DEVELOPMENT OF THE SMALL SCALE PISTON TYPE BRIQUETTING TOOL

MOHAMMAD KHAIRULNIZAM BIN IBRAHIM

Thesis submitted to the Faculty of Mechanical Engineering in
Partial Fulfillment of the requirement for the award of the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering

UNIVERSITI MALAYSIA PAHANG

JUNE 2013

EXAMINERS APPROVAL DOCUMENT

UNIVERSITI MALAYSIA PAHANG
FACULTY OF MECHANICAL ENGINEERING

I certify that report entitled 'Development of the Small Scale Piston Type Briquetting Tools' is written by Mohammad Khairulnizam Bin Ibrahim with matric number MA09112. I have examined the final copy of this report and in my opinion, it is fully adequate in terms of language standard, and report formatting requirement for the award of the degree of Bachelor in Mechanical Engineering. I herewith recommend that it be accepted in fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering.

Supervisor	: Prof. Ir. Dr. Hassan Ibrahim	Signature
Position	: Professor	
Date	:	

SUPERVISOR'S DECLARATION

I hereby declare I have checked this report, which written by Mohammad Khairulnizam bin Ibrahim with matric number MA09112, and in my opinion, this report project is adequate in terms of scopes and quality for the award of the degree of Bachelor of Mechanical Engineering.

Supervisor : Dr. Gan Leong Ming
Position : Senior lecturer
Date :

Co-supervisor : Prof. Dato' Dr. Hj. Rosli Abu Bakar
Position : Professor
Date :

STUDENT'S DECLARATION

I hereby declare that the ideas, designs, analysis, results and conclusions of this project are entirely my own effort, except for quotations and summaries which have been indicated and acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature : ....
Name : Mohammad Khairulnizam Ibrahim
ID Number : MA09112
Date :

Specially dedicated to

My beloved family and those who have

Encouraged and always be with me during hard times

And inspired me throughout my journey of learning

ACKNOWLEDGEMENTS

Alhamdulillah, the highest thanks to God because with His Willingness I can finish as well as completing the final year project.

This project would not have been possible without considerable guidance and continuous support. I would like to acknowledge to those who have enabled me to complete this project. In particular, I would like to express my sincere gratitude to my dedicated supervisor, Dr. Gan Leong Ming, for encouragement, advice, critics and guidance for me to finish up the entire requirements which are needed in completing this project with clarity and that priceless gift of getting things done by sharing his valuable ideas as well as his knowledge.

My sincere thanks go to all my laboratory mates and members of the staff of the Mechanical Engineering Department, UMP, who helped me a lot in facing obstacles and made my stay at UMP pleasant and unforgettable. Many special thanks to them who give co-operation, inspirations and supports during this study.

I acknowledge my sincere indebtedness and gratitude to my parents, Ibrahim bin Ideris and Wan Hanisah bt Che Othman for their love, dream and sacrifice throughout my life. I acknowledge the sincerity of my family, who consistently encouraged me to carry on my higher studies in Malaysia. I am also grateful to my father, mother and brothers for their sacrifice, patience, and understanding that were inevitable to make this work possible. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to attain my goals. Special thanks should be given to my committee members. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this study.

ABSTRACT

Currently, renewable energy is becoming an important source of energy in our world. Renewable energy is a solution that can overcome the problems that occur in our world right now such as global warming, urban smog, acid rain and many more dangerous emmisions. Biomass is one the sources of renewable energy that have specific properties that can change our world environment right now. Biomass use and application is the one way for decreasing the above negative effect to the world. Briquette technology is the one technology which uses the biomass product in the right way. In order to develop a small scale of piston type briquetting tools, an analysis was carried out to choose the best design to develop briquette machine. Four samples of different designs then was sketch in 3D drawing by using Solidworks Premium Software. Every designs was sketch in different application of theories which are pascal theory, bottle jack theory, bottle jack theory with heavy duty spring and use of power supply of motor. By using Solidwork Premium Software stress strain anlysis, the designs then being analysed. After do the analysis, comparison and concept selection between the designs was carried out. The result is finalised and the concept of using of power supply of motor is selected. For the final stage, the machine was fabricate by using the selected concept.

ABSTRAK

Pada masa ini, tenaga boleh diperbaharui menjadi sumber tenaga yang terkenal di dunia kita. Tenaga boleh diperbaharui diketahui bahawa boleh mengatasi masalah yang berlaku dalam dunia kita sekarang seperti pemanasan global, kabus bandar, hujan asid dan banyak lagi pelepasan asap yang lebih berbahaya. Biomas adalah salah satu sumber tenaga boleh diperbaharui yang mempunyai ciri-ciri tertentu yang yang boleh mengubah persekitaran dunia kita sekarang. Penerapan penggunaan biomas adalah cara yang ideal untuk mengurangkan kesan bahaya kepada dunia. Teknologi briket adalah teknologi satu yang menggunakan produk biomas ke arah cara yang betul. Untuk penghasilan mereka bentuk mesin briket jenis omboh yang berskala kecil , analisis dijalankan untuk memilih reka bentuk yang sesuai. Empat jenis dengan perbezaan reka bentuk dilakarkan dalam bentuk 3D dengan menggunakan perisian jenis Solidwork Premium. Setiap reka bentuk dilakarkan dengan menggunaka teori yang berbeza terdiri daripada teori pascal, teori jack botol, teori jack botol dengan spring tahan kuat dan penggunaan kuasa motor. Dengan menggunakan perisian Solidwork Premium, setiap reka bentuk dianalisis dengan menggunakan ujian tekanan analisis ketegangan.Selepas melakukan analisis, perbandingan dan konsep pemilihan antara reka bentuk dijalankan. Keputusan pemilihan reka bentuk dimuktamadkan dan konsep dipilih. Untuk peringkat akhir, mesin di buat dan direka dengan menggunakan konsep penggunaan bekalan kuasa motor.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND STUDY

Renewable energy is getting more important nowadays. Generated energy from variety of sources makes it important. There are many forms of sources that can become renewable energy and biomass is one of it. All earth's living matter thing that growth through photosynthesis which includes microbes, animal, plants and the organic material that is excreted and metabolized by them is referred as biomass (Zhang et al, 2009).

Organic matter that derived from plants is defined as biomass. Plant, animal materials such as wood from forests, seaweed, crops, material left over from agricultural and forestry processes, organic industrial, human and animal waste are the example of biomass product. Other than that, biomass also known as plant biomass or phytomass, animal biomass or zoomass. The process of converted photosynthesis into chemical energy is then stored in the form of aquatic vegetation and terrestrial after the sun's energy intercepted by plants. Zoomass (animal biomass) and excreta is converted from vegetation which is gazed by animal. The dairy terrestrial animal excreta can be used as a source of energy compared to aquatic animals, which os its excreta gets dispersed and it could not possible to collect and use for the energy production (Zhang et al, 2009).

Other than that, the earliest sources of energy in rural areas where at there often only accessible and affordable sources is biomass. Biomass as a renewable energy which have very specific properties is made up from carbohydrates. Other renewable energy such as wind energy cannot beat biomass energy because biomass is well known as a versatile fuel that can produce liquid fuels, biogas and electricity (Saidur et al, 2011).

1.2 PROBLEM STATEMENT

As we all know, oil, coal and natural gases represent as the prime energy sources in the world. We can see that there increasing of greenhouse effect which is affected to global environment warming. Although there are prime energy sources, they gives a bad effect to the world from the production of emissions such as increasing of greenhouse effect due to global environment warming, acid rain and urban smoke and this problems have temped the world which try to reduce carbon emissions by 80% (Saidur et al, 2011).

In some places, they do the direct burning of loose biomass. They do not reuse the biomass into the correct way. Millions of tons of a biomass product, rice straws are burnt away and abandoned by the farmers in the fields after finished harvest the rice. The burning of the rice straws not only gives the pollution to the environment but also cause the traffic accident if the field is close to the freeway. When there are rainy season, the abandoned of biomass, rice straws in the field will flow into the drainage system and cause an obstruction and for sure also will provide the place for bacteria to propagate (Chuen et al, 2008).

So, the developing of biomass briquette machine is will overcome the problems to become more worst. The product that forms is called briquettes have a lot of advantages which will not emit fly ash, smoke with sulphur or phosphorus. Thus, it is not dangerous to the environment (Grover & Mishra, 1996).

1.3 PROJECT OBJECTIVES

Basically, this thesis would be done for fulfill the following

a. To design and analysis the small scale piston type briquetting tool
b. To fabricate a briquetting machine prototype of small scale piston type briquetting tool

1.4 SCOPE OF STUDY

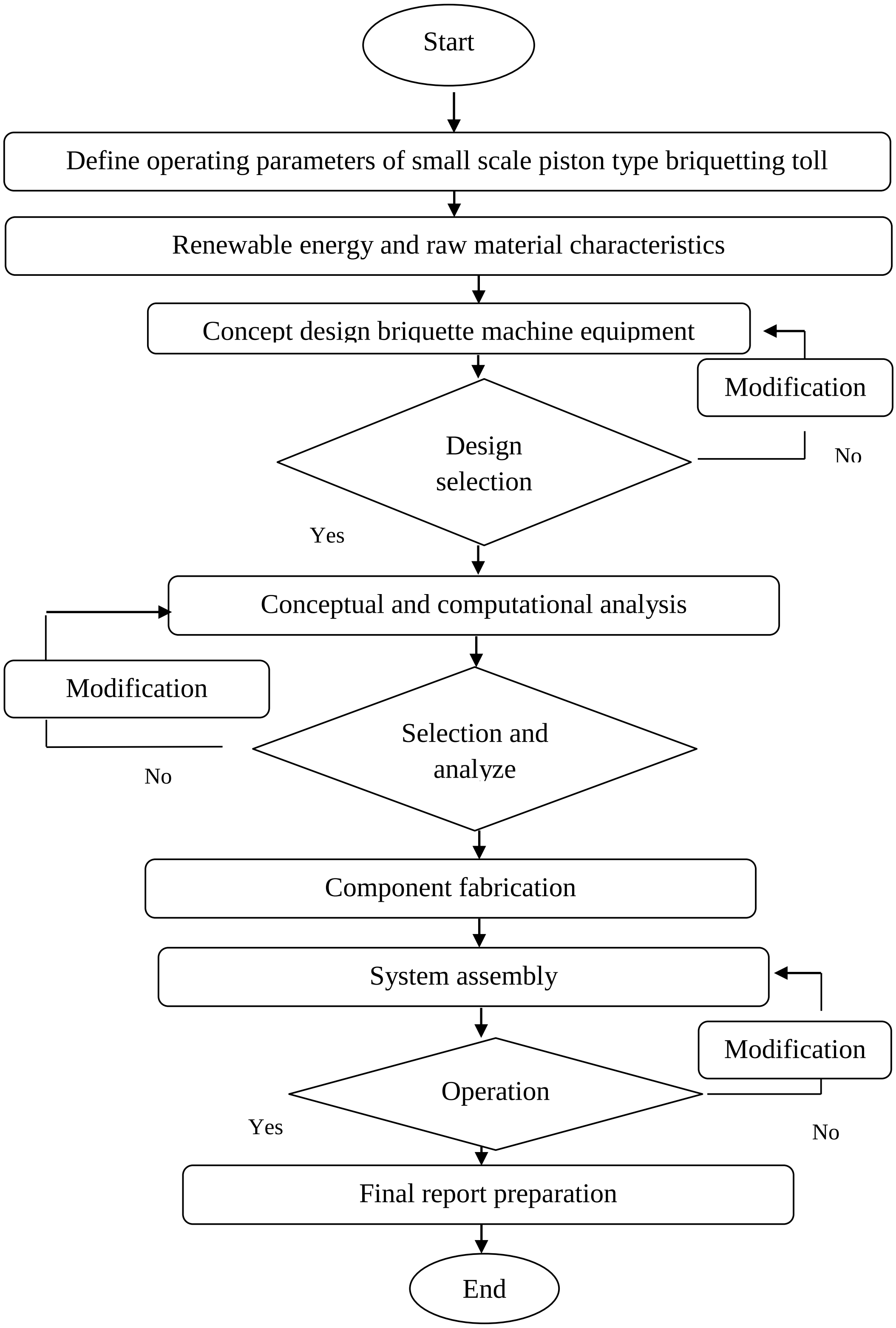
The ability to contribute the scope in designing the product is important to make it success. It can be the benchmarking for the development of the product. To accomplish the objectives, there are the scopes, which are:

a. Literature study of the small scale piston type briquetting tools using solid works.
b. Conceptual design of the small scale piston type briquetting tools.
c. Development and fabricating model of small scale piston type briquetting tool.
d. Computational analysis on the fabrication model.
e. Final report preparation

1.5 HYPOTHESIS

Briquette machine of small scale piston could achieve all aspects in design consideration which is functionality and ability of the machine. A selected design from several design will choose and by the end of the development, prototype model could mount all components together and built as working model prototyping.

1.6 FLOW CHART



CHAPTER 2

LITERATURE REVIEW

2.1 BRIQUETTE APPLICATION IN BIOMASS

Among the energy resources, biomass briquette becomes the most important energy sources. This due to biomass briquette which has variety of appealing properties such as low acidic gas emissions, low greenhouse gas and low production cost (Chuen et al, 2009).

Biomass is the third largest primary energy and then followed by coal and oil. For more than half of the world's population, biomass remains the primary source of energy. Biomass has provides about 14% of the world's annual energy consumption or 1250 million tons oil equivalent (Mtoe) to the world. If compared to fossil fuels, biomass is more better due to biomass is a renewable and sustainable fuel that can deliver significant in net of carbon emissions. Biomass also known as attractive clean development mechanism because of its function that could reducing greenhouse gas emission (Chen et al, 2009).

Biomass is an energy sources that can be classified as a combustible materials and sources for biomass are unlimited. The energy that contained in biomass actually comes from the sun. Carbon dioxide in the air is transformed into a carbon that containing molecules such as sugar in plants through photosynthesis process. These sugars are called bio-energy or known as carbohydrates are stored in plants and animals waste product (Saidur et al, 2011). Figure 2.1 shows the sources energy of biomass.

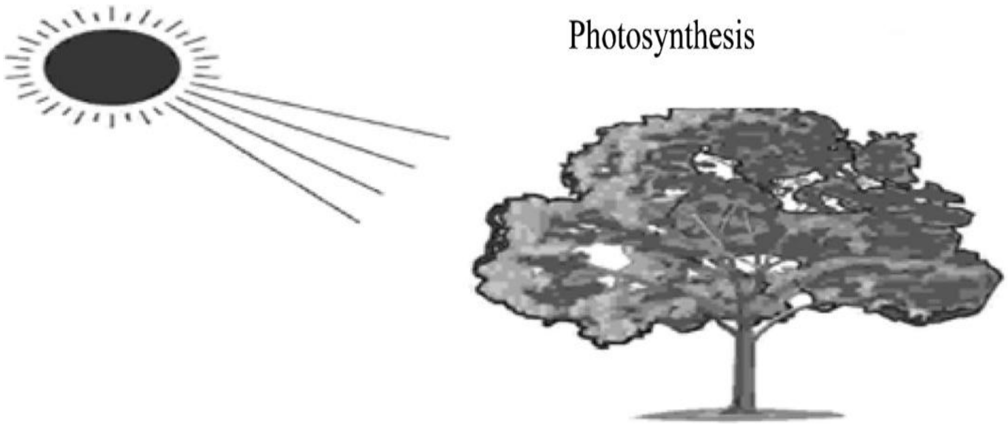


Figure 2.1 Source energy in biomass

In the photosynthesis process, radiant energy is converted from plants to the sun into chemical energy in the form of glucose:

Water + Carbon dioxide + Sunlight $\longrightarrow$ Glucose + Oxygen

$6H_20 + 6CO_2$ + Radiant Energy $\longrightarrow$ $C_6H_{12}0 + 60_2$

Source: Saidur et al (2011)

Currently, fossil fuel such as coal, oil and natural gas has becomes the primary energy in the world. Although fossil fuel got the highest ranking, however it is anticipated that it will depleted within in the next 40-50 years. So, biomass is the best sources to replace fossil fuels. Biomass is the better sources compared to fossil fuels which will make the environmental damages such as acid rain, dangerous smoke, acid rain and others problems that can caused an increasing in carbon emissions (Saidur et al, 2011). Table 2.1 and Figure 2.2 shows the target of biomass sources for future.

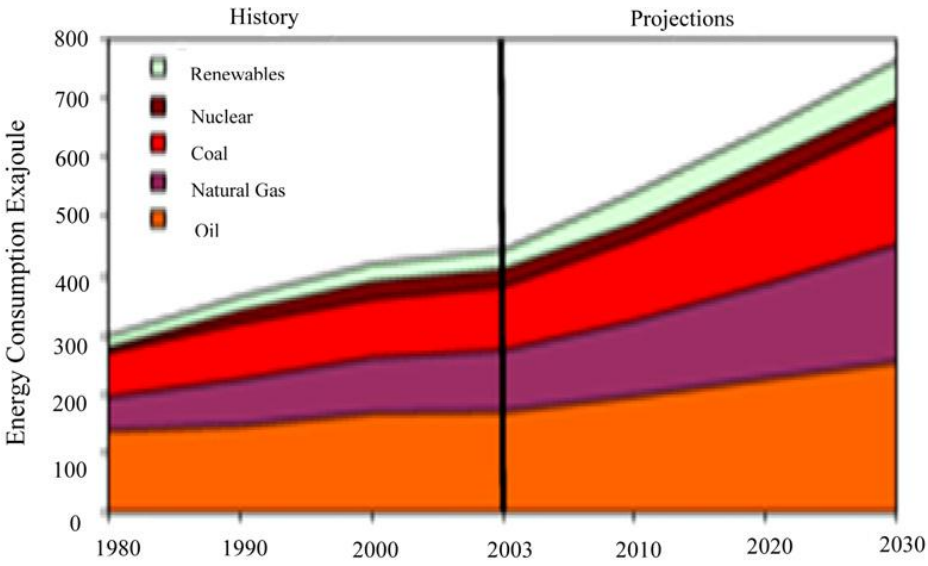


Table 2.1 Energy Consumption

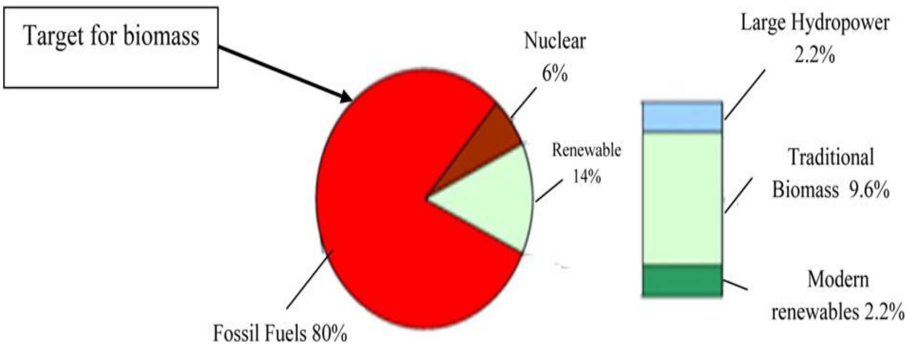


Figure 2.2 Sources of energy consumption

Sources: Saidur et al (2011)

Biomass also known as carbon neutral source of energy which means when biomass in burned or used it after converting it to other types of fuel like liquid, solid, and gaseous fuels (charcoal, ethanol, methane), the biomass carbon then reacts with oxygen to form carbon dioxide . This carbon dioxide will be released to the atmosphere. The amount of carbon dioxide which is fully combusted is equal to the amount which was taken from during the growing stage from the atmosphere. So, biomass can be regarded as a carbon sink as there is no addition of carbon dioxide. This process is known as zero carbon emissions or a carbon cycle (Saidur et al, 2011). Figure 2.3 shows flow of a carbon cycle.

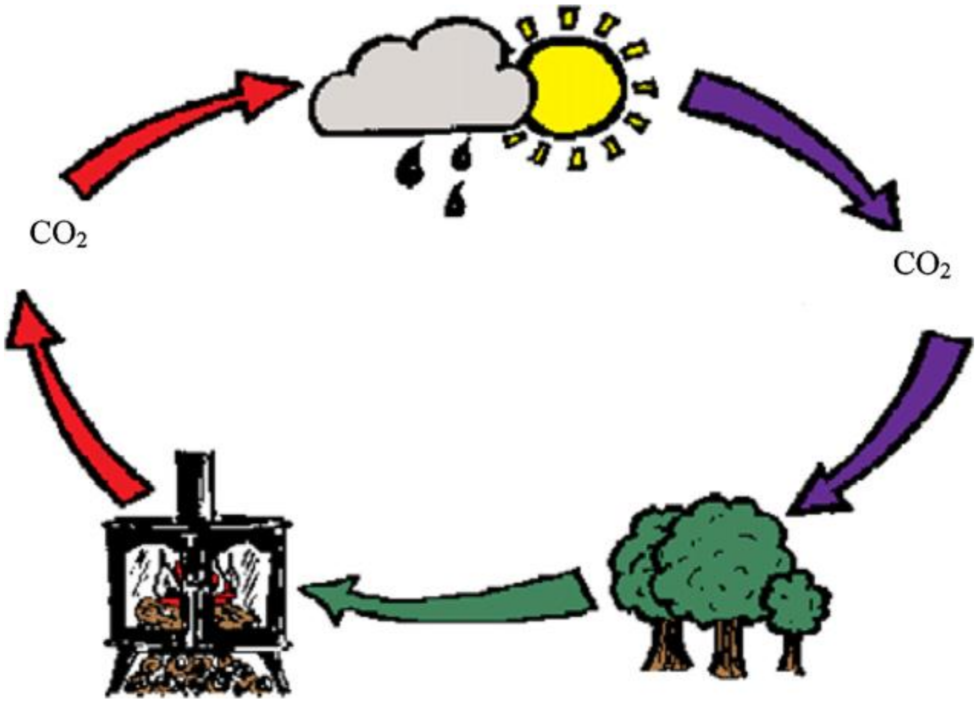


Figure 2.3 Carbon Cycle of Biomass Product

Sources: Saidur et al (2011)

One of the technologies which convert loose agricultural residues or biomass product is develop which is biomass briquetting (Chen et al, 2009). Biomass briquetting is the process known as biomass densification which represents a technology set that makes a fuel by conversion of biomass. Energy production can be expanding by using this biomass technology. For the compaction technique, the solid particles are the starting of the material (Grover & Mishra, 1996).

Briquette technology is the process where giving a high pressure to the raw materials and then then raw materials will become in a compact shape. The strength of the compact shape of solid is affected by Van der Waal's forces, valence electron or interlocking. A binder between the particles will forms due to prevailing a high pressure condition to the raw material (Grover & Mishra, 1996). The figure 2.4 shows some of the mechanism binding.

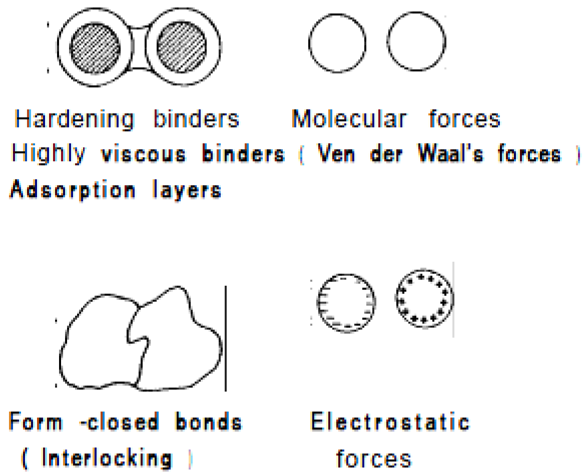


Figure 2.4 Binding mechanism in biomass product

Sources: Grover & Mishra (1996)

2.2 PARAMETERS THAT INFLUENCED PROCESS OF THE BRIQUETTE

To achieve a good quality of briquette, there are some parameters need to follow. A parameters need to be review to get a good quality of briquette.

2.2.1 Moisture Content

The moisture content is one of the critical factors that influence strengthens of the briquette. At 6-8 percent of moisture content, the briquette will in a strong condition and free of cracks. When the moisture content more than 10%, the briquette condition is in poor and week and the briquette operation also will be in erratic. Water also acts as a binder agent. Water helps to promote the bonding of van der WaAls' by increasing the area of contact of the particles (Grover & Mishra, 1996).

The moisture content should be the range of 10-15%. High moisture content will pose a problem due to excessive energy required for drying and firing. Huge moisture will lead to hinder the combustion of reaction products, reduces the combustion temperature and most worst is it will affect the quality of the combustion (Chen et. al, 2009). Low moisture content is the most important factor to increase the strength (Chou et al, 2009). Table 2.2 shows different biomass materials have the different moisture content.

Table 2.2 Sample of biomass moisture content

Crop	**Residue**	**Moisture Content (%)**
Rice	Straw	15.5
Rice	Husk	10.4
Corn	Stalk	7.7
Corn	Cob	11.0
Corn	Husk	14.6
Wheat	Straw	15.0
Millet/Rye/Oats	Straw	16.3
Barley	Straw	15.0
Sorghum	Straw	15.0
Cassava	Stalk	7.8
Groundnut	Husk/Shell	12.0
Groundnut	Straw	15.0
Soybean	Straw	49.8
Sugar cane	Bagasse	62.5
Sugar cane	Tops/Leaves	12.0
Cotton	Stalk	10.0
Cotton	Husk	10.0
Coconut	Shell	10.9
Oil palm	Shell	7.3
Oil palm	Fibre	36.7
Oil palm	Empty bunches	36.7
Coffee	Husk	15.0

Source: Chen et al (2009)

2.2.2 Particle size

Size of particle and shape are the main important factor to produce briquette. There are a lot of sizes that can be made but the ideal size is the particle size between 6-8 mm with 10-20% powdery component is the best result. The size of the material will affect the appearance the briquette. When use 10-5 mm size of particle, the appearance of solid briquette is rougher than compared by using 5- 2 mm size of particle (Chou et al, 2009).

High static strength and appearance will depends on the present of different size of particles. The machine will be jammed and the briquetting process will not be smooth and clogging will occur if using briquette material of oversized particles (Mazzu, 2007). Table 2.3 shows the appearance of compactness of biomass briquette due to use variety of size.

Table 2.3 Appearance compactness of briquette

Test	**Material**	**Particle Size (mm)**	**Maximum pressure (bar)**	**Density (g/cm^3)**	**Apparent compactness**
1	Straw	30-50	300	0.57	Insufficient
2	Straw	30-50	400	0.57	Medium
3	Straw	30-50	580	0.74	Good
4	Straw	30-50	400	0.61	Sufficient
5	Straw	10-30	580	0.80	Good
6	Straw	10-30	580	0.84	Good
7	Straw	10-30	580	0.85	Good
8	Millet stems	10-15	580	0.83	Good
9	Millet stems	10-15	580	0.92	Good
10	Millet stems	10-15	580	0.88	Good
11	Grass	10-15	580	1.01	Good
12	Grass	10-15	580	1.06	Good
13	Grass	10-15	580	1.01	Good
14	Grass/stems/straw/leaves	10-15	580	0.84	Good

Source: Mazzu (2007)

2.2.3 Temperature

Briquette crushing strength and moisture stability can be varied by varying the temperature of biomass of the briquette density. In a screw extruder cases, the external and internal friction causes local heating and self-bonding material properties is develop at elevated temperature (Grover & Mishra, 1996).

Moisture present in the material forms can be assumed to form steam at high pressure conditions which then hydrolyses the hemicellulose and lignin portions of biomass into lower lignin products, sugar polymers, molecular carbohydrates and other derivatives. These products will act as adhesive binders and provide a bonding effect when subjected to heat and pressure. The addition of heat relaxes the inherent fibers in biomass and also softens the structure. Next, it will reduce the resistance to briquette by decreasing the specific power consumption, increasing in production rate and reduction in wear of the contact parts. The temperature also needs to not exceed the limit of 300 ^{o}C of the decomposition of temperature to avoid the circumstances (Grover & Mishra, 1996).

Table 2.4 shows the sample of test conditions of preparing the biomass briquette by use variety of temperatures.

Table 2.4 Variety of temperature used to prepare briquette

Briquette test	**Percentage or rice straw/ percentage of rice bran**	**Size of smashed rice straw (mm)**	**Air-dry mass of material for preparing solid fuel (g)**	**Hot-pressing temperature (°c)**
B 1	100/0	10-5	53.38	90
B 2	100/0	10-5	53.38	110
B 3	100/0	10-5	53.38	130
B 4	100/0	10-5	53.38	150
B 5	100/0	5-2	53.33	90
B 6	100/0	5-2	53.33	110
B 7	100/0	5-2	53.33	130
B 8	100/0	5-2	53.33	150
B 9	100/0	<2	53.58	-
B 10	100/0	<2	53.58	90
B 11	100/0	<2	53.58	110
B 12	100/0	<2	53.58	130
B 13	100/0	<2	53.58	150
B 14	80/20	<2	53.58	-
B 15	80/20	<2	53.58	90
B 16	80/20	<2	53.58	110
B 17	80/20	<2	53.58	130
B 18	80/20	<2	53.58	150
B 19	60/40	<2	53.56	-
B 20	60/40	<2	53.56	90
B 21	60/40	<2	53.56	110
B 22	60/40	<2	53.56	130
B 23	60/40	<2	53.56	150

Source: Chou et al (2009)

2.3 HISTORICAL AND DEVELOPMENT OF BRIQUETTE MACHINE

Research and developing the biomass briquette technology is expandable through the years and several technology of briquetting machine is developed. For the development of machine, there have four development of briquette machine which is hydraulic press, piston press, screw press and roller press.

2.3.1 Historical of biomass briquetting technology

The starting of developing the briquette machine still in research but it was found that the R&D (Research and Development) of biomass briquetting technology can be traced back to around 20 years ago. Institute of Chemical Industry of Forest Products (ICIFP) had carried out a research on biomass briquetting technology during China's Seventh Five-Year Plan (1986-1990). The R&D of biomass briquette technology in China is divided into three stages consists of before 1995, focusing on the basic of the technology development. The first generation technology, implement to promote the small scale industry was in year 1995 until 2005. The biomass briquetting technology improved and upgrades to achieve the vision to enter a large scale industry (Chen et al, 2009).

In pre-2005, some institutions in China has come out with develop a few prototype, such as ZT-63 biomass briquetting device (food processing machine) and OBM-88 briquette device for formed solid biofuel. In year 1996-2005, there scope more detail by study the mechanical behavior at all stages of the compression process of different biomass materials (Chen et al, 2009).

In post 2005, the scope cover on renewable and clean energy is the choice for sustainable economic growth, for the harmonious of human and environment as well as for the sustainable development. In order to ensure the rapid and promote, effective and sustainable development of biomass, the study more concerned to explore the binding mechanism, the effect of pre-processing on biomass properties, develop briquette device with high productivity and low energy consumption. The R&D aim to focus on the upgrading the briquette machine and to provide clean and renewable energy (Chen et al, 2009).

2.3.2 Hydraulic Press

Hydraulic press works when a high pressure of oil system is exerted, energy are produced from the electric motor and then will transmitted to the piston. Hydraulic press not as others mechanical machine press because it only can give a slower press cylinder. Although the results in lower outputs, it can tolerate higher moisture content of agricultural residues (Chen et al, 2009).

Hydraulic press machine is the compact and light machine. Lower outputs in the results due to slower press cylinder compared to mechanical press machine. Briquette produces may have bulk density lower than 1000 kg/m^3 due to pressure limited to 40-135 kg/h. Hydraulic press machine also can tolerate moisture content higher than accepted mechanical piston press which is 15% moisture content (Grover & Mishra, 1996).

The Figure 2.5 shows example of biomass hydraulic jack press machine.

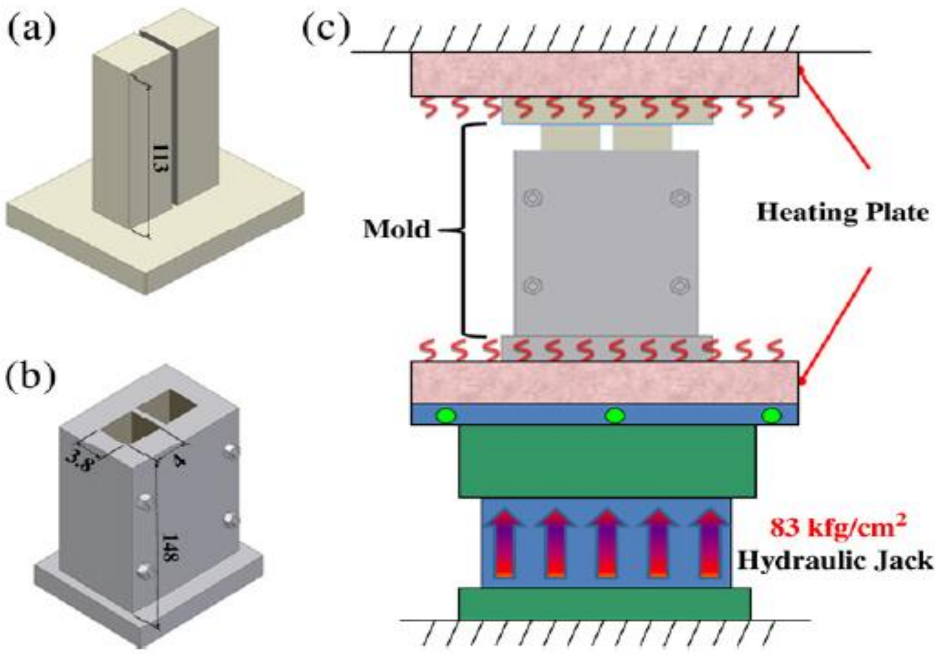


Figure 2.5 A hydraulic jack press machine

Source: Chou et al (2009)

2.3.3 Piston Press

Piston press or also known as die technology or ram. High pressure is applied to punch the biomass into die by a reciprocating ram. Low power consumption and long life of wearing parts is the specialist of the piston press. Compressions of piston press are wide range of raw materials because it can compress any type of biomass product such as sun flower stalks, cotton stalks, ground nut shell, peanut shell and many more type of biomass product. Although it can compress variety type of biomass, it has some advantages which is it needs a higher level of maintenance, briquette form in a lower quality and it cannot be carbonized compared to screw press type (Chen et al, 2009).

Better results were produced in year by Energy Research Centre (ERC) by develop a double press machine in Sudan. By using double piston hydraulic press, produced about 25 kg/h of briquette of a density mainly achieved to 500 kg/m^3, the briquette system becomes more productive and reliable system (Abakr & Abasaeed, 2006). Figures 2.6 show the development of double piston press machine by using hydraulic as the pressure source.

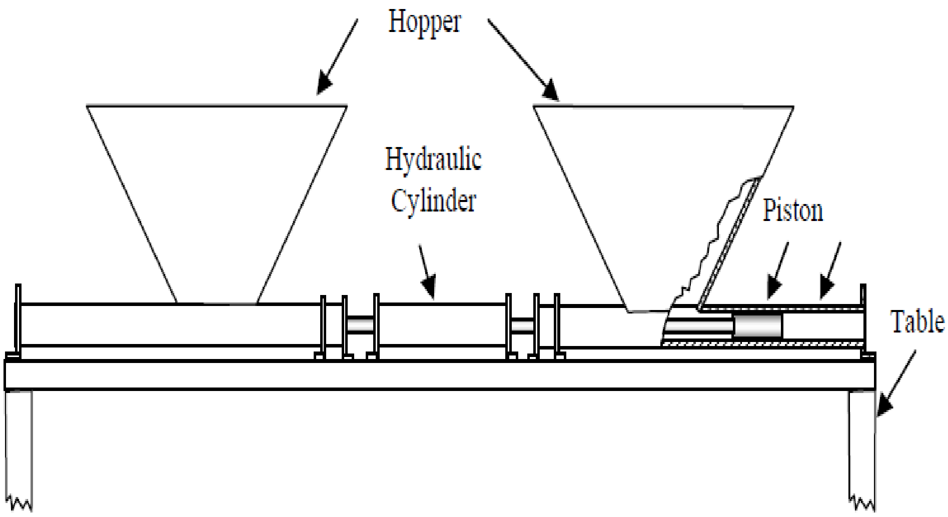


Figure 2.6 A double piston hydraulic acting briquette

Source: Abakr & Abasaeed (2006)

2.3.4 Screw Press

Screw press mainly about the biomass is extruded continuously by using heated taper die. To reduce the friction, the heated taped die is heated externally. Screw press has their own advantages which are high quality of briquettes and smooth and noiseless operation. High wear of the screw and the large specific comparatively required are the two major impediments of the screw press (Chen et al, 2009).

In developing countries, small scale application type screw press briquetting is a very popular. The material is inserted to the hopper and then compressed by a screw in screw-press briquette. A denser and stronger briquette can be produced by using this type of machine (Bhattacharya et al, 2002). Figure 2.7 shows the type of heated-die screw press type briquetting machine that used.

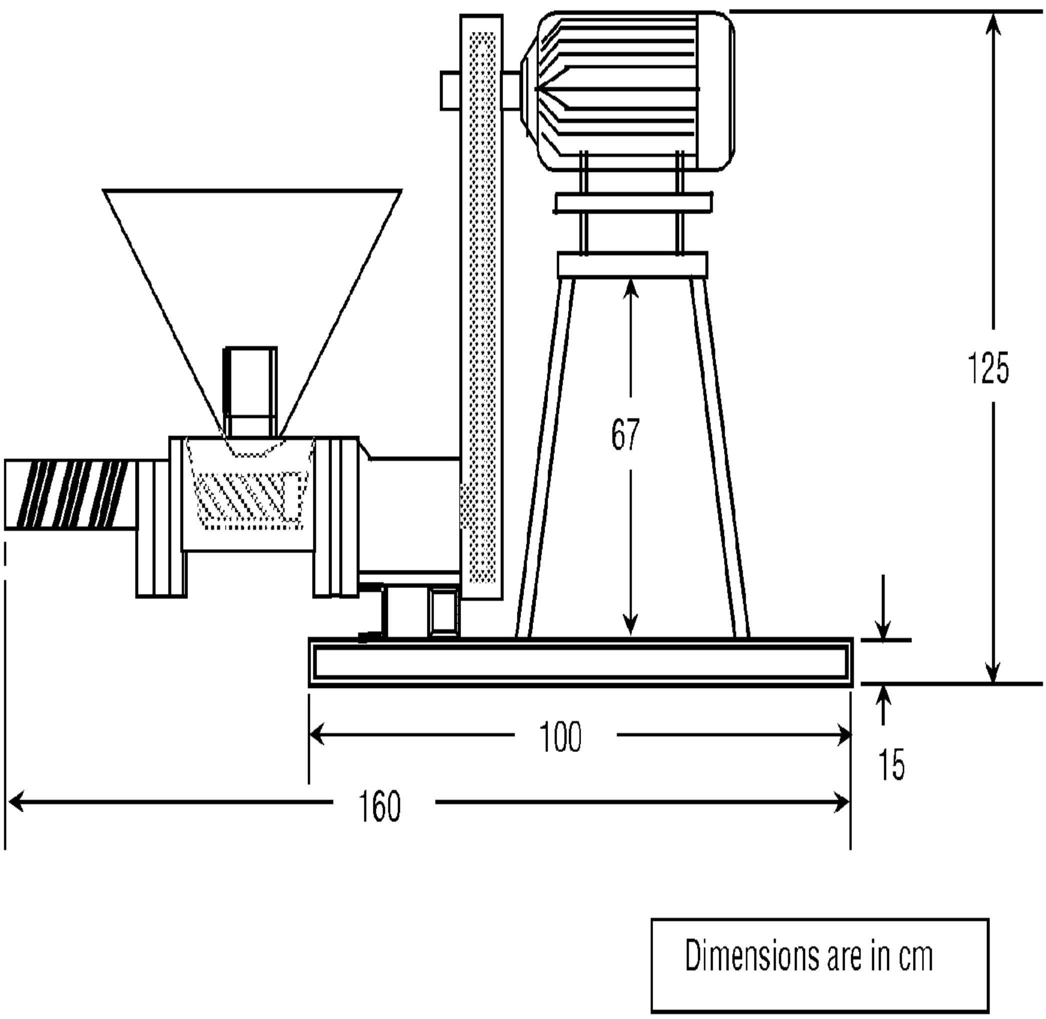


Figure 2.7 The heated-die screw press type briquetting machine

Source: Bhattacharya et al (2002)

Screw press has a lot of advantages compared to the others machine. Screw press will not having any shock load and can runs very smoothly, continuous in output and the size of briquette is in uniform size. The oils that used in the machine parts are free from dust or from raw material contamination. Power requirement of the machine also high compared to piston press and the most benefit is the screw press is light than piston press (Grover & Mishra, 1996). Table 2.5 shows the comparison of screw and piston press.

Table 2.5 A comparison between a screw extruder and a piston press

Scope	Piston press	Screw extruder
Optimum moisture content of raw material	10 to 15%	8 to 9%
Wear of contact parts	low in case of ram and die	high in case of screw
Output from the machine	in strokes	continuous
Power consumption	50 kWh/ton	60 kWh/ton
Density of briquette	1-1.2 g/cm³	1 to1.4 g/cm³
Maintenance	high	low
Combustion performance of briquette	not so good	very good
Combustion charcoal	not possible	makes good charcoal
Suitability in gasifies	not suitable	suitable
Homogeneity of briquettes	non-homogeneous	homogeneous

Source: Grover & Mishra (1996)

2.3.5 Roller Press

Roller press is using smaller dies (approximately 30 mm) and then the product form is called pellets. The material is forced in dies by using of two or three rollers as the dies arranged as holes bored on a thick steel disc or ring. There have two types of pellet press whish are flat type and ring type. Plat type possessed a circular perforated disc on which two or more rollers rotate while ring type has a rotating perforated ring on which roller press onto the inner diameter (Chen et al, 2009).

Roller press hot briquette is the process to produces a briquette pellet. Direct reduced iron is discharges hot form to become reduction process. Pocket is the main role to rotate rollers to form a pellet briquette. High pressure exerted about 120 kN/cm and temperature of 700 ^{0}C. The continuous briquette string leaving the rollers is controlled by heavy chute (Schutze, 2008). Figure 2.8 shows the flow sheet of a briquetting line for roller briquette machine to form pellets.

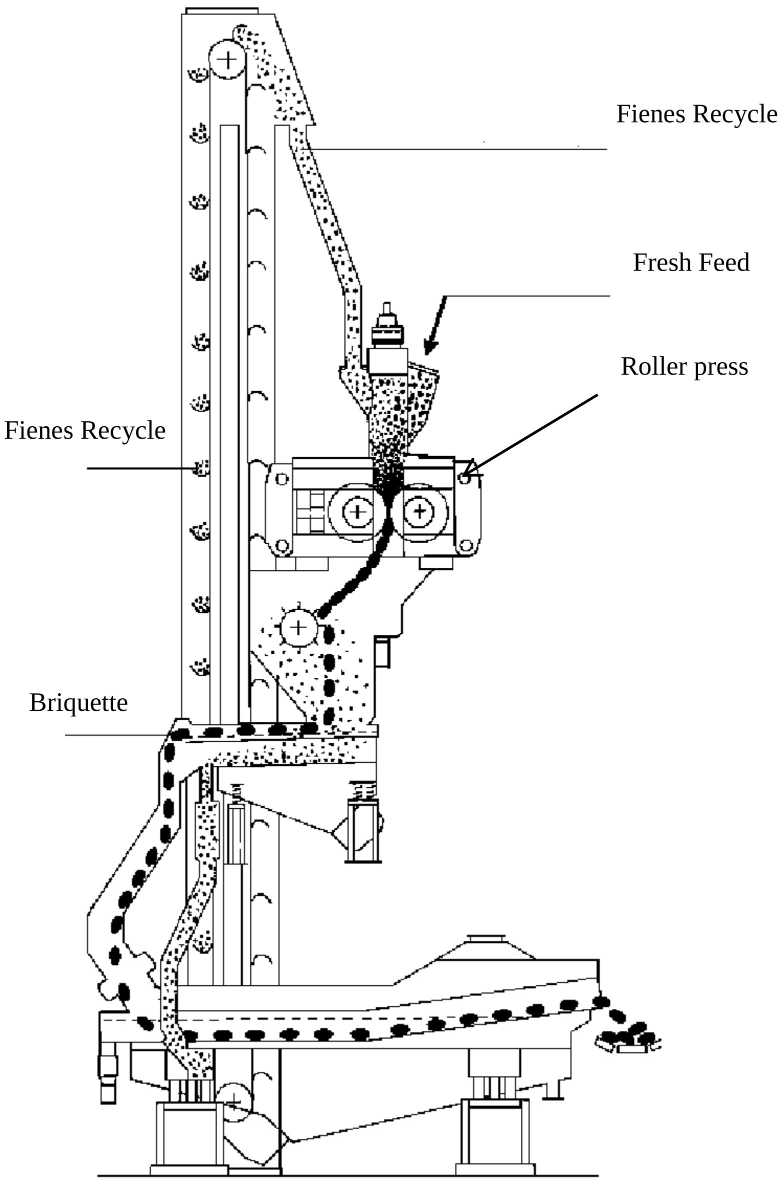


Figure 2.8 Flow sheet of a briquetting line for roller briquette machine

Source: Schutze (2008)

2.4 GOVERNING EQUATION

Some equations that need to review in briquetting process are:

The percentage of change in briquette volume, ηV:

$$\eta V = \frac{VB - VMC}{VMC} \times 100 \tag{2.1}$$

In Eq. (1), the briquette volume is represents by term VB, which was measured after 10 minutes of removal of briquettes from the mold. Then, the volume of the mold is represents by term VMC represents cavity.

The percentage of loss of briquette mass ηM:

$$\eta M = \frac{MF - MB}{MF} \times 100 \tag{2.2}$$

In Eq. (2), the briquette mass is represents by the term MB, which was measured after 10 minutes of removal of briquettes from the mold. The air-dry mass of material filled into the mold cavity for preparing solid fuel is represents by the term MF.

The theoretical heating value of the solid fuel briquette HB:

$$HB = H_{RS}W_{RS} + H_{RB}W_{RB} \quad (2.3)$$

In Eq. (3), H_{RS} represent the heating value of the powder of the rice (MJ/kg) , W_{RS} represents the percentage of the rice straw in the briquette, H_{RB} represents the heating value of the powder of the rice bran (MJ/kg), and W_{RB} represents the percentage of the rice bran in the briquette.

Source: C. S. Chou et al (2009)

CHAPTER 3

METHODOLOGY

3.1 CONCEPTUAL DESIGN

Based on the study of biomass briquetting, there have several type of briquetting machine which is mechanical piston press, screw press, hydraulic press and lastly roller press. For chosen an appropriate design that suitable to implement, several designs will be sketched and some investigation will be done. In this part, all the general idea in this phase, a 3D drawing will be made and the design will be more detailed and the entire thing involved in the design will be taking in to consideration.

The literature review involved studies and collecting information, particularly from previous research. Researcher then reviewed the current issue or development of small scale piston type briquetting tools, and made comparison among the researches to identify the flaw of existing systems. Problems or shortcomings were identified and remedies were proposed in hardware and software development stage.

Starting with information gathered on the machine structure followed by design concept or sketching the prototype of small scale piston type briquetting tools will be evaluated in order to select the best design and drawn using Solid Work. After designing process is completed, an analysis process will be done on the structure of the machine which is to make sure whether the design can be used or not or maybe the design need to be modified. In detail design phase, the dimension, tolerance and details are finalized. This design has to be analyzing to ensure it can work perfectly. These include stress and strain distribution, deflection and safety factor after that a decision will be make whether to proceed with the design or make a modification on the design before proceed to next phase. This process is the process where the final design will be chosen.

Continuing the process is fabrication process which the frame will be fabricated based on the design has been made. This process will follow in order to develop the design. Fabrication process involves all basic mechanical processes such as cutting, grinding, drilling, welding and others process.

3.2 CONCEPT OF DRAWING

Several designs with different type of concept mechanism that can be applied in has been done by using Solid Work. In order to find one of the best, an analysis will be done to all the design. Between this four proposed designs, only one design will be choose to be applied in the machine system. Several designs that have be sketch in Solid Work.

By using Solidworks software, sketches of several design of small scale piston type briquetting tools had been design. In Solidworks, there are 3 type of option file which are part file, assembly file and 2D drawing file. The design was started drawn in sketches in a part file with the complete radius and placing of the origin. To design this all aspect have to considered like the clearance and spacing of the structure to suitable fit in all the other part of the machine part, for example piston, mould, and etc. Sample of the sketch of the small scale piston type briquetting tools is shown.

3.2.1 1st design

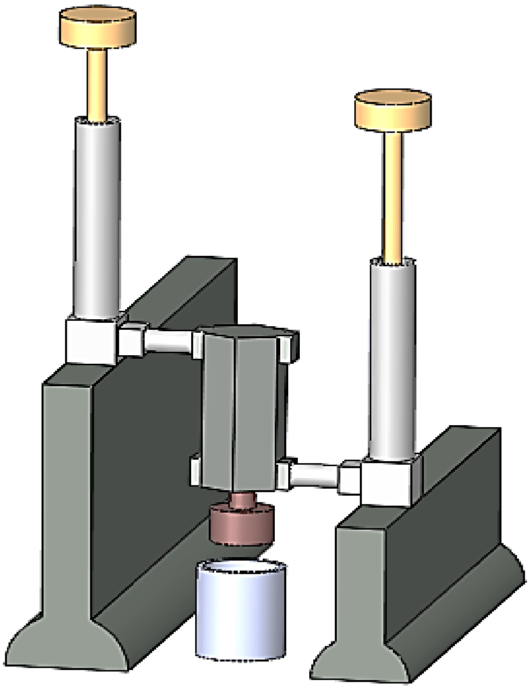


Figure 3.1 Isometric of 1st Design

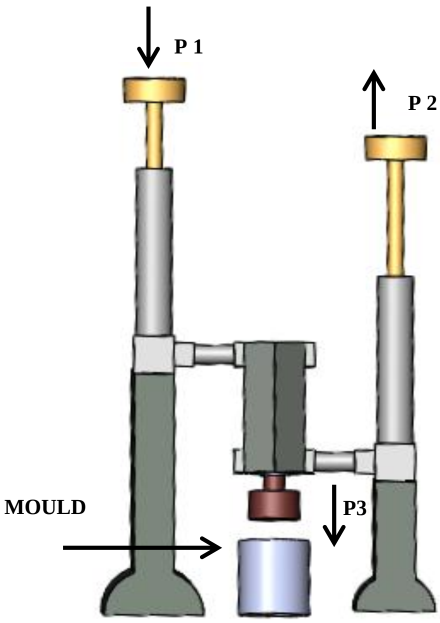


Figure 3.2 Front view of 1st Design

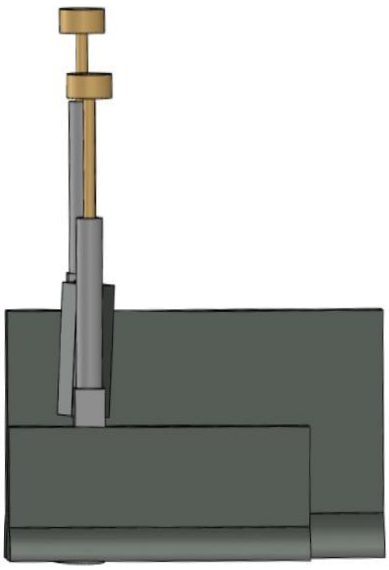


Figure 3.3 Side view of 1st Design

The conceptual of the 1st design apply the Pascal's Law. Pascal law is stated that pressure in a closed container is the same at all points. Therefore, a two cylinders connected together, a small one and a large one, and apply a small force to the small cylinder and then the force emitted by the second cylinder would be greater this would result in a given pressure.

By using the theory, fluid is the medium that will exert piston (P3) to compress downward after pressure 1 (P1) is exerted and piston 2 (P2) will move upward due to the compression of the fluid. Pressure then will compress downward (P2) to make the piston (P3) move upward.

An analysis of this structure of design is included the result and discussion chapter. It will explain and show all the stress strain analysis about this structure.

3.2.2 2nd design

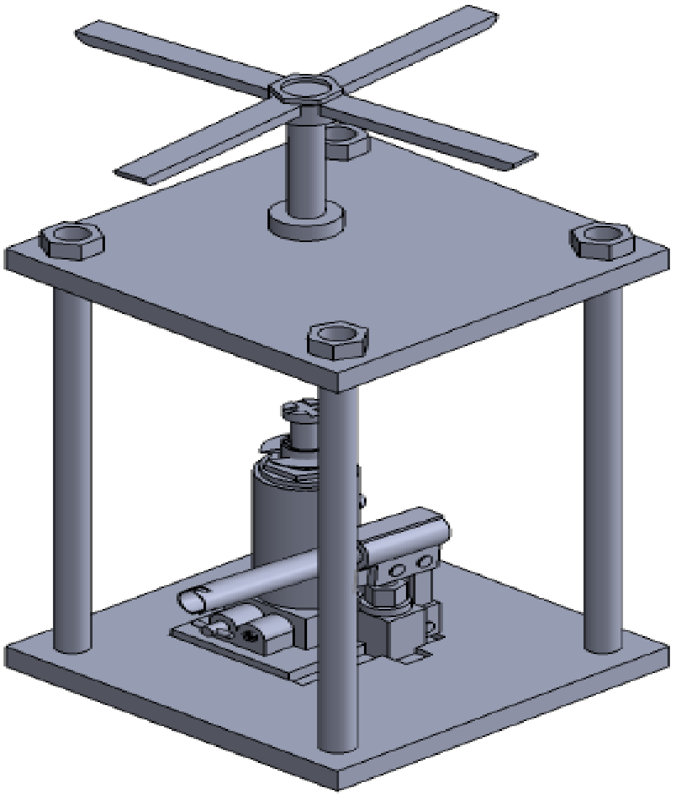


Figure 3.4 Isometric view of 2nd Design

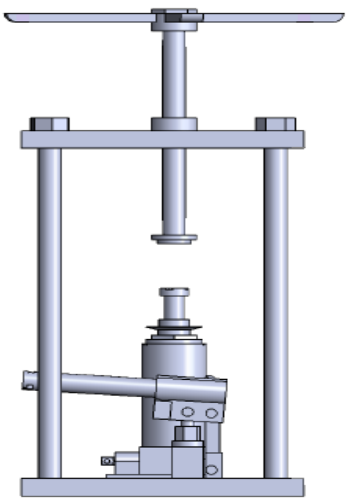


Figure 3.5 Front view of 2st Design

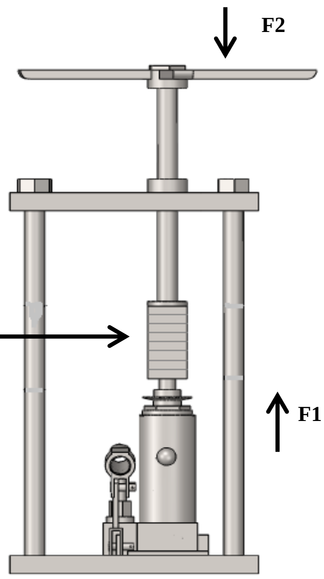


Figure 3.6 Side view of 2st Design

The 2^{nd} design follows the hydraulic jack press theory. A hydraulic jack type bottle jack is used. Bottle jack which is also known as hand jacks. Bottle jacks provided an easy way for an individual to lift up a vehicle for roadside inspection or service. Their resemblance to milk bottles earned bottle jacks their name today, they range in size and weight to offer a lifting capability ranging from one hundred to several tons.

So, the bottle jack is used in this design. The bottle jack piston will be used as compression mechanism. Force 1 (F1) will be applied and then the piston will move upward, then screw stud (F2) will be compress down until reach the certain distance. The simple mechanism is applied from the hydraulic theory.

An analysis of this structure of design has in the result and discussion chapter. It will explain and shows all the stress strain analysis about this structure.

3.2.3 3rd design

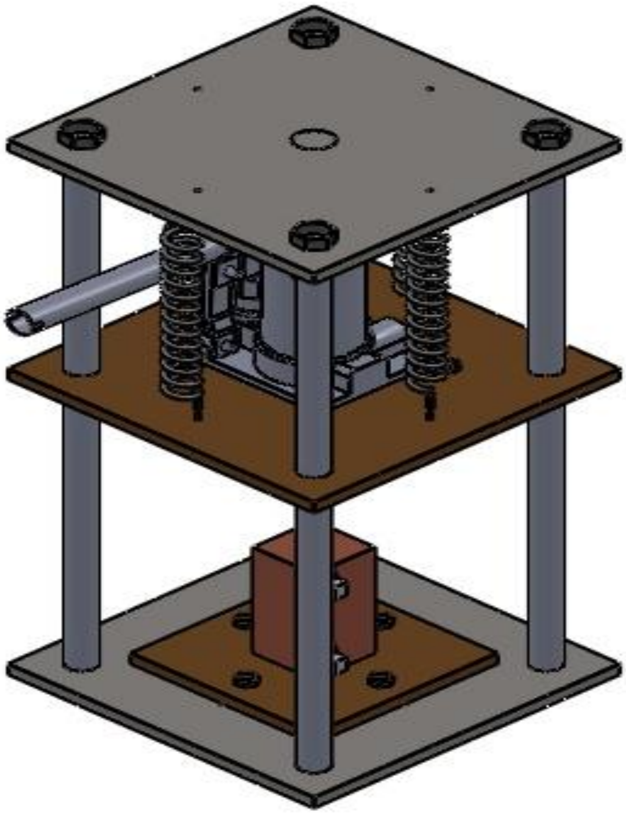


Figure 3.7 Isometric view of 3rd Design

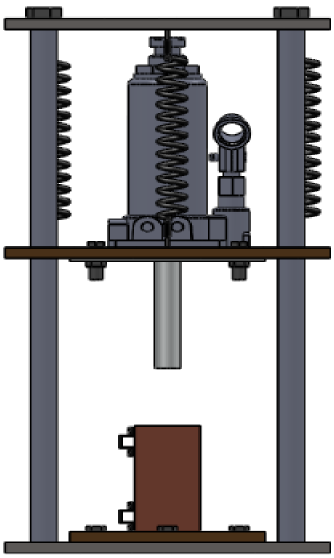


Figure 3.8 Front view of 3st Design

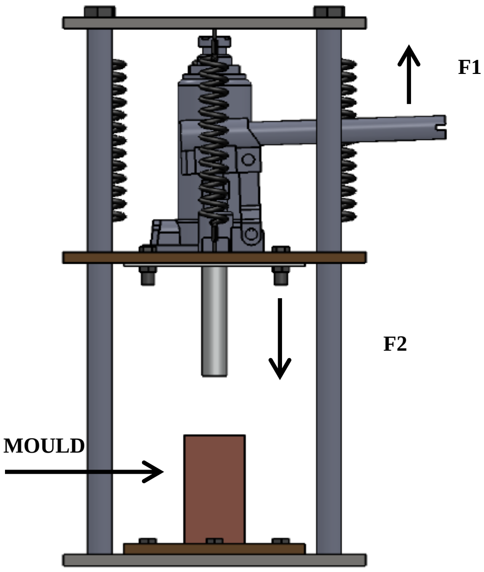


Figure 3.9 Side view of 3st Design

The next design is upgraded from the 2nd design. The principle of bottle jack is still used. Although they are most commonly used in the automobile industry , 1.5 to 5 ton jacks are frequently used to lift cars, bottle jacks have other uses as well. The bottle jack theory still used in this 3rd design. Its advantages in medical industry such as can be used in hydraulic stretchers and patient lifts and its application in industrial area such as can be found as pipe benders used in plumbing, as cable slicers for electrical projects, and as material lifts within warehouses. Then, the ability of bottle jack to lift heavy loads plays a big role in enabling the repair of large agricultural machinery make the bottle jack still being used in this design.

For the upgraded, a heavy duty spring being used. A spring type heavy duty is used to make the hydraulic jack move upward (F1) after it compress downward (F2). So, a heavy duty spring is function as the mechanism to make the bottle jack come to original position.

An analysis of this structure of design has in the result and discussion chapter. It will explain and shows all the stress strain analysis about this structure.

3.2.4 4th design

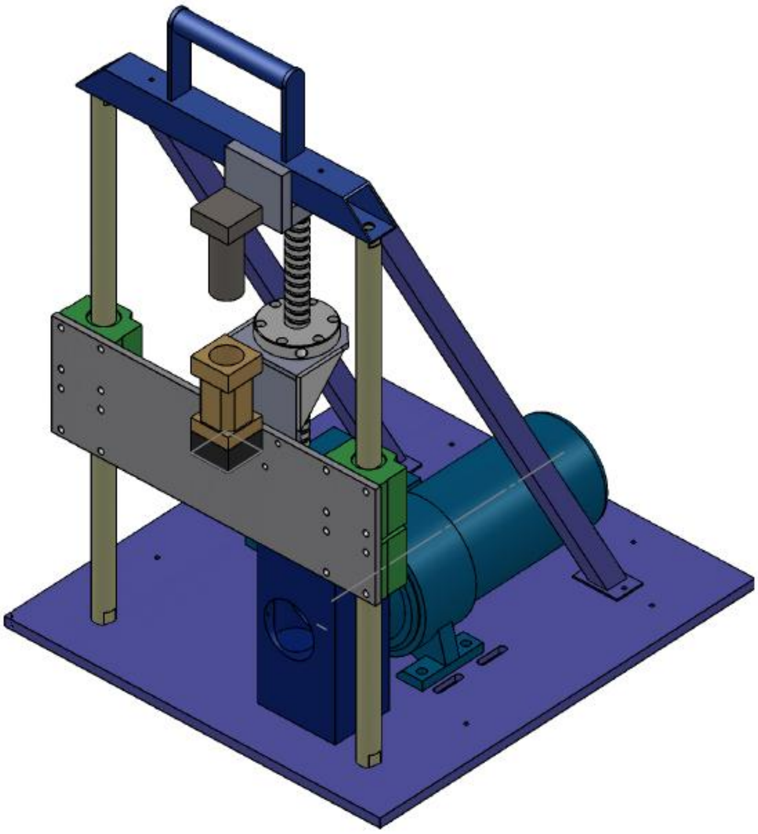


Figure 3.10 Isometric view of 4th Design

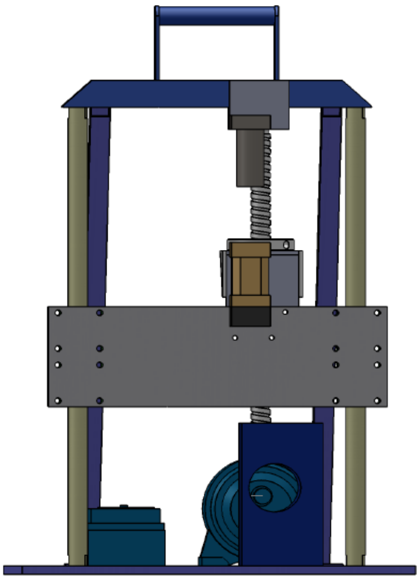


Figure 3.11 Front view of 4th Design

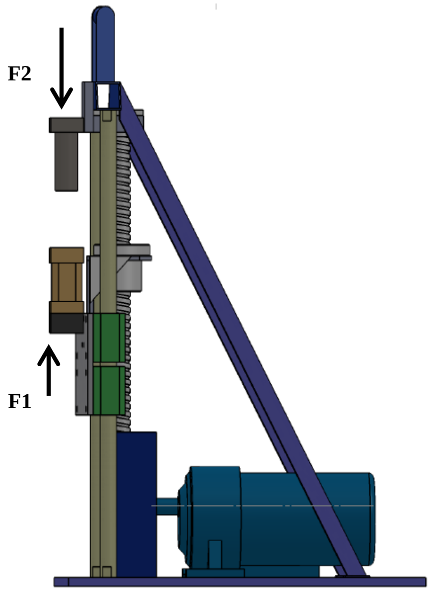


Figure 3.12 Side view of 4th Design

Analysis is done to all designs. Then, the 4^{rd} conceptual design is made. A more powerful, stable structure was made. All the problems was discovered and some touch up, renovation had do and the 4^{th} design is the upgraded version from the previous design.

A screw stud is used and the stand is more stable than the previous design. The upwards and downwards compression (F1) are done by motor and inverter is used to control the speed. Piston (F2) will be in the static condition. The function of using motor is to make sure the speed to increasing and decreasing the piston is on the smooth working. By using motor, there are no obstructions will occur and the flow of speed can move freely. Next is inverter, inverter main function is to control speed of the machine. For this design, the function of inverter is to control the speed. High, low speed can be controlled by using this inverter.

This design is the best and all the previous problems are overcame by using this design. This design is selected and fabrication process is the next process. The stress strain analysis has been analyses in the result and discussion chapter.

3.3 COMPUTATIONAL STRESS AND STRAIN ANALYSIS

The prototype of the machine is built in SolidWorks software and will be analyzing the strength of the machine by using SolidWorks Simulation. SolidWorks is software version that contains a core package in it such as easy to use, single user interface for finite element modeling, results evaluation and presentation and a suite of modeling capabilities.

The machine part which is the compression part will be analysis by using static linear stress analysis. Element type, element definition and material of all part of the machine will be select AISI 1020. After all the parts being selected its properties, the amount of forces will be set up and exerted to some part. The forces exerted will be focused on the compression part that consists of piston and mold. The force is exerted to the piston or from the piston.

Value of forces will be varies according to the designs. For the failure criteria, maximum von Mises Stress Criteron will be used. Function of von Mises Stress Criteron is to predict at what condition the piston will be damaged. The von Mises strees Criteron satisfies the property that two strees states with equal distortion energy have equal von Mises Stress.

Analysis result will be concerned on the highest stress at the certain point will be determined and enhancement needed to improve the design. Some modification will be added to frame machine accordingly to ensure frame has a enough strength to support components, parts and machine grinding.

3.4 FABRICATION PROCESS

When the analysis has achieved the limit of factor of safety, the fabrication of the machine will start. The beginning stage of this fabrication is to having all the material that needed. There process of fabrication consists of 3 part of process that need to be done which is cutting part, assembly part and lastly wiring part. A schedule for every process part need to be done such as the place that process will do, duration time to complete every part, equipment that need to use and others that need to know. The purpose to do a schedule is to make sure the fabrication process will go smoothly and if some problems occur, it can be settle down quickly without waste time.

The first part of cutting process which means that after having all the material that needed, the cutting process will be done. The process of cutting AISI 1020 will be cut by using several of type of machine cutting such as band saw machine, lathe machine, vertical milling machine and hand grinder. Every part will be properly cut accurately by follow the dimension as sketch. The parts that need to cut will be mark carefully to prevent a wrong cutting.

Assembly parts will the next process that will be do after done the cutting process. There are many parts that need to assembly and the correct sequence need to be follow to assembly it. Welding process will be the process to stick between two parts of steel. According to the design, the process of assembly only consists of using bolt and nut and only a little bit of the welding process. According to the schedule, FKM laboratory will be the place for the assembly part will be done.

Finally, after the machine finished the fabrication process. The test will be done to make sure whether it could work or not. If the machine can work well, then next step which is testing compaction of biomass product will be done. Leaf of trees that has around UMP (University Malaysia Pahang) will be used as a biomass product. The leaf then will be grind according the size that needed. Then, test the machine and the data, result will be collect.

3.4.1 Fabrication tools

After the design is selected, the fabrication of the small scale of piston will be started. Several machine process need to be handle to fabricate of the model. Several process of fabrication process that will covered is stated.

Figure 3.13 Vertical milling machine

Milling is the machining process of using rotary cutters to remove material from a work piece advancing in a direction at an angle with the axis of the tool. It covers a wide variety of different operations and machines, on scales from small individual parts to large, heavy-duty gang milling operations. It is one of the most commonly used processes in industry and machine shops today for machining parts to precise sizes and shapes.

Figure 3.14 Lathe machine

Lathe machine are the machine tool which rotates the work piece on its axis to perform various operations such as cutting, knurling, drilling, deformation, facing, turning with tools are applied to the workpiece to create an object which has symmetry about an axis of rotation.

Figure 3.15 Oxy acetylene

Oxy-fuel cutting are processes that use fuel gases and oxygen to weld and cut metal. In short, oxy-fuel equipment is quite versatile, not only because it is preferred for some sorts of iron or steel welding but also because it lends itself to brazing, braze-welding, metal heating.

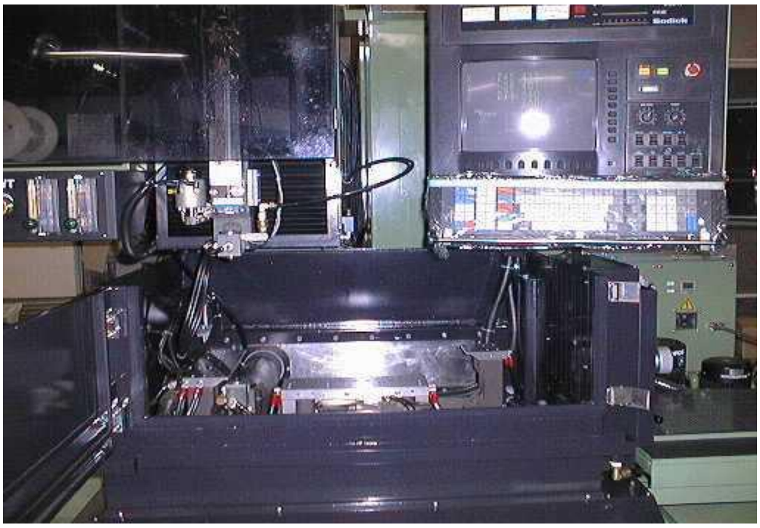


Figure 3.16 EDM wire cut

Electric discharge machining (EDM), sometimes colloquially also referred to as spark machining, spark eroding, burning, die sinking or wire erosion, is a manufacturing process whereby a desired shape is obtained using electrical discharges (sparks). Material is removed from the workpiece by a series of rapidly recurring current discharges between two electrodes, separated by adielectric liquid and subject to an electric voltage.

Figure 3.17 Band saw machine

A band saw machine is a power tool which uses a blade consisting of a continuous band of metal with teeth along one edge to cut various workpieces.

Figure 3.18 (MIG) welding machine

Welding process is defined as the joining of materials by the application of heat or friction. Usually involves the localized fusion of both contacting surfaces. MIG (Metal Inert Gas) is a welding process in which an electric arc forms between a consumable wire electrode and the workpiece metal, which heats the workpiece metal, causing them to melt, and join.

Figure 3.19 Hand grinder

An angle grinder, also known as a side grinder or disc grinder, is a hand held power tool used for cutting, grinding and polishing.

Figure 3.20 Hand drill

Hand drill is known as the mini machine that makes a hole to the work piece. Variety size can be made depends on the drill bit. Drill bit is the cutting tools that will make a hole to the work piece.

Figure 3.21 Hand Tap

Taps and dies are cutting tools used to create screw thread which is called threading. The process of cutting threads using a tap is called tapping, whereas the process using a die is called threading.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 BIOMASS BRIQUETTE DESIGN

Every design had a stress strain analysis. Stress analysis, strain analysis, displacement analysis and factor of safety. A comparison is do between the designs and the best result will be chosen.

After do stresses strain analysis and by using all the information from the literature review, research and after a few final adjustments, a final design is determined. 4th design is chosen due to the stress strain analysis and due to some criteria that have been investigated. Figure 4.1 and 4.2 shows the design that have been selected from the several sample that being analyses. The further analysis is shown in simulation result.

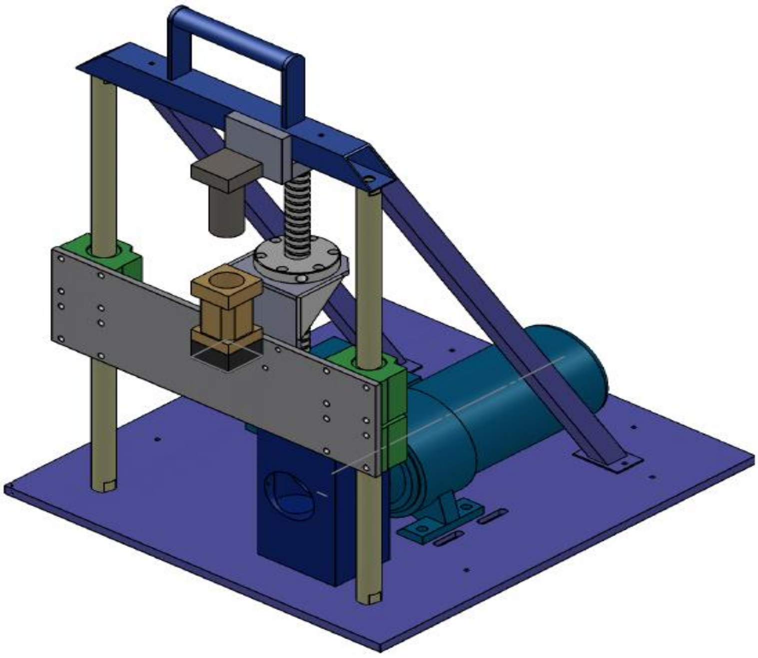


Figure 4.1 Final designs in isometric view of 4th design

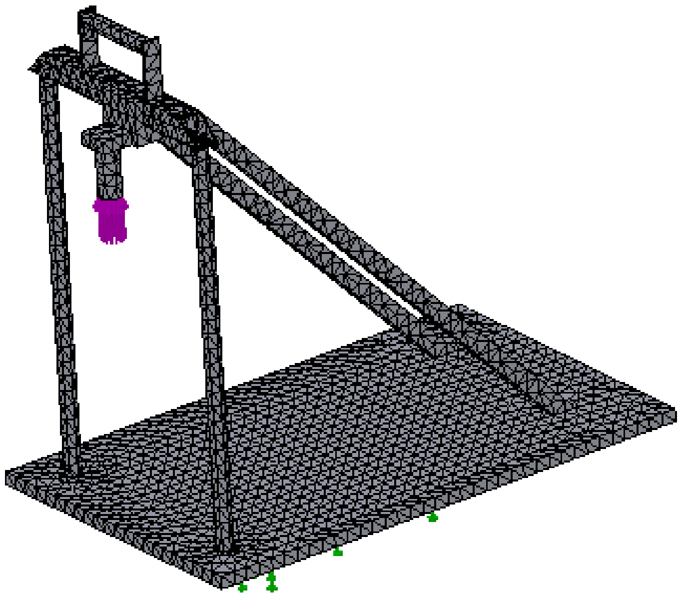


Figure 4.2 Final designs in isometric mesh form of 4th design

4.2 SIMULATION RESULT

Stress-strain simulation feature analysis for all the designs is using SolidWorks Premium 2012 software. It consists the analysis of von mises stress, strain, displacement and factor of safety. A fixed geometry is fixed and forces are applied on the structure. The SolidWorks simulation software mesh the model with a number of small pieces of standard shape or element, connected at common points or nodes.

4.2.1 Simulation of 1st design

Table 4.1 shows the material that is used in the 1st design and amount of force that exerted. Illustrates frame structure 3D model with fixtures, loads and meshing is done to the design.

Table 4.1 Parameter for the 1st design

PARAMETRS	
Material Steel	AISI 1020
Total force applied	50N

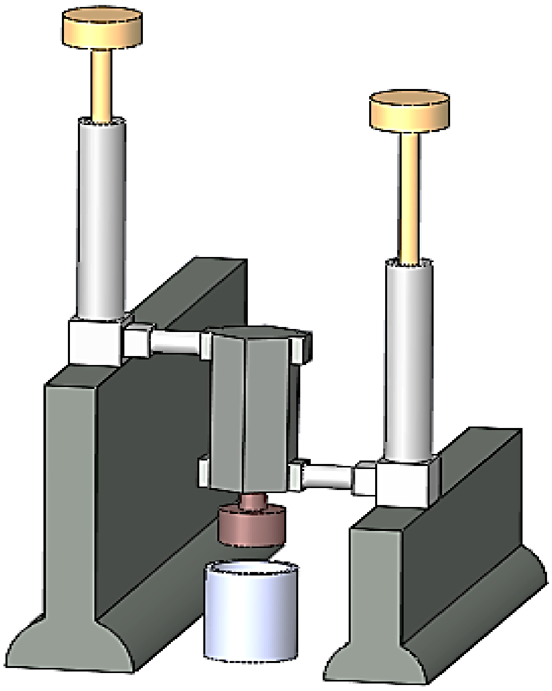


Figure 4.3 Isometric view of 1st Design

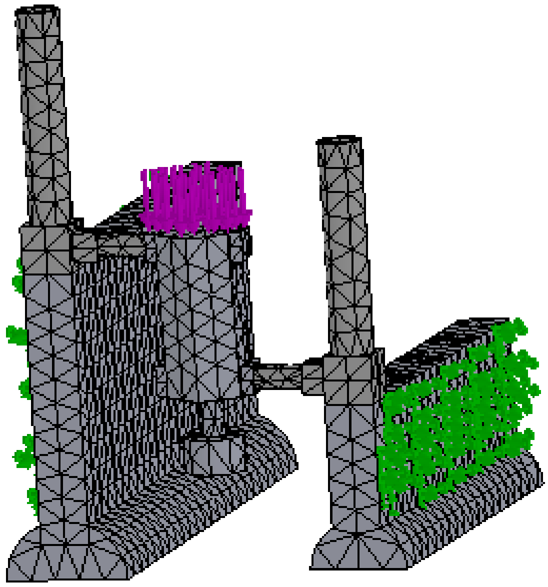


Figure 4.4 Isometric mesh view of 1st Design

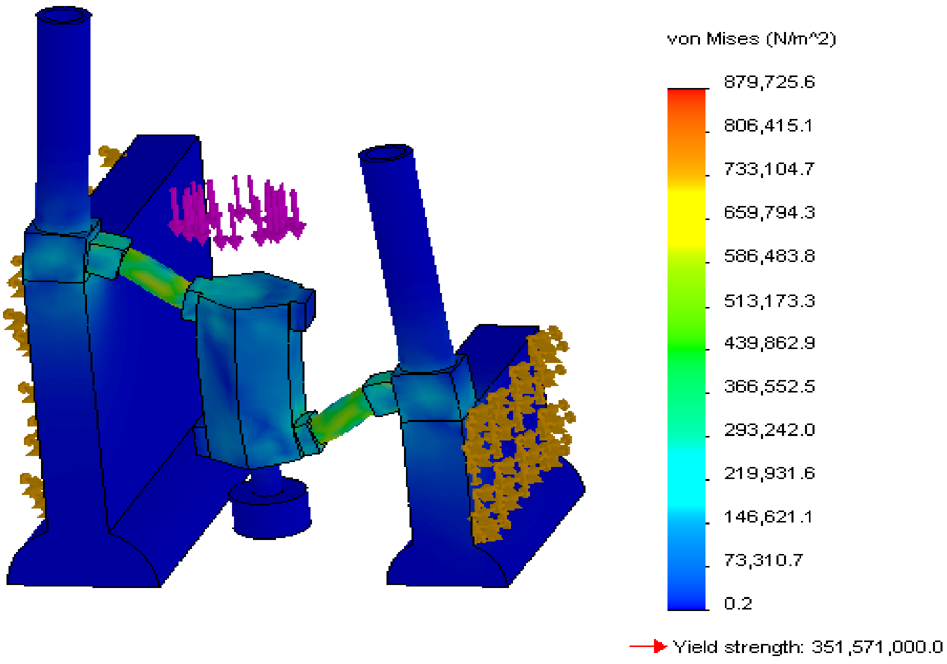


Figure 4.5 Von mises stress simulation result

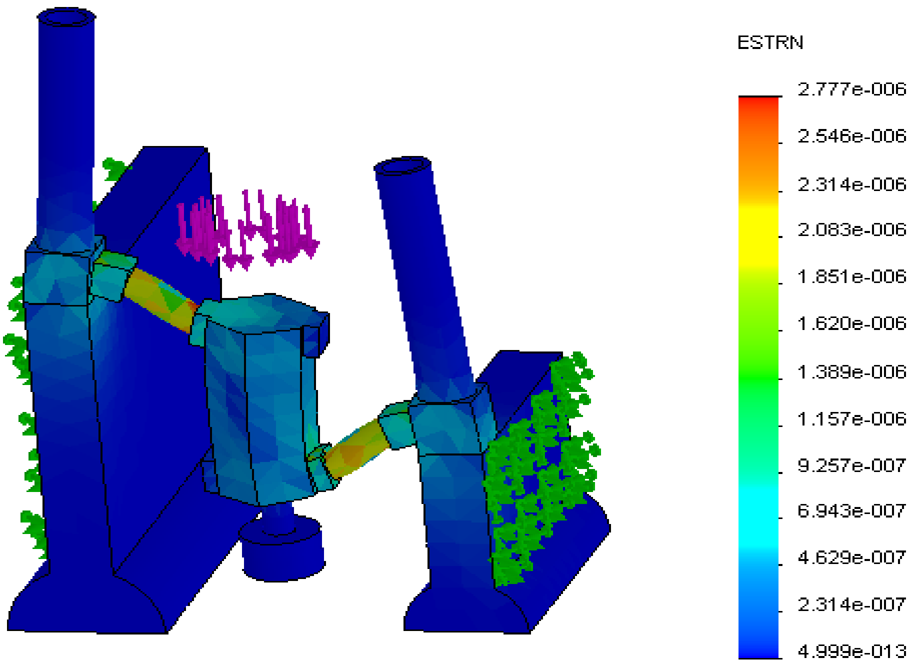


Figure 4.6 Strain simulation result

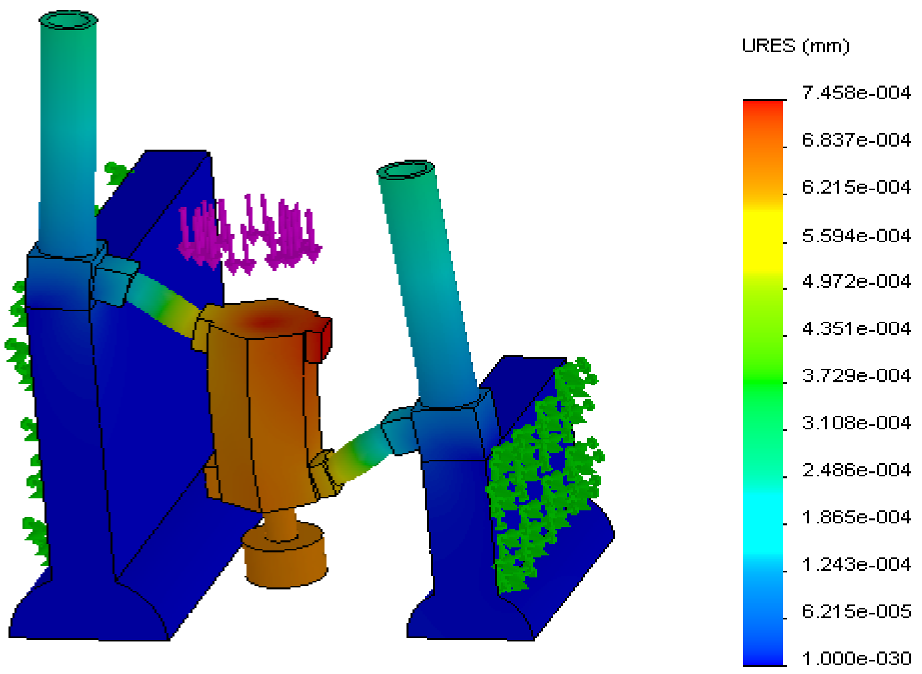


Figure 4.7 Displacement simulation result

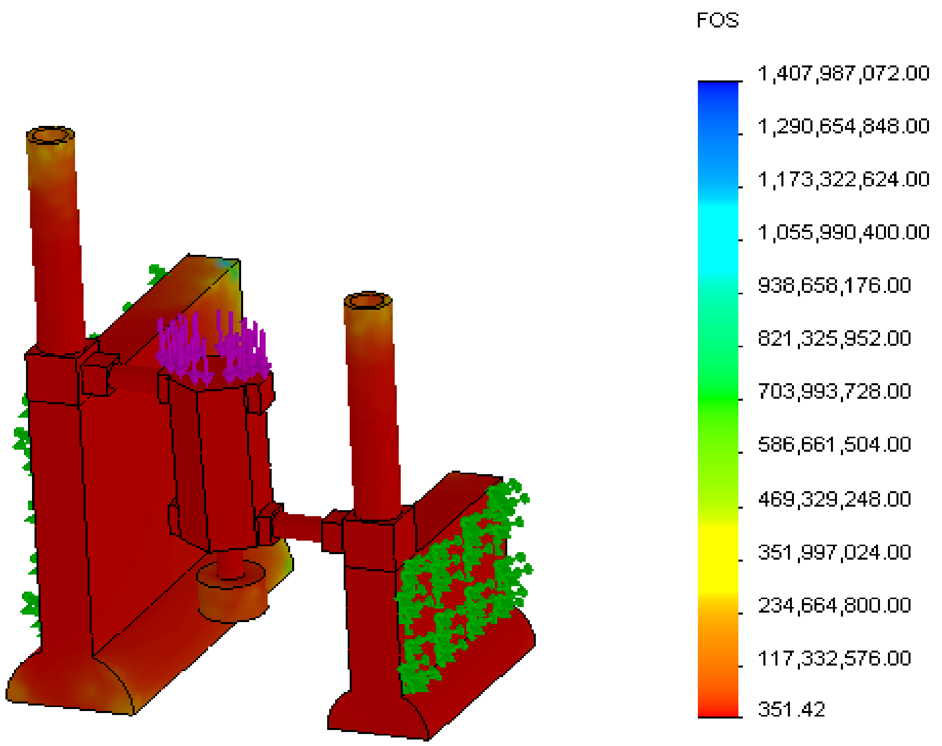


Figure 4.8 Factor of safety simulation result

Table 4.2 Result for the 1st design

Name	Type	Min	Max
Stress	VON: Von Mises Stress	0.2 N/m^2	879 725.6 N/m^2
Strain	ESTRN: Equivalent Strain	4.999e-013	2.777e-006
Displacement	URES: Resultant Displacement	1.000 e-030 mm	7.458e-004 mm
Factor of Safety		351.42	1407987072.00

From Table 4.2, it shows the result from analysis of frame structural analysis using Solid Works software. The dark blue color is referring to the minimum value stress load in applied, while the red color is refer to maximum value of stress. From this analysis, each part of the structural showed different color which is mean each single part hold different stress. The stress distribution can be seen where the highest stress is at the restrains areas and at the joining part of the rod steel to the mould. These occur because the areas around the restraint are fixed thus making the stresses focuses on those areas. The design is still can be accept because the stresses are still in the safe range as indicated by the color on.

The critical part which is representing by yellow in color adepts the biggest stress which it can be bends if the load exerted is too heavy. The yellowish color part will bend at first and then continues by nearest area. This analysis is very important of the material used before the fabricating process. Besides that, even though critical part has been determine, some part which might have chance to bend is shown in greenish color. This is because the maximum stresses at each color give different maximum value of stress. The result also shows the stress value is lower than yield strength, thus suggesting the structure is safe.

In the strain simulation result, the maximum of strain value is 2.777×10^{-13}. Highest strain is occur at the joining between mould and the rod steel. From the result it shown the maximum strain is less than the maximum allowable strain, this machine is in safe condition. From the displacement simulation result, it shows the maximum value of displacement that deform is 0.0007458 mm.

The simulation result for FOS shows in most of the machine structure is having FOS minimum value it is a 351.42. There is FOS value must be greater than 1, for the minimum value also have already greater than 1 and thus it is very safety.

4.2.2 Simulation of 2nd design

Table 4.3 shows the material that is used in the 2nd design and amount of force that exerted. Illustrates frame structure 3D model with fixtures, loads and meshing is done to the design.

Table 4.3 Parameter for the 2nd design

PARAMETRS	
Material Steel	AISI 1020
Total force applied	50N

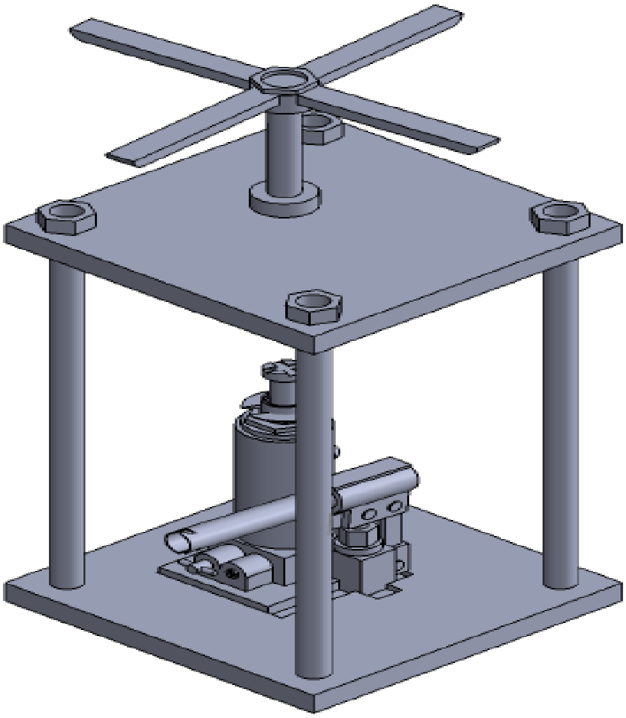


Figure 4.9 Isometric view of 2nd Design

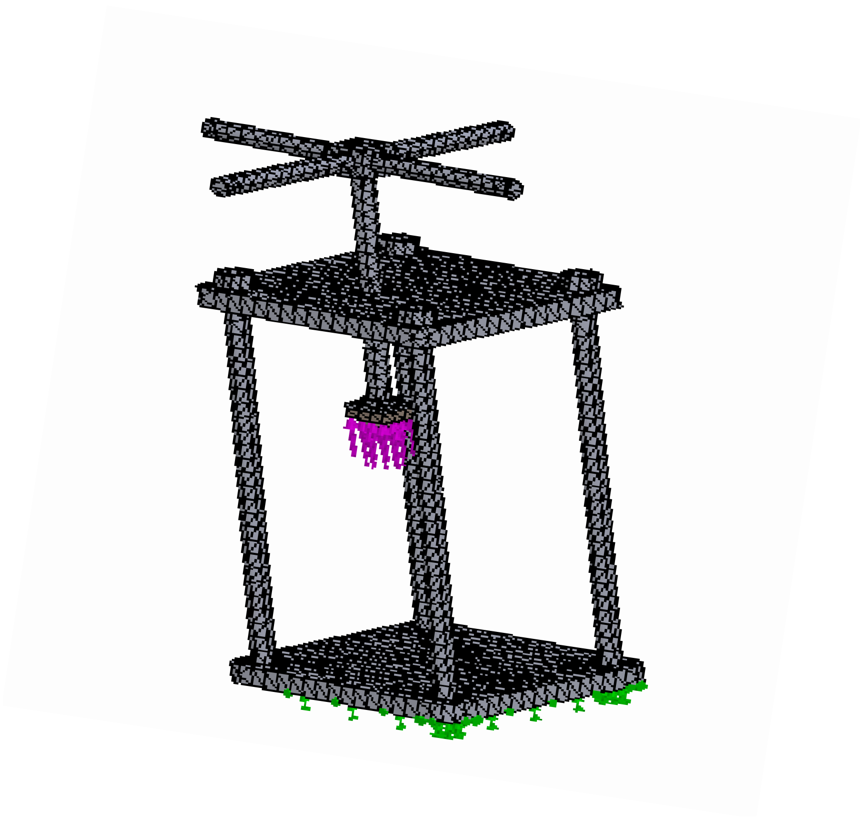


Figure 4.10 Isometric mesh view of 2nd Design

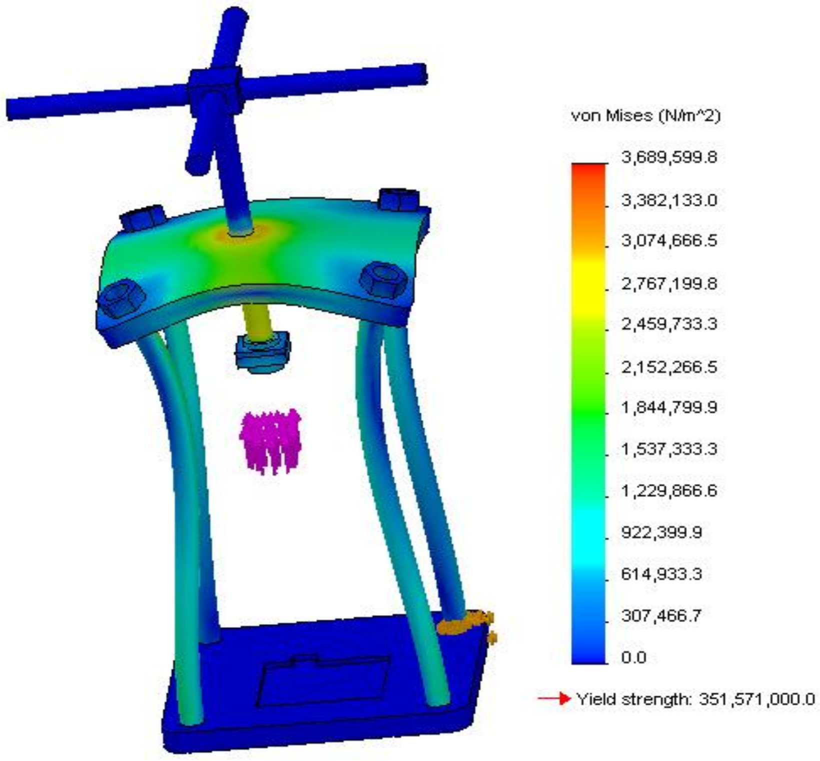


Figure 4.11 Von mises stress simulation result

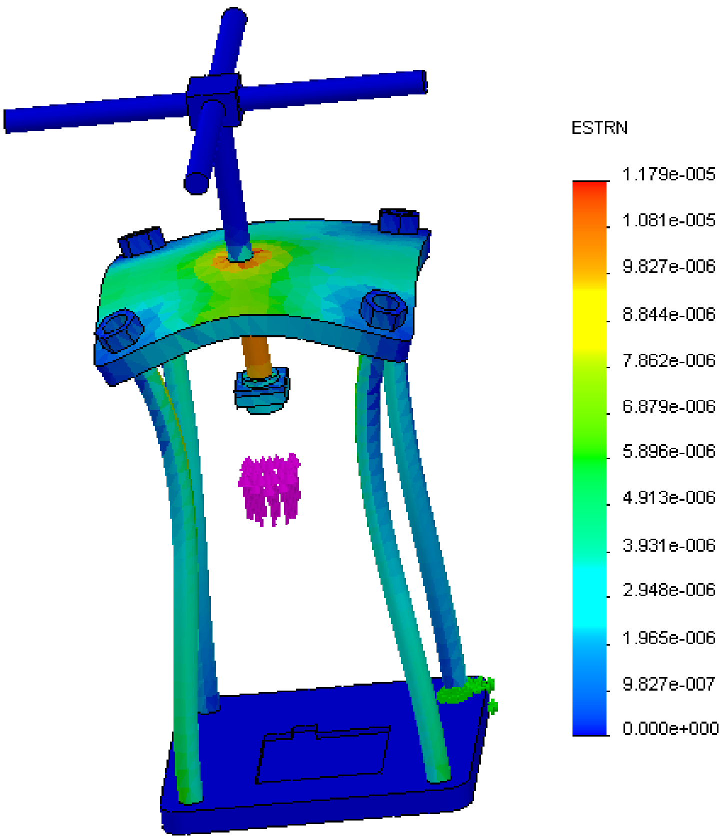


Figure 4.12 Strain simulation result

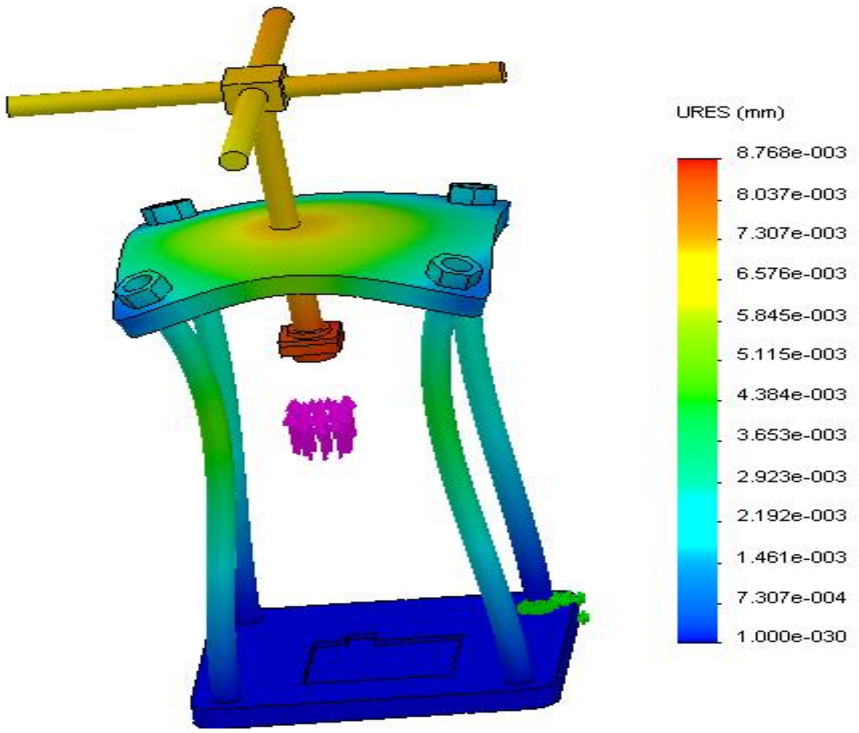


Figure 4.13 Displacement simulation result

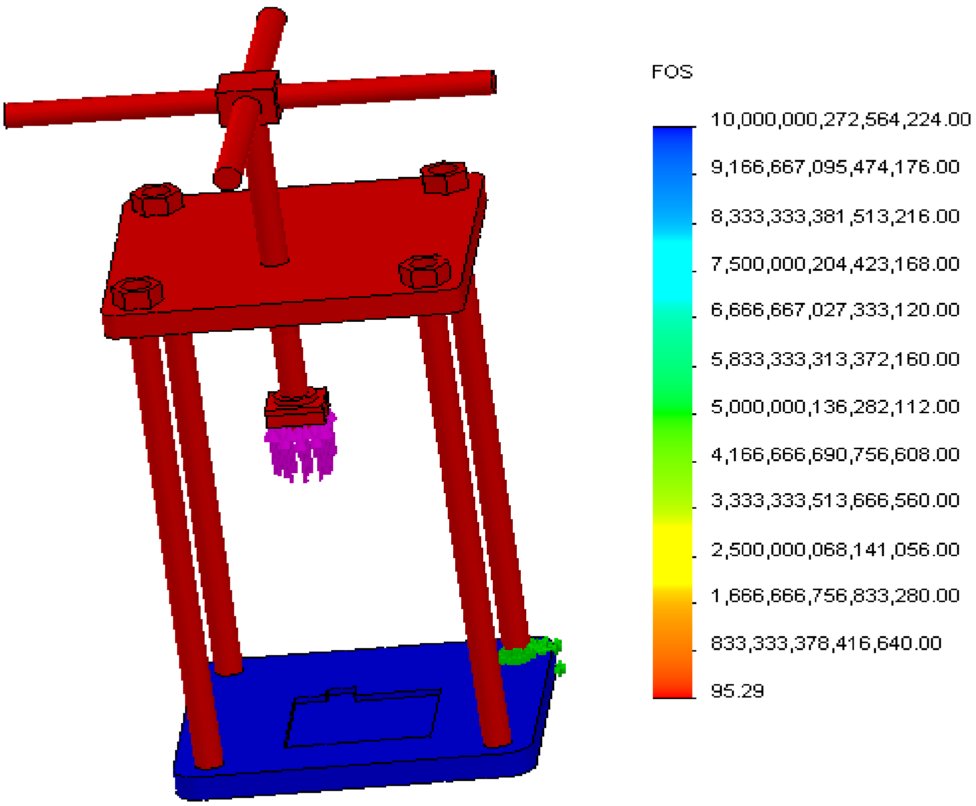


Figure 4.14 Factor of safety simulation result

Table 4.4 Result for the 2nd design

Name	Type	Min	Max
Stress	VON: von Mises Stress	0.0 N/m^2	3689599.8 N/m^2
Strain	ESTRN: Equivalent Strain	0.000e+000	1.179e-005
Displacement	URES: Resultant Displacement	1.000e-030 mm	8.768e-003 mm
Factor of Safety		95.29	10 000 000x10^9

From Table 4.4, it shows the result from analysis of frame structural analysis using Solid Works software. The dark blue color is referring to the minimum value stress load in applied, while the red color is refer to maximum value of stress. From this analysis, each part of the structural showed different color which is mean each single part hold different stress. The stress distribution can be seen where the highest stress is are at the restrains areas and at the joining part of the centre of the plate and the rod. These occur because the areas around the restraint are fixed thus making the stresses focuses on those areas. The design can still be accepted because the stresses are still in the safe range as indicated by the color on. The stress analysis result for minimum and maximum stress is show in Table 4.2.

The critical part which is representing by yellow in color adepts the biggest stress which the centre can be bends if higher force is exerted. The yellowish color part will bend at first and then continues by nearest area. In other word, the critical point where the plate will likely to fail at higher load exerted. This analysis is very important of the material used before the fabricating process. Besides that, even though critical part has been determine, some part which might have chance to bend is shown in greenish color. This is because the maximum stresses at each color give different maximum value of stress. The result also shows the stress value is lower than yield strength, thus suggesting the structure is safe.

.

In the strain simulation result, the maximum of strain value is 8.768×10^{-3} mm. highest strain is occur at the centre of the upper plate and the rod. From the result it shown the maximum strain is less than the maximum allowable strain, this 2nd design is in safe condition. From the displacement simulation result, it shows the maximum value of displacement that deform is 0.008768 mm.

The simulation result for FOS shows in foremost of the design is having FOS minimum value of 95.29. There is FOS value must be greater than 1, for the minimum value also have already greater than 1 so it very safety. The overall of the result shows the 2nd design is good and safe to use.

4.2.3 Simulation of 3rd design

Table 4.5 shows the material that is used in the 3rd design and amount of force that exerted. Illustrates frame structure 3D model with fixtures, loads and meshing is done to the design.

Table 4.5 Parameter for the 3rd design

PARAMETRS	
Material Steel	AISI 1020
Total force applied	400N

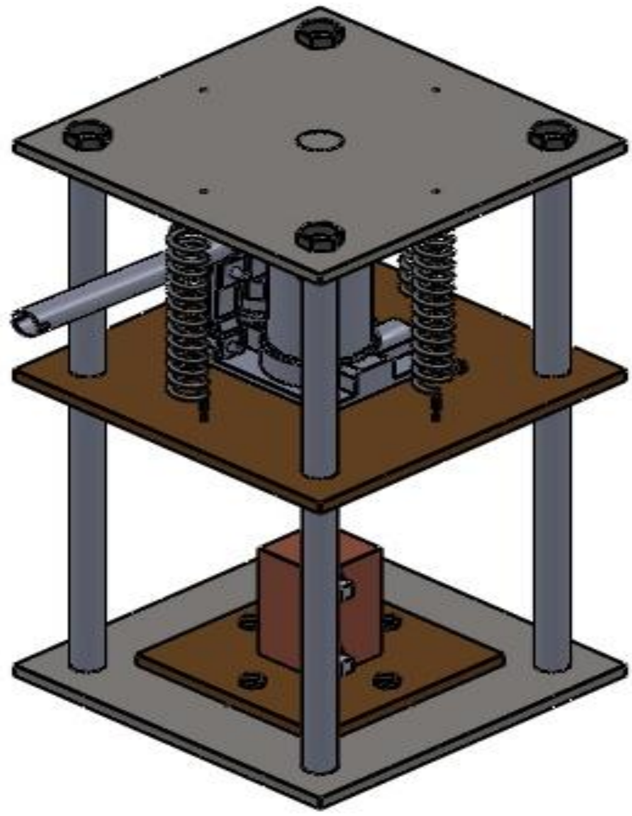


Figure 4.15 Isometric view of 3rd design

Figure 4.16 Isometric mesh view of 3rd design

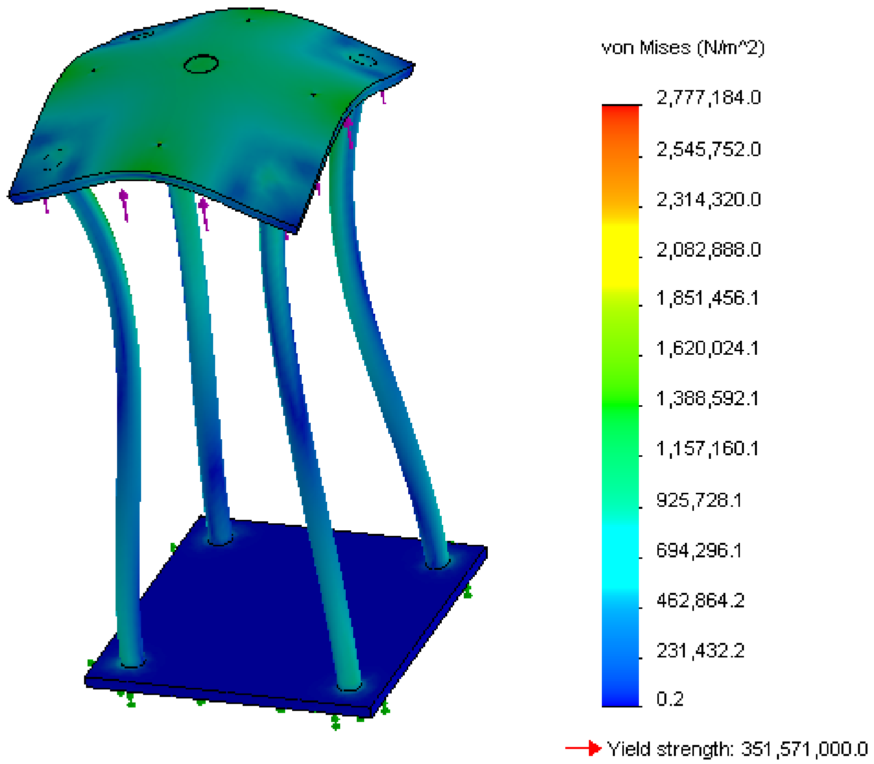


Figure 4.17 Von mises stress simulation result

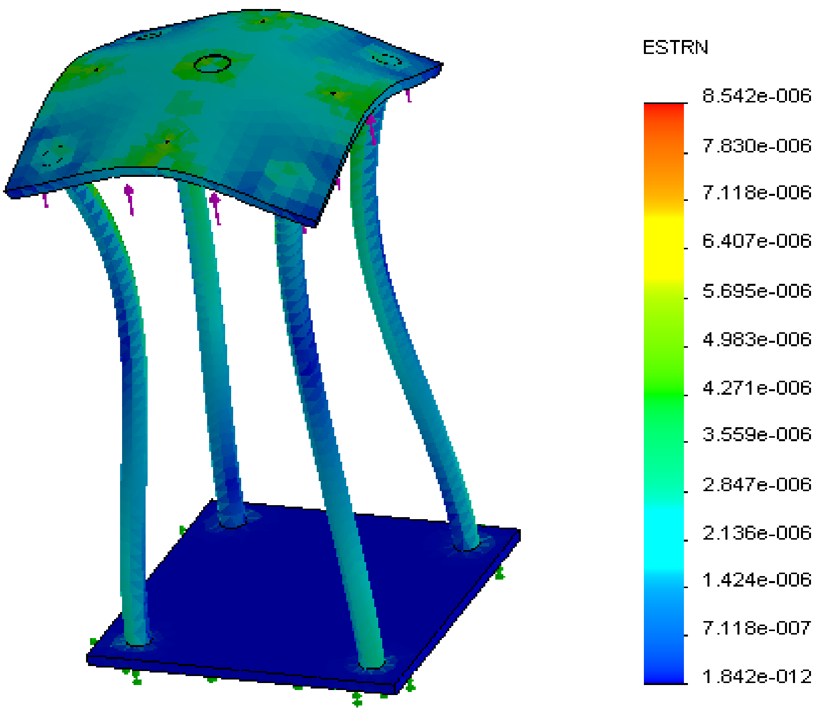


Figure 4.18 Strain simulation result

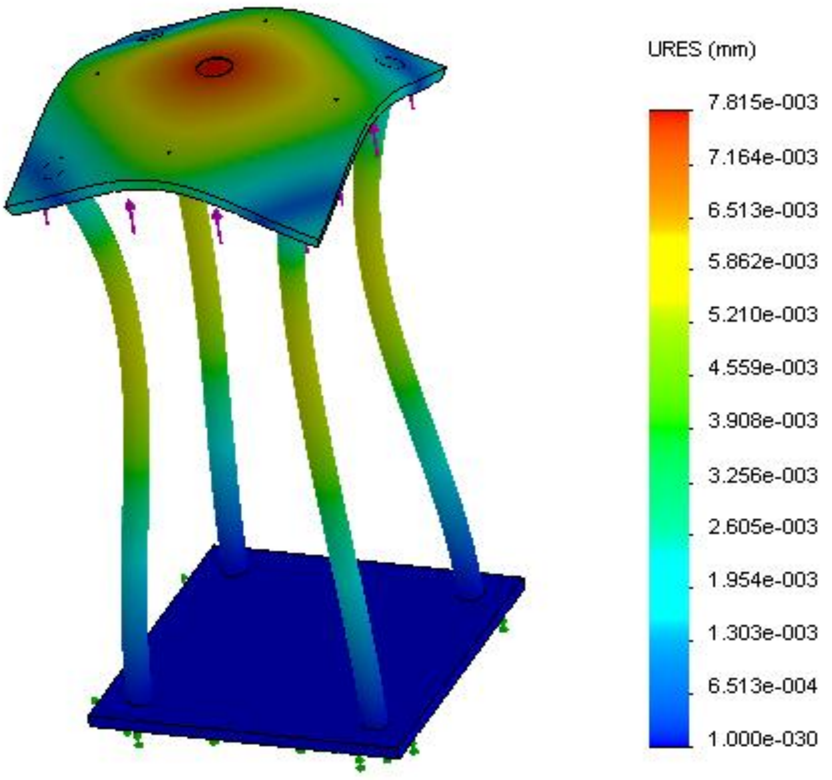


Figure 4.19 Displacement simulation result

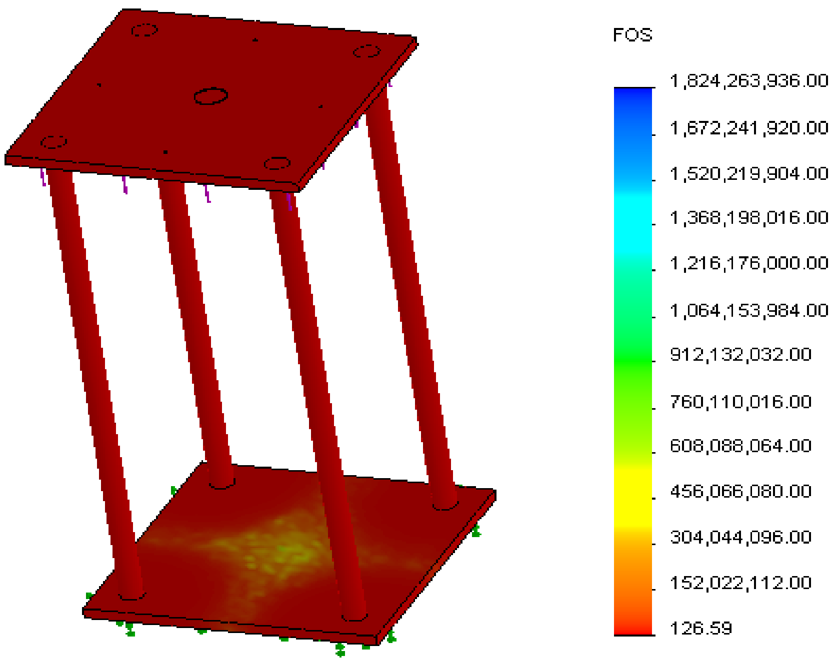


Figure 4.20 Factor of safety simulation result

Table 4.6 Result for the 3rd design

Name	**Type**	**Min**	**Max**
Stress	VON: von Mises Stress	0.2 N/m^2	2777184.0 N/m^2
Strain	ESTRN: Equivalent Strain	1.842e-012	8.542e-006
Displacement	URES: Resultant Displacement	1.000e-030 mm	7.815e-003 mm
Factor of Safety		126.59	1824263936.00

From Table 4.6, shows the result from analysis of frame structural analysis using Solid Works software. The dark blue color is referring to the minimum value stress load in applied, while the red color is refer to maximum value of stress. From this analysis, each part of the structural showed different color which is mean each single part hold different stress. The stress distribution can be seen where the highest stress is are at the center of the plate, same the 2nd design. These occur because the higher force is exerted to the centre of the plate. The design still can be accepted due to the stresses are still in the safe range as indicated by the color on. The stress analysis result for minimum and maximum stress is show in Table 4.6.

The critical part which is representing by yellow in color adepts the biggest stress which it can be bends if the higher force is exerted. The bend will occur which is where the yellowish color part will bend at first and then continues by nearest area. In other word, the critical point where the plate to be fail at higher load exerted. This analysis is very important of the material used before the fabricating process. Besides that, even though critical part has been determine, some part which might have chance to bend is shown in greenish color. This is because the maximum stresses at each color give different maximum value of stress. The result also shows the stress value is lower than yield strength, thus suggesting the 3rd design is safe.

In the strain simulation result, the maximum of strain value is $8.542x10^{-6}$. Highest strain is occur at the plate that exerted by the force. From the result it shown the maximum strain is less than the maximum allowable strain, this 3rd design is in safe condition. From the displacement simulation result, it shows the maximum value of displacement that deform is $0.007815 x10^{-3}$.

The simulation result for FOS shows in the design shows that it is having FOS minimum value it is a 126.59. There is FOS value must be greater than 1, for the minimum value also have already greater than 1 so it very safety. The overall of the result shows the 3rd design is good and safe to use.

4.2.4 Simulation of 4th design

Table 4.7 shows the material that is used in the 4th design and amount of force that exerted. Illustrates frame structure 3D model with fixtures, loads and meshing is done to the design.

Table 4.7 Parameter for the 4th design

PARAMETRS	
Material Steel	AISI 1020
Total force applied	400N

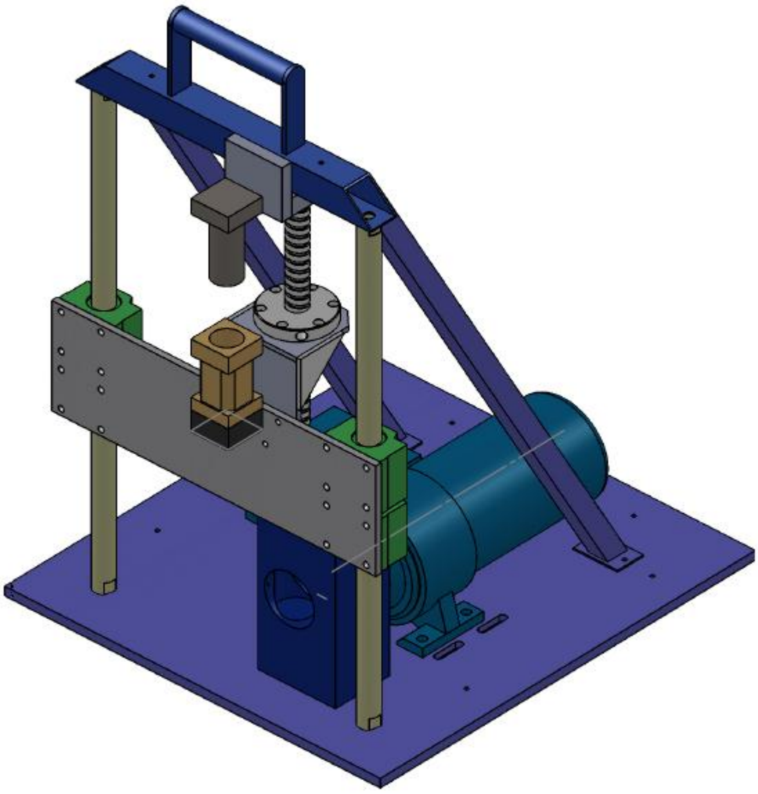


Figure 4.21 Isometric view of 4th design

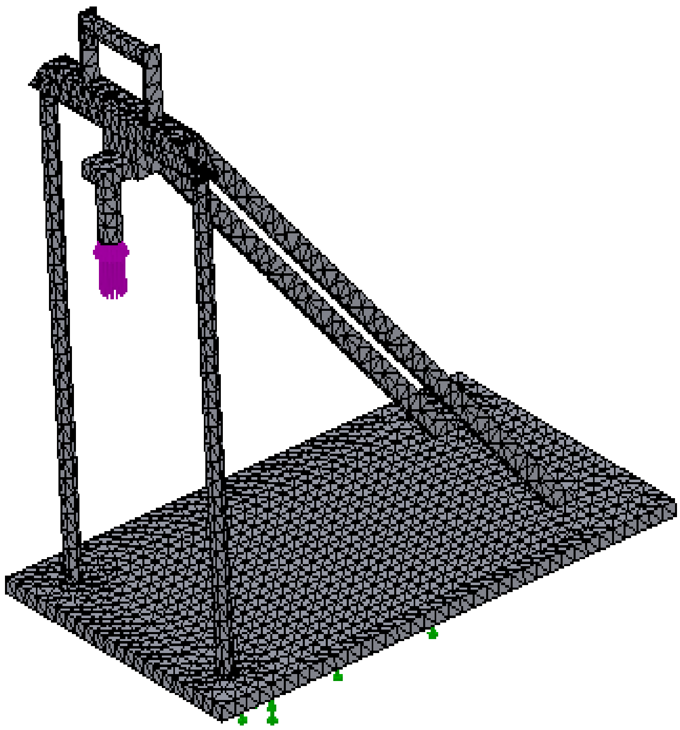


Figure 4.22 Isometric mesh view of 4th design

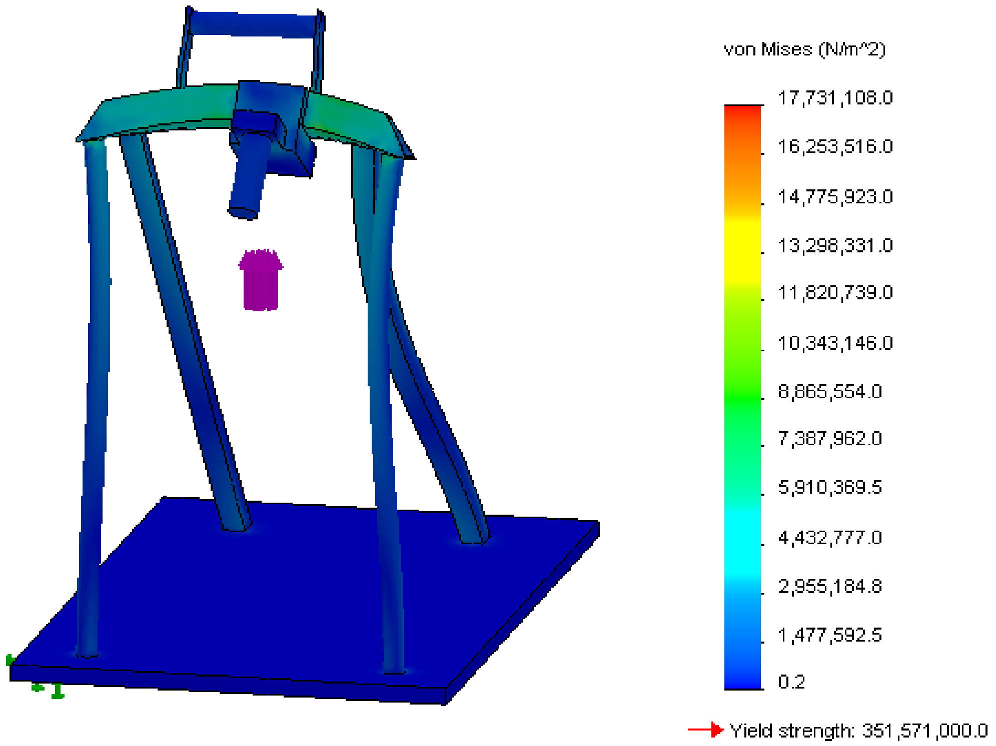


Figure 4.23 Von mises stress simulation result

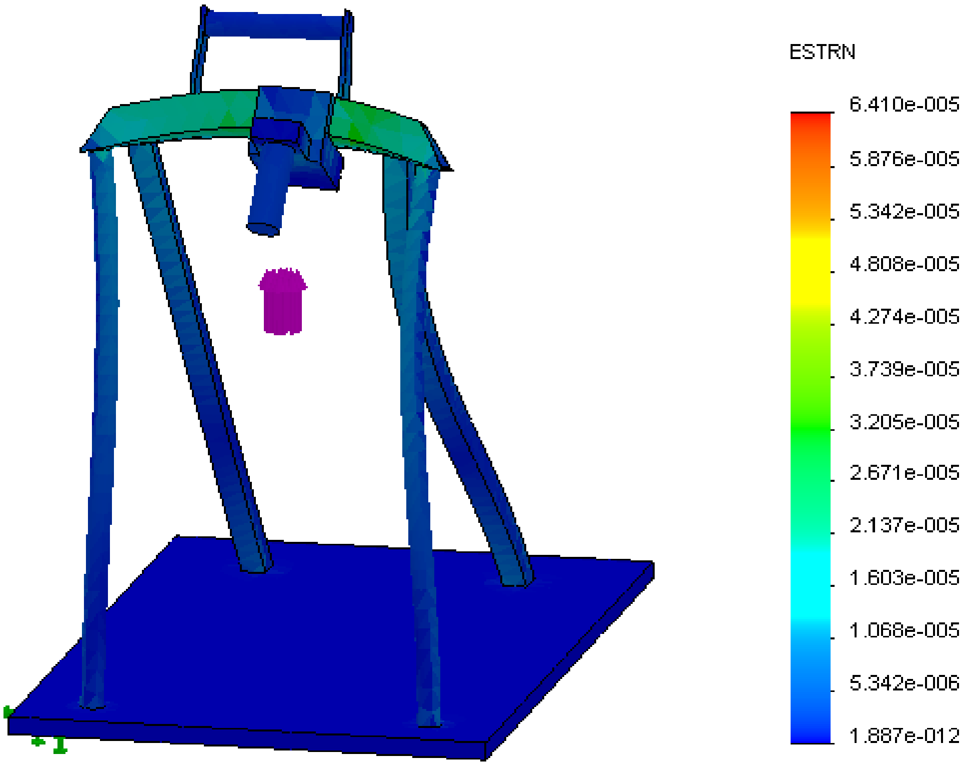


Figure 4.24 Strain simulation result

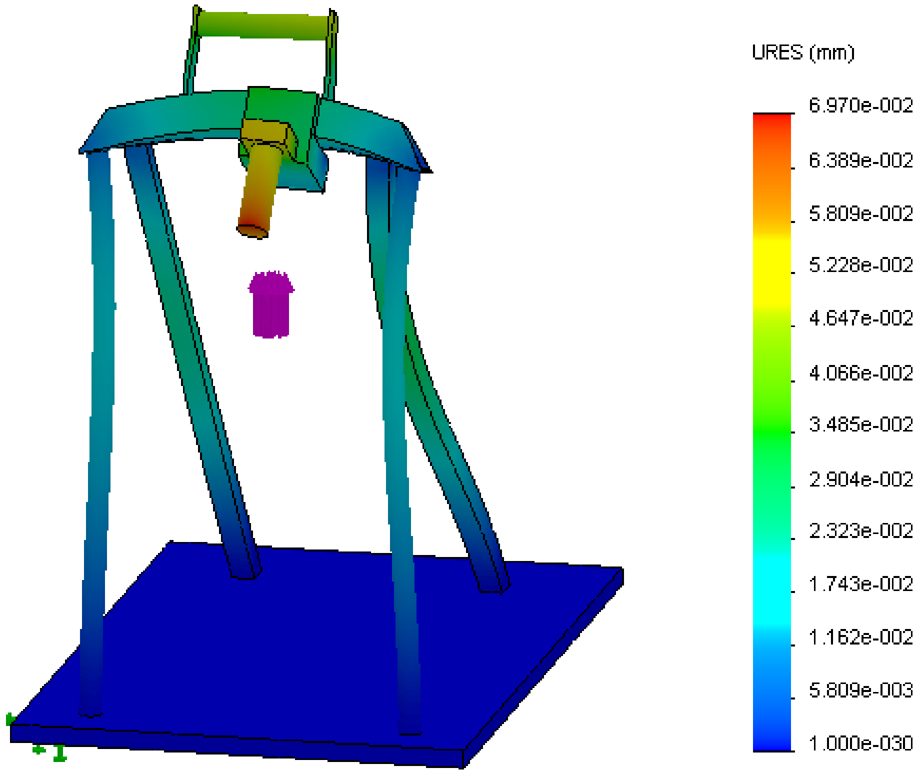


Figure 4.25 Displacement simulation result

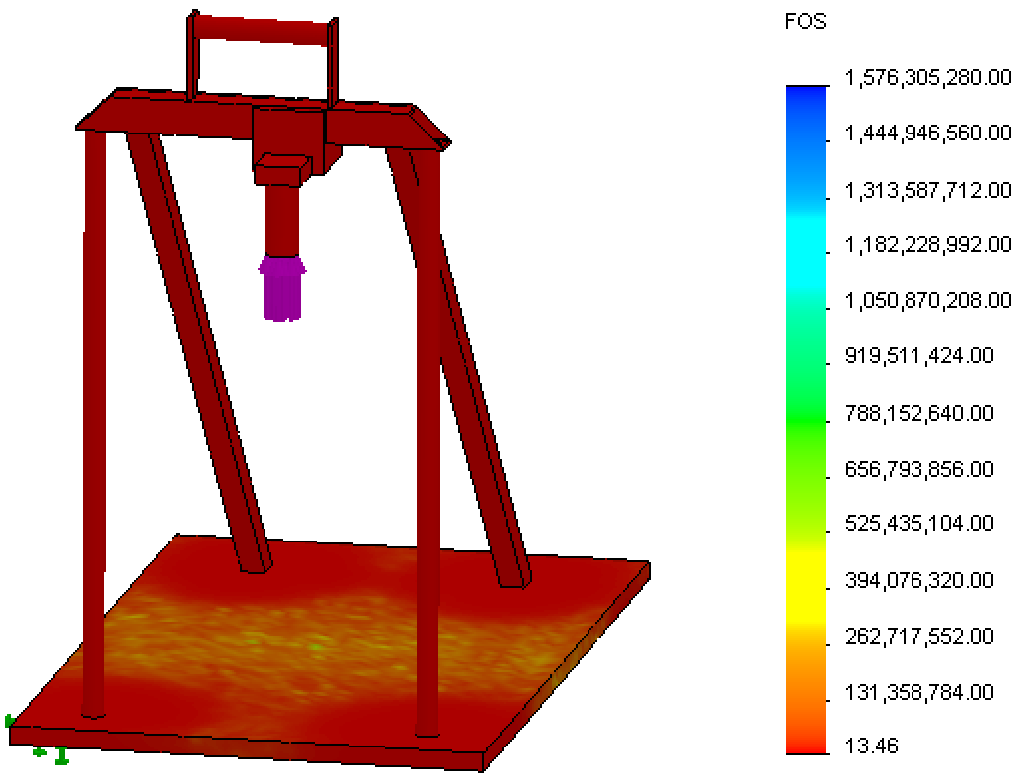


Figure 4.26 Factor of safety simulation result

Table 4.8 Result for the 4th design

Name	Type	Min	Max
Stress	VON: von Mises Stress	0.2 N/m^2	17731108.0 N/m^2
Strain	ESTRN: Equivalent Strain	1.887e-012	6.410e-005
Displacement	URES: Resultant Displacement	1.000e-030 mm	6.970e-002 mm
Factor of Safety		13.46	1576305280.00

From table 4.8, it shows the result from analysis of frame structural analysis using Solid Works software. The dark blue color is referring to the minimum value stress load in applied, while the red color is refer to maximum value of stress. From this analysis, each part of the structural showed different color which is mean each single part hold different stress. The stress distribution can be seen where the highest stress is at the piston. These occur because the areas around the restraint are fixed thus making the stresses focuses on those areas. The design still can be accepted because the stresses are still in the safe range as indicated by the color on. The stress analysis result for minimum and maximum stress is show in table.

The critical part which is representing by yellow in color adepts the biggest stress which it can be bends if the higher forced is exerted. The yellowish color part will bend at first and then continues by nearest area. In other word, the critical point where the design will having fail at the upper plate where higher force is exerted. This analysis is very important of the material used before the fabricating process. Besides that, even though critical part has been determine, some part which might have chance to bend is shown in greenish color. This is because the maximum stresses at each color give different maximum value of stress. The result also shows the stress value is lower than yield strength, thus suggesting the structure is safe.

In the strain simulation result, the maximum of strain value is 6.410 $x10^{-5}$. Highest strain is occur at the plate that force exerted on it. From the result it shown the maximum strain is less than the maximum allowable strain, thus this design is in a safe condition. From the displacement simulation result, it is shows that the maximum of displacement that deform is 0.06970 mm.

The simulation result for FOS shows the design having FOS minimum value at 13.46. The FOS value must be greater than 1, for the minimum values also have already greater than 1 so it is very safety. The overall of the result shows that the design is in good to use.

4.3 DESIGN SELECTION

A stress strain analysis has been and the appropriate design is chosen. After do a stress strain analysis, it shows that all the design can be applied but only one design must be chosen. Table 4.9 above shows the concept selection to choose an appropriate design.

Table 4.9 Concept selection

DESIGN	1st	2nd	3rd	4rd
Low manufacturing cost	-	+	+	-
Easy to fabricate	+	+	+	+
Safety	+	+	+	+
Durability	+	+	+	+
Low maintenance	-	+	+	-
Functionality	-	-	-	+
Easy to use	-	-	-	+

From the table 4.9, it is shows that 4^{th} design is best design to choose. Although the design is high in cost, the functionality and easy to use is the factor that affected to choose it as the right design. Next, fabrication process will be done by follow this design.

4.4 FABRICATION OF THE DESIGN

Fabrication will be made by using the most suitable process and machine. The most suitable is welding process are chosen and the bills of materials are completed. From the entire welding machine which had been list down on the literature review, a Metal-Inert Gas Welding will be used because it does not required high level skills to operate it.

Fabricating is the process of the fabricate the part of the machining using certain machine and process to cut, to attached, to assemble and finishing of the machine. Normally this process is take logiest section to complete in doing the project. It takes 4 to 5 or more that to finish all the fabricating process. Fabricating part involves machine process, welding process if needed, cutting process, finishing process and so on. Figure 4.9 shows the components that have in briquette machine.

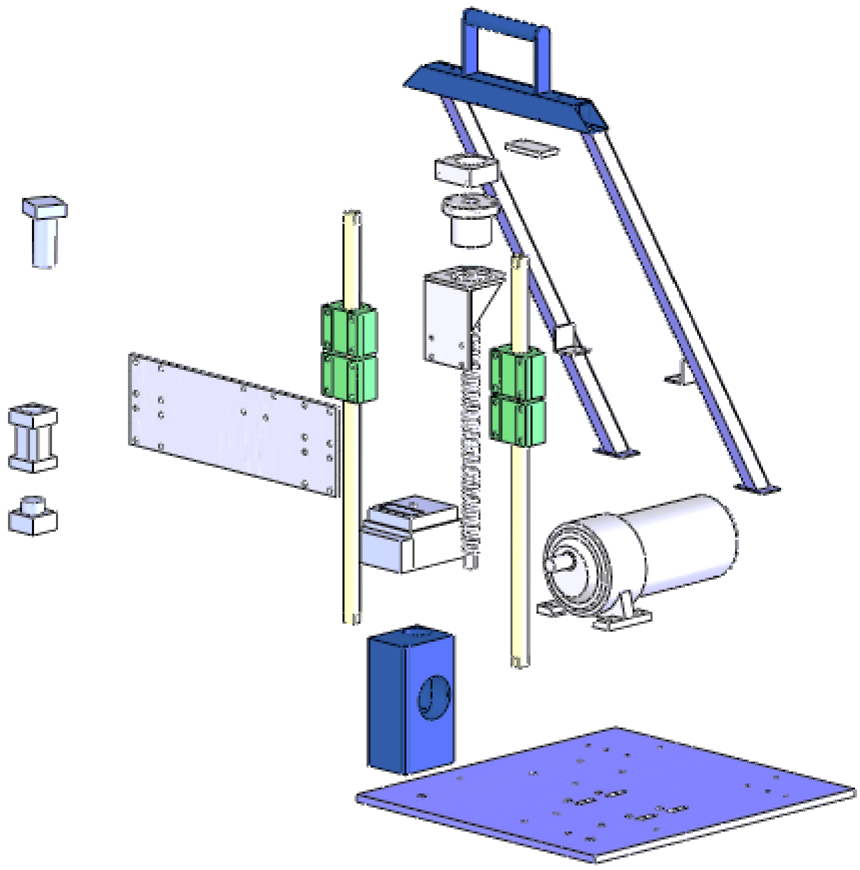


Figure 4.27 Components in briquette machine

4.3.1 Part of machine

Figure 4.28 Base Plate

The first process of the base plate cutting go on oxy acetylene cutting. The cutting proses do in FKM lab. Then, for proper cutting is done by using vertical milling machine. A proper dimension accuracy will be checked several time before use vertical milling machine. This to prevent from wrong cutting dimension. After that, a hand tap is used to make a thread to the base plate.

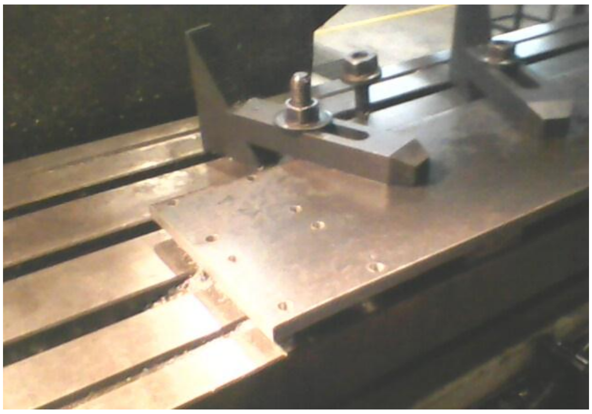


Figure 4.29 Horizontal plate

The process is same process as base plate sequence process. The horizontal plates also go on the oxy acetylene process before vertical milling machine. Oxy acetylene will do a rough cutting before vertical milling takes places as a proper accurate cutting process.

Figure 4.30 Shaft rod

For the shaft rod, a stainless steel rod is used. The cutting proses into the dimension carried by band saw machine. Then, to make a hole, by using a lathe machine.

Figure 4.31 Bearing

There are 4 bearing that needed. The bearing was ordered according to the design of the shaft. The function of the bearing is to make sure the horizontal plate easy to move up and down when attached to it.

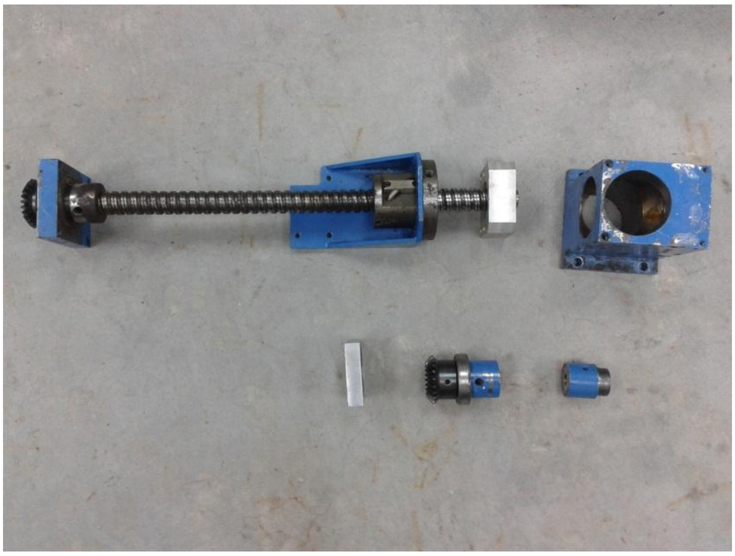


Figure 4.32 Screw rod

A screw rod was ordered and the screw follow the dimension that needed. The function of the screw to move the mould up and down.

Figure 4.33 Upper holder

Using hand cutting machine to cut the upper holder part. By using hollow square mild steel. Then, a welding process (MIG) , Metal Inert Gas welding is used to attach the part to become a holder part.

Figure 4.34 Hollow bar support

Hollow bar support used a square bar mild steel. A proper cutting process need to precise to avoid wrong cutting dimension.

Figure 4.35 Piston

Firstly, the process of making piston start with rough cutting of solid bar by using of band saw machine. The process of accurate dimension is done by vertical milling machine. Facing process and then cutting the solid bar occurred. Next, it will go to lathe machine to make a round shape. A precise, accurate process need to be done to get a precise cutting of round shape.

Figure 4.36 Mould

For making the mould. the square bar is done rough cutting by using band saw machine. Next, it will undergoes a vertical milling machine to do a facing process. To make an accurate hole, it undergoes a Electric discharge machining (EDM) wire cut.

Figure 4.37 Support mould bar

A square bar being cutting by band saw machine. Then, Lathe machine is the next process to facing the surface. After do a facing process, the next step process is cutting the solid bar to become a round bar. A proper speed of lathe machine must be precisely adjust to make a good surface facing.

Figure 4.38 Bolt

The bolt and nut used according to the size of hole that being drilled. Type of hexagon head bolt is used in the machine. The function of using hexagon head bolt is to easy to do the tighting process.

4.5 ASSEMBLE OF COMPARTMNET

The final stage in development of small scale of piston type briquetting tools resource is assembling parts and components. For this machine, a lot of joining is done by using bolt. Only several part will undergoes a welding process. The base plate, stud and others part is assembled.

Figure 4.39 Assemble process

The material is set up for the starting for the assembly proses. For assemble this prototype, the location take placed in Solar House Lab. The equipment to assemble all the part have in in solar house lab. The base plate in assemble with the rod and the horizontal plate. All the assemble process is using bolt. It is much easier than others technique of assemble. The horizontal plate is connected with the bearing and screw rod. This part then then will be assemble to the base plate. This is the welds joint between piston and the support base mould. MIG (Metal Inert Gas) is the process that used in this joining. The current of the welding must be in a good condition. Position of the support base mould and piston must be in a good position before do a welds process.

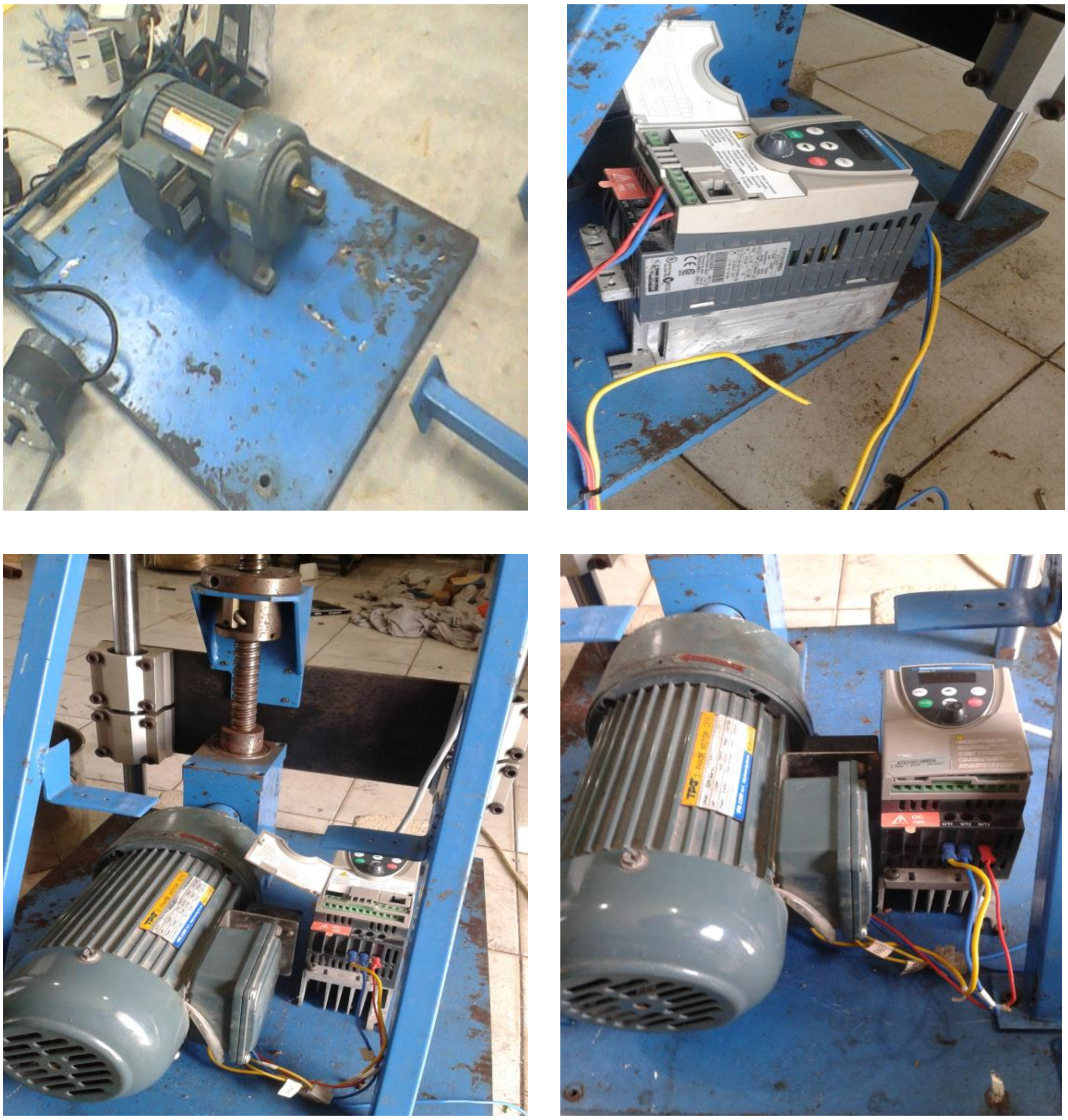


Figure 4.40 3 phase motor and inverter

Motor type 3 phase will be used as the mechanism to make a movement of the machine. A motor then being connected to the inverter. Inverter is will convert DC (direct current) to AC (alternating current) .Inverter main function is to control speed of the machine. to control the speed. High, low speed can be controlled by using this inverter.

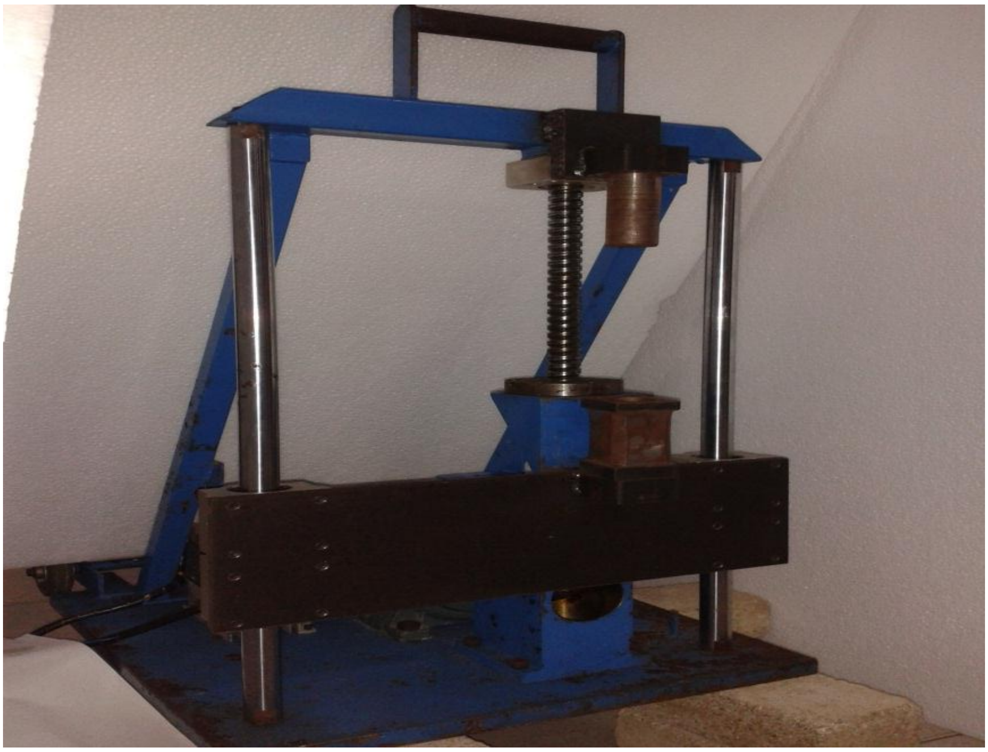


Figure 4.41 Final design

Figure 4.42 Side view of the machine **Figure 4.43** Front view of the design

Finally, the design is completed assemble. The 4th design 3D sketching now have been transform to the real small scale piston type briquetting tools.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

As a conclusion, the development of small scale of piston type briquetting tools has been developed. The conceptual design was fully requirement which is enough space for the compartment and having the ability to receive forces. By referring the actual dimension of components and part, the space for all components was provided. The strength of the structure of the design has been proved in computational stress and strain analysis.

The several designs were sketched and analysis of stress strain simulation was applied to the design. Von mises stress, strain, displacement and factor of safety are the factor that be analysed and the results is observed. Every design have their own advantages and a comparison between all the designs have been done. After do the comparison, the best design is selected which is 4^{th} design.

The structure of the design was a strong enough to support forces from the result of simulation, the stress of von Mises Stress is lower than yield strength of the material mild steel type AISI 1020 which mean the small scale of piston is pass and in a safe condition according to Mises Hecky theory. Fabrication process was proceeded after get the positive result in simulation.

5.2 RECOMMENDATION

For the recommendation in future research, the sequence to do a cutting process must be planning early and must have a backup plan. When do a fabricating process, there are a lot of error will be face and a backup plan will be a rescuer to the problems that faces. This is due to the problems that having when to finished this machine. To make a mould for the piston, there must be a precise dimension to make sure the piston can enter into the mould smoothly. To make the piston enter the mould smoothly, the dimension of make a hole to the mould must be precisely accurate with the diameter round bar of the piston. If the hole of the mould bigger than diameter of the round bar of the piston, there piston cannot enter the mould smoothly and there will be a leaking to the system. As a solution, to make a precisely hole of the mould the process of drilling and make a hole must be proceed by using EDM wire cut. It is better than use manual lathe machine because an error will be faces. Other than that, by using automatic machine programme machine is the most efficient process compared by using manual machine.

REFERENCES

R.Saidur, E.A Abdel Aziz, A. Demirbas, M.S Hossain, S. Mekhilef, 2011. A review on biomass as a fuel for boilers renewable and sustainable energy reviews, 15: 2262-2289.

Longjian Chen, Li Xing, Lujia Han, 2008. Renewable energy from agro-residues in China. Solid biofuels and biomass briquetting technology.

Susanne Paulrud, Calle Nilsson, 2001. Briquetting and combustion of spring-harvested reed canary-grass. Effect of fuel composition biomass and bioenergy, 20: 25-35.

Felix Fonseca Felfli, Juan M. Mesa P, Jose Dilcio Rocha , Daniele Filippetto, Carlos A. Luengo, Walfrido Alonso Pippo, 2009. Biomass briquetting and its perspectives in Brazil Biomass and Bioenergy, 35: 236-242.

P.D Grover & S.K Mishra, 1996. Biomass briquetting. Technology and practices.

S.C. Bhattacharya, M. Augustus Leon and Md. Mizanur Rahman, 2002. A study on improve biomass briquetting.

Zhang Peidong, Yang Yanli, Tian Yongsheng, Yang Xutong, Zhang Yongkai, Zheng Yonghong, Wang Lisheng, 2009. Bioenergy industries development in China. Dilemma and solution renewable and sustainable energy reviews, 13: 2571- 2579.

Arun K. Tripathi, P. V. R. Iyer and Tara Chandra Kandpal, 1998. A techno-economic evaluation of biomass briquetting in India. Biomass and bioenergy, 14:79-488.

Wolfgang R. Schutze, 2008. Hot briquetting of direct reduced iron. Technology and status of industrial application.

Chuen Shii Chou, Sheau Horng Lin, Wen Chung Lu, 2009. Preparation and characterization of solid biomass fuel made from rice straw and rice bran. Fuel processing technology, 90: 980-987.

Yousif A. Abakr, Ahmed E. Abasaeed, 2006. Experimental evaluation of a conical-screw briquetting machine for the briquetting of carbonized cotton stalks in Sudan. Journal of engineering science and technology, 1: 212-220.

APPENDICES

	SCOPES	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	Week9	Week10	Week11	Week12	Week13	Week14
FYP 1	Renewable energy and raw material														
	Analysis of parameters														
	Conceptual and computational														
	FYP 1 draft report preparation														
FYP 2	Computer mechanism fabrication														
	Mechanism assembly														
	Operation and modification														
	Final report preparation														