COMPREHENSIVE ANALYSIS OF A LIGHT WEIGTH LIFT SYSTEM

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Report submitted in fulfillment of the requirements for the award of the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITY MALAYSIA PAHANG

6th DICEMBER 2010

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I certify that the project entitled "Comprehensive Analysis of a Light Weight Lift System " is written by Mohd Fauzi bin Muhammad. I have examined the final copy of this project and in my opinion; it is fully adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering. I here with recommend that it be accepted in partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering.

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I 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'S DECLARATION

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

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Dedicated to my beloved parents and families

ACKNOWLEDGEMENTS

I would like to express my highest gratitude to Allah the Almighty for blessing me in finishing this project. Besides I would like to take this opportunity to express my sincere gratitude and appreciation especially to my supervisor, Mohd Yusof Taib for his constant guidance, consideration and constructive idea in leading me to accomplish this project.

Besides that, I wish to express my sincere appreciation Academic Advisor, whom I owe particular debt of gratitude for her suggestion and assisted me tremendously in many aspects.

Last but not least an expression of thanks is extended to everyone who has offered their help and support especially to my family and friends. All of their favour is very significant to the success of this project. I cannot find the appropriate for their devotion, support and faith in my ability to attain my goal.

ABSTRACT

Lift is a kind of system in building to move people upward and downward vertically at height building. In Malaysia, most of the lifts in the buildings are available only five levels and above thus the movement of disable people below than five levels are limited. So, the idea of design and analysis of light weight and lift system for the use of disable people is developed. Disable people subjected for whom using wheelchair or more specifically people walking is difficult or impossible due to mental or physical illness, injury, or disability to move. The aim of design is transporting a disable people using wheelchair from ground floor to first floor. Design concept of lift is based on rails, electric motor and gears. A suitable rail, electric motor and gear have considered in this design. Another part of lift design is platform and space requirement of platform depend on space of wheelchair and capacity of lift design. All components have been selected in order to design reliable lift system. The structural and component model of lift will be developed using the SOLIDWORKS software. The three-dimension solid model is then imported to the ALGOR software to an analysis on the sustainable and the COSMOS (motion) software to see the motion of the lift system.

ABSTRAK

Lif ialah suatu sistem yang digunakan manusia untuk bergerak ke atas dan ke bawah di sebuah bangunan yang tinggi.Di Malaysia, lif kebiasaannya akan dibina dalam bangunan yang mempunyai lima atau lebih dari lima tingkat, ini bermakna pergerakan untuk orang kurang upaya di dalam bangunan kurang dari lima tingkat adalah terbatas. Dengan itu, terbitlah satu idea untuk merekabentuk dan menganalisa sebuah lif yang ringan untuk kegunaan orang kurang upaya. Orang kurang upaya yang dimaksudkan ialah orang yang mengunakan kerusi roda atau dengan lebih tepat orang yang melalui kesukaran untuk berjalan berpunca daripada masalah kesakitan mental atau fizikal, kecederaan dan tidak mampu berjalan dengan baik. Fokus utama rekabentuk lif ini adalah membawa orang kurang upaya terutamanya yang mengunakan kerusi roda begerak dari tingkat bawah ke tingkat pertama. Konsep rekabentuk lif terdiri daripada landasan, motor elektrik, dan gear. Landasan, motor elektrik, dan gear yang bersesuaian dipilih dalam mereka bentuk sebuah lif. Dalam rekabentuk lif ini, satu lagi bahagian yang perlu dipertimbangkan ialah pelantar dan ruangan pelantar yang bergantung kepada keluasan sebuah kerusi roda and kapasiti sebuah lif. Semua komponen dalam sebuah lif dipastikan terlebih dahulu sebelum merekabentuk sebuah lif yang lengkap. Semua struktur dan penyambungan component model sebuah lif direkabentuk dalam software SOLIDWORK. Kemudian, rekabentuk tiga penjuru tersebut akan dianalisa dalam software ALGOR untuk menganalisis kekukuhan dan software COSMOS (pergerakan) untuk menganalisis pergerakan lif tersebut.

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LIST OF SYMBOLS

σ	stress
A	area
ε	strain
ΔL	difference between original length and deformation length
L	length
F	Force

LIST OF ABBREVIATION

AISI	American iron and steel institute
CAD	Computer-aided drafting
DSW	Department of Social Welfare Malaysia

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

From the Department of statistic Malaysia, Malaysian population updated until 31st July 2009 is about 28.31 million. From here, there are 7560 of disabled people who have registered with the Department of Social Welfare Malaysia (DSW) at the end 2008.

By this era development, we cannot to alienate and forget about the disabled people. They are also involved in the contributing of development of this country. Because of the human right, they also have the right to joy the facilities same like the normal people such as education, employment, proper housing, medical care, accessible transportation, a barrier-free environment, sports and recreation facilities and also a right to participate in all aspects of life. If they are alienated by this era, of course our country will lost the precious stone in the future and the development that we have today cannot be achieved. By this objective, there are many facilities are already prepared at the public and the private sectors specialized for the using of the disable people.

It is about 70% of disable people are expected using wheelchair as their medium of movements. The statistic only recovered for people already have registered as disable people. There are some emergency cases of disable people are coincidently faces trouble and loss mental or physical part permanently or some distances of time. Therefore, the statistic of disable people will be more than the statistic. So, the number of the disable people using wheelchair will be higher than stated percentages.

As we know, an elevator can be considering as a transport device used to move goods or people upward and downward vertically in a building. Elevator maybe classified according to the driving power employed, it is steam driven elevator, hydraulic and electric elevator. In the past, lift systems were powered by steam and water hydraulic pistons. Then, after steam and hydraulic elevator, it was developed to the electric elevator. By this electric system, motor is used to move the platform up and down vertically. It is more practical because it's capability to braking and controlling the lift system efficiently. Nowadays, lift consists of a cab (also called a "cage" or "car") mounted on a platform within an enclosed space called a shaft, or in Commonwealth countries called a "hoist way".

1.2 PROBLEM STATEMENT

As we know height building which is consist more than five levels in Malaysia has lift system to facilitate the moving of these people. However, this facility is not provided in building with less than five levels. It is also can be applied and set up at the bungalow. Thus, this project is aiming to design and analyze a light weight of lift system for the use of disable people to move between the ground floor and the first floor of the building and bungalow.

1.3 OBJECTIVE

The objective of this project is to design and analyze a light weight lift system for disable people which are four meter height.

1.4 SCOPES OF STUDY

To design and analyze of this light weight lift system, firstly finding detail information about studying the lift already exists in many buildings today. Then, design a suitable elevator based on the objective, which is to design a light weight lift system and then continue with analysis and simulation on the sustainable and movement of the lift system.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Lift or elevator is a device for vertical transportation of passengers or freight to different floors or levels, as in a building. The term elevator generally denotes a unit with automatic safety devices; the very earliest units were called hoists. Elevators consist of a platform or car traveling in vertical guides in a shaft or hoist way, with related hoisting and lowering mechanisms and a source of power. The development of the modern elevator profoundly affected both architecture and the mode of development of cities by making many storied buildings practical.

The history of power elevators in the U.S. began in 1850, when a crude freight hoist operating between two adjacent floors was installed in a New York City building. In 1853, at the New York Crystal Palace exposition, the American inventor and manufacturer Elisha Otis exhibited an elevator equipped with a device called a safety to stop the fall of the car if the hoisting rope broke (College.1905).

Until today, there are two types of elevator had been used in many buildings, they are hydraulic elevator and the second one is traction or roped elevator. The hydraulic elevator consists of a cab attached to the top of a hydraulic jack similar to a jack used for a car lift in a service station. The hydraulic jack assembly normally extends below the lowest floor and is operated by a hydraulic pump and reservoir, both of which are usually located in a separate room adjacent to the elevator shaft. Hydraulic elevators are the type generally used in single-family residences. The second type is the roped elevator. This is the system that is most commonly associated with elevators. The roped system consists of a cable that is connected to the top of the cab and is operated by an electric motor located in a penthouse above the elevator shaft (Grondzik, W. T. et al. 2010).

2.2 TYPES OF LIFT

2.2.1 Hydraulic elevator

Hydraulic elevator systems lift a car or platform using a hydraulic ram, a fluid-driven piston mounted inside a cylinder. The cylinder is connected to a fluid-pumping system. The hydraulic system has three parts such as a tank or fluid reservoir, pumps, powered by an electric motor. The pump forces fluid from the tank into a pipe leading to the cylinder. When the valve is opened, the pressurized fluid will take the path of least resistance and return to the fluid reservoir. But when the valve is closed, the pressurized fluid has nowhere to go except into the cylinder. As the fluid collects in the cylinder, it pushes the piston up, lifting the elevator car. We can see how this system works in figure 2.1 below. (Binggeli, C. 2010)

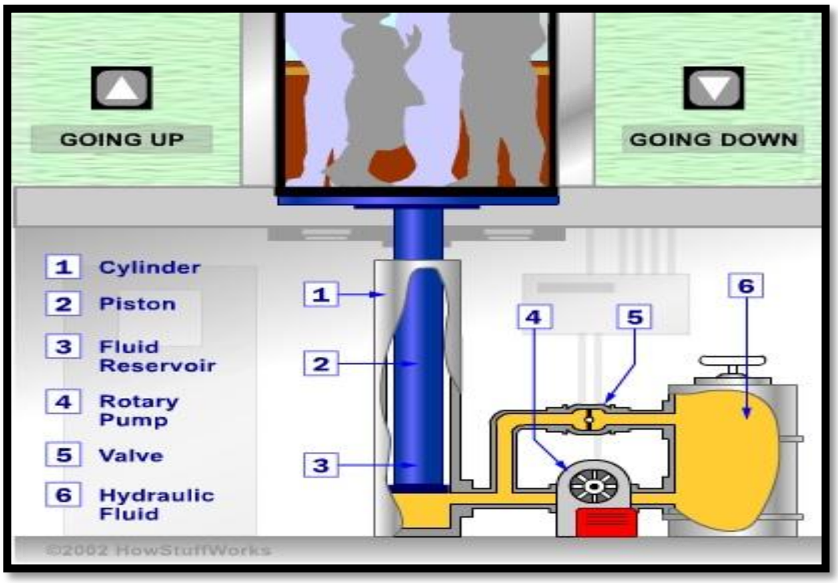


Figure 2.1: Schematic diagram of Hydraulic Lift system

Source: http://uabf.asu.edu/elevators/February 2010

When the car approaches the correct floor, the control system sends a signal to the electric motor to gradually shut off the pump. With the pump off, there is no more fluid flowing into the cylinder, but the fluid that is already in the cylinder cannot escape in other word it cannot flow backward through the pump, and the valve is still closed. The piston rests on the fluid, and the car stays where it is located (Binggeli, C. 2010).

To lower the car, the elevator control system sends a signal to the valve. The valve is operated electrically by a basic solenoid switch. When the solenoid opens the valve, the fluid that has collected in the cylinder can flow out into the fluid reservoir. The weight of the car and the cargo pushes down on the piston, which drives the fluid into the reservoir. The car gradually descends. To stop the car at a lower floor, the control system closes the valve again. This system is incredibly simple and highly effective, but it does have some drawbacks (Binggeli, C. 2010).

2.2.1.1 Advantages and disadvantages of Hydraulics lift

The main advantage of hydraulic systems is they can easily multiply the relatively weak force of the pump to generate the stronger force needed to lift the elevator. But these systems suffer from two major disadvantages. The main problem is the size of the equipment. In order for the elevator car to be able to reach higher floors, you have to make the piston longer. The cylinder has to be a little bit longer than the piston. Since the piston needs to be able to collapse all the way when the car is at the bottom floor. In short, more stories mean a longer cylinder. The problem is that the entire cylinder structure must be buried below the bottom elevator stop. This means we have to dig deeper as we build higher. This is an expensive project with buildings over a few stories tall. To install a hydraulic elevator in a 10 story building, for example, we would need to dig at least nine stories deep. The other disadvantage of hydraulic elevators is that they're fairly inefficient. It takes a lot of energy to raise an elevator car several stories, and in a standard hydraulic elevator, there is no way to store this energy. The energy of position only works to push the fluid back into the reservoir. To raise the elevator car again, the hydraulic system has to generate the energy all over again (Binggeli, C. 2010).

2.2.2 Traction or roped elevators

The most popular elevator design is the roped elevator. In roped elevators, the car is raised and lowered by traction steel ropes rather than pushed from below. The ropes are attached to the elevator car, and looped around a sheave. A sheave is just a pulley with grooves around the circumference. The sheave grips the hoist ropes, so when you rotate the sheave, the ropes move too. The sheave is connected to an electric motor. When the motor turns one way, the sheave raises the elevator; when the motor turns the other way, the sheave lowers the elevator. In gearless elevators, the motor rotates the sheaves directly. In geared elevators, the motor turns a gear train that rotates the sheave. Typically, the sheave, the motor and the control system are all housed in **a** machine room above the elevator shaft (Shamil, A. A.2007).

The ropes that lift the car are also connected to a counterweight, which hangs on the other side of the sheave. The counterweight weighs about the same as the car filled to 40-percent capacity. In other words, when the car is 40 percent full, the counterweight and the car are perfectly balanced. The purpose of this balance is to conserve energy. With equal loads on each side of the sheave, it only takes a little bit of force to tip the balance one way or the other. Basically, the motor only has to overcome friction and the weight on the other side does most of the work. To put it another way, the balance maintains a near constant potential energy level in the system as a whole. Using up the potential energy in the elevator car (letting it descend to the ground) builds up the potential energy in the weight (the weight raises to the top of the shaft). The same thing happens in reverse when the elevator goes up. The system is just like a see-saw that has an equally heavy kid on each end (Shamil, A. A. 2007).

Both the elevator car and the counterweight ride on guide rails along the sides of the elevator shaft. The rails keep the car and counterweight from swaying back and forth, and they also work with the safety system to stop the car in an emergency. Roped elevators are much more versatile than hydraulic elevators, as well as more efficient. Typically, they also have more safety systems (Shamil, A. A. 2007).

2.3 USES OF ELEVATORS

2.3.1 Passenger service

Passenger Elevators to meet these vertical transportation needs in low-rise homes, multistory buildings, hotels, hospitals, commercial & industrial buildings. The speed of travel ranges from single speed of 0.7m/s to variable speeds of 1.5m/s. Passenger elevators capacity is related to the available floor space. Generally passenger elevators are available in capacities from 1,000 to 6,000 pounds (450–2,700 kg) in 500 lb (230 kg) increments. Generally passenger elevators in buildings eight floors or less are hydraulic or electric, which can reach speeds up to 200 ft/min (1.0 m/s) hydraulic and up to 500 ft/min electric. In buildings up to ten floors, electric and gearless elevators are likely to have speeds up to 500 ft/min (2.5 m/s), and above ten floors speeds begin at 500 ft/min (2.5 m/s) up to 2000 ft/min (10 m/s) (Shamil, A. A. 2007).

2.3.2 Freight elevators

A freight elevator is used to do just what its name implies to elevate, or lift, freight, or goods. It is built to carry goods rather than people, though some do both to allow operators and those loading goods along for the ride. Given its distinct purpose, a freight elevator is typically larger and can carry more weight than a passenger elevator. A freight elevator is often custom designed for the warehouse, shopping center or other large-scale facility it will serve. The designs are based on needed dimensions, the amount of weight it will carry and how goods will be loaded and unloaded, whether it is by hand, car or industrial truck. A heavy-duty freight elevator can hold a truck and can handle as much as 100,000 pounds (45, 359 kilograms), using a dual rope system for support (Grondzik, W. T. et al, 2010).

2.3.3 Stage lifts

Stage and orchestra lifts are specialized lifts, typically powered by hydraulics, that are used to lift entire sections of a theater stage. For example, Radio City Music

Hall has four such lifts an "orchestra lift" that covers a large area of the stage, and three smaller
lifts near the rear of the stage. In this case, the orchestra lift is powerful enough to raise an entire orchestra, or an entire cast of performers up to stage level from below.

2.3.4 Vehicle elevators

Vehicle elevators are used within buildings or areas with limited space, typically to move cars into the parking garage or manufacturer's storage. Geared hydraulic chains (not unlike bicycle chains) generate lift for the platform and there are no counterweights. To accommodate building designs and improve accessibility, the platform may rotate so that the driver only has to drive forward. Most vehicle elevators have a weight capacity of 2 tons.

2.4 SAFETY SYSTEMS

Safeties are activated by a governor when the elevator moves too quickly. Most governor systems are built around a sheave positioned at the top of the elevator shaft. The governor rope is looped around the governor sheave and another weighted sheave at the bottom of the shaft. The rope is also connected to the elevator car, so it moves when the car goes up or down. As the car speeds up, so does the governor. The diagram below shows one representative governor design (Craighead, G. 2009).

In this governor, the sheave is outfitted with two hooked flyweights (weighted metal arms) that pivot on pins. The flyweights are attached in such a way that they can swing freely back and forth on the governor. But most of the time, they are kept in position by a high-tension spring.

As the rotary movement of the governor builds up, centrifugal force moves the flyweights outward, pushing against the spring. If the elevator car falls fast enough, the centrifugal force will be strong enough to push the ends of the flyweights all the way to the outer edges of the governor. Spinning in this position, the hooked ends of the flyweights catch hold of ratchets mounted to a stationary cylinder surrounding the sheave. This works to stop the governor.

The governor ropes are connected to the elevator car via a movable actuator arm attached to a lever linkage. When the governor ropes can move freely, the arm stays in the same position relative to the elevator car (it is held in place by tension springs). But when the governor sheave locks itself, the governor ropes jerk the actuator arm up. This moves the lever linkage, which operates the brakes.

A wedge-shaped safety, which sits in a stationary wedge guide. As the wedge moves up, it is pushed into the guide rails by the slanted surface of the guide. This gradually brings the elevator car to a stop (Craighead, G. 2009).

2.5 CONTROLLING SYSTEM

2.5.1 General controls

A typical modern passenger elevator today will have counterweight, elevator machinery, control panel, speed governors, limit switch, buffer, hoistway door, operating control, and supervisory control. All these components are important to ensure the movement of lift system is smooth.

2.5.2 External controls

Elevators are typically controlled from the outside by up and down buttons at each stop. When pressed at a certain floor, the elevator arrives to pick up more passengers. If the particular elevator is currently serving traffic in a certain direction, it will only answer hall calls in the same direction unless there are no more calls beyond that floor. In a group of two or more elevators, the call buttons may be linked to a central dispatch computer, such that they illuminate and cancel together. This is done to ensure that only one car is called at one time. Key switches may be installed on the ground floor so that the elevator can be remotely switched on or off from the outside (Roos, F. 2006)

2.5.3 The elevator algorithm

The elevator algorithm (also SCAN/C-SCAN) is a disk scheduling algorithm to determine the motion of the disk's arm and head in servicing read and write requests. The algorithm is so named since the behavior is akin to an elevator. The drive maintains an incoming buffer of requests, and tied with each request is a cylinder number of the request. Lower cylinder numbers indicate that the cylinder is closest to the spindle, and higher numbers indicate the cylinder is further away. From some initial arm head starting position with incoming requests, we also have a current indication of the arm movement, either in or out. As requests arrive, the requests are serviced in the direction of the arm movement until there are no further requests in the current direction. When this happens, the direction of the arm reverses, and the requests that were remaining in the opposite direction are serviced, and so on. One variation of this method ensures all requests are serviced in the one direction, that is, once the head has arrived at the outer edge of the disk, it returns to the beginning and services the new requests in the one direction only (or vice versa). The arm movement is thus always less than twice the number of total cylinders then, for both versions of the elevator algorithm. The variation has the advantage to have a smaller variance in response time. The algorithm is also relatively simple. However, the elevator algorithm is not always better than Shortest sought first, which is slightly more optimal, but can result in statistical performance issues (Wu, W. 2007).

2.6 DESIGN CONSIDERATION

The mechanical and electrical design of elevators is dictated according to various standards, which may be international, national, state, regional or city based. Whereas once many standards were prescriptive, specifying exact criteria which must be complied with, there has recently been a shift towards more performance-based standards where the onus falls on the designer to ensure that the elevator meets or exceeds the standard. One of the national elevator standards include USA ASME A17.Because an elevator is part of a building, it must also comply with standards relating to earthquake resilience, fire standards, electrical wiring rules and so forth. The American National Elevator Standards Group (ANESG) sets an elevator weight standard to be 2200 lbs. Additional requirements relating to access by disabled persons, may be mandated by laws or regulations such as the Americans with Disabilities Act (Baucom, H. A. 1996).

2.7 NOISE MADE BY ELEVATOR

From the research titled of Application of active noise control to an elevator cabin, it can be summarized that that the application of ANC (active noise control) to an elevator cabin succeeded in reducing the noise signal by over 10 dB at the frequencies of interest, not only on the plane containing the error sensors but also on several planes in the elevator cabin. In the prototype built in the laboratory, the proximity of the noise source and the polarization of the noise signal prevented better results from being obtained. Considering the total noise weighted for the human ear, the reduction achieved with the active techniques was 3.5 dB. Finally, it was observed that with a combination of active and passive control methods a total noise reduction of over 7 dB for the human ear was obtained inside the cabin.

2.8 GEARING SYSTEM

Gear is used in this lift design. As we know gear is a rotating machine part having cut teeth, or cogs, which mesh with another toothed part in order to transmit torque. Two or more gears working in tandem are called a transmission and can produce a mechanical advantage through a gear ratio and thus may be considered a simple machine. Geared devices can change the speed, magnitude, and direction of a power source. The most common situation is for a gear to mesh with another gear, however a gear can also mesh a non-rotating toothed part, called a rack, thereby producing translation instead of rotation. The gears in a transmission are analogous to the wheels in a pulley. An advantage of gears is that the teeth of a gear prevent slipping. When two gears of unequal number of teeth are combined a mechanical advantage is produced, with both the rotational speeds and the torques of the two gears differing in a simple relationship. In transmissions which offer multiple gear ratios, such as bicycles and cars, the term gear, as in first gear, refers to a gear ratio rather than an actual physical gear. The term is used to describe similar devices even when gear ratio is continuous rather than discrete, or when the device does not actually contain any gears, as in a continuously variable transmission (Budynas, G. R. 2008).

2.8.1 Type of Gear

Actually there are fourteen types of gears are having in market. They are gears, Spur, Helical, Double Hypoid, Crown, Worm, non-circular rack and pinion, epicycle, sun and planet, harmonic drive, cage gear.

2.8.2 The most suitable Gear (rack and pinion)

Rack and pinion is the most suitable gear to be used in this design. This is because a rack is a toothed bar or rod that can be thought of as a sector gear with an infinitely large radius of curvature. Torque can be converted to linear force by meshing a rack with a pinion, the pinion turns; the rack moves in a straight line. Such a mechanism is used in automobiles to convert the rotation of the steering wheel into the left-to-right motion of the tie rod. Racks also feature in the theory of gear geometry, where, for instance, the tooth shape of an interchangeable set of gears may be specified for the rack (infinite radius), and the tooth shapes for gears of particular actual radii then derived from that. The rack and pinion gear type is employed in a rack railway (Budynas, G. R. 2008). The figure 2.2 shows the schematic of rack and pinion.

Figure 2.2: Schematic of rack and pinion.

Source: http://www.statetoolgear.com/services/rack.php 2010

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

To make this light weight lift system to become realized, it is actually has five steps. The five steps including, literature review, make the design concept consideration and evaluation, modeling the lift system using solid work software, and analysis the lift system using Algor software and finally carry on with simulating the lift system by using the cosmos (motion) software.

The Literature review of this thesis is about finding the detail information about existing lift or elevator system installed in the building higher than five levels. The second step is design the lift concept base on the geometrical, and parameter itself. The third step is modeling the lift system have been designed by using the solid work software. The next step is analyzing the lift system using Algor software to analyze the capability of the lift system to transport the disable people which the load about 1500N from the ground floor to the first floor which is about four meter height. All of the steps as mentioned above are summarized in the flowchart of methodology in figure 3.1 at the next page.

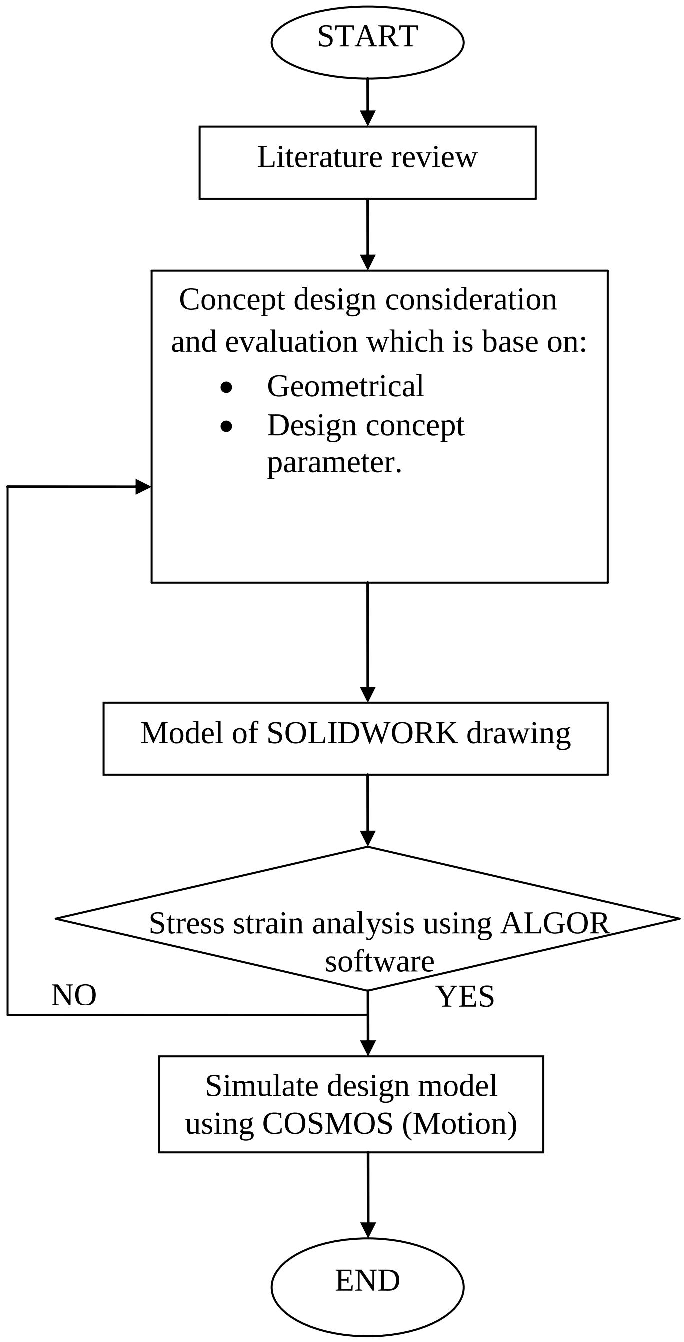


Figure 3.1: Flowchart of methodology.

3.2 FIRST STEP: LITERITURE REVIEW

Literature review of this thesis is about studying the lift system already exists in many buildings today. There are two types of elevator. The first one is the hydraulic elevator and the second one is cable or roped elevator system. Hydraulic elevator systems lift a car or platform by using a hydraulic ram, a fluid-driven piston mounted inside a cylinder. The cylinder is connected to a fluid-pumping system. It is also has three parts such as a tank or fluid reservoir, pumps, powered by an electric motor. In cabled or roped elevators, the car is raised and lowered by traction steel ropes rather than pushed from below. The ropes are attached to the elevator car, and looped around a sheave. Next, the literature review is also studying about the use of lift, safety of lift system, controlling system, design consideration and gearing system. All of these information are important to me finish this comprehensive analysis of a light weight lift system thesis.

3.3 SECOND STEP: DESIGN CONCEPT CONSIDERATION AND EVALUATION

To design this light weight lift system there are some considerations and evaluations have to be made so that it is following all the standards and criteria. The design concept consideration is base on the elevator that already exists in many buildings. The first lift design concept are referred is hydraulic lift design concept. The hydraulic lift has the advantage, it is can easily multiply the relatively weak force of the pump to generate the stronger force needed to lift the elevator. But it also has the disadvantage. It cannot be reached until to the height level. This is due to the difficulty of its installation.

Then, the second lift design concept is roped lift. The most popular elevator design is the roped elevator. In roped elevators, the car is raised and lowered by traction steel ropes rather than pushed from below. The ropes are attached to the elevator car, and looped around a sheave**.** A sheave is just a pulley with grooves around the circumference. The sheave grips the hoist ropes, so when you rotate the sheave, the ropes move too. The sheave is connected to an electric motor. When the motor turns one way, the sheave raises the elevator; when the motor turns the other way, the sheave lowers the elevator. In gearless elevators, the motor rotates the sheaves directly. In geared elevators, the motor turns a gear train that rotates the sheave.

Typically, the sheave, the motor and the control system are all housed in a machine room above the elevator shaft. Both the elevator car and the counterweight ride on guide rails along the sides of the elevator shaft. The rails keep the car and counterweight from swaying back and forth, and they also work with the safety system to stop the car in an emergency. Roped elevators are much more versatile than hydraulic elevators, as well as more efficient.

After consider these two lift design concept, it's created an idea to invent a new lift design concept which is based on the gearing concept. The concept of the lift system is, the lift system consists of a platform which is attached by other eight rollers, supported by four extruded aluminum attached to lip channel to guide the movement of the platform. The platform design only limited for one disable passenger only, where it can support the load average about 1500N.The space of the platform is about 1m x 1m and its height is about 4m. It is able to place one disable passenger and their wheelchair. It is also has a rack gear which is connected to the spur gear as the main function to move the platform upward and downward. Then, the spur gear is connected to the break motor which is functioning to control the spur gear to moving upward and downward.

The basic components of lift include rack and pinion gears connected to the brake motor system. When the call switch at first level is pressed, it will power on the brake motor to rotate the spur gear. Then, the spur gear will move the platform mounting along the vertical rack gear. After reach the desired level, the brake motor will be stopped by the limit switch. The same thing occurs when the call switch at the ground floor is pressed, the platform at the first level will move downward vertically along the rack gear. Then, when it reaches to the desired level or ground level the limit switch will stop the brake motor again.

Because of this thesis is about comprehensive analyzing of the light weight lift system, the lightest weight of material is very needed in the making material selection.

This is important to ensure this lift is very practical and friendly. Figure 3.2 and Figure 3.3 show the technical drawing of the light weight lift system.

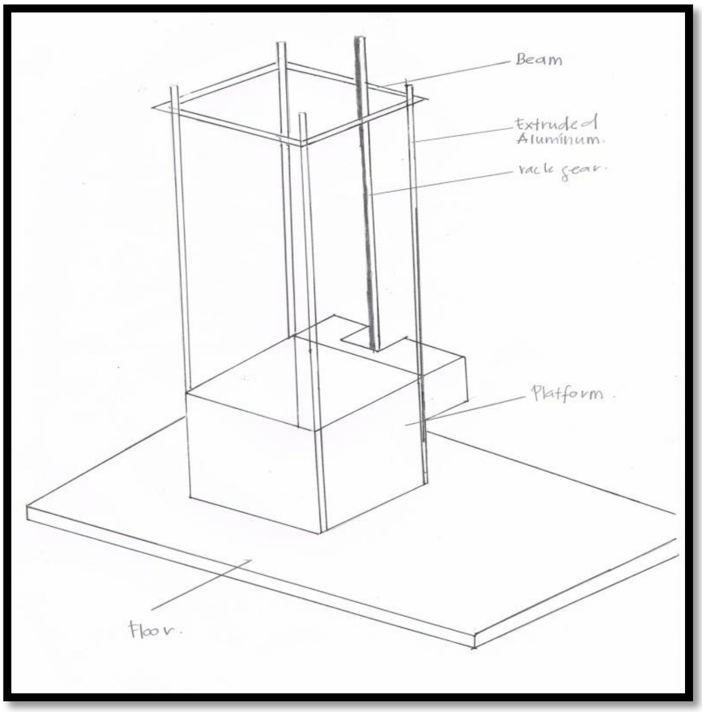
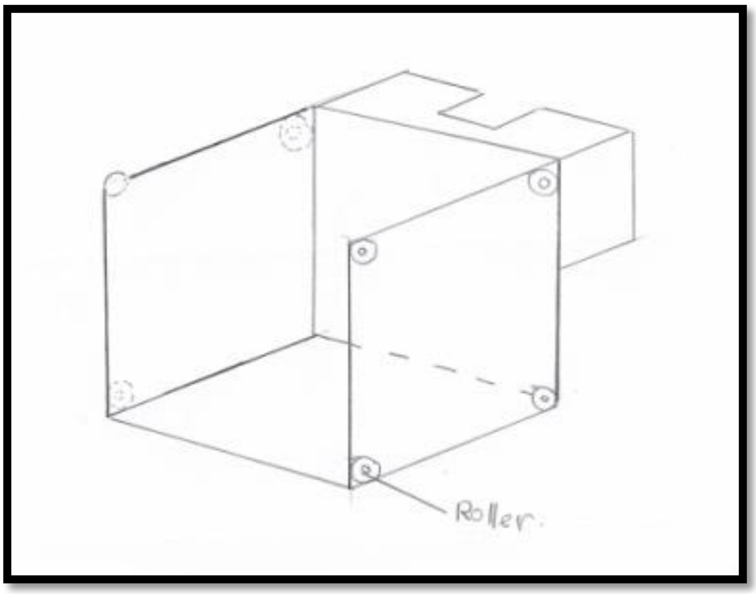
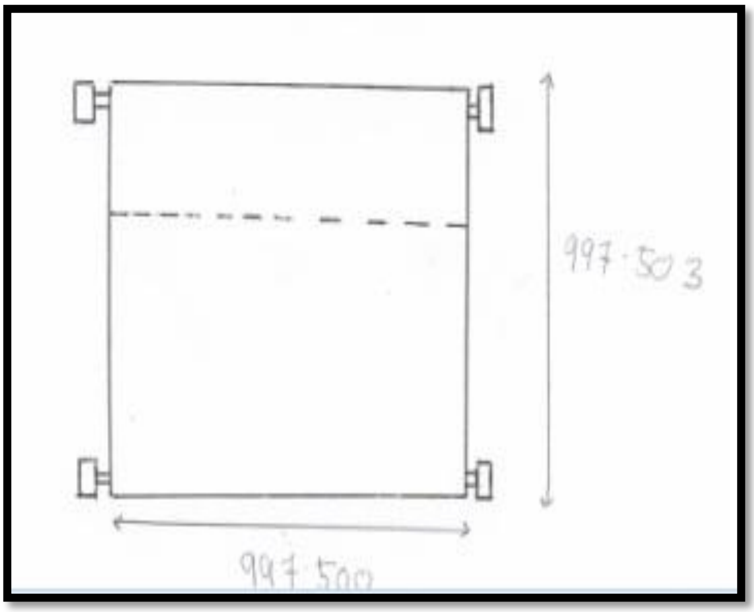


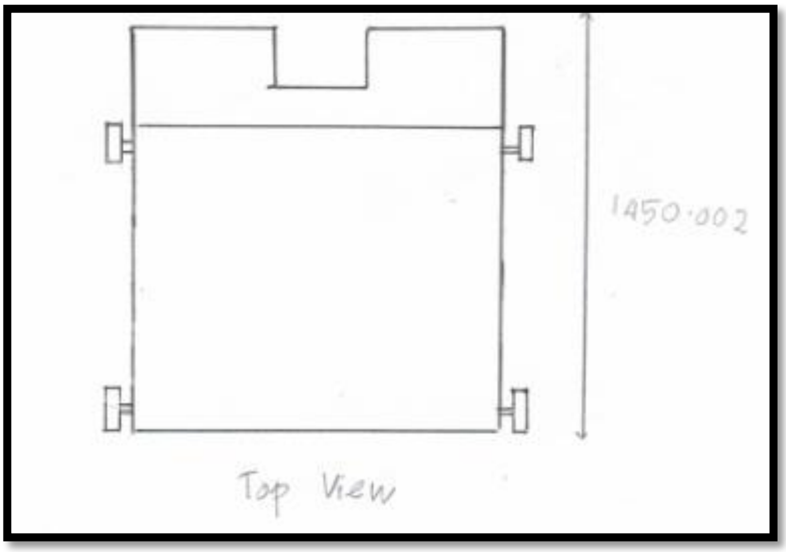
Figure 3.2: Lift system design



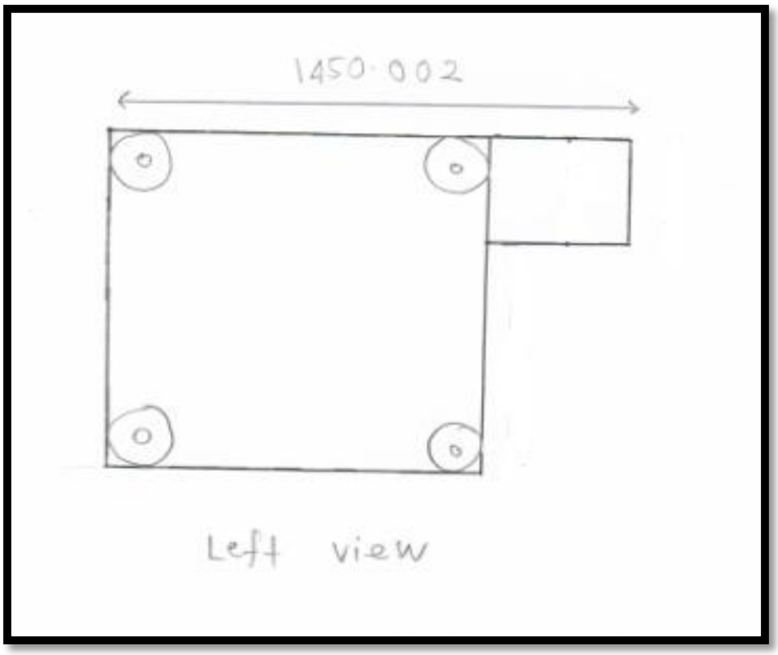
(a)



(b)



(c)



(d)

Figure 3.3: (a) Isometric view of platform (b) Front view of platform (c) Top view of platform (d) Left view of platform

3.4 THIRD STEP: MODELLING LIFT SYSTEM USING SOLIDWORK SOFTWARE.

In this step is the modeling the lift system, all parameters and components involve in the lift system are selected such as platform, beam, rollers, spur gear, lip channels and brake motor. In the moving compartment of the lift system, gears are involved in the lift system as the movement mechanism. The rack and pinion gears are the simplest moving mechanism of the lift system because the system does not trough the complex installations system. The linear rack gear type use as rack gear and for pinion gear, a spur gear type is selected.

When make suitable components selection is finish, the next step that will be carry on is generating the entire related component in computer by using solid work software. This is the importance step before performing the simulation. As known, this solid work software is called as the computer aided design software. This software is used to complete this thesis because of its capability to designer to sketch the idea of their design in the form of three-dimensional models and its ability to produce detail technical drawing. Furthermore, by using this software it is also enables to designer to design their concept drawing much faster and precisely.

As already known, solid work designs of the component for 3 Dimensional features. To build up the complete design of the lift system, it has to follow several commands of design such as sketch, features, and assemblies which is provided at the first opening figure. Firstly, the sketching command is about creating the part of the structure of the design by knowing where to put the dimension of the design in the measurement process of the components design and apply all the relations.

The next step is about features and assemblies process. The feature process is about selecting the appropriate features for each component such as extruded booth and extruded revolve. After that, determines the best features that could be applied. The next step is assembly. This process is about selecting the component or structure which had been sketched from the sketch part and assembles it by mate its surface component to another surface component by identifying the type of mate that should be applied. Finally, after whole the processes are experienced, the complete design of the part involve of the lift system are shown in the figure 3.3

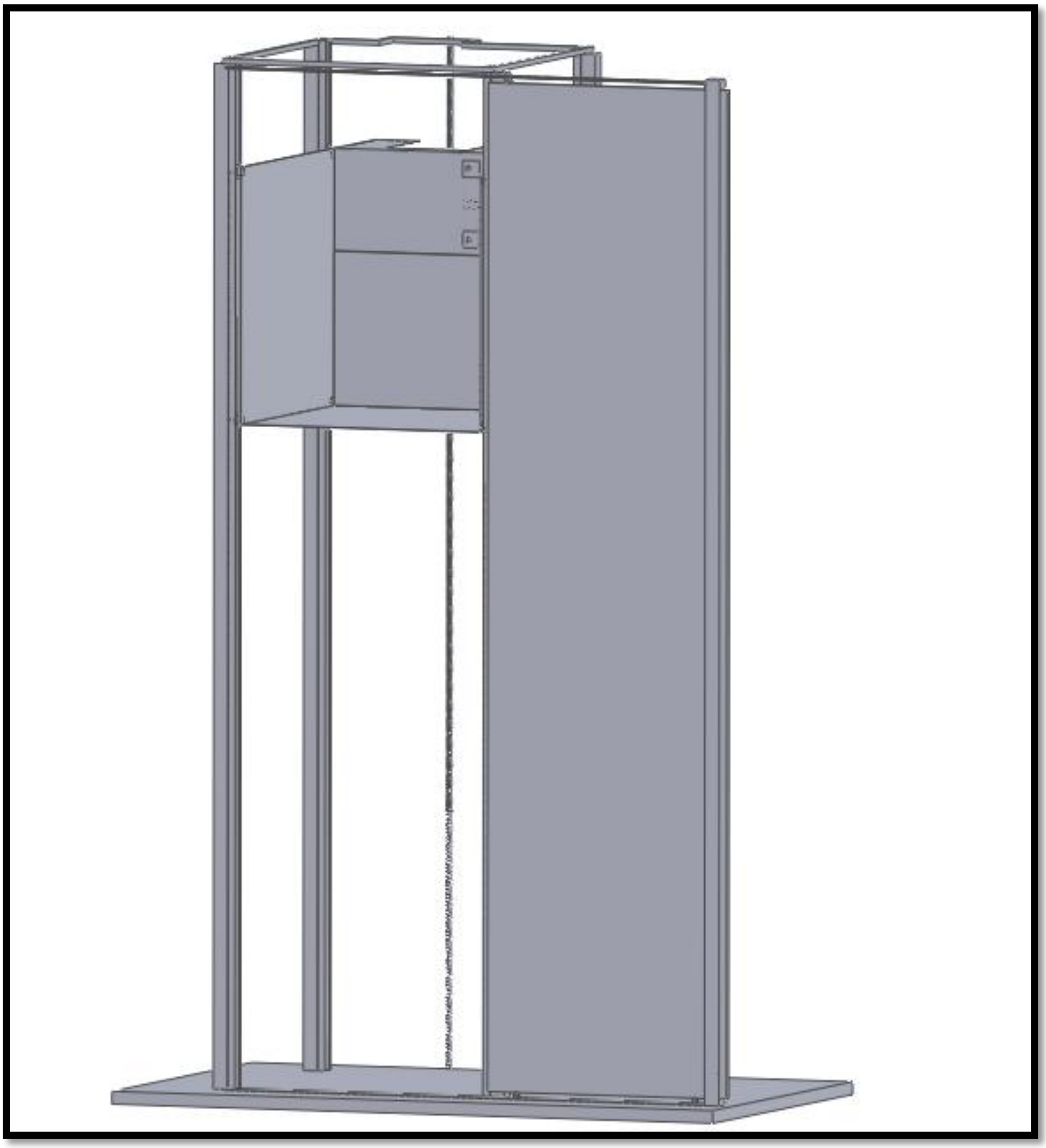


Figure 3.3: Lift System Design

3.5 FOURTH STEP: ANALYISIS 0F THE LIFT SYSTEM USING ALGOR SOFTWARE.

After finish modeling the lift system, the fourth step is to define the actual condition and sustainability of the lift system when loads are attached them. This process is important to make sure that the analysis would give the accurate and precise result. Stress and strain analysis is a useful finite element method to solve the structure analysis of the lift system design. The stress and strain analysis of this lift system is using Algor software to analyze the critical part of the structure of the lift system.

To analyze the stress and strain analysis of the lift system, it is consists of several steps to define the actual condition into simulation condition. The steps are choosing the critical part, defining the mesh and material properties, defining boundary condition, applying load and then run the simulation to obtain the solution. The critical parts of the lift system are used to be analyzed are platform structure with the extruded aluminum and the connection between the spur gear and rack gear. The critical part that should be analyzed is separated in different file.

For the first step, the meshing and material properties of the part are defined. The materials properties are depend on material selection that was decided before designing the lift system. The material property that being used for platform is Aluminum sheet 6061-T6, extruded aluminum is AISI 6061-T6 511 and gears are using same material which is AISI 1045 steel. Then, the next step is defining the boundary condition for each part of the system. The boundary conditions to represent the actual condition of the critical parts.

The further step is applying loads to the critical part. The load on the platform structure is starting from the optimum value for the lift system which is 1500N. The loads of 1500N represent the maximum capacity of the passenger attach on the platform. The load or force which is attached to the platform and extruded aluminum will be increase by 500N and 1000N. Then the final part is the connection between gears carried load of 2000N with the same case of rack gear and spur gear. The 2000N loads represent the total of the passenger capacity and the weight of platform that is assembles with the lip channel and extruded aluminum.

After defining all of the information needed in the analysis, the critical part can start to run the analysis to obtain the solution. When finishes analyze the critical part, data from von misses stress and strain result are recorded. If this analysis process failed, then the lift system should have some modification processes as suggested in the flowchart in figure 3.1.

3.6 FIFTH STEP: SIMULATION OF DESIGN MODEL USING COSMOS (MOTION) SOFTWARE.

This light weight lift system design only complete if analysis about the movement and the operation of the lift system occur. The movement and the operation of the lift system can be simulated by using Cosmos (motion) software. The cosmos software concern all about the properties consist in the movement characteristics of the system. The properties consist in the software program are defining the moving and grounding parts, defining joint parts, run the simulation and defining result data. All parts involved in the lift system are defined in software because all of the parts are connected to the movement system. Then, moving and ground parts were defined from all the parts consist in the system. The brake motor, spur gear, extruded aluminum, rollers and platform are decided as the moving parts of the system.

When finished decided the moving and the ground parts, the joint should be define between all of the parts. Firstly, the joining parts between the moving brake motor and spur gear with revolute type of joint. The revolute joint between brake motor and spur gear rotate in z-axis with angular velocity of 30rev/min. Secondly, the connection between platform and extruded aluminum parts moving in translation type of joint. The translation between the joint parts is moving at z-axis with velocity of 300mm/s. Third joint is the connection between moving rails arm and ground rails. The simulations of the lift system consist between two parts which is moving upward and moving downward with the same moving type properties. When complete defined the data needed for all the part, the lift system can start run the simulation of the all the moving and ground parts. Then, the simulation need to analyze by using the result and plot to get the result in terms of graph.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter will be carry on with further discussion about analysis and simulation of the critical part of the lift system. The analysis of critical part of the lift system was simulated by using Algor software.

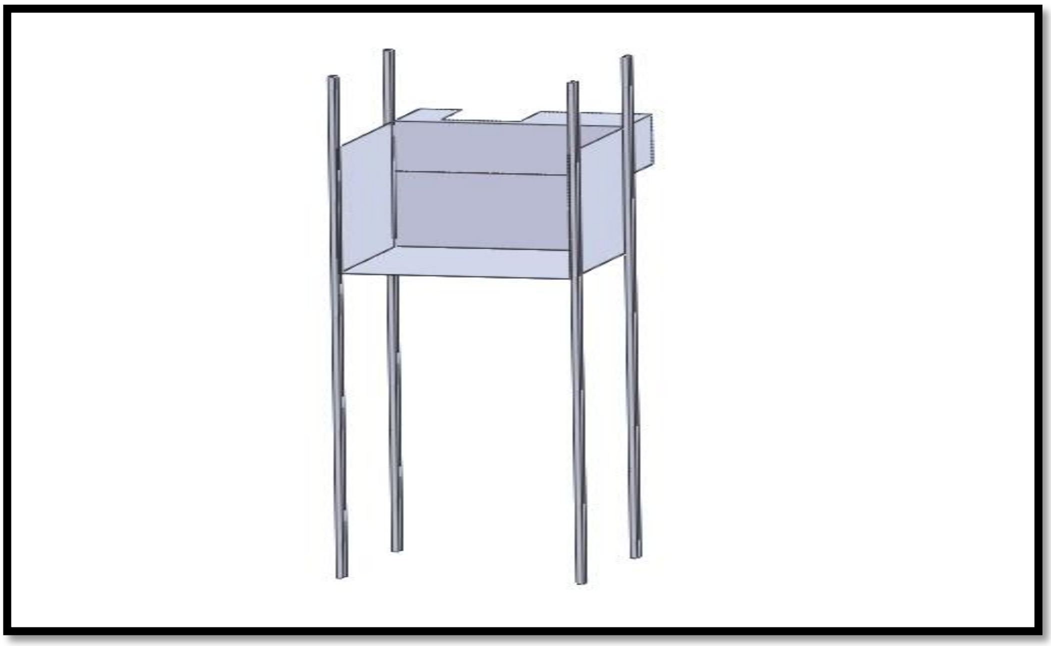
The stress and strain analysis is used to investigate the sustainability of the critical parts involved in this light weight lift system. The analysis section also will be discussing further about the stress allowable and factor of safety of each of the critical parts.

4.2 ANALYSIS OF THE LIFT SYSTEM

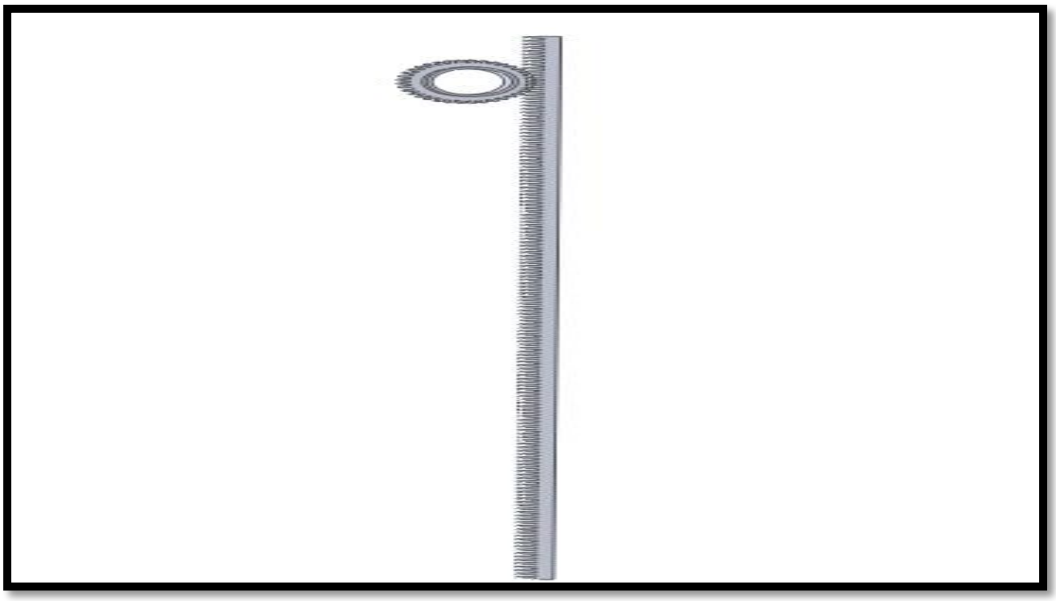
This sustainability of the light weight lift system was analyzed by using Algor software. This software was used because it is ability to determine the stress and the strain. The value of the stress and strain were determined after considering its mesh, material properties, boundary condition and forces attach to the lift system. All the information were involving in the analysis was based on the real condition of the lift system. After that, the result value was analyzed in the incremental value of force attached on the lift system.

4.2.1 The Stress and Strain Analysis

The main parts of the lift system consist of two parts which the first part is platform and extruded aluminum and second one is spur gear and rack gear. The main part of the lift system is shown in the Figure 4.1 below.



(a)



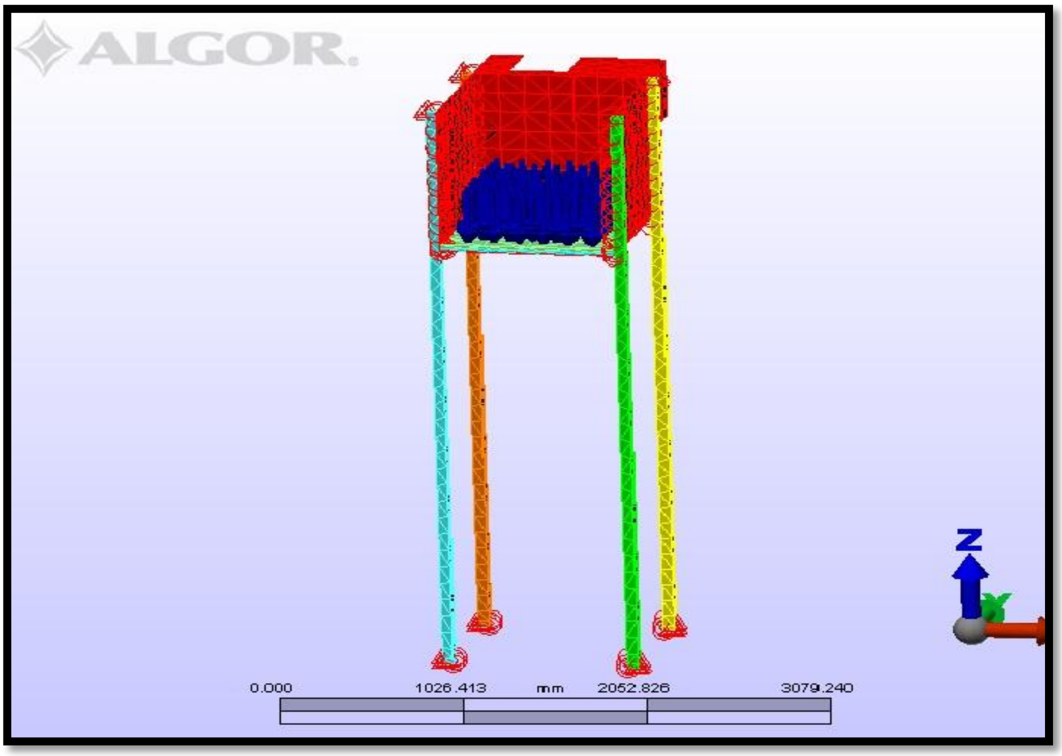
(b)

Figure 4.1: (a) The main parts consist of extruded aluminum and platform
(b) The critical parts consist of rack gear and spur gear.

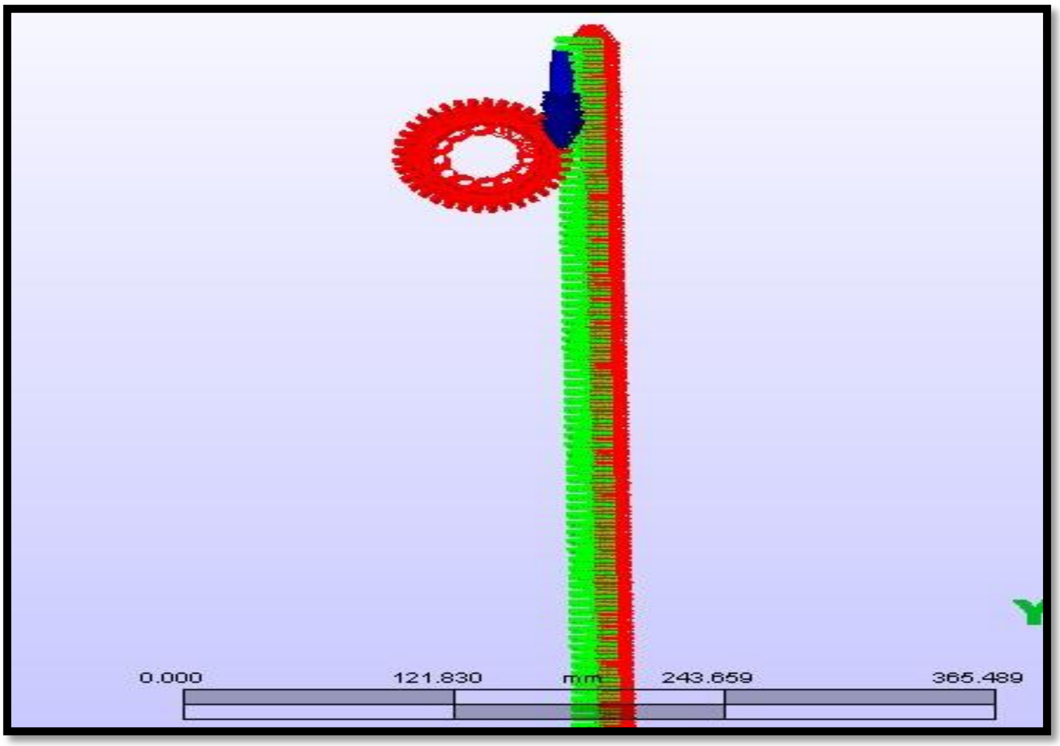
Figure 4.1 (a) shows the main parts in the lift system. These parts were defined such that because the platform was used to locate the load from passenger attached on the platform. The amount of the load applied on the platform is 1500N. The optimum force as mention is the maximum summation of the weight of one passenger and with a wheelchair or without wheelchair. The platform was attached to extruded aluminum at the highest position. This is because by this position it has the highest bending moment and forces. So, from here we can know the maximum load for this lift system will fail. Then, figure 4.1 (b) show the second part and the gears used to bring the force from the platform with a passenger in the rotation condition. The same case happens where the spur gear is located at the highest position. The summation of the platform and passenger is 2000N attach on the gears surfaces.

4.2.2 Analysis properties of the lift system

In this analysis section, to run the analysis, the file from Algor software have been opened were imported. Then, the model was imported from file which is saved in the IGES format. Then were generated the mesh of model structure first and then add boundary condition and force as show in the Figure 4.2. The boundary condition and forces were created base on the real condition such as the fix part and nodal forces.



(a)

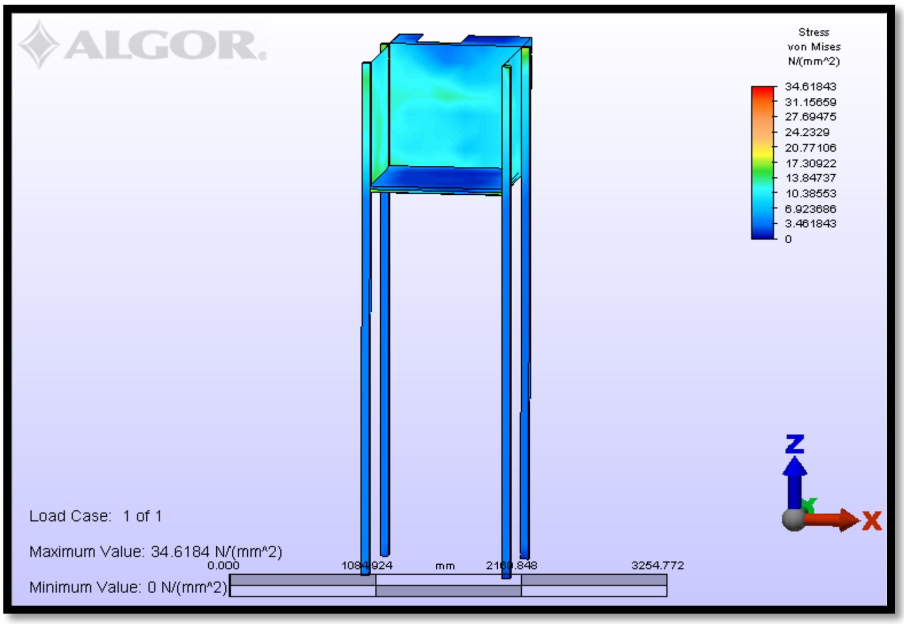


(b)

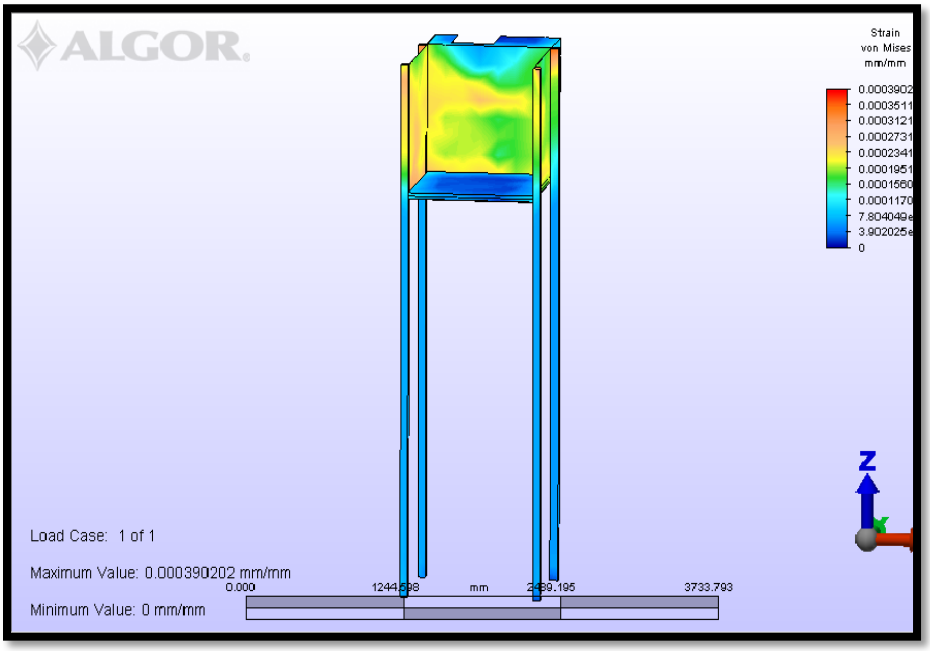
Figure 4.2: (a) The boundary condition and forces acting on the platform and (b) The boundary condition and forces acting on the spur gear and rack gear.

The boundary condition and forces in the model structure was complete for the initial forces which is 1500N for Figure 4.2 (a) and 2000N for Figure 4.2 (b). Then the part was continued analyze with ten times analysis with the increasing the value of forces to get the accurate and precise result.

After make the analysis, the result of the analysis was recorded in the stress and strain data. In the software analysis was recorded in the von misses stress and von misses strain data type of results. The von misses stress and strain data for platform and extruded aluminum were shown in Figure 4.3 and von misses stress and strain for gears are shown in Figure 4.4 with the maximum and minimum values. The von misses value result is the data of analysis in effected resulting areas.



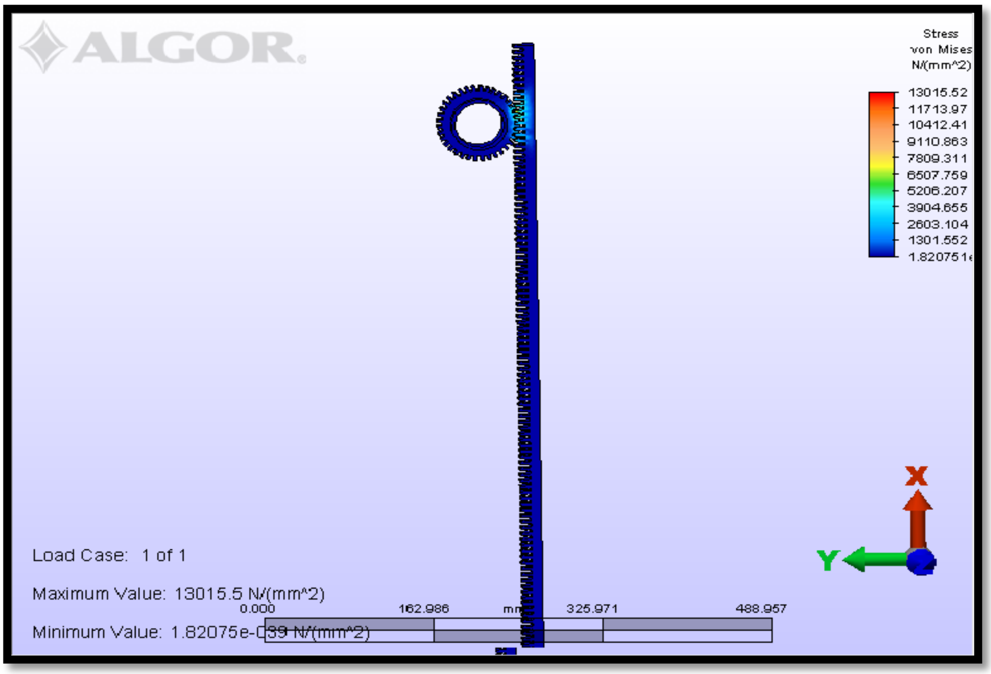
(a)



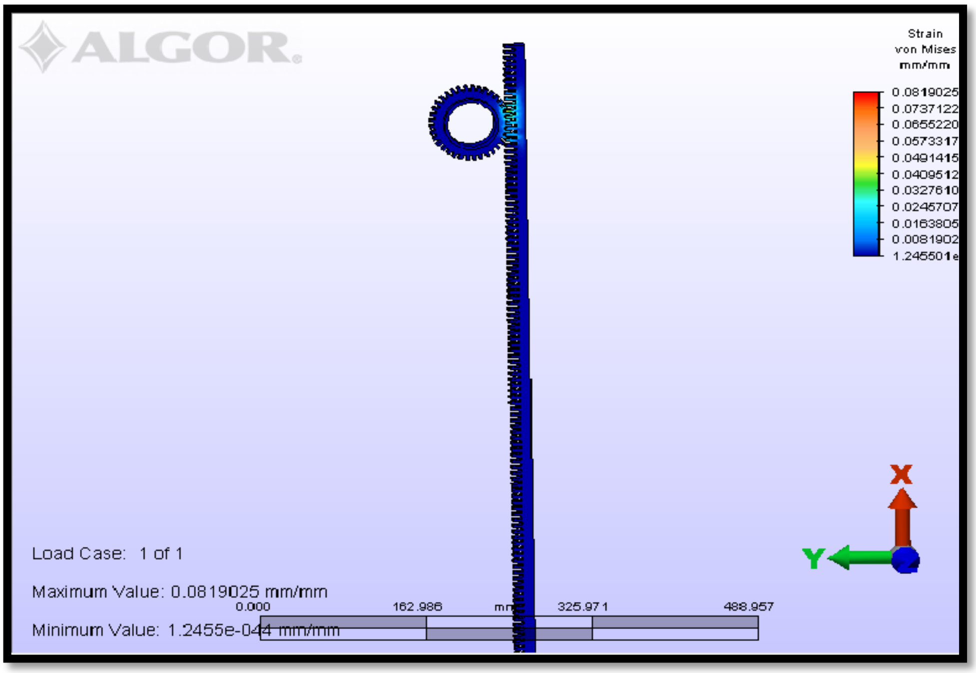
(b)

Figure 4.3: (a) The von misses stress data for platform and extruded aluminum model.

(b) The von misses strain data for platform and extruded aluminum.



(a)



(b)

Figure 4.4: (a) The von misses stress data for spur and linear rack gears model.

(b) The von misses strain data for spur and linear rack gears model.

From the Figure 4.3 and 4.4 of the von misses stress and strain analysis, the resulting data show the various result data in difference affected areas. In the analysis data also gives the maximum and minimum base on the affected area involve in the data. Base on the analysis data, the result given is the effect of forces acting on the area.

4.2.3 Result Analysis of the Critical Part

In the analysis of the critical part, each critical part was analyzed using different value of forces. There were 10 different of forces acting on the reasonable area of parts. By using this method, it can define the sustainable part for the lift system. The result of analysis data was collected and arranged in to form of table for platform and extruded aluminum part shown in Table 4.1 and spur and linear rack gears shown in Table 4.2.

Table 4.1: Results analysis data of the maximum von misses stress and strain of the platform and extruded aluminum part

Results data for platform and extruded aluminum			
No.	**Load(N)**	**Max. Strain (mm/mm)**	**Max. Stress (N/mm)**
1	1500	0.000390202	34.6184
2	2000	0.000520270	46.1579
3	2500	0.000650337	57.6974
4	3000	0.000780405	69.23686
5	4000	0.001040540	92.31582
6	5000	0.001300675	115.3948
7	6000	0.001560810	138.4373
8	7000	0.001820945	161.5527
9	8000	0.002081080	184.6316
10	9000	0.002341215	207.7106

Table 4.2: Results analysis data of the maximum von misses stress and strain of the Spur and linear rack gears.

Results data for spur and linear rack gears			
No.	**Load(N)**	**Max. Strain (mm/mm)**	**Max. Stress (N/mm^2)**
1	2000	0.0819025	13015.52
2	3000	0.1092034	17354.02
3	4000	0.3650420	21692.53
4	5000	0.1638051	26031.04
5	6000	0.2184067	34708.05
6	7000	0.2730084	43385.08
7	8000	0.3276101	52062.07
8	9000	0.3822118	60739.08
9	10000	0.4368135	69416.10
10	11000	0.4914152	78093.11

The load in the table was predicted base on the material properties of each of the part. From the table range loads for platform and extruded aluminum are 1500N to 9000N and range loads for gears are 2000N to 11000N interval.

4.2.4 Discussion of the Analysis.

The stress and strain analysis was done to determine the distribution of stresses and the deformation the assembly parts. Firstly, the data of von misses strain was collected to define as the deformation of the part per unit length. Then second the data of von misses stress was define as the forces acting on the parts per unit area.

When a load is applied to the particular part, deformation will be results. The deformation is elastic if it is completely recovered immediately after load is removed. Purely elastic deformation is associated with stretching of the primary bonds in specimens. Stress is the force per unit area.

$$\sigma = F/A$$

4.1

Strain is elongation per unit length:

$$\varepsilon = \Delta L / L$$

4.2

By plotting the von misses stress verses to the von misses strain as the increasing load applied to the part so as increased the yield a von misses stress-strain diagram. The graph of both critical parts is compared between yield strength of the material and strength of the maximum force state in the lift system limitation. The comparison of the yield strength is shown on the Figure 4.5 and 4.6.

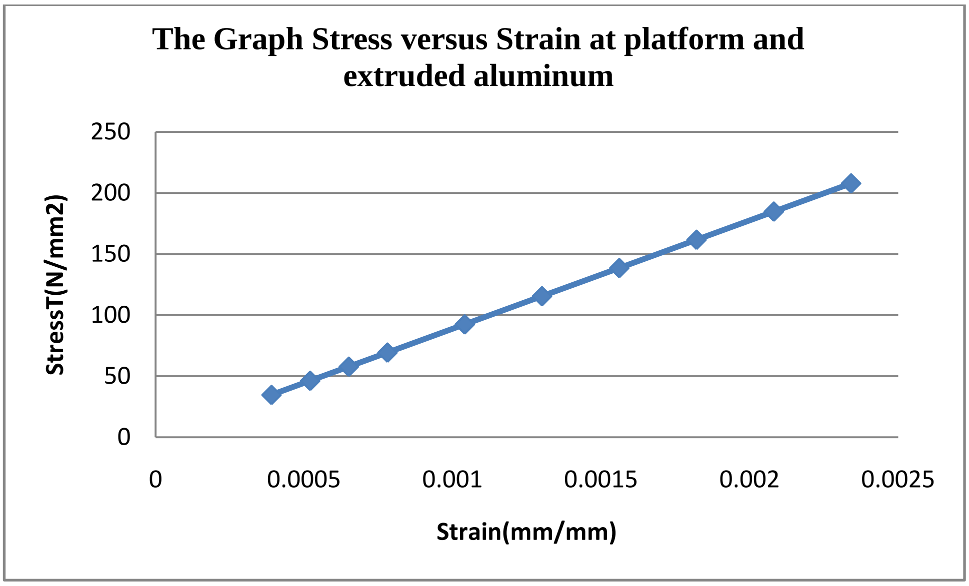


Figure 4.5: The graph of the yield strength of the platform and extruded aluminum.

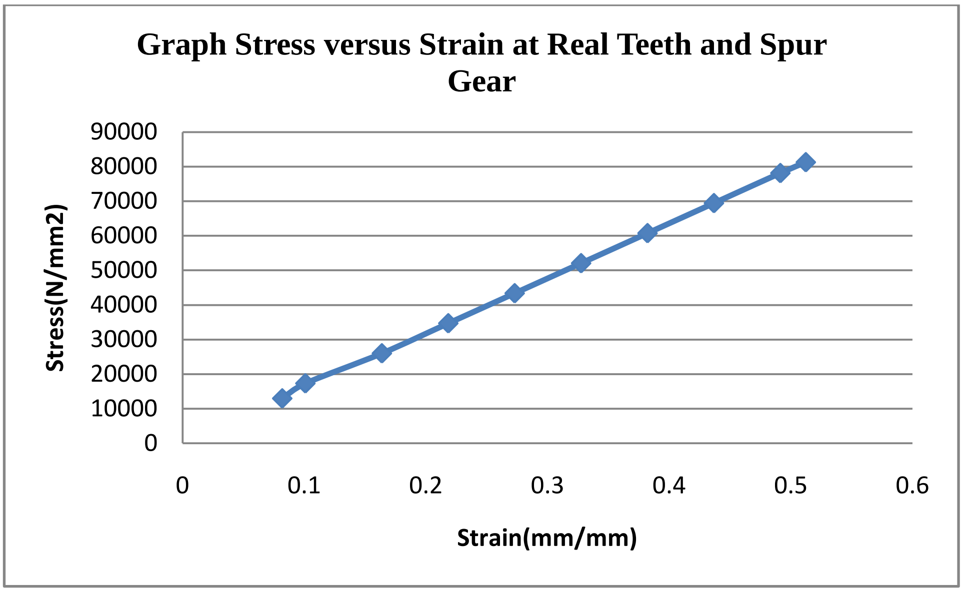


Figure 4.6: The graph of the yield strength of the spur and linear rack gears.

By referring to the literature review on the graph stress versus strain, the yield strength of the part was determined by watching the load on the graph analysis. After increasing steadily, the load will observed to sudden drop to slightly lower value, which is maintained for a certain period while the part keeps elongating. But in the graph analysis above show the increasing continually without any dropping. According to further studied state that the result data given from analysis using software hardly defined the value of load drop to the lower value. So, the value of the yield strength was identified by the software in the properties of the material consist on the report of the analysis software.

Yield strength (σ_y) is the stress at which strain change from elastic deformation to plastic deformation, causing it to deform permanently. The value of yield strength of platform analysis is 276 kN/mm. Then the yield strength for gears connection is 530 kN/mm. The value of yield strength for each of the parts is show high gap of differences between the maximum stress values for the lift system.

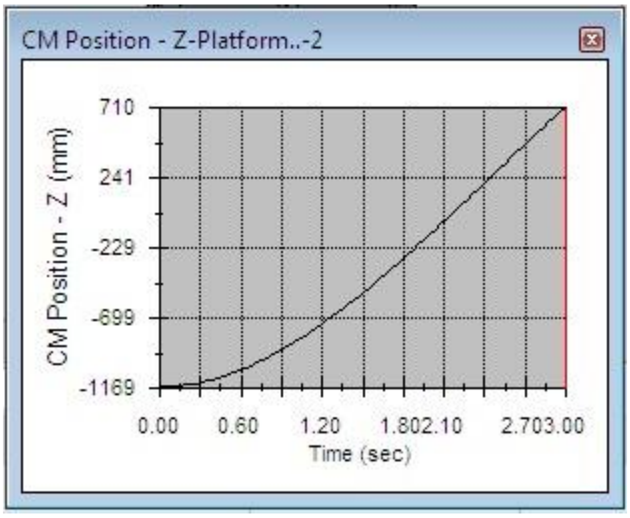
After the yield point, the specimens will undergo a period of strain hardening in which the stress increases again with increasing strain up to ultimate strength. If the specimens are unloaded at this point, stress- strain curve will be parallel to that portion of the curve between origin and the yield point. In the yield point the elongation the materials are permanent that mean the material was fails and unavailable to use.

4.3 SIMULATION OF THE LIFT SYSTEM

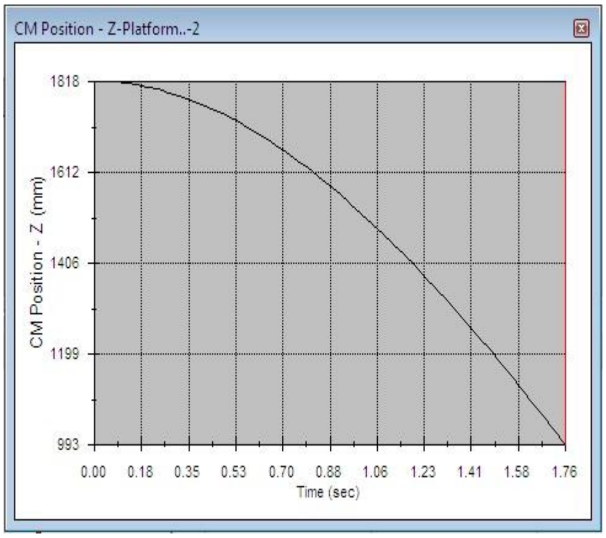
By this simulation section it is about the movement results data from simulation using Cosmos (motion). In the simulation results data which is considered in the lift system is the movement data of platform, and revolution of spur gear. The result of simulation are analyze in the form of graph data.

4.3.1 The Movement of Platform

The movement of the platform simulation are divided into three parts of data result, firstly the result on the upward and downward position data, secondly the velocity data and the last one is the acceleration data. The result of the movement upward and downward position is shown in the Figure 4.7.



(a)

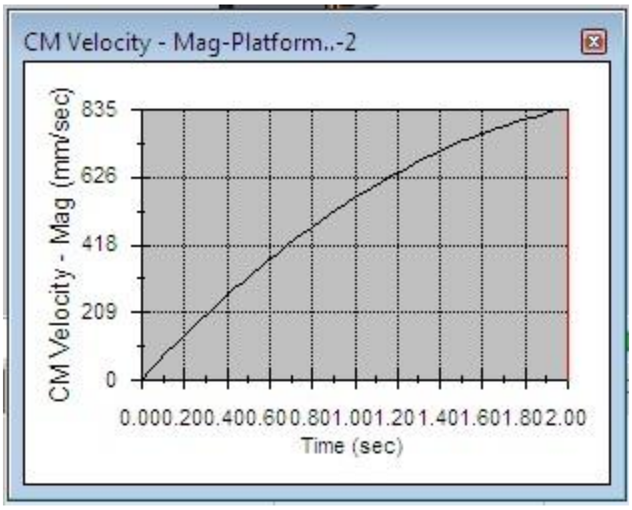


(b)

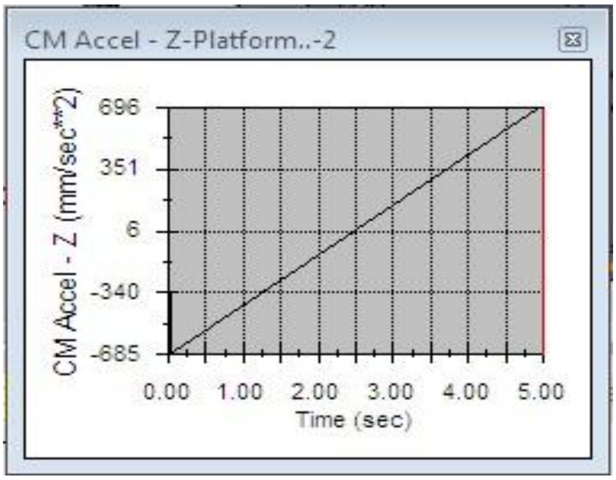
Figure 4.7: (a) the position of the platform in upward direction movement
(b) the position of platform in downward direction movement.

The result graph of CM position (mm) in Z direction verses time (s) is shown in the graphs above. The positive quadratic graph was show by the increasing value of times in upward direction of platform and the negative quadratic graph by increasing value of times for downward direction movement.

Then, the second and third results are about the velocity and the acceleration of the platform data. The movement of the platform result data is effected from the connection between platform and extruded aluminum. The graph of simulation results is shown in figure 4.8 at the next page.



(a)



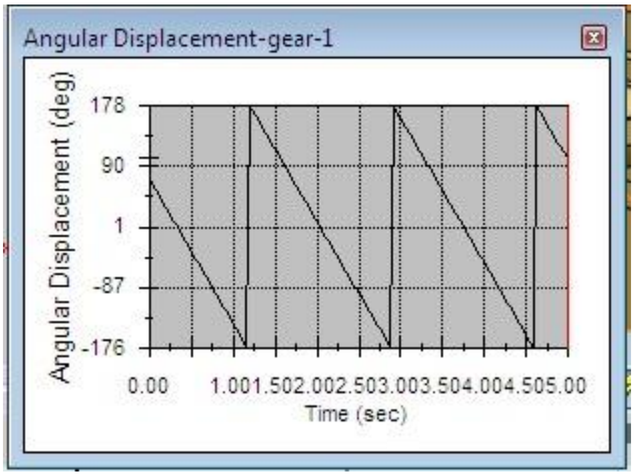
(b)

Figure 4.8: (a) the simulation CM velocity of the platform
(b) the simulation CM acceleration of the platform.

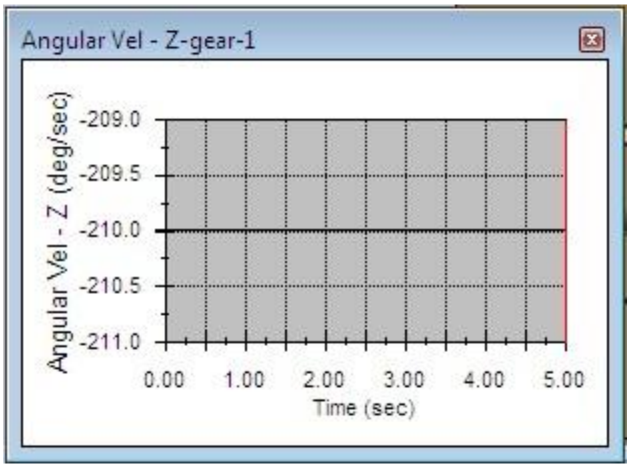
The graph CM velocity (mm/s) verses times(s) and CM acceleration (mm/s^2) was shown in the graph.

4.3.2 The Movement of spur gear.

The simulation result of spur gear was analyzing by using graph data. The displacement, velocity and acceleration are the data from the simulation result. The simulation result is shown the figure 4.9 below. The displacement velocity, angular velocity and angular acceleration type of data was collected in the simulations data because of the rotation movement involve to simulate the lift system.



(a)



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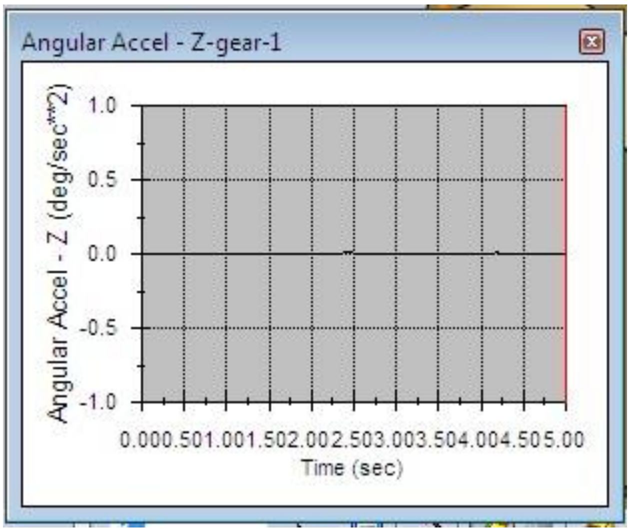

(c)

Figure 4.9: (a) The angular displacement of the spur
(b) The angular velocity of the motor
(c) The angular acceleration of the spur gear

4.3.2 The Simulation Discussion

In the simulation result, the movements of the platform are increasing with the value of time(s) and the position of the platform start from 0 to 4000mm. The movement of the spur gear rotate in the z-axis to bring the upward and downward traveling for the platform. The maximum velocity of the spur gear is constant at 1.58 deg/s and acceleration is zero due to the constant value of speed.

CHAPTER 5

CONCLUSION AND RECOMMANDATION

5.1 CONCLUSION

As the conclusion from this study of the light weight lift system, this lift was designed to improve the facility for disable people who have the difficulty to transport from ground floor to the first level. This is because many buildings in Malaysia are not providing this facility due to the height cost, lacking of space and hard to install.

To finish this light weight lift project, it had faced the process of designing and analysis. In the designing process, Solidwork software was used to design the 3D dimension. Solidwork 2010 is most up-to-date software to use because it is also able to be used in 2D dimension. Even it is also can be used as the analysis medium.

After that, it was analysis process. The Algor software was used to analyze the sustainable of the lift system. Algor is good software to use to analyze the sustainable of this lift system. This software is very useful because, it is very fetish. It is no need to engineer to go to laboratory to fabricate the lift model and make analysis due to the load needed. This software able to solve all these problems just by include all the data needed and finally analyze the data.

5.2 PROBLEM AND RECOMMANDATION

There are a lot of problems occurred during finishing this project. One of it, is while carry out the analysis using Algor software. The lift cannot be analyzed due to mesh error. To solve this problem, the fine mesh was chosen compared before was coarser. To analyze the lift system, it has to be more fine mesh to analyze.

The lift system only enable of travelling only one level. It should has the capability of traveling two or three level in the building below than five levels. Therefore, the disable people can reach the possible level by using the improvement lift will be made.

The lift is capable to sustain the forces only one person with wheelchair or without wheelchair. The lift can be improved by increasing the number of passenger same as existence lift install in the high building.

The lift system are producing high quantity of noise, by that the lift system can be improved by reducing the level of noise from the contacting gears and motor electric that use for generating power to the lift system.

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APPENDIX A

Gantt chart For Final Year Project 1

TITLE	JANUARY				FEBRUARY				MARCH				APRIL			
WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
RESEARCH PSM TITLE	●															
CHOOSE PSM TILTLE		●														
SUPERVISOR INTERVIEW(CHOOSE STUDENT)			●													
FIND INFORMATION				●	●											
STUDY PREVIOUS RESEARCH						●	●	●	●							
DESIGN PROJECT										●	●					
PREPARE REPORT												●	●	●		
PRESENTATION															●	
SUBMIT REPORT																●

APPENDIX B

Gantt chart for Final Year Project 2

TITLE	JULY		OGOS				SEPTEMBER				OCTOBER				NOV	
WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
REDESIGN THE LIFT SYSTEM	●	●	●													
LEARN THE ALGOR SOFTWARE AND COSMOS SOFTWARE				●	●	●										
MAKE THE ANALSIS TO LIFT SYSTEM							●	●	●							
MAKE CONCLUSION AND PROVIDE SUGGESTION FOR IMPROVEMENT										●						
MAKE THE REPPORT DRAFT											●	●				
DRAFT SUBMISSION													●			
PREPARE FOR PRESANTATION														●		
FINAL YEAR PROJECT 2 PRESRNTATION															●	
THESIS SUBMISSION																●

APPENDIX C

Description of Lift System

Number	Part	Description	Quantity
1	Platform	Capacity:1500N	1
		Mass: 50 kg	
2	Brake motor	Generate power to lift to move upward and downward	1
		Reversible motor (AC):1 hp	
		Input voltage: 240V	
		Control voltage: 24V	
		Output speed: 30rpm	
3	Spur Gear	Connected to electric motor	1
4	Bolt	To hold the brake motor to platform	4
5	Roller	To move the platform upward and downward.	8
6	Lip Channel	To guide the movement of roller	4
7	Rack Gear	Connected to spur gear	4
8	Beam	Support platform in first floor	1
9	Floor	To erect the extruded aluminum	1
10	Rail	Guidance for movement of Sliding door	2
11	Sliding door	For passenger enter and exit.	1
12	Roller Door	Guide the movement of sliding door	4
13	Stud	To enforce the extruded aluminum	5
		And rack gear	
14	Extruded aluminum	To enforce the lift system.	4

		Connected with the lip channel	
15	Square bar	To erect the sliding door	2

Table C: Description of Lift System

APPENDIX D