DEVELOPING A MANUAL HAND PEDALING ELEVATOR FOR A WHEELCHAIR USER

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DECLARATION

I declare that this project report entitled "DEVELOPING A MANUAL HAND PEDALING ELEVATOR FOR A WHEELCHAIR USER" is the result of my own work except as cited in the references

Signature : ....

Name : SHAHER ABDULWAHUD AL-HATTAMI

Date : 7/27/2021

APPROVAL

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

Signature :. ....

Name of Supervisor : Dr. Shamsul Anuar bin Shamsudin

Date : ....

DEDICATION

To my beloved mother and father

ABSTRACT

An elevator is a type of vertical transportation that transports passengers or freight from one level to another in a tall building. The majority of existing lifts and elevators are powered by electric motors and supported by a counterweight connected by a series of cables and pulleys. Having an elevator can be life-changing for many people, especially for those with mobility issues which can assist them to move from one level to another with ease. However, elevators are still unavailable in some high rise buildings due to the high cost of it, which makes the wheelchair users face difficulties in moving between floors. This study is for designing and developing a manual hand pedaling elevator for wheelchair users, which will allow the users to easily elevate themselves to a higher level The invention accomplishes this through a mechanical mechanism of the compiling between compound gears and pulleys without using any external energy or motor, designed to provide fast performance and easier movement with extreme stability. This paper presents an overview of elevators and provides the mechanism analysis of each design. The report includes the selection of the best possible design for the wheelchair user based on several analyzed designs. The analysis was done with ANSYS and manual calculation to achieve the best results of the static and dynamic analyses.

ABSTRAK

Lif adalah jenis pengangkutan menegak yang mengangkut penumpang atau barang dari satu tingkat pencakar langit ke tingkat yang lain. Sebahagian besar lif yang ada digerakkan oleh motor elektrik dan disokong oleh timbal balik yang dihubungkan oleh rangkaian kabel dan takal. Mempunyai lif boleh mengubah hidup banyak orang, terutama bagi mereka yang mempunyai masalah mobiliti yang dapat membantu mereka bergerak dari satu tingkat ke tingkat yang lain dengan mudah. Tetapi lif masih tidak wujud di beberapa tingkat bangunan yang tinggi kerana harganya yang tinggi, yang menjadikan pengguna kerusi roda golongan yang menghadapi kesukaran untuk bergerak dari lantai A ke lantai B. Kajian ini adalah untuk merancang dan mengembangkan lif manual kayuhan tangan untuk pengguna kerusi roda yang akan membolehkan pengguna dengan mudah mengangkat diri ke tahap yang lebih tinggi. Penemuan ini dapat dicapai melalui mekanisma mekanikal dengan penyusunan antara gear kompaun dan takal tanpa menggunakan tenaga luaran atau motor, yang direka untuk memberikan prestasi pantas dan pergerakan yang lebih mudah dengan kestabilan yang tinggi. Laporan ini memberikan gambaran umum mengenai lif ini dan memberikan analisis mekanisma bagi setiap reka bentuk. Kajian ini dirancang untuk memilih reka bentuk yang terbaik untuk penguna kerusi roda berdasarkan reka bentuk yang dianalisis. Analisis telah dilakukan dengan ANSYS dan pengiraan manual untuk mencapai hasil terbaik meliputi analisis statik dan dinamik.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

An elevator is a vertical transportation to carry passengers or freight from one level to another in a skyscraper. Most of the existing lifts/elevators are powered by electric motors and supported with a counterweight linked by series of cables and pulleys. By providing an opportunity to the high buildings, the elevator has played a key role in developing the character of many modern cities that plans to play an indispensable role in future growth. The process of lifting loads by mechanical methods during construction operations goes back to Roman times; in the 1st century BC (Britannica et al. 2019), the Roman architect-engineer Vitruvius described lift platforms using pulleys and caps or windlasses powered by human, animal, or water control. Steam power had been introduced to such machines in England by 1800. Elisha Graves Otis introduced the first safety contrivance for elevators in 1852 (Meda, Gudukeya, and Mbohwa, 2020). Otis started up a company for the manufacture of elevators and proceeded to dominate the elevator field. Otis Elevator Factory is today the world's largest supplier of vertical transport systems. Motor technologies and methods of regulation developed rapidly, and the agreed source of power soon became electricity.

Having an elevator can be life-changing for many people, especially for those with mobility issues which can asset them to move from one level to another with ease. But elevators still don’t exist in some high levels of buildings due to the high cost of it, which makes wheelchair users, people face difficulties in moving from floor A to floor B. By designing a manual elevator, it is supposed to be making life easier for wheelchair users. The Verti-walk requires riders to manually propel themselves vertically with pedaling using their arms (Frieling et al. 2016), without the need for fuel or electricity which will lead to decreasing the cost of elevators to be more affordable with less space. However, some researchers have been made to power manual elevator which requires riders to manually propel themselves vertically using their arms and legs. A vertical rowing motion needs to be carried out by the user. They will slightly change their weight back and forth by balancing themselves between a footplate and a seat to help carry themselves up to various floors. This is going to be difficult for wheelchair users due to the requirement of using legs.

1.2 PROBLEM STATEMENT

Universiti Teknikal Malaysia Melaka is a Malaysian public technical university located in Durian Tunggal in Melaka city. Fakulti Teknologi Maklumat dan Komunikasi (FTMK), is 3 levels building located on the main campus of UTeM and contains 2164 undergraduate students, 210 postgraduate students, and 132 academic staff. This very large number of students and staff are not able to use elevators to go for classes, Unfortunately, wheelchair users are facing a serious problem due to the unavailability of vertical transportations. Developing a manual elevator for wheelchair users to make it easier for them to attend classes on the high floors.

1.3 OBJECTIVE

The objectives of this project are as follows:

1. To design a manual pedalling elevator for wheelchair users by using Solidworks.
2. To calculate and minimize the effort required to lift a body.

1.4 SCOPE OF PROJECT

The scopes of this project are:

1. To develop a manual hand-cranked pedalling elevator for wheelchair users.
2. The design should be made with SOLIDWORKS software.
3. The results of force are required to pedal the crank.
4. The results of the total deformation and equivalent stress.
5. The experiment should be done using simulation.

1.5 THEISI ORGANIZATION

This thesis consists of five chapters. Chapter 1 is the introductory chapter that introduces the inspiration for the research, the problem statement, the aims, the nature of the study, and the overall thesis.

The literature review of relevant studies concerning the thesis is presented in Chapter 2. The design concept of the elevator since the beginning of the invention to the modern elevators. As well as the mechanism of gears along with pulleys. Review of published papers related to the project. The aim of this chapter is to give criteria for choosing project components.

Chapter 3 presents the methodology of the design, which are the mechanism of the design, the house of quality, and components that will be designed by Solidworks software.

Chapter 4 presents the simulation analysis of the gears and brake system using Ansys, also by using manual equations. The obtained data and results will be shown and analysed in this chapter.

Finally, Chapter 5 The concluding chapter is here. The chapter summarizes the work completed during the entire project. Recommendations and directions are also outlined for future research work.

CHAPTER 2

LITERATURE REVIEW

This part will discuss the literature review related to the concept of the elevator and its history along with its procedures. Types of elevators, a briefing about the history of pulley and wheel gears, a wheelchair will be discussed also along with the requirements of the disabled people.

2.1 Types of Elevators and Developments

Since the 1800s, elevators have not changed much. The original goal of moving people through floors is still maintained by elevators. In most elevator types, the Otis Safety Mechanism is used since the 1850s. Therefore, modern elevators have been improved in the control system, speed, and safety, nevertheless, most elevators still contain counterweight as a load to stay balanced and reduce the weight to be lifted.

As table 2.1 shows that five different types of elevators are being used at least till now. Firstly, hoist (lifts) in the twentieth century, there were no automatic elevators that will let the cab stops itself or even raising. And these elevators are usually controlled by bulling ropes with a rheostat or manually controlled power such as human power, animal power, or waterpower. On Sept. 2, 1969, the study was made on a self-operated elevator which is being controlled by one-manpower and scaffold with a work platform from which a cage stretches upward. A winch is installed on the cage and, for vertical movement of the elevator, a cable stretches upwards from the winch to a cage support member as shown in Figure 2.1 (Eleator et al. 1969).

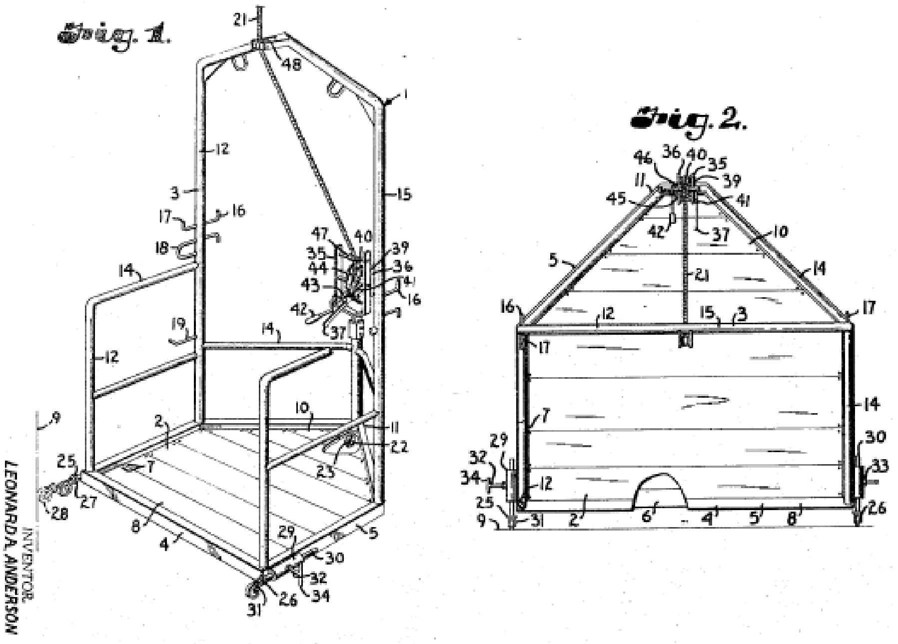

Figure 2.1 Self-Operated Elevator

Traction Elevator has two categories as shown in table 2.1 and Figures 2.3, It is divided into two different categories, geared and gearless traction elevators. Geared traction is powered by using a DC or AC motor connected with a worm gear that helps to control the elevator by just rolling it, supported in a gearbox housing by a pair of tapered roller bearings, one end of which projects out of an opening in the gearbox housing and is connected to the engine. The motor end bearing assembly is protected by a retainer ring against the axial motion, which is secured in a groove in the gearbox casing, and a dynamic seal, also secured in the housing, seals the motor end the worm shaft. To pre-load the bearings to a predetermined level, the cap bears against the bearings at the other end of the shaft. In this way, without affecting the pre-load environment, the dynamic seal can be replaced. Walker said that by putting bearings at opposite ends of the gearbox housing in openings that are wide enough to allow the worm shaft to be removed from either end. The arrangement simplifies the output of the gearbox and reduces the time and parts required for the dynamic seal to be replaced as shown in Figure 2.2, (Formation et al. 1995). Whereas, the engine spins the gear train that rotates the sheave in a geared unit. For medium-speed applications, geared traction devices are used which have powerful velocities from 0.5 m/s to 2.0 m/s or from (100 fpm) to (400 fpm). the speed of freight is slower than the speed that usually being used in mid-rise buildings between 10 floors or less (A. Bhatia et al. 2012).

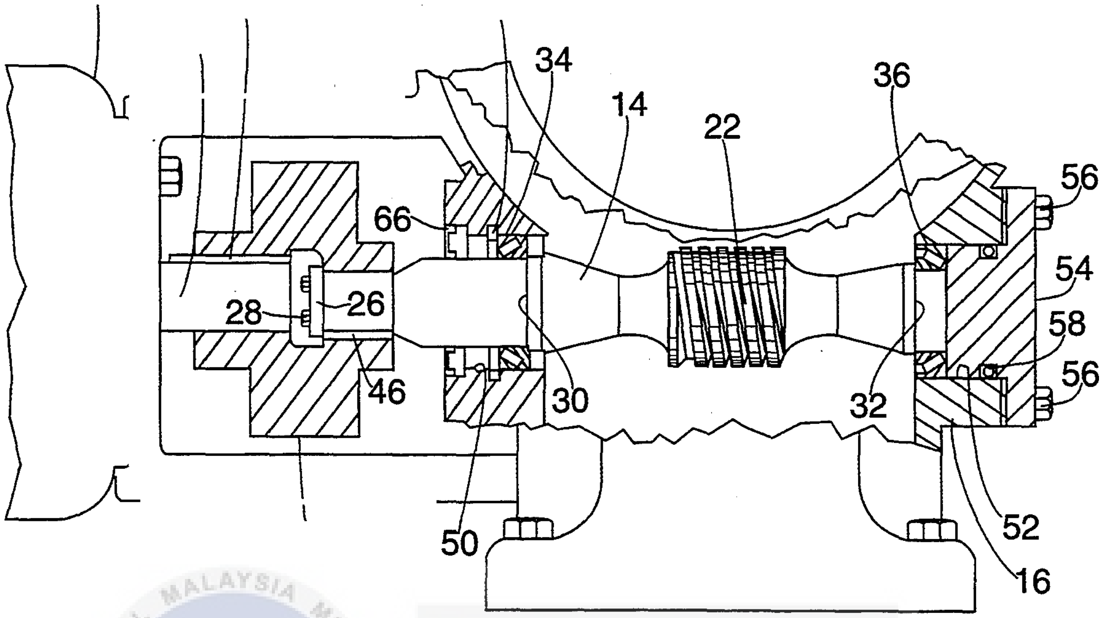

Figure 2.2 Geared Elevator System

While the gearless is like the geared traction but with less speed due to that, the sheave is directly connected to the end of the AC or DC motor causing a decrease in the speed, which reaches 20 m/s. Therefore, the pattern of modern elevators has been the constant magnet direct-drive traction system. Due to low costs, lift traction machines prefer using incremental low-resolution encoders as a position and velocity input device. A weight-transducer less it is proposed to prevent the presence of elevator car rollback for the gearless elevator installed with an incremental encoder with a general resolution, based on off-set free model predictive control, starting torque strategy (Wang et al. 2015). For high-speed goals with arrange of effective speeds from 2.5 m/s to 10.0 m/s, gearless traction elevators are listed (2000 fpm). On taller buildings of more than 10 floors, these are commonly used. The gearless drive has no gear transfer loss in terms of energy performance, so it has a transmission efficiency of 100% (A. Bhatia et al. 2012). The difference between geared and gearless traction elevators is that due to friction, the gear train can lose some energy and the transmission efficiency of the geared elevator is thus inferior to the gearless system.

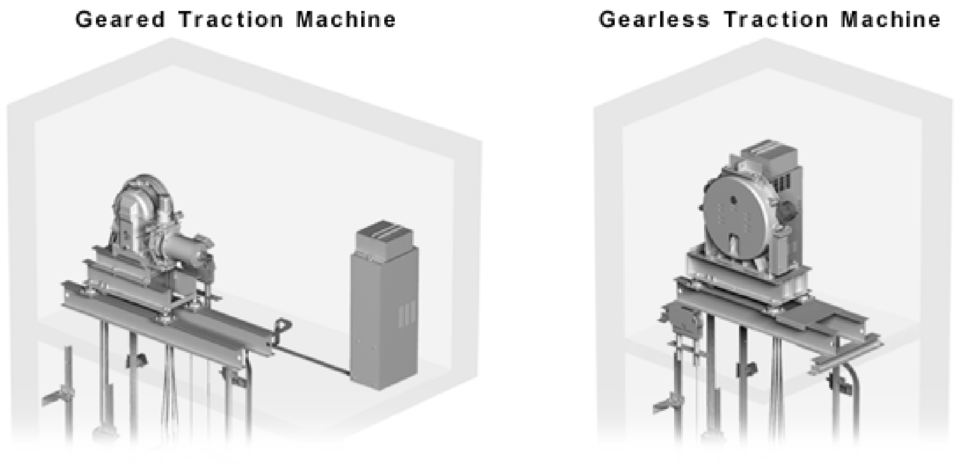

Figure 2.3 Geared and Gearless Traction Machine

Table 2.1 shows that Hydraulic Elevator is divided into three categories Roped, conventional, and hole-less. Roped hydraulic elevators have a hydraulic jack in a roped hydraulic elevator whose upper end, ideally, the plunger end, is fixed to the upper elevator hoist area and whose lower end is free to travel vertically. The lower end of the jack is supported by a first sheave, and at least one overhead sheave in the upper hoist way area is supported. One end is secured to the hoist way at the top of the hoist way by a rope. Around the first sheave, the rope stretches backward, upward from the first sheave to the overhead sheave, and downward from the overhead sheave to the vehicle, where it is locked. Preferably, the lower end of the said jack is protected by a counterweight. Often, one or two guide rails and guide shoes are preferably used to guide the lower end and counterweight jack motions. The elevator is relatively simple and a 2:1 ratio of car movement (Wulff et al. 2000). Jack movement is created by the roping method, which enables the use of a shorter jack or, instead, a higher range of vehicle travel as shown in Figure 2.3.

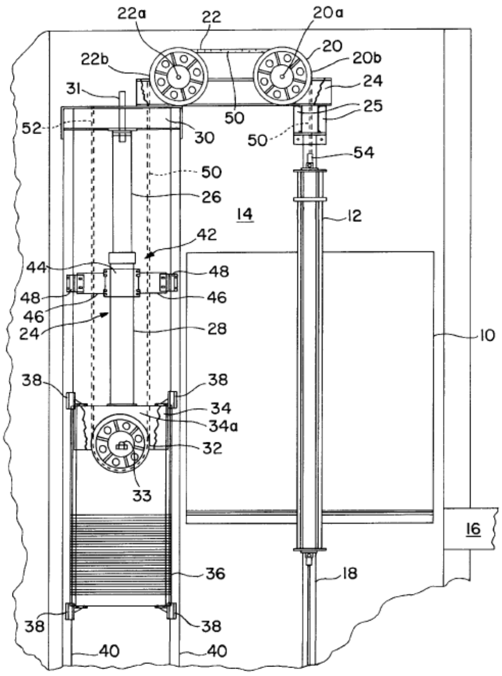

Figure 2.4 Roped Hydraulic Elevator

The second category is the conventional hydraulic elevator. It is developed with an elevator; it comes with a sheave that stretches under the pit floor. The pit supports a retracting piston as the elevator continues to fall. A traditional hydraulic elevator may need a shallower hole beneath the pit in certain setups that accepts a collapsing telescoping piston when the elevator drops. 60 feet is the estimated distance it will fly. As well as since the safety system uses electronically controlled variable flow solenoid valves, as paired with mechanical safety devices that have also been used in traditional hydraulic elevators, it is remarkable quickly in reaction and highly stable. But in conventional hydraulic elevators, the greater the dropping energy of the elevator has converted into heat and increased (Galliger et al. 1985).

Lastly, in the hydraulic elevators is hole-less hydraulic elevator. Holed hydraulic is also known as direct-acting elevators, as shown in figure 2.5. It is mounted on a piston that runs within a cylinder. The cylinder reaches a depth equal to the height to which the elevator would lift into the building. When hydraulic fluid is pumped through a valve into the cylinder, the car rises. The car descends as the fluid returns to the tank. Hole-less hydraulic elevators it is a piston installed inside the hoist way to go up or down. It helps bedrock blocks and buildings, a high-water table, or places with unstable soil conditions that can make it impossible to dig the hole needed for a traditional hydraulic elevator. Where the direct-acting elevators plunger lifts the car directly at a 1:1 ratio of plunger-to-car movement (Mitsubishi, 2021).

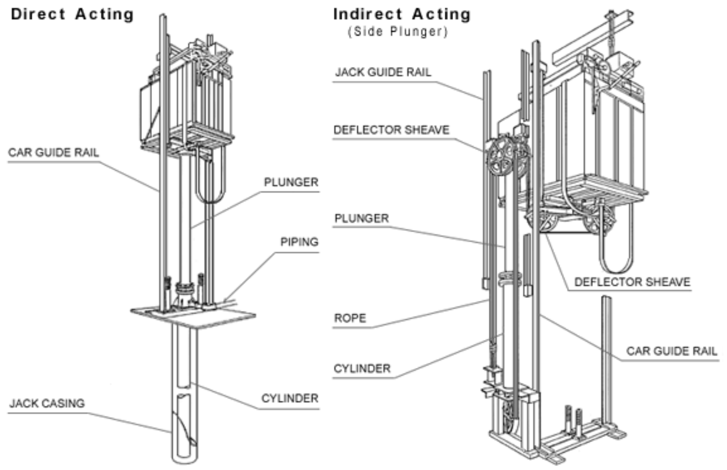

Figure 2.5 Direct And Indirect Acting Lifts

Machine-Room-Less (MRL) Elevator is an elevator that contains a room above the elevator for maintenance inquires as shown in Figure 2.6. A system fitted in the override room has this type of elevator, and it can only be reached from the top of the elevator car if maintenance is needed. For mid-rise buildings, Machine-Room-Less elevators are gaining popularity because they save electricity and take less space during construction. The installation of Motor Room Less (MRL) elevators has been the most critical advancement in the recent history of elevators. The bulk of MRL solutions are gearless technology based. Traditionally, the sheave, engine, and control system are all located in a machine room above the elevator shaft in motor room setups, but the equipment is mounted in the elevator shaft itself in MRL elevators. The invention and implementation of permanent magnet (PM) device technology in the lift motor, which decreased the size of the motor by up to four times, made this possible. A 6.5kW motor used in an MRL setup, for instance, can accomplish the same role as a typical 16.8kW traction engine. Technical advances, such as increasing the armature winding density in the PM and applying its own patented joint-lapped core, further decreased the dimensions of the engine