MODIFICATION OF WHEELCHAIR FUNCTION FOR HANDICAP PURPOSE USAGE

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

Faculty of Mechanical Engineering
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…… …….

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MODIFICATION OF WHEELCHAIR FUNCTION FOR HANDICAP PURPOSE USAGE

ZAIDIE BIN RAHIM

BACHELOR OF MECHANICAL ENGINEERING WITH AUTOMOTIVE
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2009

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

Signature :

Name of Supervisor : Mr. Hadi Bin Abdul Salaam.

Position : Lecturer

Date : 23 November 2009

STUDENT'S DECLARATION

I Zaidie Bin Rahim declare that this report entitled "Modification of Wheelchair Function for Handicap Purpose Usage"is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :
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ID Number: MH07001
Date : 23 NOVEMBER 2009

Dedicated to my beloved Maa and Abah

ACKNOWLEDGEMENTS

Throughout two semesters, I met numbers of lecturers and professionals who have assisted me in many ways towards completing my research. Firstly, I would like to express my sincere appreciation to my supervisor, Mr. Hadi Bin Abdul Salaam, who generously shared his insights and suggestions, for his critics, trust, encouragement, and attention. Without their continued support and interest, this project report would not have been the same as presented here.

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I am also obliged to express my appreciation towards my beloved mom and dad and also my family members for their enduring patience, moral and financial supports. My fellow friends should also be recognised for their support. My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. Thank you to all. Thank you for everything. May God bless all of you.

ABSTRACT

This report is an outcome of the work I have carried out in doing and completing my final year project, the Modification of Wheelchair Function for Handicap Purpose Usage. The report starts off with an introduction wheelchair concerning of definition of important component of this topic such as definition of optimization, wheel chair and handicap. Then a further describe on the critical part of stress on the wheelchair. In this steps, from the knowledge gathered from the questionnaire is use to make a design refers to case data that suitable for the project. Several sketches have been made and only a few have been selected based on the suitability design. Based on the sketches, material needed in this project will be listed and suitable design will be selected. Next all the sketches will be draw into Solidworks 2006 software. Then, go through to simulation process by using FEA tools that is ALGOR software, the design was analyzed using constant force. Improvement of critical part of seating support and front tire design was compared based on material used, analysis on Stress Von Mises. At the end, when all the process mentioned above is done, the material for report writing is gathered. The report writing process will be guided by the Universiti Malaysia Pahang final year report writing guide. This process also included the presentation slide making for the final presentation of the project. The project ended after the submission of the report and the presentation slide has been presented.

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ABSTRACT

Laporan ini adalah hasil dari kajian dalam menyiapkan Projek Sarjana Muda saya yang bertajuk “Mereka Bentuk Semula Fungsi Kerusi Roda Untuk Kegunaan Orang Kurang Upaya”. Projek dimulakan dengan pengenalan kepada tajuk-tajuk penting dan juga bahagian – bahagian yang akan dikaji menerusi projek ini. Ianya merangkumi maksud dan pengenalan mengenai proses optimunan, kerusi roda dan orang kurang upaya. Kemudian mengkaji dengan lebih lanjut mengenai bahagian yang paling tinggi tekanan dikenakan. Soal selidik yg dikumpul dijadikan sebagai rujukan utama dalam meneruskan projek ini. Selepas itu, beberapara lakaran dilukis dan dipilih berdasarkan bentuk yg sesuai bagi tujuan penganalisis seterusnya. Kemudian, kesemua lakaran yg dipilih itu dilukis semula di dalam program Solidwork 2006 bagi mendapatkan lukisan dalam bentuk 3 dimensi sebelum di masukkan kedalam Program FEA ALGOR untuk proses analisis daya tekanan. Seterusnya, penambahbaikan bahagian penting seperti pelapik tempat duduk dan tayar depan kerusi roda dikaji berdasarkan kekuatan tekanan Von Mises bergantung kepada jenis – jenis bahan yang digunakan dan dipilih megikut spesifikasi yang terbaik. Akhir sekali,laporan lengkap akan dirangka dan ditulis mengikut garis panduan yang ditetapkan oleh Universiti Malaysia Pahang.Selain laporan lengkap, slaid pembentangan juga akan disiapkan pada fasa teakhir projek ini. Projek ini berakhir dengan rasminya apabila ia berjaya dibentangkan dan laporan akhir dihantar.

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LIST OF SYMBOLS

ac	Acceleration
r	Radial Position
$\dot{r}$	Radial Displacement Speed
S	Displacement
So	Initial Displacement
t	Time
V	Velocity
Vo	Initial Velocity
θ	Angle
$\dot{\theta}$	Angular Displacement Speed

LIST OF ABBREVIATIONS

3-D	Three Dimensional
AC	Automatic Control
CAD	Computational Aided Design
DC	Direct Current
FEA	Finite Element Analysis
RPM	Rotational Per Minutes

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Earlier wheelchairs used belts in the drive-train. The motor turned a rotor which had a belt wrapped around it, and the belt transmitted the power to the wheels. Today's wheelchair use direct drive, meaning the motor turns gears which in turn move the power through a gear transmission to the wheels. Direct drive is more reliable and needs less maintenance.

Basically, this wheelchair was called as electric chairs until have a marketer declare this product to the public as an electric wheel chair. This product content with batteries, motor, hydraulic system and the suitable seat and it’s also using the drive mechanisms.

That product also was used for daily life activities such as old people, lady pregnant and for sport. By the way, for the athletes’ mobility this design should be redesign suitable with their function and their own shape.

This chapter discussed about project background and the history about wheel chair. Its include the problem statement and objectives. The important thing is problem statement to create the objective. The scopes were already used for this project because we don’t throughout this project of out of topic.

1.2 PROBLEM STATEMENT

Wheelchair system is one of the common vehicle is limited in its functions, such as it needs human force to move it. It is also can't be use for a long period as the user will be tired in moving the chair using his or her own energy. Then, the other problem is the existence wheel chair is also not really comfortable as the shape and its position also cannot be fixing to the user's body in getting comfortable seat. The storage compartment was really important because it has no spaces to store the user's things and his or her daily stuff.

1.3 PROJECT OBJECTIVES

The objectives of this thesis are to:

(i) Identify suitable general wheel chair for the usage of handicap people.
(ii) Redesign the wheelchair to for handicap people.
(iii) Analyze the critical part of wheelchair design using ALGOR software.

1.4 PROJECT SCOPE

This project is confined to the following scopes of study:

(i) Identify and selected the suitable wheel chair for daily life activity.
(ii) Redesign of Wheel chair drawing using CADCAM software with Solidwork 2006.
(iii) Analysis the strength of the redesign drawing using as ALGOR software.
(iv) Simulate the prototype of product by ALGOR software.

1.5 ARRANGEMENT OF REPORT

This study will be divided into 5 chapters. In the first chapter, the introduction of the study will be discussed. This chapter provides the problem statement of the study. Then a brief introduction to the project about the wheel chair. Next, it also discusses about the project statement, project objectives and project scopes to carry out the project.

Chapter two consists of literature review concerning of definition of important component of this topic such as definition of optimization, wheel chair and handicap. Then, it also involve about the type of wheel chair that already used today. Lastly, this chapter ends with the previous research of handicap purpose.

Chapter three discusses about process flow that used for this project. Its include with identifying the suitable product. Then, the most important part is to evaluate the sketching of wheel chair. Its include the operational function and the problem or disadvantages of product. For the next step was doing the drawing of product using Solidwork 2006. Lastly, the material selection for every part of wheel chair that has been selected.

Chapters four was include the design process are based on the result of questionnaire after go through the brainstorming session and few design was constructed with simple sketching.After that, the sketching was draw in Solidworks 2006 to produce the 3D drawing before go through to analysis procedure. Then, the simulation process it was analysis using Algor software. The critical part was divide two it were Seating Support and Front Tire. Finally, the suitable material are obtained and was selected as material for Seating Support and Front Tire.

Chapter five discuss about the conclusion and the recommendation of the overall project. It also discuss about the further process should use to make sure this project are really succesfull.

1.6 CONCLUSION

In the early part of this chapter, the objectives and scopes of the project are stated to emphasize the mission of the project and specify the boundary of the study. At the end of this chapter, the arrangement of report is discussed briefly to give a better insight into the content of the report.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides with the detail description literature review done according to title of “Modification of Wheel Chair Functions for Handicap Purpose Usage”. Since the aim of this project is to redesign the wheel chair drawing using Solidwork 2006 and the suitable software such as ALGOR, CADCAM and other related software. Thus literature review related definition of optimization, wheel chair and handicap. This literature review will give an overview or a brief introduction of the techniques that are suitable to be used in this project.

2.2 OPTIMIZATION

The procedures used to make a system or design as effective or functional as possible, especially the engineering techniques involved. Means that, optimization is a process or methodology of making something as a design, system or decision as fully perfect, functional and effective (Van Ryzin, et al, 1993). Conclusively, it can be referring as their improvements increased the value of the property.

2.3 WHEELCHAIR

Wheelchair is a mobility device in which the user sits. The device is propelled either manually turning the wheels by the hand or via various automated systems. Wheelchairs are used by people for whom walking is difficult or impossible due to illness like physiological or physical, injury, or disability. People with both sitting and walking disability often need to use a wheel bench. The earliest record of wheelchairs dates back to the 6th century, and was found inscribed on a stone slate in China (S.F. Simmons,et al, 2000).

2.3.1 Type of Wheelchair

Nowadays, there are many type of wheelchair that is available in the market. It is design based on different shapes and functions. Beside its main usage, wheelchair is also use for exercise activities. The types of wheelchair are manual wheelchair, electric powered wheelchair, sport wheelchair and beach wheelchair. This type was having difference system and function.

2.3.1.1 Manual Wheelchair

Manual wheelchairs are those that require human power to move them. Many manual wheelchairs can be folded for storage or placement into a vehicle, although modern wheelchairs are just as likely to be rigid framed.

Figure 2.1: Manual Wheelchair.

2.3.1.2 Electric Powered Wheelchair

Three general styles of Electric Powered Wheel chairs (EPW) exist: rear, center, front wheel driven or four wheels driven. Each style has particular handling characteristics. EPW are also divided by seat type some models resemble manual chairs, with a sling-style seat and frame, where as others have 'captain's chair' seating like that of an automobile. EPW run the gamut from small and portable models, which can be folded or disassembled, to very large and heavy full-featured chairs.

EPW may be designed specifically for indoor use, outdoor use, or both. They are generally prescribed for persons who have difficulty using a manual chair due to arm, hand, shoulder or more general disabling conditions, and do not have the leg strength to propel a manual chair with their feet.

The user typically controls speed and direction by operating a joystick on a controller. Many other input devices can be used if the user lacks coordination or the use of the hands or fingers. This controller is the most delicate and usually the most expensive part of the chair. EPW can offer various powered functions such as tilt, recline, leg elevation, seat elevation, and others useful or necessary to health and function.

EPWs use electric motors to move the wheels. They are usually powered by 4 or 5 amp deep-cycle rechargeable batteries, similar to those used to power outboard boat engines. These are available in wet or dry options. Currently dry cell batteries are more popular. Many EPW carry an on-board charger which can be plugged into a standard wall outlet older or more portable models may have a separate charger unit.

2.3.1.3 Sport Wheel chair

Disabled athletes use streamlined sport wheelchairs for disabled sports that require speed and agility such as basketball, rugby, tennis and racing. Each wheelchair sport tends to use specific types of wheelchairs, and these no longer look like their everyday cousins. They are usually non-folding it’s in order to increase solidity, with a pronounced angle for the wheels which provides stability during a sharp turn and made of composite, lightweight materials. Sport wheelchairs are not generally for everyday use and are often a second chair specifically for sport use. Although some users prefer the sport options for everyday (Kulig. K, et al, 2002).

A new sport has been developed for powerchair users called powerchair football or power soccer. It is the only competitive team sport for powerchair users. The Federation Internationale de Powerchair Football Associations (FIPFA) governs the sport and is located in Paris, France with country affiliates around the world.

Figure 2.2: Sport Wheelchair.

2.3.1.4 Beach Wheelchair

This wheelchair allows users to enter the water and provide a better mobility in the sand. There are lots of different models available. In many countries in Europe where the Accessible Tourism is well set, many beaches are wheelchair accessible and provide this kind of wheelchairs to clients free of charge.

Figure 2.3: Beach Wheelchair.

2.4 HANDICAP

Handicap can be defined as the loss of ability or malfunction of the human bodies. Handicap can be categorized into several types. The condition of being unable to perform as a consequence of physical or mental unfitness such as reading disability and hearing impairment (Robert Feeney Associates, 2002). It is similarity with disability or disablement.

2.5 PREVIOUS RESEARCH OF HANDICAP PURPOSE

Several previous projects related to these applications have been studied. Several projects related to the application had been done in this chapter. The most relevant projects will be discussed briefly below and shows the summary of the previous projects.

2.5.1 Electric Wheelchair (ZUMP-3)

Prof. Dr. Rosli Abu Bakar (2008), “Design and Development Simple Electric Wheelchair for Disable Community (ZUMP-3)”. An university charity program which organized by UMP vice chancellor and FKM research group. The disable people Miss Siti Hawa Binti Apandi is a teenage girl with a genetic disease called ’Spinal Muscular Atrophy Type II (SMA-2). Her body muscles could not support the weight of the body but disability does not stop her from achieve flying color result in PMR and SPM. In 2007, she successfully applied UMP as Diploma student in Computer Sciences. Her mother had to stay with her at the student hostel, just to take care of her day and night. To overcome this problem, FKM community researcher development the wheelchair based on the general information of wheelchair user. It is 4 directional sensitive joysticks with ergonomic design it is easier to use with on / off button. It also attached with 3 in 1 study table like multipurpose table and has storage compartment & safety belt.

Figure 2.4: Electric Wheelchair UMP (ZUMP-3).

2.5.2 Vacuum Cleaner

Martin, J. et al., (1994). “The prevalence of disability among adults”. OPCS surveys of disability in Great Britain study about Vacuum Cleaner. The disability are cannot lift and so pushes along the floor, should chose a special lightweight cleaner for easier carrying and also difficulty in manipulating the cord. Then, it is difficulty in reaching when using and difficulty with an upright vacuum cleaner with the vertical release mechanism. The implication for measuring capabilities and the capacities of disable. The important motor factors were manipulation, lifting, gripping, and

transporting. Vacuum cleaners suggest that the ability of disabled people to carry items of different weights and weight distribution characteristics should be measured. This should be done in combination with an investigation of the handle characteristics as discussed for kettles and teapots. For the tentative of design implication are participants had most difficulty with the weight of vacuum cleaners, which relates to lifting and transporting of the device. Therefore the overall weight of vacuum cleaners needs to be reduced. Participants also had difficulty manipulating the various mechanisms of vacuum cleaners, including the on/off switch and the device that releases the vacuum cleaner from the upright position. Manipulation of the cord after use also caused difficulty. Other, easier to use mechanisms need to be designed.

2.5.3 Iron Board.

Dickerson A E and Fisher, A G. (1997). “The effects of familiarity of task and choice on the functional performance of young and old adults”. Psychology and Aging study about iron Board. The disabilities are difficulty getting close enough to the ironing board when using a wheelchair and difficulty unfolding the ironing board due to the weight. It is also too heavy and awkward to carry. Finally, the iron on a different surface as cannot use an ironing board. The implications for measuring capabilities and capacities of disabled people are also the important motor factors were manipulation, lifting, gripping, and transporting. This was emphasized by the comments recorded during the experiment. The main implication in terms of measurement is that of the weight of the device. The other factors that can be improved upon with good design principles, as discussed below. Therefore the ability of disabled people to carry items of different weights and weight distribution characteristics should be measured. The tentative of design implications should be unfolding the ironing board caused problems in terms of supporting the weight of the device while manipulating the release handle and unfolding the legs. When the ironing board has been unfolded many wheelchair users found it difficult to get close enough to the ironing board due to the configuration of the legs. Finally transporting the ironing board was found to be difficult due to the weight and the awkward shape. The problems that have been encountered suggest designing a lighter ironing board that incorporates an easy opening mechanism with legs that allow a knee hole for wheelchair users.

2.5.4 Refrigerator

Martin, J. et al. (1994). The prevalence of disability among adults. OPCS surveys of disability in Great Britain study about Refrigerator. The disabilities are about difficulty in reaching into the bottom trays for vegetables and difficulties in reaching the middle and top shelves. It also uses a small fridge mounted on the work surface to make it easier to reach. Next, it's Leans on the door for support whilst reaching into the fridge. Then, for the implications for measuring capabilities and capacities of disabled people are reaching capability of disabled people should be measured for reaching to both the front and side of the body. Also the gripping and manipulation ability of disabled people at various distances away from the body in order to determine if effectiveness of these two factors decreases with increased reaching distance. Finally, the tentative of design implication are the problem of reaching into a refrigerator is different depending on configuration. The participants had problems reaching to the bottom of single fridges, and the top and middle shelves of fridge freezers where the fridge is the top component. Modification of fridges to reduce shelf depth, or raising floor-mounted fridges should help to alleviate the problem.

2.6 CONCLUSION

In this chapter, literature review of definition optimization, wheel chair and handicap has been provided. Besides, topics related to optimization of wheel chair function for handicap have also been discussed in this chapter. In addition, previous research of handicap purpose is also included in this chapter.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter provides a discussion of the methodology used in conducting this project from starting until it is completed. This chapter begins with design of project study, where the methodology used in conducting this project is discussed. Then, discussion of analysis testing with ALGOR is discussed in general.

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3.2 OVERVIEW OF METHODOLOGY

Process begins with meeting with supervisor and discuss about want to clarify the title suitable to use to my FYP. Then, we fixed the weekly appointment for sure the progress of project should be success. After that, finding the information related with my title of “Modification of Wheelchair functions for Handicap Purpose Usage”. The journals and reference book was searching to get the information. Most of the journal was taken from science direct data and website.

Then, decided the sub topic of every chapter. The planning of progress also was doing at this week. After that I had to write a letter to apply permission for use FKM lab for drawing and simulation using ALGOR software. The permission letter needs to be sent to person in charge that is Mr. Fazli bin Ismail.

Next, the progresses are to do the questionnaire for survey the idea and opinion from other people to attach into this project. From the respondent response I have to analyze the survey, three sketches to choose the best design for my FYP. The sketch shown to supervisor for further comment and advices regarding the sketch. I have to improve my sketching for better result and the drawing are made using SOLIDWORK 2006 software in FKM lab. After all the improvement is made I have to design a presentation slide to present my project in week 15.

Next, to proceed this project, first of all I have to decide the material that I am going to use, and then I have to decide the suitable motor for my project. Material selection will guided by Mr. Lee Giok Chui. Motor specification selection is guided by Mr. Fazli bin Ismail. They though me how to select the most suitable motor system to be installed in my wheel chair.

Finally, test is done on the selected drawing. The strength of the wheel chair is tested on critical part of the wheel chair which is the seating support and the front tire. The data gain is analyzed and there is some decision had to made that is whether to do the conclusion if the data is correct or roll back to previous stage to re-do the analysis. Conclusions are made directly from the gained data.

3.3 PROCESS FLOW

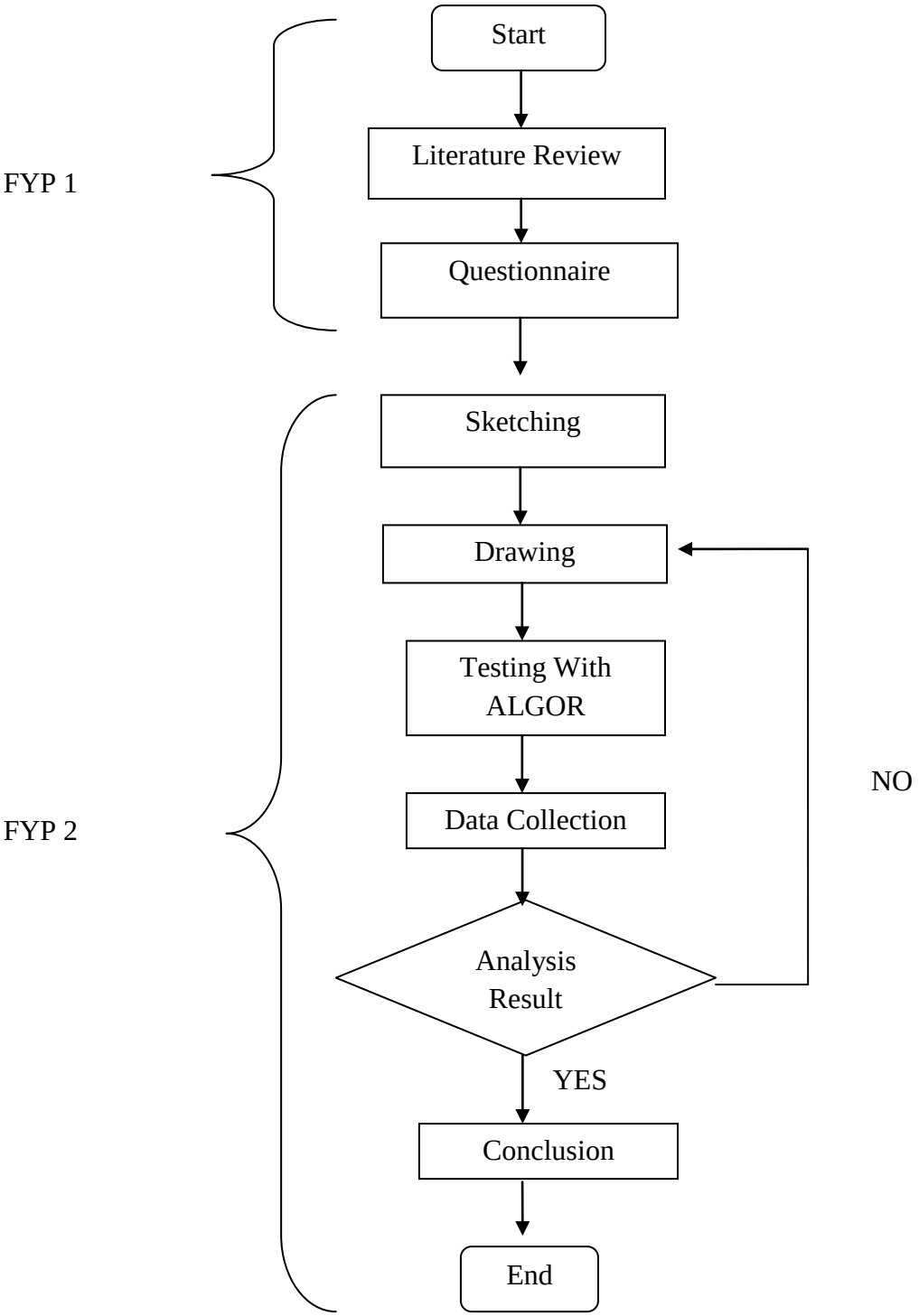

Figure 3.1: Flow Chart for Final Year Project.

3.4 DRAWING OF PRODUCT. (SOLIDWORK 2006)

Solidwork is the global standard in 3D mechanical design software. It helps organization to reduce time to market, design better quality product faster, maintain a competitive advantage, and increase the sales. Solidwork delivers powerful 3D design capabilities, unmatched ease of use, and an affordable cost. Solidwork software allows Autocad user to become rapidly productive using 3D mechanical design and 2D detailing capabilities of Solidworks as well as leveraging 2D legacy data.

Then, it also provides tutorials specifically develop for the Autocad user, using familiar terminology to help speed up the learning process. Solidworks provides a data migration wizard and innovative 2D to 3D tools that allow Autocad users to maintain their legacy data or build 3D models from 2D drawings. Before performing the Solidwork model, proper dimension of each component and part need to be measure accurately to avoid problem on the assembly part for this software application.

Figure 3.2: Solidwork 2006.

3.4.1 Simulation Process

The first step in simulation process is measurements of every body part need to be taken before transferring into 3-D model using Solidworks 2006. The wheelchair model is needed to be completely measured for the entire exterior part or component before do the 3-D model. 3-D model will be using in Algor software in order to do the stress analysis using simulation.

3.4.2 3D Modeling

Using data parameter from measurement, it is used in building the 3-D model of Wheelchair. The model is design using Solidworks software. There are exact samples of 3-D model of wheelchair in the internet. But the model provided cannot be use in Algor due to some geometric error problem. Then, using the dimension of the exact model, the new 3-D model of the body part was draw using Solidworks.

The new 3-D model is not much detail as the exact model since the bolt and screws hole will be neglected in this analysis. But, the critical part are front tire and seating bucket will be design precisely because that is the part that going to be analyze on this project.

Figure 3.3: The Exact 3D Model.

3.5 FINITE ELEMENT ANALYSIS. (ALGOR)

Finite element analysis (FEA) is a software which basically including the discipline of mathematics, physics, and engineering and computer science. The method has wide application and enjoys extensive utilization in the structural, thermal and fluid analysis areas.

The main advantages of FEA are numerous and important. A new design concept may be modeled to determine its real world behavior under various load environments, and may therefore be refined prior to the creation of drawings, when any changes will not involving any cost. Once a detailed CAD model has been developed, FEA can analyze the design in detail, saving time and money by reducing the number of prototypes required. Beside, FEA can be performed on increasingly affordable computer workstations and personal computers, and professional assistance is available.

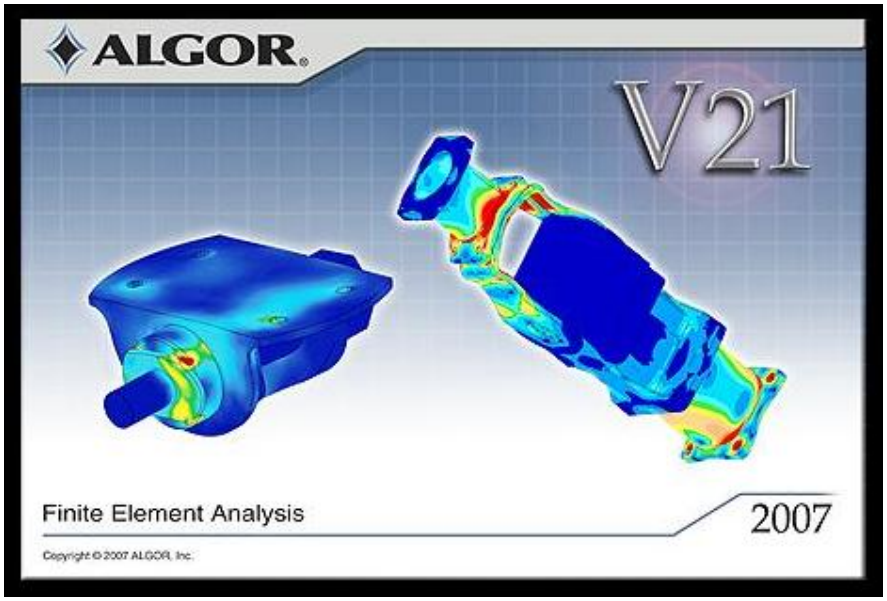

Figure 3.4: Finite Element Analysis. (ALGOR).

3.5.1 Mesh Setting

The mesh setting that used in this analysis is 70%. The front tire and supporting seating model was meshed with 25913 Tet-10 elements and 25819 nodes. The finer mesh size the better result will come out. But the finer mesh size needs a high performance computer to mesh the model. 70% mesh size was the best setting that gets from the operating computer.

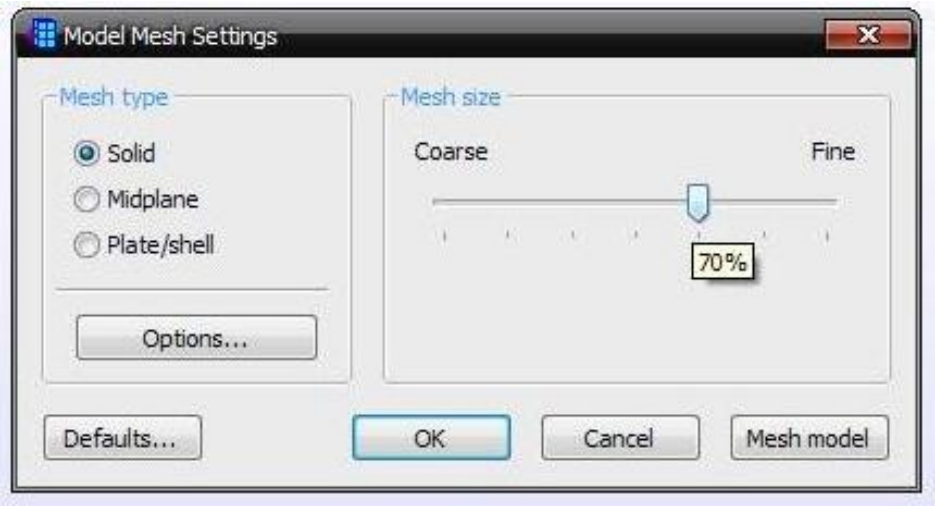

Figure 3.5: Model Mesh Settings

3.5.2 Defining Boundary Condition

The boundary conditions are different for each analysis. For linear static stress analysis, the boundary condition used is to represent the real operation environment of the front tire and supporting seating.

3.6 MATERIAL SELECTION

Material was likewise an important consideration when choosing part of wheelchair, because it determines how long the units will last and how strong the body part will be to endure the stress when the force was apply. Basically there are three types of material that usually used for this body part which is Steel ASTM A36, Aluminium SAE 2024 and Mild Steel AISI 1045. The suitability of each material has been selected based on this main table which is Strength-Density table and Young's Modulus-Density Table.

3.6.1 Steel ASTM A36

The Steel ASTM A36 has a density of 0.28 lbm/in³ is 7.8 g/cm³. Steel ASTM A36 almost shape in plates, bars, and with thickness of less than 8 inch or 200 mm has a minimum yield strength of 36,000 psi (250 MPa). The Ultimate Tensile Strength (UTS) of 58000 – 80000 psi (400–550 MPa). The plates thicker than 8 in have a 32,000 psi (220 MPa) yield strength and the same of The Ultimate Tensile Strength (UTS). The Steel ASTM A36 is a standard carbon steel then it's also without advanced alloying.

3.6.2 Aluminium SAE 2024

Aluminium SAE 2024 was alloys in which aluminium is the predominant metal. Typical alloying elements are copper, zinc, manganese, silicon, and magnesium. There are two principal classifications, namely casting alloys and wrought alloys, both of which are further subdivided into the categories heat-treatable and non-heat-treatable. About 85% of aluminium is used for wrought products, for example rolled plate, foils and extrusions. Aluminium SAE 2024 alloys yield cost effective products due to the low melting point, although they generally have lower tensile strengths than wrought alloys. Aluminium SAE 2024 are widely used in engineering structures and components where light weight or corrosion resistance is required. Aluminium SAE 2024 surfaces will keep their apparent shine in a dry environment due to the formation of a clear, protective oxide layer. In a wet environment, galvanic corrosion can occur when an Aluminium SAE 2024 is placed in electrical contact with other metals with a more

negative corrosion potential than aluminium. Aluminium SAE 2024 compositions are registered with The Aluminum Association. Many organizations publish more specific standards for the manufacture of Aluminium SAE 2024, including the Society of Automotive Engineers standards organization.

3.6.3 Mild Steel AISI 1045

Mild Steel AISI 1045 also called plain carbon steel is steel where the main alloying constituent is carbon. The AISI defines carbon steel as steel is considered to be carbon steel when no minimum content is specified or required for chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium or zirconium and other element to be added to obtain a desired alloying effect when the specified minimum for copper does not exceed 0.40 percent or when the maximum content specified for any of the following elements does not exceed the percentages noted manganese 1.65, silicon 0.60 and copper 0.60. The term “Mild Steel AISI 1045" may also be used in reference to steel which is not stainless steel in this use carbon steel may include alloy steels. Mild Steel AISI 1045 with low carbon content has properties similar to iron. As the carbon content rises, the metal becomes harder and stronger but less ductile and more difficult to weld.

In general, higher carbon content lowers the melting point and its temperature resistance. Carbon content influences the yield strength of steel because carbon atoms fit into the interstitial crystal lattice sites of the body-centered cubic (BCC) arrangement of the iron atoms. The interstitial carbon reduces the mobility of dislocations, which in turn has a hardening effect on the iron. To get dislocations to move, a high enough stress level must be applied in order for the dislocations to break away. This is because the interstitial carbon atoms cause some of the iron BCC lattice cells to distort. 85% of all steel used in the U.S. is carbon steel.

3.7 CONCLUSION

The all of the method of design and analysis is presented in this chapter. This includes the Solidworks 2006 software to draw the drawing and Finite Element Analysis (ALGOR) to analyze the critical part of the wheel chair. Then, the evaluation of the design and selected the suitable design to optimize. Lastly, the material selection of the critical part wheelchair on the product. Lastly, result and discussion for select the best design of critical part will be identified and discussed in the next chapter.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter discuss about the result obtained from the survey by using questionnaire. The objective of this chapter is to determine the final model of wheelchair and also its features. It also to analyze the distribution of static load that cause stress forces transmitted to the surface contact at the top of the chassis. The data was collected, analyzed and graphs are constructed.

4.2 ANALYSIS OF QUESTIONNAIRE

The questionnaire was distributed of student for two week. Every copies of the questionnaire were distributed to Universiti Malaysia Pahang (UMP) students and a handicap people in Pekan, Pahang for gathering information about product function for handicapped. After two week, there were 100 respondent was response to the questionnaire. For each question, the interviewee had to choose the best answer among the given answer.

In these questionnaires, there are 15question include objective and opinion question that ask people especially handicap people in order to get some information about the handicap life. Those questions are about the important of wheelchair to them, what the most wanted tools and the important handicap to do the daily life activities. The other question are about the suggest weight of handicap and the target user of that wheelchair.

4.2.1 Analyze of Gender.

From the survey, 54% of candidates are male, while 46% are female. It's shown at Figure 4.1.

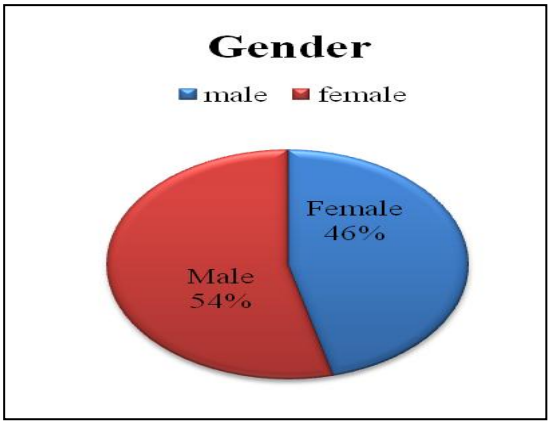

Figure 4.1: Gender of the Respondents.

4.2.2 Analyze of Important of Wheelchair to handicap.

From the survey, 52% are say the Important of Wheelchair for Handicap are useful, while 32% are is useful, 12% are less useful and just only 4% are unable to aid. It's shown at Figure 4.2.

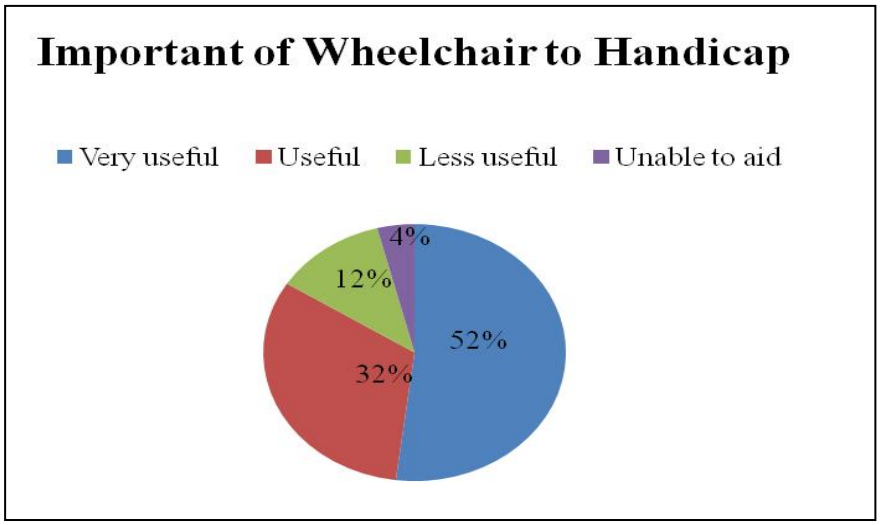

Figure 4.2: Important of Wheelchair to Handicap.

4.2.3 Analyze of Importance Handicap People to do daily activity.

From the survey, 48% are say the Important of Handicap to do the daily activities are needed, while 24% are less useful, 16% are very needed and just only 12% are unable to aid. It's shown at Figure 4.3.

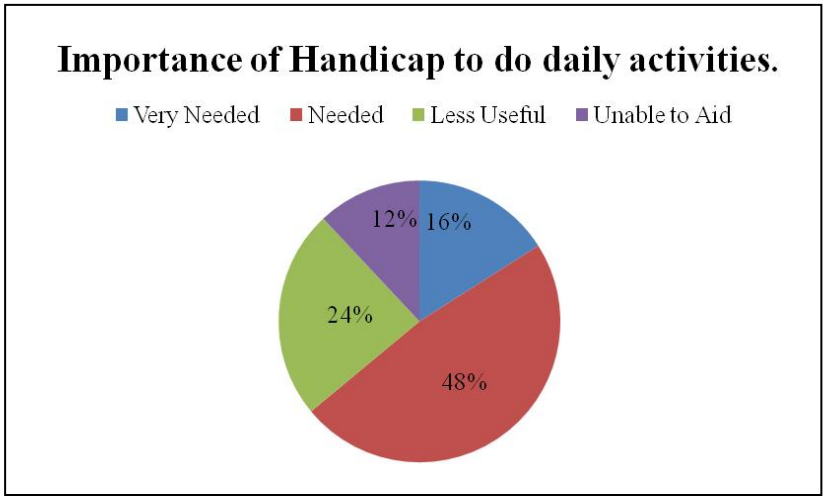

Figure 4.3: Important of Handicap to do Daily Activities.

4.2.4 Analyze the Target User

From the survey, 40% are say the target user are the handicap, while 26% are paralyzed, 18% are old folk and just only 16% are patient in hospital. It's shown at Figure 4.4.

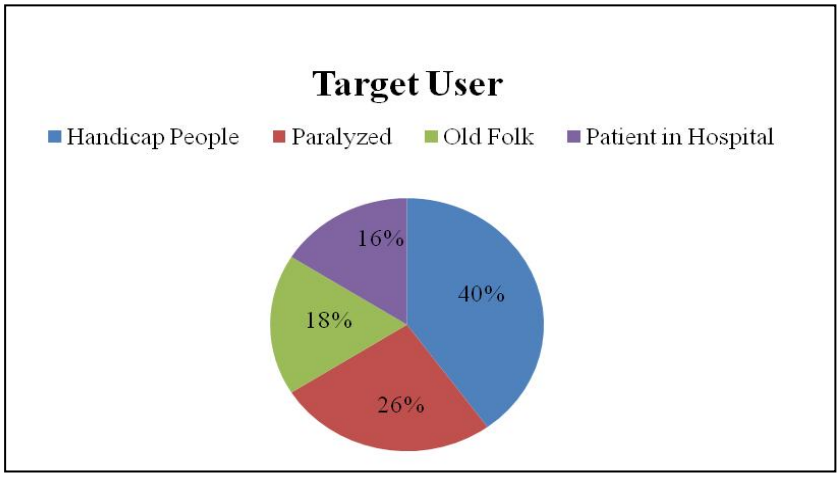

Figure 4.4: Target User.

4.2.5 Analyze the Most wanted Tool to add on Wheelchair.

From the survey, 44% are say the most wanted tools of wheelchair are motor system, while 30% are hydraulic system, 18% are storage compartment and just only 8% are comfortable seat. It's shown at Figure 4.5.

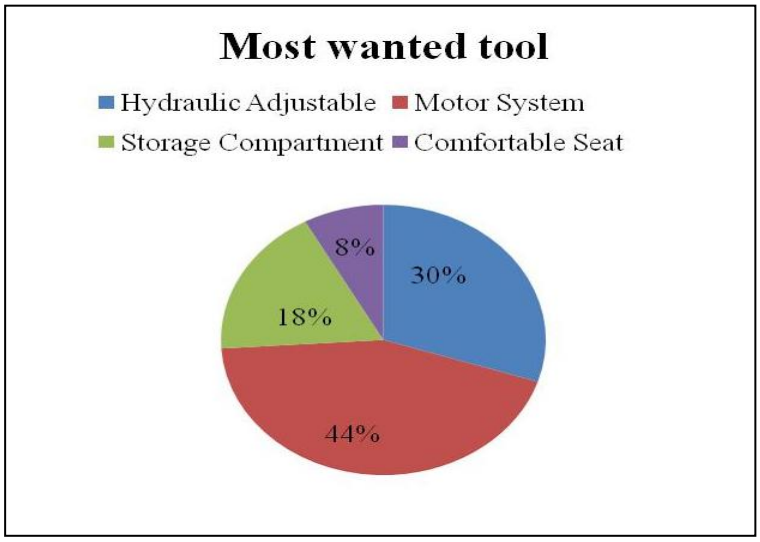

Figure 4.5: Most Wanted Tools.

4.2.6 Analyze the weight of Handicap.

From the survey, 40% are say the weights of handicap suggest are 61kg – 75kg, while 34% are 46kg – 60kg, 20% are 30kg – 45kg and just only 6% are over than 76kg. It's shown at Figure 4.6.

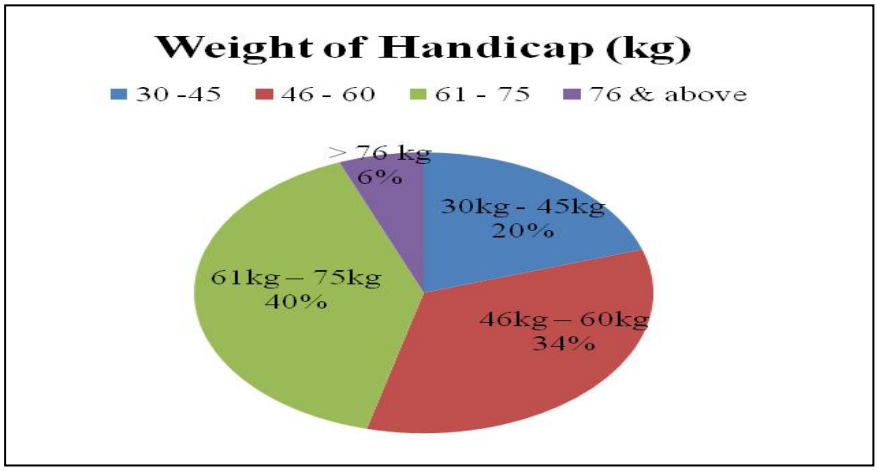

Figure 4.6: Weight of Handicap (kg)

4.3 DESIGNED WITH SKETCHING

The design criteria are based on the ease of maintenance, installation, cost and ease of use. After go through the brainstorming session, few design was constructed with simple sketching.

4.3.1 Design 1. (Type A)

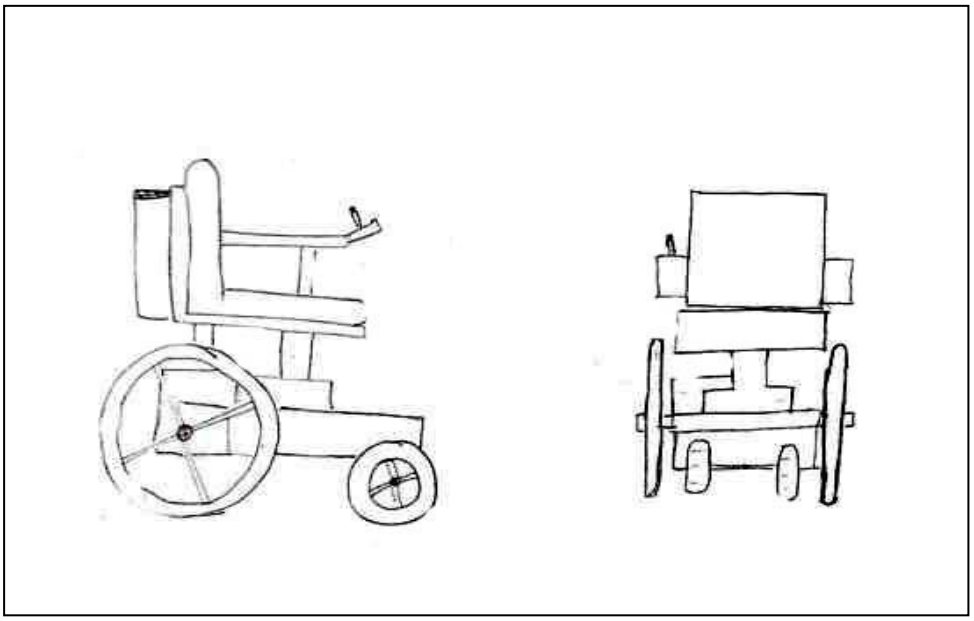

Figure 4.7: Wheel Chair Type A.

Firstly, based on the design 1 on Type A refer to Figure 1, the operation functional are working principle and main structure the device is designed for handicap purpose and its includes a AC motor, wheel, motor base, hydraulic system, storage battery for hydraulic and the luggage.

Then, the motor is used to move the wheel chair without using the additional human forced. By the way, hydraulic system is used for adjustable position upward and downward of wheel chair. Finally, the disadvantages of this product are the type of wheel chair is used big diameter of wheel, so that it had more power from motor to moving forward.

4.3.2 Design 2 (Type B)

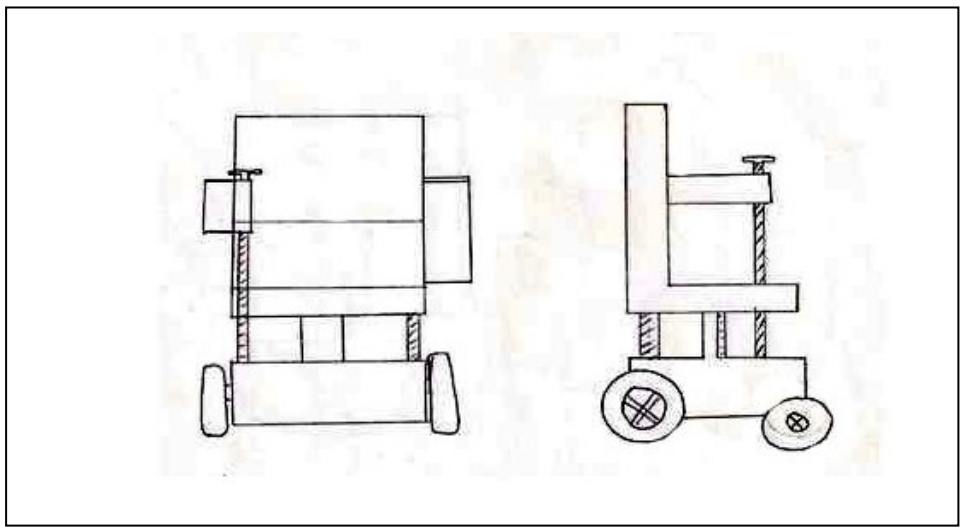

Figure 4.8: Wheel Chair Type B

Then, depends on the design 2 on Type B refer to Figure 2, the operation functional is using the adjusted same as using on the tent. The system is manually. Then the disadvantages of this product are handicap should adjust the high position of wheel chair manually.

4.3.3 Design 3 (Type C)

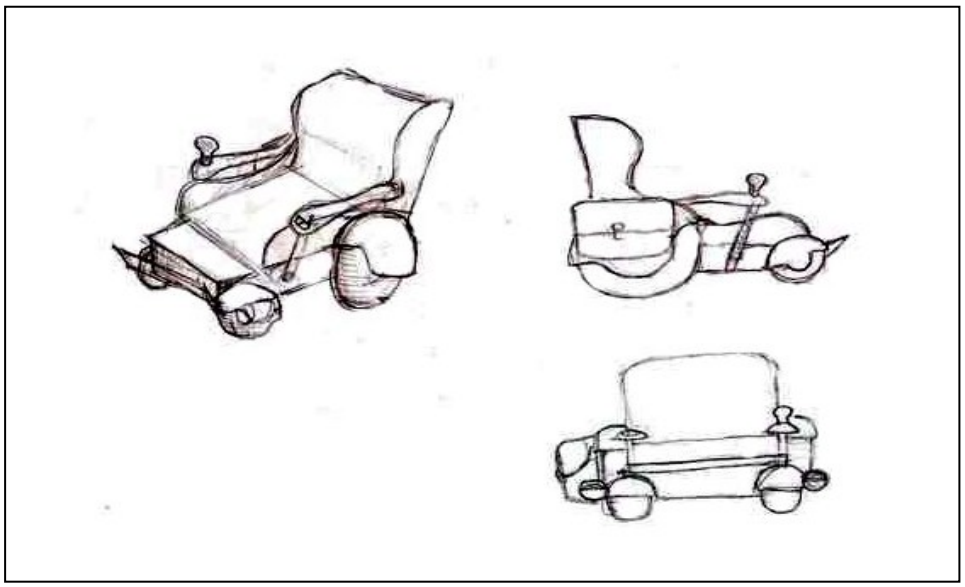

Figure 4.9: Wheel Chair Type C

For the third design of Type C refer to Figure 3, the operation functional is interest interested in comfortable usage for human. It is using the comfort seat and the luggage is placed on the side of wheel chair. Then, the disadvantages is about their weight of seat is so heavy because using the big and wide seat.

4.4 DESIGNED WITH SOLIDWORK 2006

The design criteria are based on the previous sketching and the analyze of questionnaire. After go through the brainstorming session, few design was constructed with the 3D drawing in Solidwork 2006.

4.4.1 Design 1

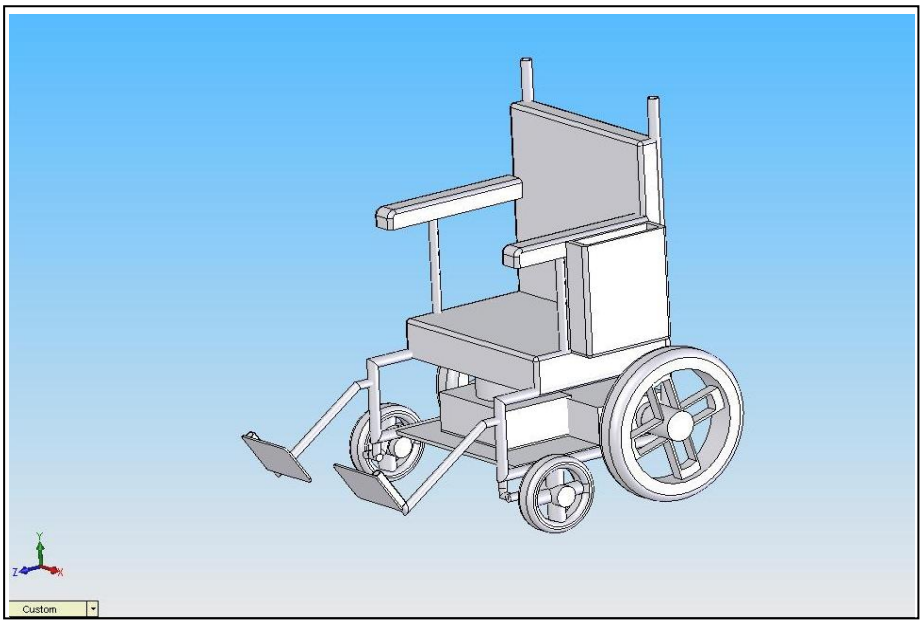

Figure 4.10: Design 1

Firstly, based on the design 1 in Figure 4.10, the operation functional are working principle and main structure the device is designed for handicap purpose and its includes a AC motor, wheel, motor base, hydraulic system, storage battery for hydraulic and the luggage. Then, the motor is used to move the wheel chair without using the additional human forced. By the way, hydraulic system is used for adjustable position upward and downward of wheel chair.

4.4.2 Design 2

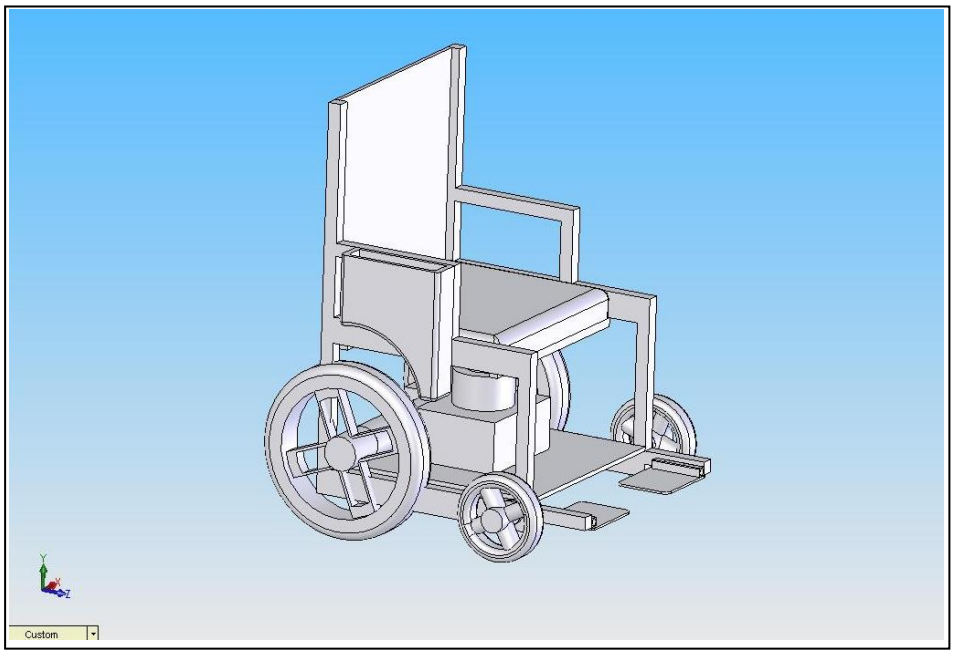

Figure 4.11: Design 2

For the second design on Figure 4.11, the operation functional is interest interested in saving for costing. It is using the plate as backrest and the part is not much or discomfort. The luggage is placed on the side of wheel chair.

4.4.3 Design 3

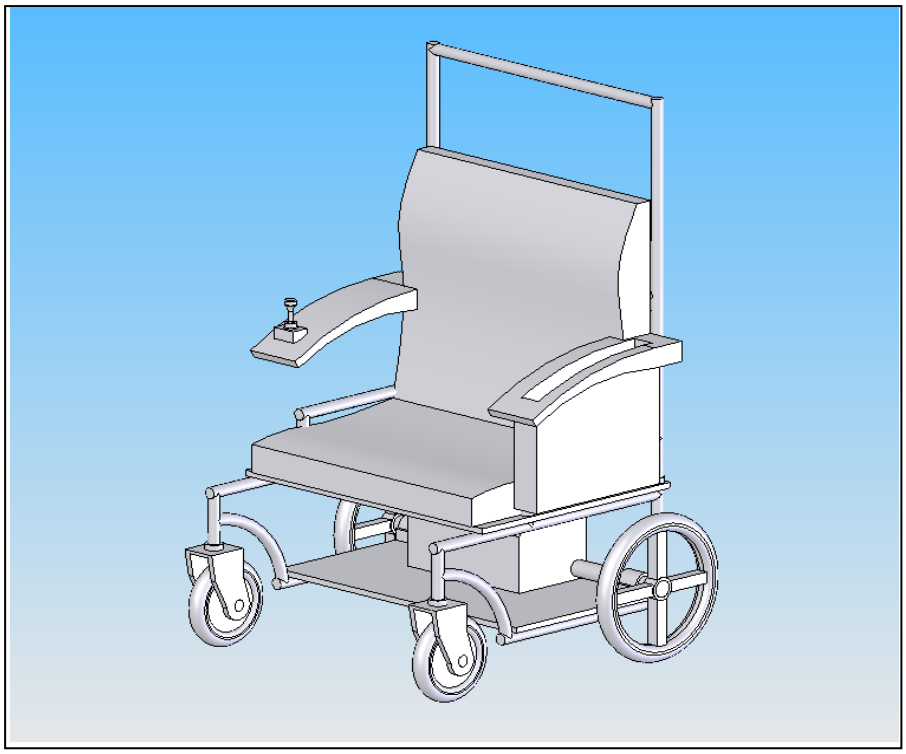

Figure 4.12: Design 3

For the third design on Figure 4.12, the operation functional is interest interested in comfortable usage for human. It is using the comfort seat and the luggage is placed on the side of wheel chair. Then, the motor is used to move the wheel chair without using the additional human forced. The operation functional is working principle and main structure the device is designed for handicap purpose properly.

4.5 SIMULATION USING ALGOR /FEA

There are two critical part was analyze on stress analysis for select the best design. Every part has three designs to compare with three different materials on stress analysis.

4.5.1 Stress distribution for Seating Support (Load 1200N)

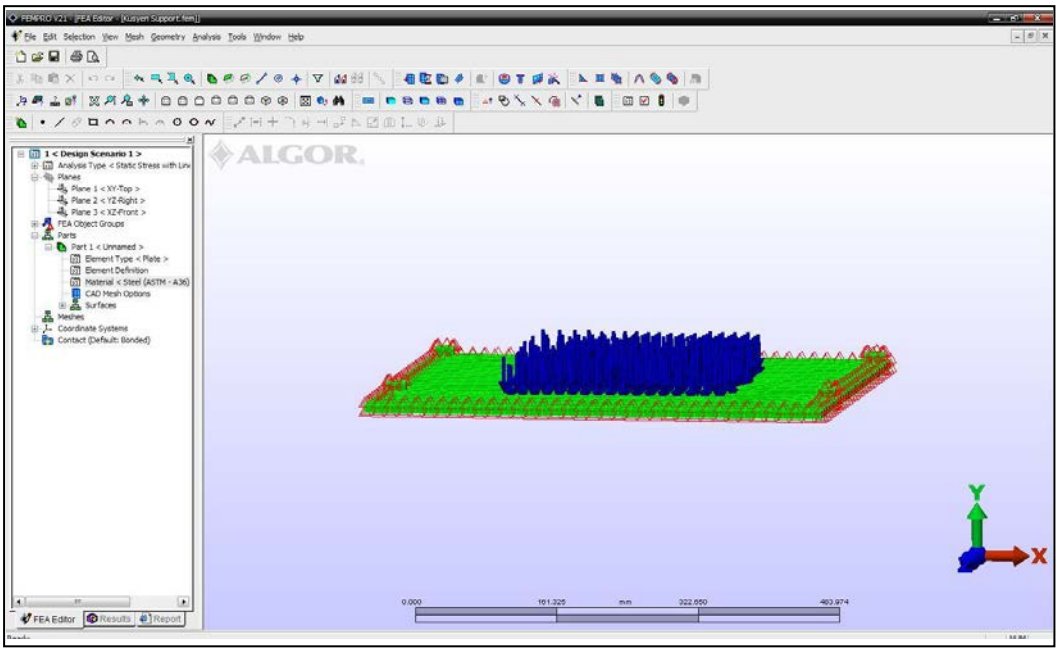

Figure 4.13: Testing on seating support

4.5.2 Analysis on Part 1 (Seating Support)

After do the finite element analysis in Part 1 (Seating Support), we obtain the suitable material to develop critical part of wheelchair. From that analysis, the Aluminium SAE 2024 was chosen because the maximum value for von misses stress is lower compare with Steel ASTM A36 and Mild Steel AISI 1045 it's depending by design 1, design 2 and design 3.

Table 4.1: Comparison between Designs depends on different material.

	PART 1 (SEATING SUPPORT)		
DESIGN MATERIAL	**DESIGN 1**	**DESIGN 2**	**DESIGN 3**
STEEL ASTM A36	**2127.311 N/mm^2**	**76.346 N/mm^2**	**94.266 N/mm^2**
ALUMINIUM SAE 2024	**2102.848 N/mm^2**	**73.637 N/mm^2**	**92.806 N/mm^2**
MILD STEEL AISI 1045	**2112.916 N/mm^2**	**75.196 N/mm^2**	**93.516 N/mm^2**

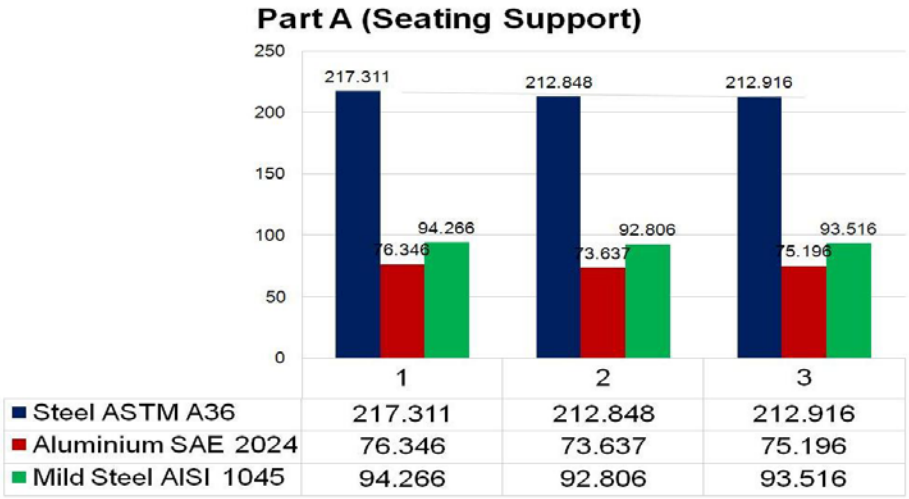

Figure 4.14: Graph Comparison between Designs depends on different material.

4.5.3 Stress distribution for Front Tire (Load 385N)

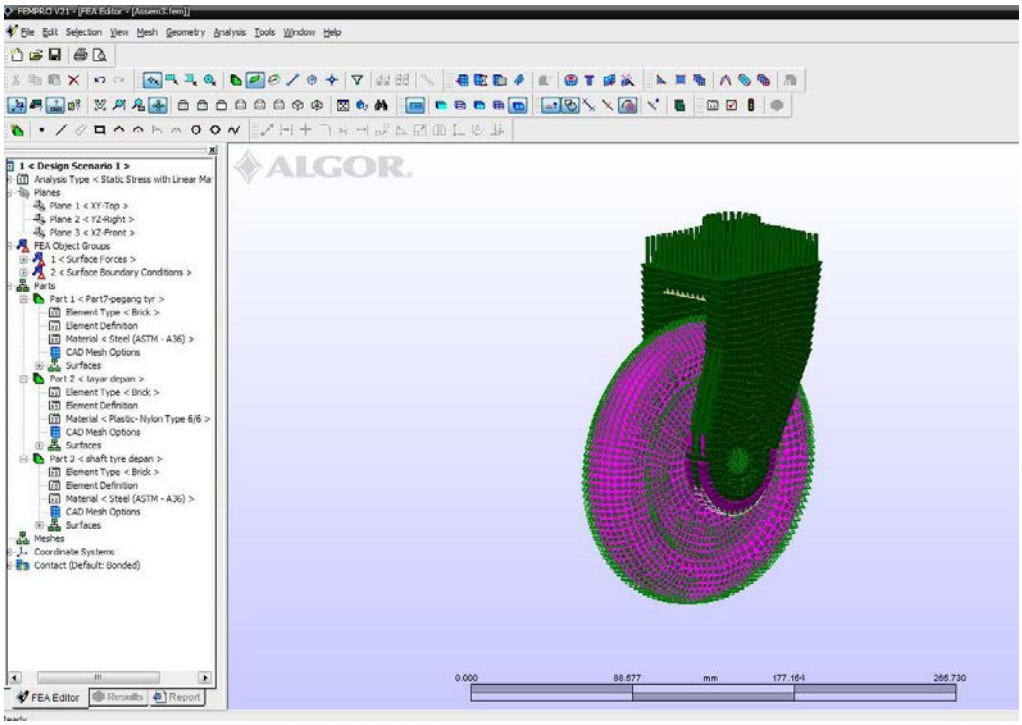

Figure 4.15: Testing on Front Tire.

4.5.4 Analysis of Part 2 (Front Tire)

After do the finite element analysis in Part 2 (Front Tire), we obtain the suitable material to develop critical part of wheelchair. From that analysis, the Aluminium SAE 2024 was chosen because the maximum value for von misses stress is lower compare with Steel ASTM A36 and Mild Steel AISI 1045 it's depending by design 1, design 2 and design 3.

Table 4.2: Comparison between Designs depends on different material.

	PART 2 (FRONT TIRE)		
DESIGN MATERIAL	**DESIGN 1**	**DESIGN 2**	**DESIGN 3**
STEEL ASTM A36	**47.893 N/mm^2**	**38.525 N/mm^2**	**294.9213 N/mm^2**
ALUMINIUM SAE 2024	**45.721 N/mm^2**	**37.541 N/mm^2**	**293.696 N/mm^2**
MILD STEEL AISI 1045	**47.142 N/mm^2**	**37.938 N/mm^2**	**290.655 N/mm^2**

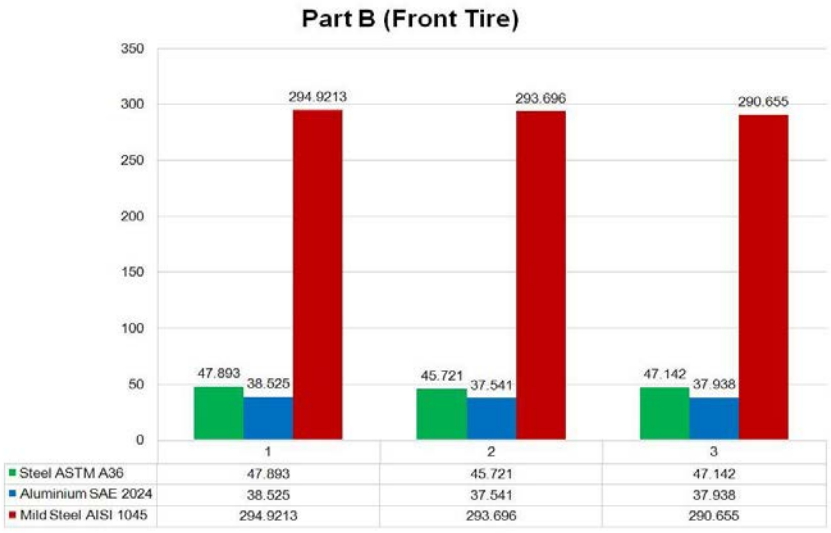

Figure 4.16: Graph Comparison between Designs depends on different material.

4.6 CONCLUSION

Three type of material are choose as a material for the part and the seating support. The materials are Steel ASTM A36, Aluminium SAE 2024 and Mild Steel AISI 1045. The force are applied to the plate are the total weight of average human being are 1200N on seating support and 385N on front tire. Stress Von Misses is the total force that acting in surface area. The maximum value of the plate of steel can support the force of 1568.638 N is 5.53948 N/ (mm^2). The maximum value of the plate of Aluminium SAE 2024 can support the force of 73.637 N/mm^2**.** The maximum value of the plate of Mild Steel AISI 1045 can support the force of 75.196 N/mm^2. This is mean the maximum value of stress by Aluminium SAE 2024 are lower than the Steel ASTM A36 and Mild Steel AISI 1045. So, to choose the perfect material are Aluminium SAE 2024 for the Design 2. This criteria also needs to consider such as weight, resistant to chemical, corrosion resistance. Aluminum are lighter than steel, have better thermal conductivity and also the aluminum have good corrosion resistance better than steel. The Aluminum provides greater structural strength.

Simulation result shows that the critical point of stress occurred at the Seating Support and the Tire. The stress is critical at this point because boundary condition was applied at that point. Since the fatigue failure started from highest stress point, it can be conclude that these critical points will probably failure.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter will discuss about the recommendation and the overall conclusion of the project.

5.2 CONCLUSION

Simulation result shows that the critical point of stress occurred at front tire and seating support. The magnitude of highest stress is critical because the value of numerical simulation is too much. Since fatigue failure started from the highest stress point, it can be concluded that this critical point is an initial to probable failure. Thus, it is important to take note to reduce stress magnitude at this point.

The minimum stress occurred on Aluminium SAE 2024 of the front tire and seating support on the chassis. The stress is biggest at this point because the critical stress that acting at the boundary condition is highest and also cause by the boundary condition at the critical part which is define as fixed.

For the very beginning, the objective and the scope of this project were focused on the stress that acting on front tire and seating support. From the above argument, the overall objective for this project had been achieved successful.

5.3 RECOMMENDATION

In order to improve the design of wheelchair for handicap people, more features should be added to the design concept for example hydraulic system and ergonomics factor of mechanism.

As the engineering design areas are highly developing in these day, application of design software is very useful. The Finite Element Analysis (FEA) and design software such as SolidWork, CATIA and AutoCAD should be widely recognizable to student as it very helpful especially in engineering design study.

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APPENDIX A1

Gantt Chart for FYP 1

APPENDIX A2

Gantt Chart for FYP 2