm.

Due to rusting factor, zinc was reconsidered not suitable for this project. Only galvanic iron and aluminum sheet metal enlisted as possible material. In the end, aluminum been considered as the best material for the table due to its properties and also because it is easier to work with.

3.6.2 Fabrication

As mentioned earlier, this project needs two machines to be complete, the Hydraulic Shear and TrumaBend V85S.

3.6.1.1 Hydraulic shear

This machine been used in the early stage of the fabrication process. The metal plate has to be cut into size using this machine. Although the machine is very convenient, is also has its limitation. It can extend as far as 1000mm in term of cutting length. Due to that, it is important to cut the work piece below 1000mm. As for the minimum value, it cannot cut below 10mm. The picture for this machine can be refer at appendix figure no 9 (page 46).

3.6.1.2 TrumaBend V85S

After all the material is cut to required length, the next machine, the TrumaBend V85S will continue the operation. The machine also has limitation in length of material it can bend. The limitation is due to limited amount of bending tooth available at the laboratory. It cannot bend material that has a length higher than 1000mm. its picture can be refer to figure 10 in appendix (page 47).

3.7 PRODUCT TESTING AND ANALYSIS

The last stage in this project is the testing and analysis process. As for this project, a load weight 100N is placed on the project to find out that whether the structure can endure the assigned weight. It also determines the success or failure for the project.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

In this chapter, the result from ALGOR analysis and manual analysis, which is testing on the completed work piece, will be discussed. The main objective is to determine the value from software analysis and value from actual analysis.

This chapter also will determine the success or failure for the entire project. If the value from actual test can proves the value from software analysis, then the project will shows some promising result.

4.2 THEORY

From theory, the value of yield strength for aluminum 2024-T4 is 325MPa which is stated in table 4.1. It is the maximum value that it can take before fail. This means, if higher value is exerted on the material, the material will break and fail.

To prevent the project from failing, many solutions can be used but as for this project, it will focus on the design of the table itself. Most optimal design to prevent the table from failing must be made.

Table 4.1: Properties of aluminum [3]

Material	Density kg/m^3	Ultimate Strength: Tension, MPa	Ultimate Strength: Compression,[2] MPa	Ultimate Strength: Shear, MPa	Yield Strength[3]: Tension, MPa	Yield Strength[3]: Shear, MPa	Modulus of Elasticity, GPa	Modulus of Rigidity, GPa	Coefficient of Thermal Expansion, $10^{-6}/°C$	Ductility, Percent Elongation in 50 mm
Aluminum										
Alloy 1100-H14 (99% Al)	2710	110		70	95	55	70	26	23.6	9
Alloy 2014-T6	2800	455		275	400	230	75	27	23.0	13
Alloy-2024-T4	2800	470		280	325		73		23.2	19
Alloy-5456-H116	2630	315		185	230	130	72		23.9	16
Alloy 6061-T6	2710	260		165	240	140	70	26	23.6	17
Alloy 7075-T6	2800	570		330	500		72	28	23.6	11

4.3 DIMENSION

After the designing process to obtain the most appropriate design, the final dimension value for the project will be used for the fabrication process

Below are the dimensions for the table in table 4.2

Table 4.2: Dimension of parts

Part	Dimension (mm)
Plate	600 x 200 x 30
Side plate	600 x 200 x 50
Lock	600 x 40 x 20
Small lock	300 x 40 x 20

All the Solidworks part can be refer at appendix (page 43-44) from figure 1 till figure 4. The Dimensioned drawing can be referred at appendix from figure 5 till figure 8 (page 45-46)

4.4 STRESS ANALYSIS

After applying all the boundary condition, material element, force into the design with above dimension value, the analysis can be done. The analysis then will generate the amount of stress von mises in unit of N/mm^2 or MPa.

From the analysis, the value of stress von mises can be found by changing some setting in the ALGOR option

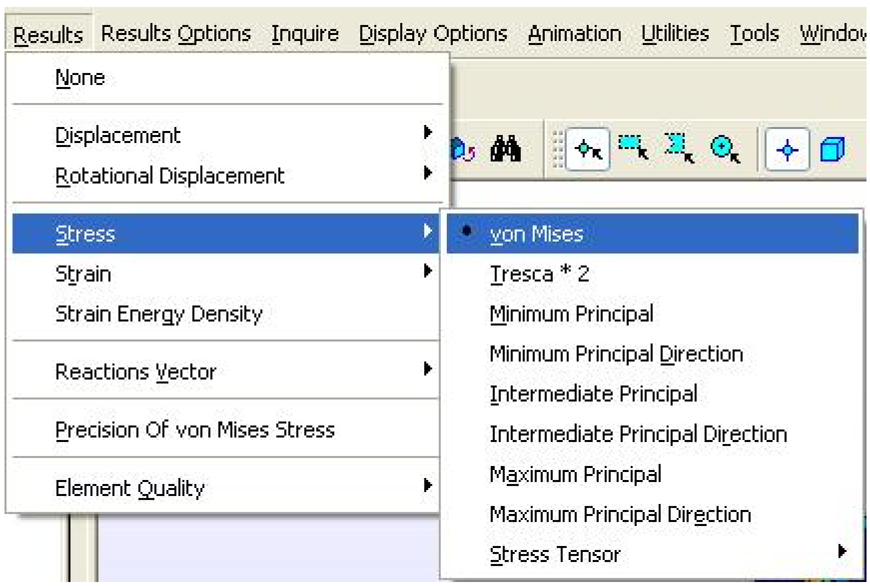

Figure 4.1: Von mises

As for this analysis, the result is as follows in figure 4.2 till figure 4.7

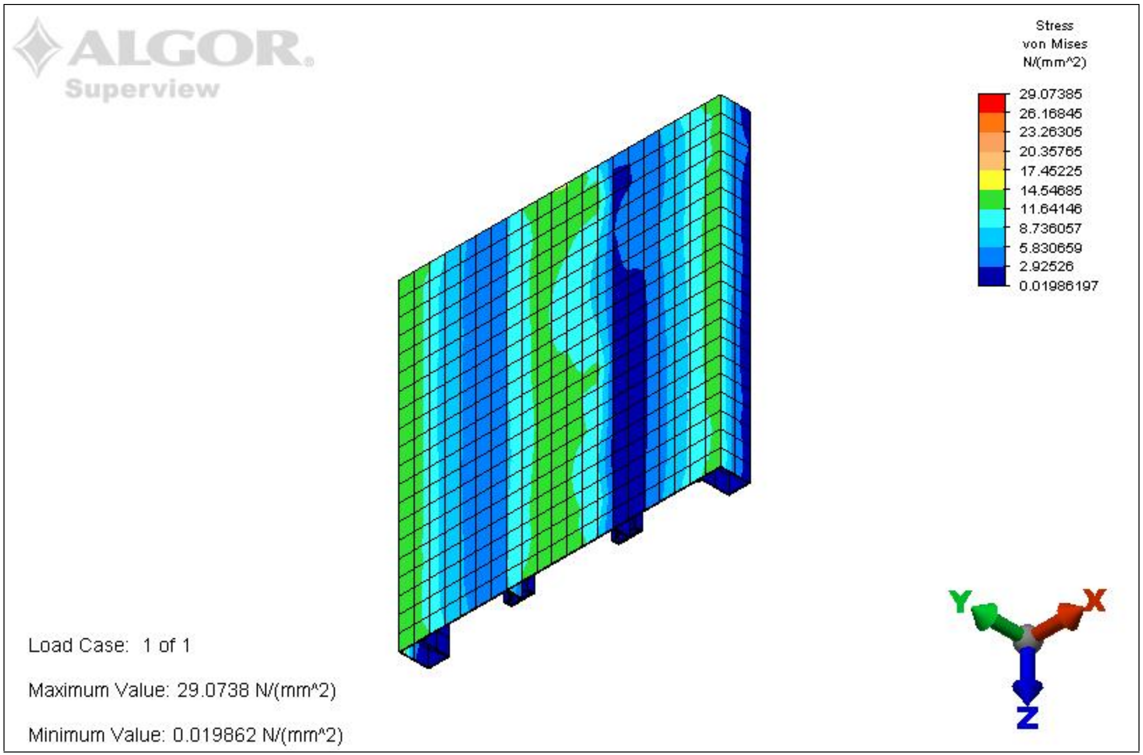

Figure 4.2: Single person table analysis (Top view)

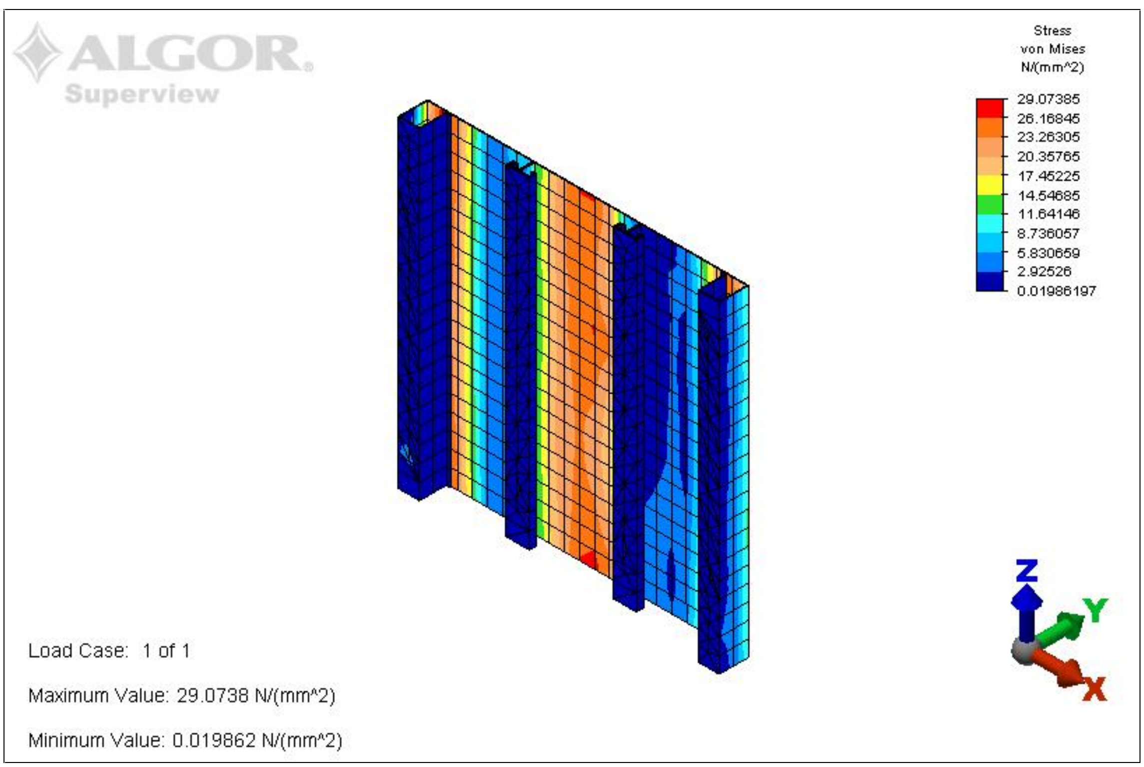

Figure 4.3: Single person table analysis (Bottom view)

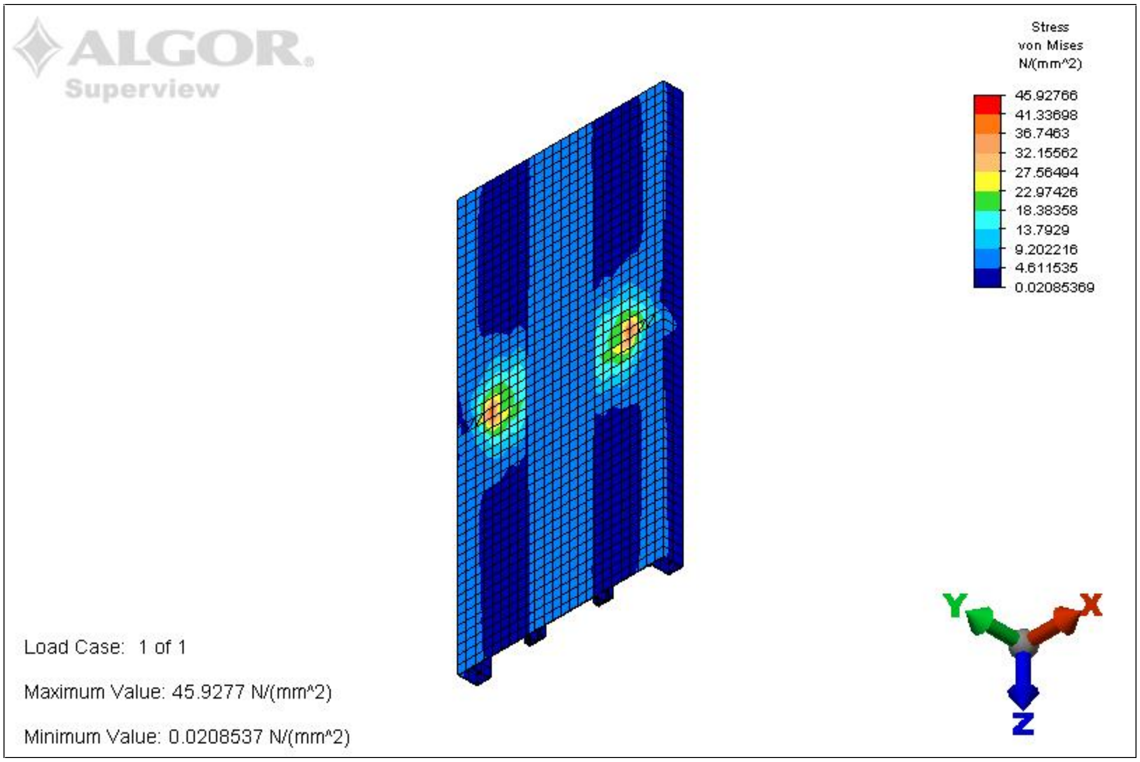

Figure 4.4: Two person table analysis (Top view)

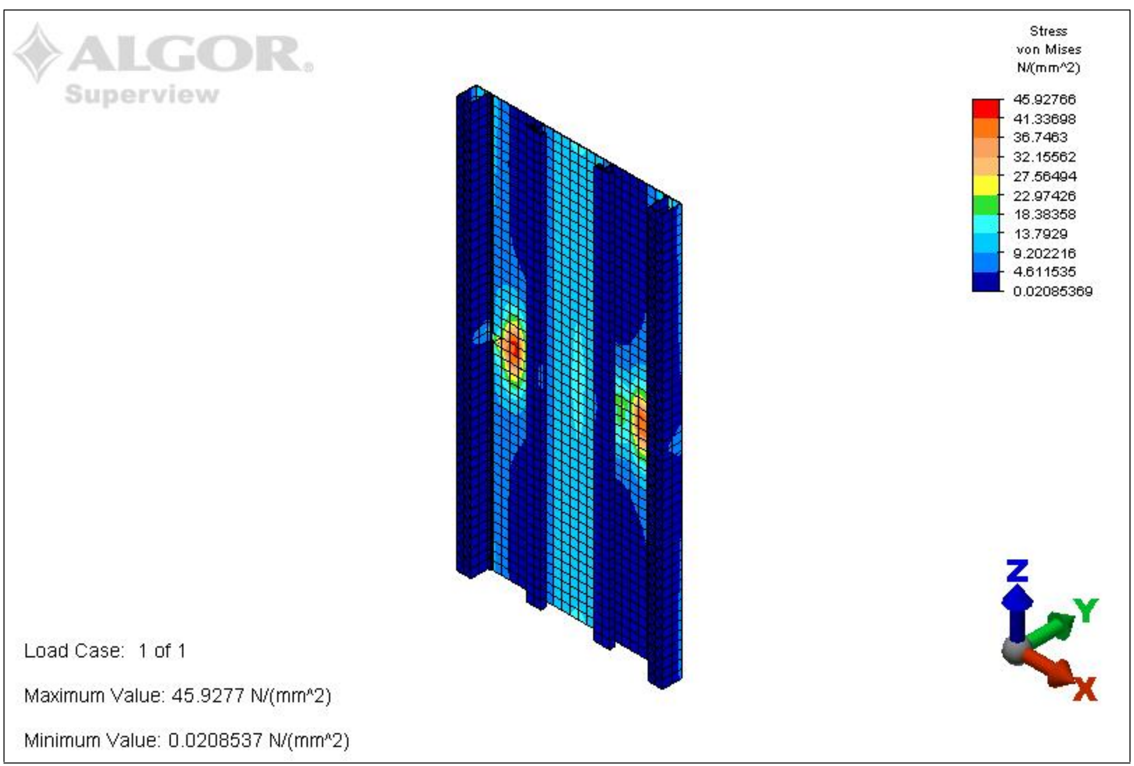

Figure 4.5: Two person table analysis (Bottom view)

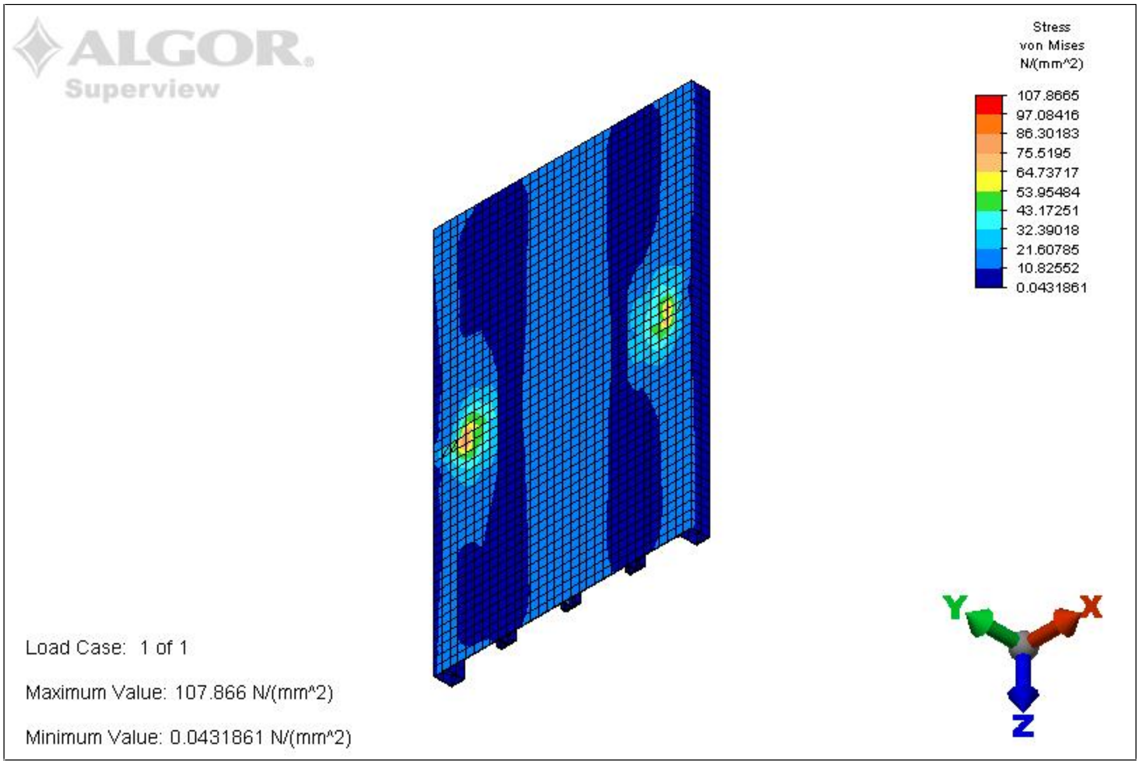

Figure 4.6: Four person table analysis (Top view)

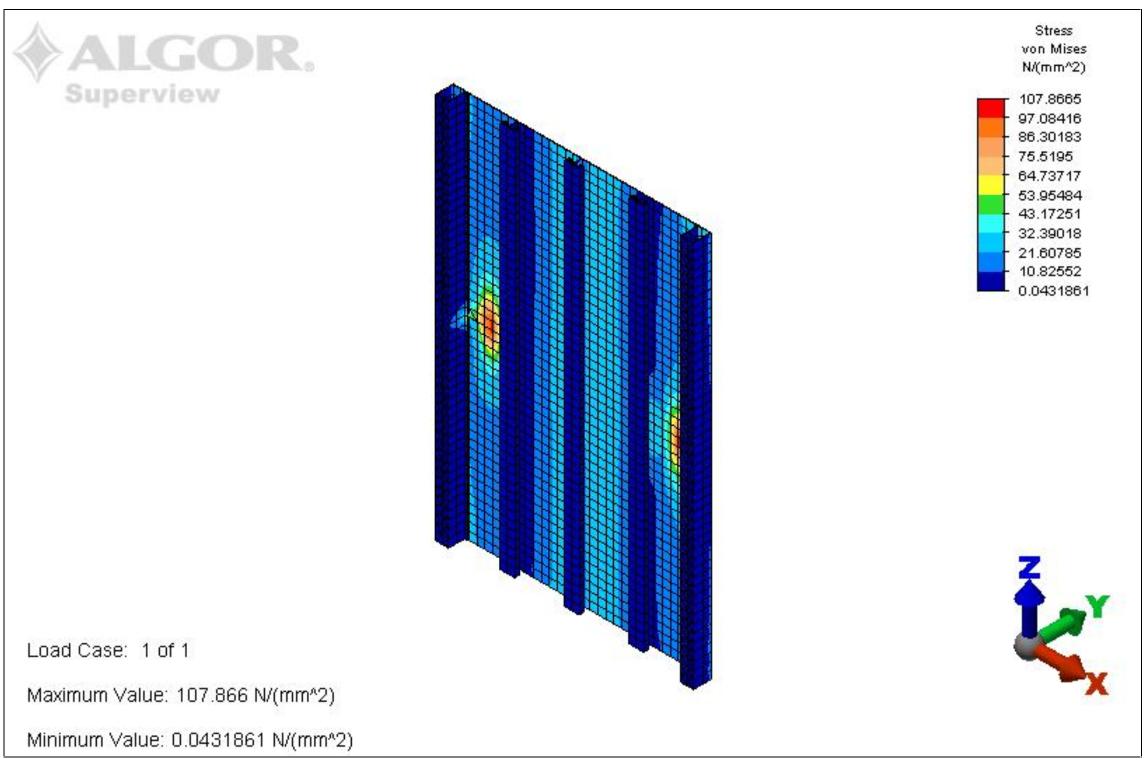

Figure 4.7: Four person table analysis (Bottom view)

Based on the analysis, the stress von mises values for three cases are as in table 4.3

Table 4.3: Maximum stress von mises value

Case	Maximum Stress Von Mises (N/mm2)
1 Person Table	29.0738
2 Person Table	45.9277
4 Person Table	107.866

From the analysis, it clear that the maximum stress happens only happens for four person table arrangement. As for one and two person table, the maximum stress is different. It is due to the force exerted on the joint that happens to be at that position.

There are certainly consist of high value in stress but the value of maximum stress von mises is less than the value of yield strength of aluminum (325MPa), so the project is possible to be fabricating using current design.

4.5 DISPLACEMENT ANALYSIS

Table 4.4 gives the information on the amount of part available in each case

Table 4.4: No. of part

Case	No.of Part			
	Side Plate	Plate	Lock	Small Lock
1 Person Table	2	1	2	-
2 Person Table	4	2	2	4
4 Person Table	4	4	3	6

ALGOR analysis software also provides information for the displacement of the design after force exerted on the work piece. The value and model can be seen by changing some setting at the result as shown in figure 4.8

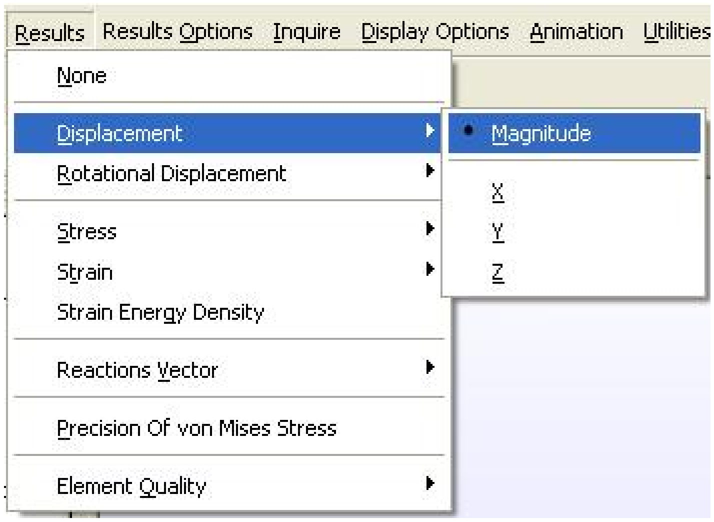

Figure 4.8: Displacement magnitude

After that, thick the option in Result Options as figure 4.9

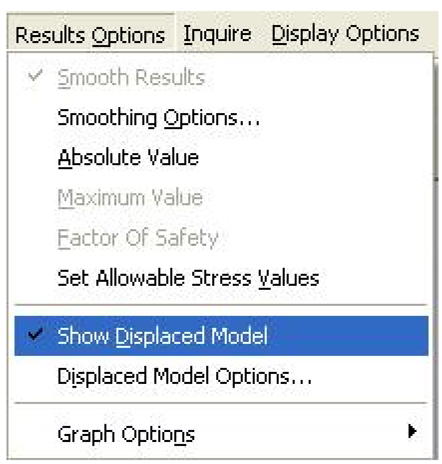

Figure 4.9: Show displaced model

After applying all the setting, the result will show the magnitude of the displaced model and the value of displacement happened on the structure as figure 4.10 till figure 4.12

Figure 4.10: One person table displacement

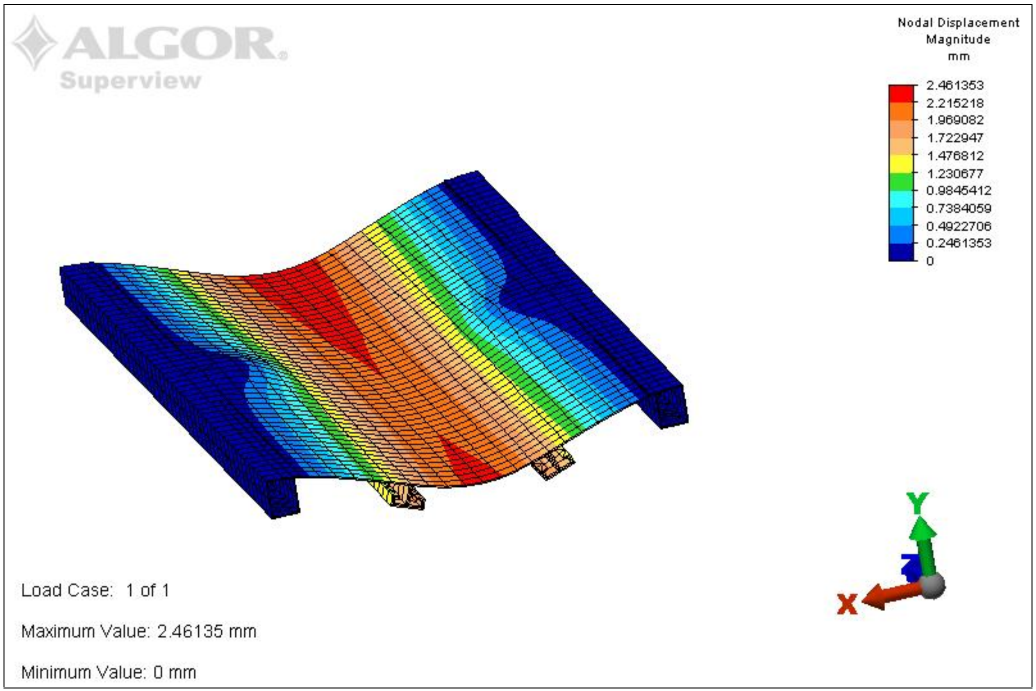

Figure 4.11: Two person table displacement

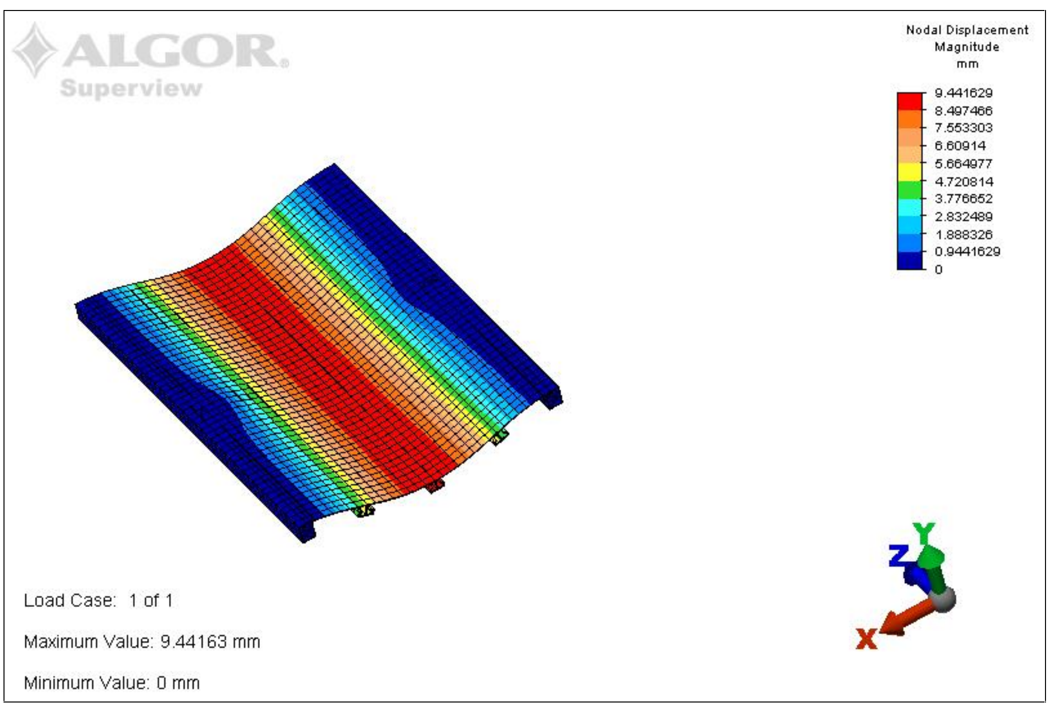

Figure 4.12: Four person table displacement

The value of maximum displacement is as shown in table 4.5

Table 4.5: Maximum displacement value

Case	Maximum Displacement (mm)
1 Person Table	4.18
2 Person Table	2.46
4 Person Table	9.44

Support only available at the side plate, due to that, the condition with most side plate will resist greater displacement. However the result shows that the most displacement occurs at table for four persons. The reason due to that situation is the four persons table has the largest area and the supported area is lesser then the other two table situation. The displacement of 9.4mm is still acceptable for construction.

4.6 TABLE FABRICATION

As can be seen in table 4.2, the modular study table consists of parts that can be assemble and dissemble according to need and requirement. The table can be assemble for the usage of one two or four person at a time

After the fabrication process the result is shown in figure 4.13

Figure 4.13: Completed table

The finished table in figure 4.13 didn't meet the expectation from the project. The table did form the shape planned but the surface of the table tend to bend even without the load. The deformation can clearly spotted in figure below relative to a straight object.

Figure 4.14: Deformation

The structure of the table cannot maintain a flat and straight surface. There is no supporter at the side or on the surface of the table.

As for the leg of the table, it cannot be fabricate due to problem to bend the lower part of the side plate part. The machine available at the laboratory, TrumaBend V85S only can make an opened angle bending as shown in figure 4.15 and it must be equipped with a special extension in order to bend a plate to square shaped sheet metal that required in this project.

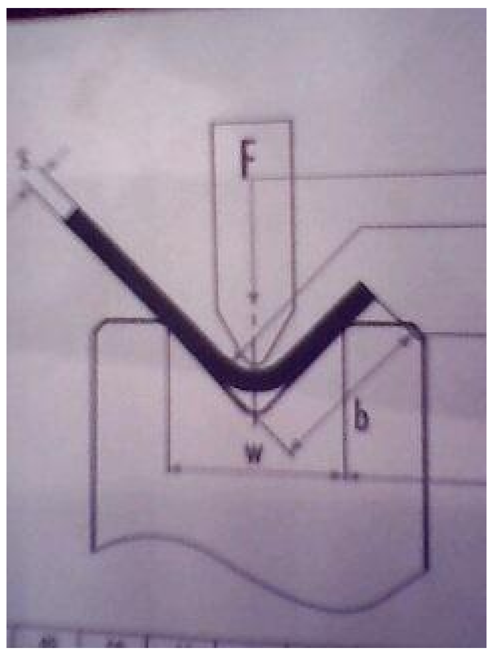

Figure 4.15: Bending limitation

Due to that, the work piece for side plate cannot be completed as required in figure 4.16. The TrumaBend V85S limitation causing the work piece to form as shown in figure 4.17

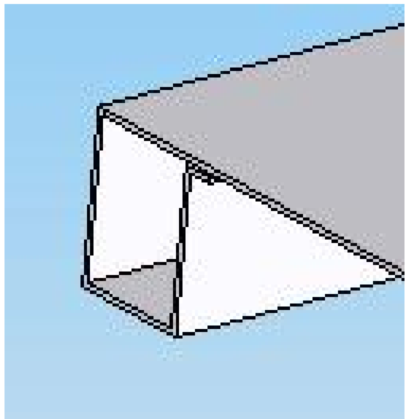

Figure 4.16: Required shape

Figure 4.17: Result shape

Due to unable to bend the lower part of the side plate, the leg of the table was unable to be properly build and connected with the table.

There also problem occurs from lock under the table. The locks suppose to act as holder for the entire table surface. Due to inconsistent bending process and slight error in dimension, the lock was not fully operated according to required standard. The lock might be nicely fit under the table but there was some of it slightly loose and some of it slightly tight. It doesn't affect the table structure but the assembly and dissemble process slightly affected due to it.

The dimension error may caused in the process of measurement, cutting process using Hydraulic Shear, or even at the TrumaBend V85S. It is not a huge error but in this project, accuracy is important to obtain a perfectly match parts.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

In the ALGOR analysis process, the table was able to withstand the assign load. The maximum stress shown in the analysis is 107.866MPa, while the value of yield strength of the aluminum is 325MPa. Displacement of 9.4mm is observed in simulation and this value is still acceptable for construction.

The modular study table is possible to be build but in this project, due to problems that occurs, the result isn't really according to plan. The table is able to be constructed but as for testing process, it cannot work as required. The structure of the table bend even before any load is exerted to it.

The aluminum sheet metal didn't has enough strength to maintain its shape compared to galvanic iron but galvanic iron was too hard to work with, so it didn't been selected as main material for this project.

The table might be a reality if some improvement were made to its design to reinforce its structure. The main reason it fail is due to limited amount of support on the surface and side part of the structure.

5.2 RECOMMENDATIONS

The table could be more effective if there were better support on its structure. Better support on the surface and side part of the structure will improve it strength and resistance to deformation process.

By using another type of material on the project is also a possible method to improve the strength of the table. Harder material such as galvanic iron but with lesser thickness might able to solve the problem faced in this project.

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[1] David W. He and Andrew Kusiak, *Member, IEEE, "*Design of Assembly Systems for Modular Products"

[2] Neil Rasmussen, Suzanne Niles, "Modular Systems: The Evolution of Reliability"

[3] Ferdinand P. Beer, E. Russell Johnston, Jr. John T. DeWolf "Mechanics of Materials, Fourth Edition in SI Units"

[4] http://www.faccents.com/tables.html accessed on 21 May 2008

[5] http://www.globalpropertyguide.com/Asia/Malaysia/ accessed on 3 July 2008

[6] http://www.freepatentsonline.com/5752450.pdf accessed on 15 August 2008

[7] http://www.freepatentsonline.com/6497184.pdf accessed on 15 August 2008

[8] www.freepatentsonline.com/US6978723.pdf accessed on 15 August 2008

[9] http://www.patentstorm.us/patents/6382109 accessed on 15 August 2008

APPENDIX

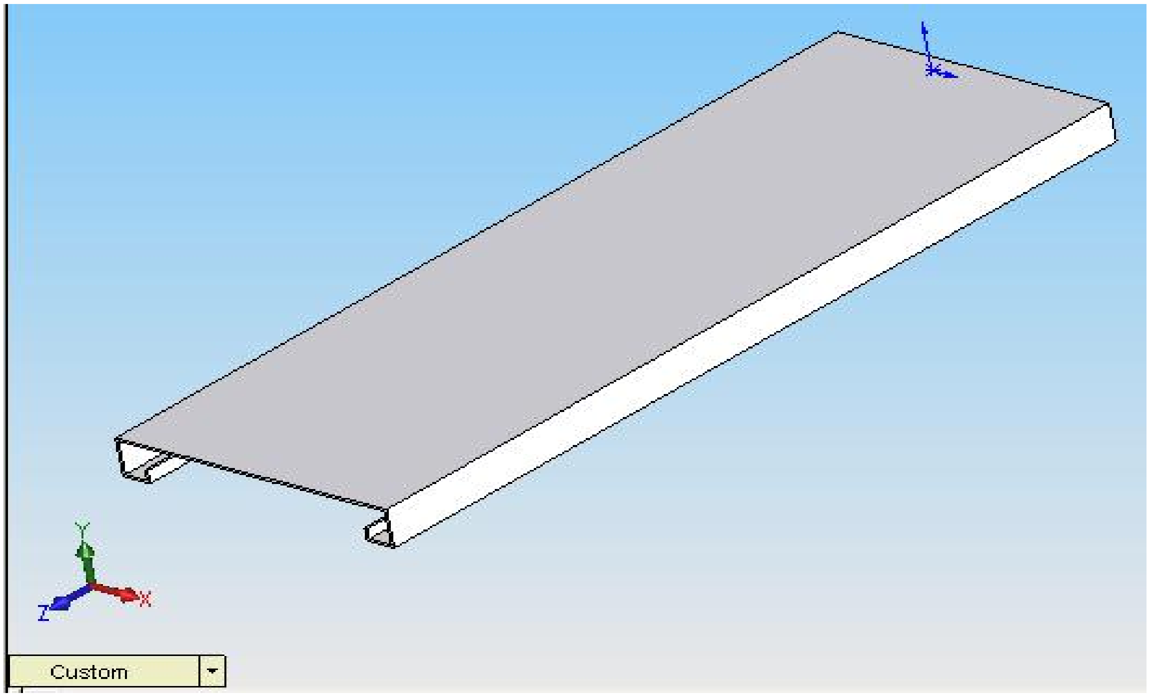

Figure 1: Plate

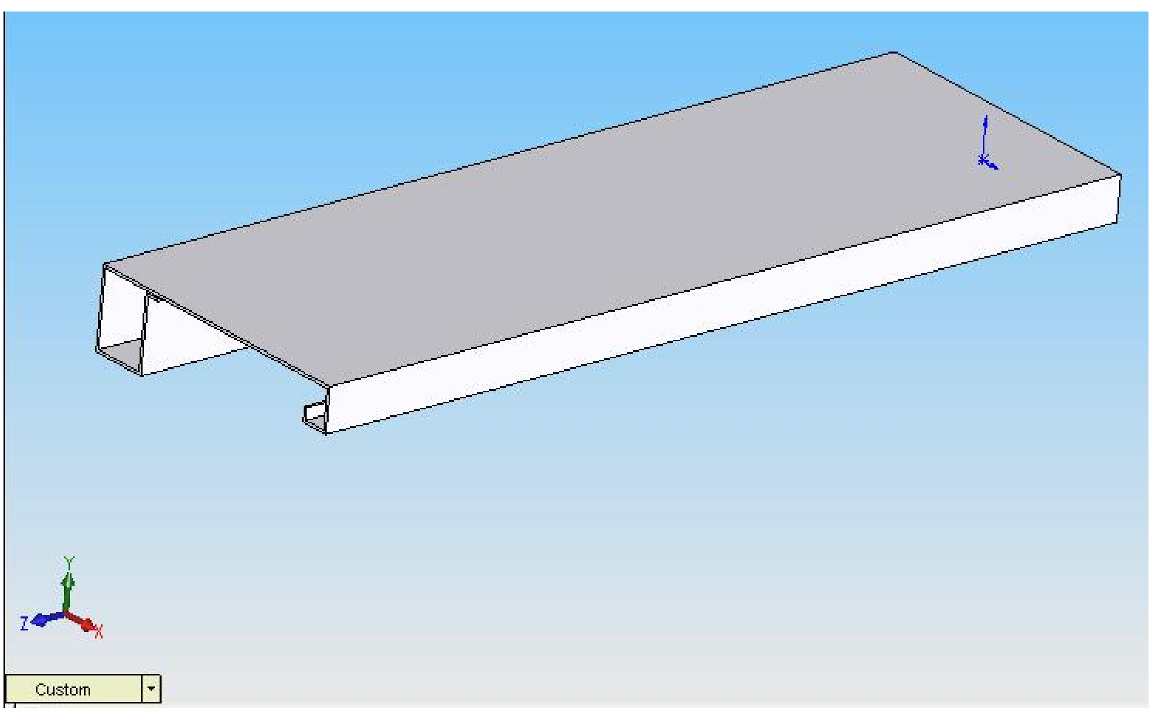

Figure 2: Side Plate

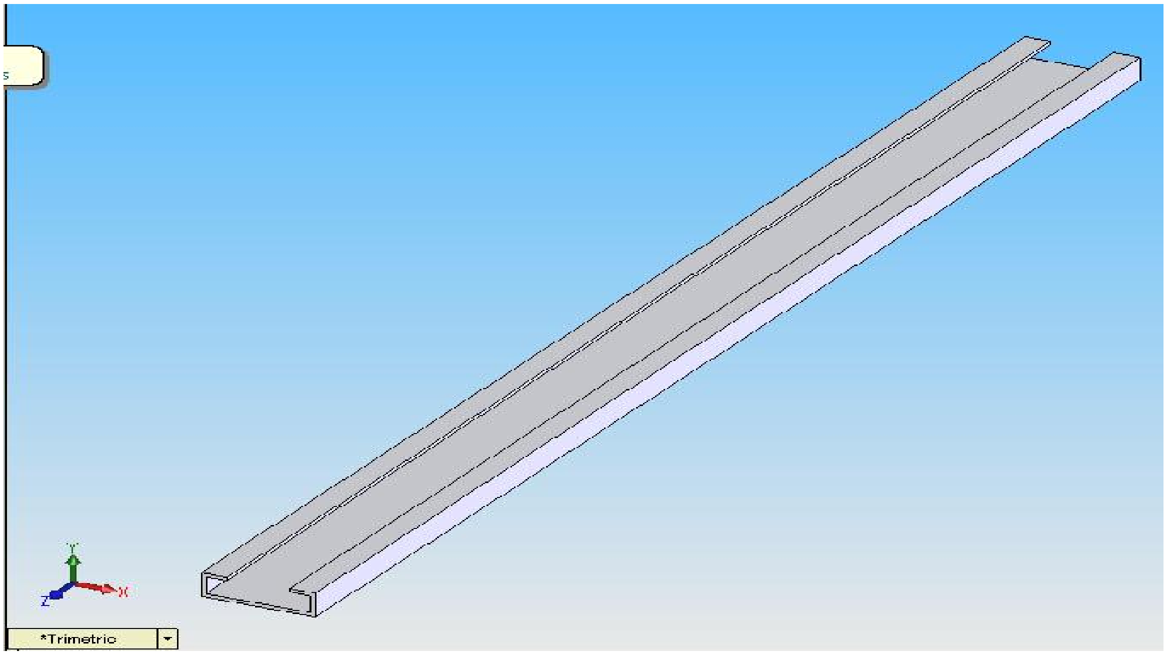

Figure 3: Lock

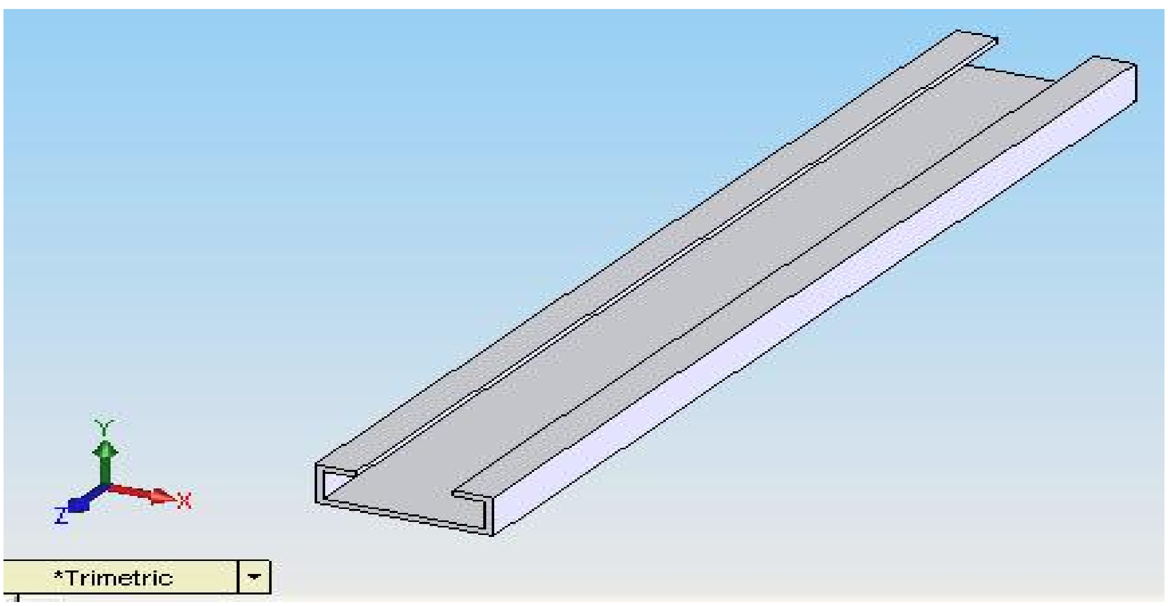

Figure 4: Small Lock

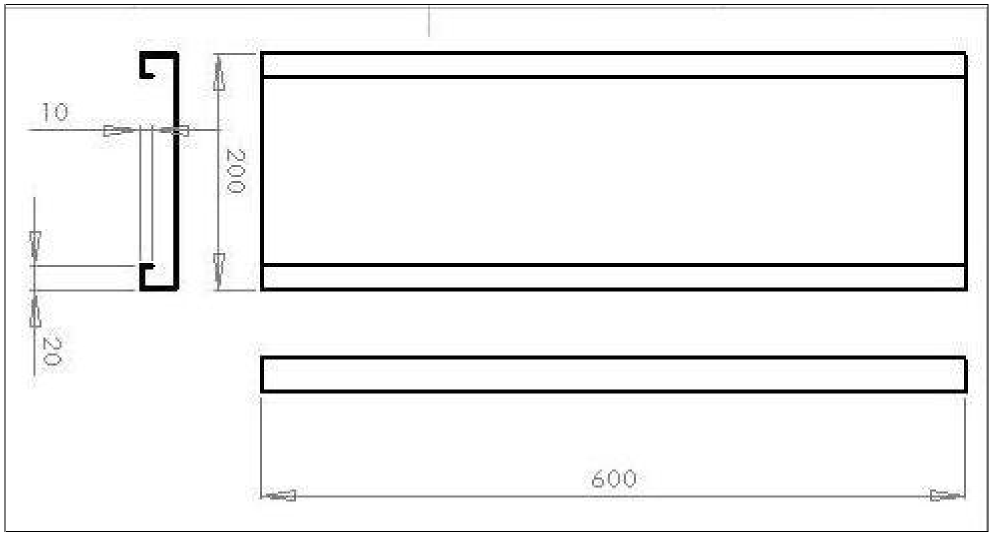

Figure 5: Plate's Dimension (unit in mm)

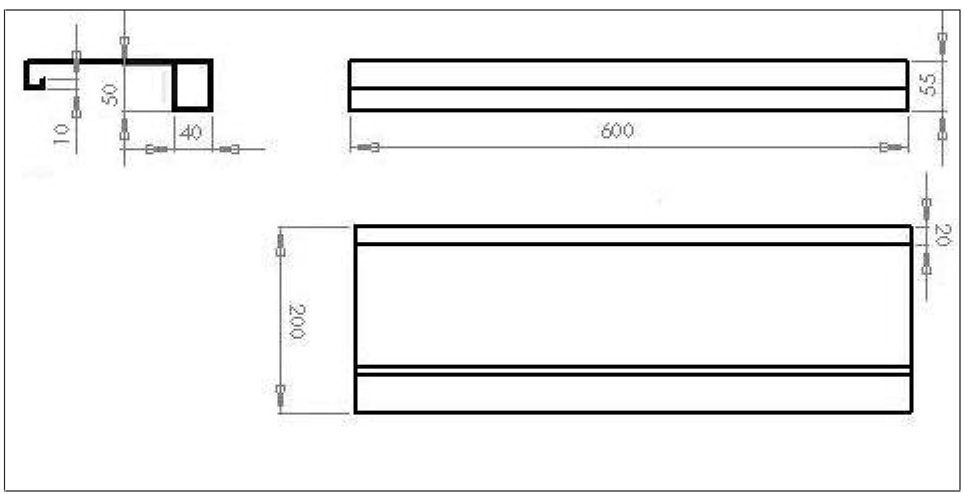

Figure 6: Side Plate's Dimension (unit in mm)

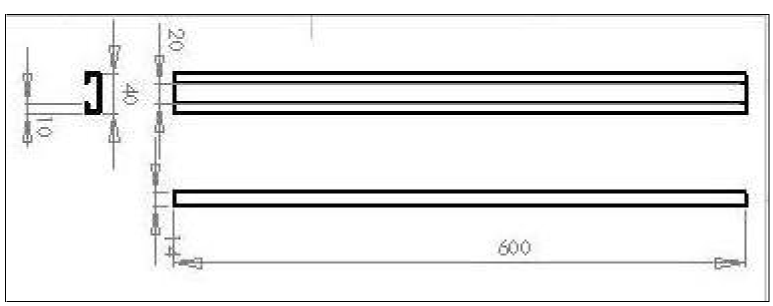

Figure 7: Lock's Dimension (unit in mm)

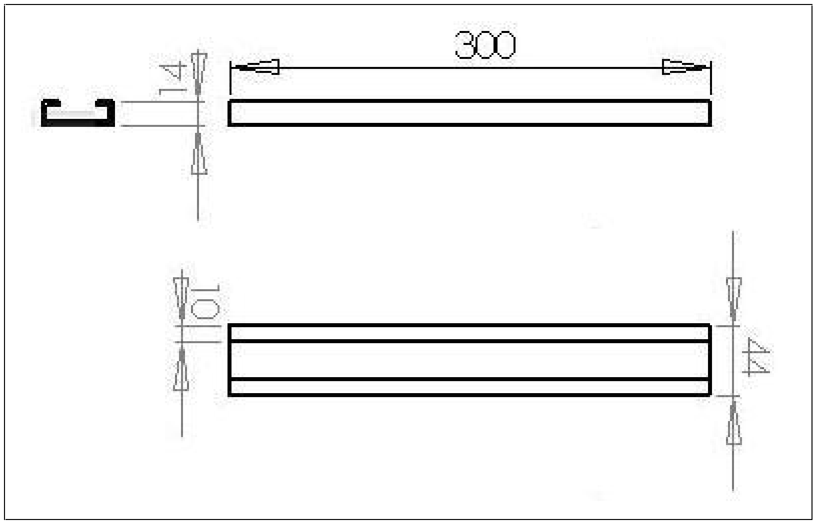

Figure 8: Small Lock's Dimension (unit in mm)

Figure 9: Hydraulic Shear

Figure 10: TrumaBend V85S