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THE DESIGN AND OPTIMIZATION OF STRUCTURE
BODY OF THREE WHEELED MOBILITY DEVICE
FOR PEOPLE WITH LOWER LIMB DISABILITY

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This report is submitted in accordance with requirement for the
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APRIL 2010

“I hereby declared that this thesis titled
‘the design and optimization of structure body of three wheeled mobility device for
lower limb disability people’ is the result of my own effort except as cited in
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What lies behind us and what lies before us are tiny matters compared to what lies within us. Huge thanks to my mom, dad, brothers and beloved one whom lie within me while completing this undergraduate project.

MOHD FAREEZ AHMAD
MALACCA
2010

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ABSTRACT

Projek Sarjana Muda is a compulsory project taken by final year student in the mechanical engineering field. The project touches on the design and optimization of structure body three wheeled mobility device for people with lower limb disability. It is an optimization to the design of current model of mobility device in the market place. By following the design process iteration, this project also considers the clinical guideline that shall be taking into the design specification of the mobility device. So that, a robust and convenient 3 wheeled mobility device could be produce for the people with lower limb impairment. The method used in preparing this project include the preparing of project mission statement, project outline, research, data analysis, product design specification (PDS), functional model analysis, concepts generation, metrics evaluation, concept selection, detail design, fabrication and software procurement, implementation and modification. Analysis on the body structural is done by using the CAE software and engineering theoretical calculation.

ABSTRAK

Projek sarjana muda adalah subjek wajib bagi pelajar akhir tahun dalam bidang kejuruteraan mekanikal. Projek ini menyentuh tentang rekabentuk dan optimisasi terhadap rekabentuk struktur tubuh peranti bergerak yang terdapat di pasaran sekarang. Dengan mengikuti dan melalui proses rekabentuk, projek ini juga mempertimbangkan garis panduan klinikal yang harus diambil kira dalam spesifikasi rekabentuk peranti bergerak ini. Oleh yang demikian, peranti bergerak 3 roda yang kukuh dan selesa mampu dihasilkan untuk golongan yang mengalami gangguan kurang upaya bahagian bawah badan. Kaedah yang digunakan dalam mempersiapkan projek ini termasuklah menyediakan pernyataan misi projek, garis rujukan projek, penyelidikan, analisis data, spesifikasi rekabentuk produk (PDS), analisis kefungasian model, penghasilan konsep, penilaian metrik, pemilihan konsep, rekabentuk yang terperinci, serta pelaksanaan dan pengubahsuaian. Analisis terhadap struktur tubuh peranti dilakukan menggunakan perisian CAE dan pengiraan teori kejuruteraan.

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LIST OF SYMBOL

T	=	thrust
σ	=	the bending stress
M	=	the moment about the neutral axis
y	=	the perpendicular distance to the neutral axis
I_x	=	the area moment of inertia about the neutral axis x
b	=	the width of the section being analyzed
h	=	the depth of the section being analyzed
σ_1	=	major principal stress
σ_2	=	minor principal stress
UTS	=	Ultimate Tensile Strength,
USS	=	Ultimate Shear Strength,
SYS	=	Shear Yield Stress,
TYS	=	Tensile Yield Stress
R	=	radius
A	=	cross section area
P	=	pressure applied
F	=	force applied

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CHAPTER I

INTRODUCTION

1.1 Project Background

A mobility device is a mechanism such as a wheelchair, a transfer chair (also called a convertible or stretcher chair), a sling lift, a sit-to-stand lift, a hobcart, or calipers, designed to aid individuals with mobility impairments. They can be either manually operated, or powered.

A wheelchair is a wheeled mobility device in which the user sits. The device is propelled either manually (by 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 (physiological or physical), injury, or disability. People with both sitting and walking disability often need to use a wheel bench.

Basic standard manual wheelchair incorporates a seat and back, two small front (caster) wheels and two large wheels, one on each side, and a foot rest.

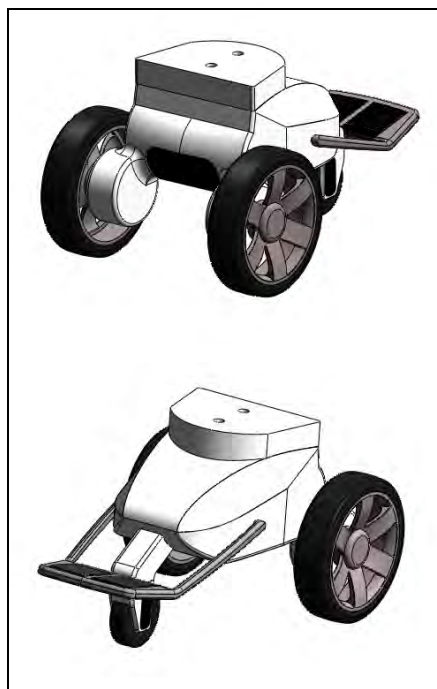


Figure 1.1: The current design of structure body of the three wheeled mobility device for with lower limb disability

Wheelchairs are often variations on this basic design, but there are many types of wheelchairs, and they are often highly customized for the individual user's needs. The seat size (width and depth), seat-to-floor height, seat angle (also called seat dump or squeeze) relative to the horizontal plane, footrests/leg rests, front caster outriggers, adjustable backrests, controls, and many other features can be customized on, or added to, many basic models, while some users, often those with specialized needs, may have wheelchairs custom-built.

Transport wheelchairs are usually light, folding chairs with four small wheels designed to be pushed by a caregiver to provide mobility for patients outside the home or more common medical settings.

1.2 Problem Statement / Definition

The structure body of the three wheeled mobility device need to design relating to the compartment inside the body including the operating automated systems and energy source to aid the individuals with mobility impairment.

- a. An aesthetic design need to be developed which is stable with the three wheels and has a robust design to withstand the total weight of the individual with the lower limb disabilities. The plug in compartment for the energy source must be easy to access and easy to reinstall by the user. It uses the propeller device to control the movement of the mobility device drive by the automated systems of motor. The structure includes the one small front (caster) wheels and two large wheels, one on each side, and a foot rest.
- b. This product development project is a derivative of existing current product platform.

1.3 Objectives

The objectives that needed to be achieved in this project are:

- a. To develop a conceptual body structure of existing 3 wheeled mobility device (WMD) design concept
- b. Optimize the body design by performing simulation analysis
- c. Producing detail design of the body structure.

In order to achieve objectives above, a prototype for structure body of the three wheeled mobility device is fabricated to prove that it is working. Some equations derived from literature review are used to determine and analyse the engineering calculation for this product. Product refinement and implementation are done repeatedly in order to solve the problems faced and improve the product.

The optimization for the mobility device will be done by several analyses by using the CAD/CAE software that available in market to archive the objectives stated above. Since this project involves the current design of mobility device, every single issue occurred on the conceptual design are determined early and redesign by follow the product development flow process.

1.4 Scope of Studies

A body structure of three wheeled mobility device for people with lower limb disability will be generated at the end of this thesis. Its design is based on the concept of electric seated mobility device and involves the mechanisms that ensure the stability, aesthetic value and functional mobility device.

Here are some scopes of study of the body structure of the three wheeled mobility device for lower limb disability people:

- a. To study on the body design and structure of wheeled mobility device (WMD)
- b. To produce ideas and develop conceptual structure body design of 3 WMD design concept that fulfill engineering design specification.
- c. Conduct critical design analysis using necessary tools to gain result.

1.5 Thesis Outline

This thesis contains all of seven chapters which is each section divided to several sub topic respectively. Chapter I introduced about the basic theory, problem encounter, also the main objectives and scopes of producing structure body design of 3 WMD design. In Chapter II of this thesis, the literature reviews and the characteristics for the existing mobility device is reviewed. Some derivation of equations that corresponding to the structure body analysis also stated in this chapter. Chapter III addresses the methodology that including design development process and data analysis from collected data and information for the implementation of this thesis until the design was verified. Continued on the Chapter IV is the configuration design for the 3D CAD detail design of the conceptual sketch. Next, on the Chapter V describes the result for finite element analysis and the analytical analysis done on the detail design. The summary and the discussion for the final design concept are briefly stated in the Chapter VI. The result of the analysis also will be discussed in this chapter. Last but not least, conclusions and recommendations for the whole project are presented in Chapter VII.

CHAPTER II

LITERATURE REVIEW

The reviews of the main ideas consist in this project is elaborated in this chapter. Every subtopic is discussed on the related background study of the mobility device itself. This chapter includes the explanation of type of mobility device existed and also type of lower limb disability. Engineering working principle also stated and the anthropometry guideline for the mobility device is included based on the research done by the Center for Inclusive Design and Environmental Access (IDEA) from the USA.

2.1 Introduction of Wheeled Mobility Device (WMD)

Firstly, it is better to give some review about the main ideas for this project about the general of wheeled mobility device. There is no common research or specified data that has been found relate to the mobility device with three wheeled mounted on the device. However, there are lots of electric scooters with controlling handle with 3 wheeled, but the design is more tend to bike scooter which is really different compare to the current conceptual design. Matching the style of chair to the activity and environmental characteristics is the next critical step (Minkel, J.L. 2005). Broadly speaking, there are three categories of products that are referred to as wheeled mobility devices: