

Design and Development of Hydraulic Chair for Handicapped Person

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Abstract: Wheelchairs are still the best form of mobility for many bedridden peoples. However, wheelchair for bedridden people is always sold at very high price. Apart from that, they're also not innovative enough. We decide to design, and build cheaper, yet feature rich wheelchair for bedridden. We make sure this product is useful, safe to use, ergonomic, and cheaper than the current one in the market. A new concept of having hydraulic system to adjust the height of the wheelchair is to address the issue of ergonomic current design. In this wheelchair we use the hydraulic jack for lifting, wheels for transfer from one location to another location and also frame of wheel chair manufactured from mild steel materials having high strength and seating arrangement is foldable.

Keywords: Hydraulic chair, Transfer device, Jack

I. INTRODUCTION

The word "bedridden" is derived from the Middle English term *bedridden*, which is the past tense of the bed, dating back to the 14th century. *Bedridden* is a fixed form of sitting that cannot move or even stand upright. Unlike bed rest, bed rest is a non-invasive treatment that is usually part of rehabilitation or restricted mobility. Some of the more serious consequences of being bedridden were the high risk of thrombosis and muscle wasting. A wheelchair is a chair with wheels, used when walking is difficult or impossible due to illness, injury, old age related problems, or disability. These could include spinal cord injuries (Paraplegia, Hemiplegia and Quadriplegia), broken leg (s), cerebral palsy, brain injury. Osteogenesis if needs of imperfect A.K.A. brittle bones, motor neurone diseases (MND), multiple the specific sclerosis (MS), muscular dystrophy (MD), Spine bifida, and many more.

Wheelchairs come in a wide variety of formats meet their users. They included with specialized seating adaptations, individualized controls, and may be specific to particular activities, as seen with sports wheelchairs and beach wheelchairs. The most widely recognized distinction was between powered wheelchairs, where propulsion is provided by batteries and electric motors, and manually propelled wheelchairs, where the propulsive force is provided either by the wheelchair user/occupant pushing the wheelchair by hand ("self-propelled"), by an attendant pushing from the rear using handle(s), or by an attendant pushing from the side use a handle attachment. There are many forms of wheelchairs to meet the specific needs of users. They included special seat adjustments, personalized controls, and may be specified to specific activities, such as sports wheelchairs and beach wheelchairs. The most widely recognized difference is the difference between an electric wheelchair and a manual wheelchair. Electric wheelchairs are powered by batteries and electric motors, while manual wheelchairs provide propulsion by the wheelchair user/occupant pushing the wheelchair by hand. As for bedridden people, there are also a specific type of wheelchair for them, it usually a manual type wheelchair.

II. PROBLEM STATEMENT

When mobility challenges make independently moving between chairs, beds, wheelchairs or toilets difficult or even impossible to complete safely, this hydraulic wheelchair make patients and caregivers safer and more comfortable from one place to another. Moving bedridden patients is a common task for nursing staff and one of the most demanded responsibilities for the body. Nursing assistants lose work days due to musculoskeletal injuries, and the rate is five times that of other industries. Auxiliary patient transportation equipment can protect caregivers from excessive force injury caused by improper or excessive weight lifting, and ensure patient safety during the transfer process.

III. RESEARCH OBJECTIVES

The objectives to this research are:

- ❖ To design a new generation of wheelchair which it will be able to disintegrate and split specifically to ease the movement of bed ridden patients?
- ❖ To create the safe to use adjustable wheelchair.
- ❖ To fabricate the useful wheelchair with the affordable price.

IV. RESEARCH STATEMENTS

Due to the fact that we need to gather opinions from the public about wheelchair for bedridden patients, these questions have been asked in the form of Google Forms as a survey so that we would be able to collect the data required.

- ❖ Have you ever experienced sitting on a wheelchair due to any forms of sicknesses or injuries?
- ❖ Do you have any relatives who are paralyzed and have to sit on a wheelchair?
- ❖ Is it difficult to transfer a bedridden individual from the bed to the wheelchair?
- ❖ Do you agree that changes should be made to the current design of wheelchair to ease the mobilization of the occupants of wheelchairs?
- ❖ Give a suggestion for modifications that can be applied to the design of current wheelchair.

V. SCOPE OF RESEARCH

Hydraulic wheelchair is specifically fabricated to help patients and caregivers to be safer and more comfortable from one place to another. The scopes and limits to this research are:

- ❖ Hydraulic wheelchair can reduce the pain experienced by patients while moving.
- ❖ Hydraulic wheelchair facilitates the caregiver from using a lot of energy when helping the patient

VI. SIGNIFICANCE OF RESEARCH

The studies were explained about the wheelchair in general and its relation with bedridden patients and nurses. All the objectives were conceived out of all the problem statements. The main objective that was focus more on this project is wheelchair with hydraulic system to solve problem of ergonomics and we make sure this wheelchair would help as a transfer patient device for bedridden patients.

This has been an issue for long time for nurse because transferring bedridden patients is not an easy task. Issues and the scope of this project was only be focusing more on the design of the wheelchair how it help nurses and patients itself during session. Thus, this new prosthetic could be beneficiary to not just nurses, but also peoples with bedridden family member as we make it cheaper than the average market price which is now very high.

VII. LITERATURE REVIEW

The World Health Organization defines a wheelchair as "a device provides wheeled mobility and seat support for the disabled it's difficult to walk or move around." Therefore, the wheelchair is to improve personal mobility. The purpose of the wheelchair the design is to produce good performance and can provide proper seat and posture support without compromise strength, durability and safety. The government can do these authorities, manufacturers, engineers, designers, service provider and users perform their respective design responsibilities. The design of wheelchairs is very different, and diversity should be considered user requirements with design functions, such as total length, weight, frame type and width, seat configuration, wheel and caster type, arm and footrest, axle position and propulsion mechanism, all have affect the function.

To ensure that the wheelchair is suitable, Designer & provider must thoroughly understand the expected demand Users and their environment. According to the design of Visagie et al. (2015). The function must match the user's functional ability and posture support needs, as well as requirements for the environment and durability claim. Realize the ideal match between the user and the wheelchair design and environment can be both difficult and important. When there are multiple models to choose from, it can best meet the needs of users which one to choose.

The design of the wheelchair should enable its users to use it participate in as many activities as possible. At least, wheelchairs should enable users to lead a more active life without have a negative impact on their health or safety. Comfort and safety, these are two important factors that affect the quality of life of long-term users.

VIII. METHODOLOGY

Methodology is the study of the methods that are employed. It is concerned with uncovering the practices and assumptions of those who use methods of different kinds. In fact, a methodology is a system of methods followed consistently. Scientists, for example, use various methodologies as they perform experiments. It might seem like the world was nothing but chaos and disorder. But actually, sometimes there is a method to this madness and sometimes there's a methodology. As the main part of this chapter, we will be showing the processes, methods, details and information throughout the journey of ours in the making of the Hydraulic wheelchair. Throughout this chapter, there will be a flow chart, the sketching of the design of the product, and a Gantt chart showing our weekly progress. Besides that, materials selection, fabrication, cost of materials and operation methodology would be shown as well in this chapter to provide in depth information about the product.

IX. CONSIDERATION OF WHEEL CHAIR

The purpose of wheelchair design was to produce a wheelchair that performs well and was able to provide a height - adjustable seat and appropriate postural support without compromising strength, durability and safety. The health and safety of users should never be compromised in order to reduce costs. A wheelchair should be designed to ensure the user's safety and health. There are many ways in which users can be injured by their own wheelchairs, as illustrated by the following examples:

- ❖ A wheelchair without a cushion or with an inadequate cushion can cause pressure sores. This in turn may require the user to spend many months in bed; without appropriate care and treatment this often leads to bedsores, secondary complications and even premature death.
- ❖ Unstable wheelchairs can tip and lead to users falling and injuring themselves.
- ❖ Wheelchairs that are too wide or are unduly heavy can cause shoulder injuries.
- ❖ Sharp edges on surfaces can cause cuts that in turn can lead to infection.
- ❖ Poor design can result in places on the wheelchair where the user or others can get their fingers or skin pinched.
- ❖ Wheelchairs that cannot endure daily use in the user's environment may fail prematurely and can injure the user.
- ❖ Strength and durability: Wheelchairs used outdoors are subjected to greater wear and tear than those designed for indoor use or use on smooth roads and paths. A wheelchair must be strong enough not to suffer a sudden failure while being used. The wheelchair should be built to have the longest possible useful life and require the fewest repairs. A wheelchair should be designed so it can be repaired near the user's home if it fails, and replacement parts should be easily available.
- ❖ Suitability for use: Wheelchairs should be appropriate for the environment in which they will be used and for the specific people who will use them. One wheelchair design will not suit everyone. When designing or selecting wheelchairs, it was necessary to think about the environment and the way in which the wheelchair may be used.

X. CONSTRUCTION AND WORKING

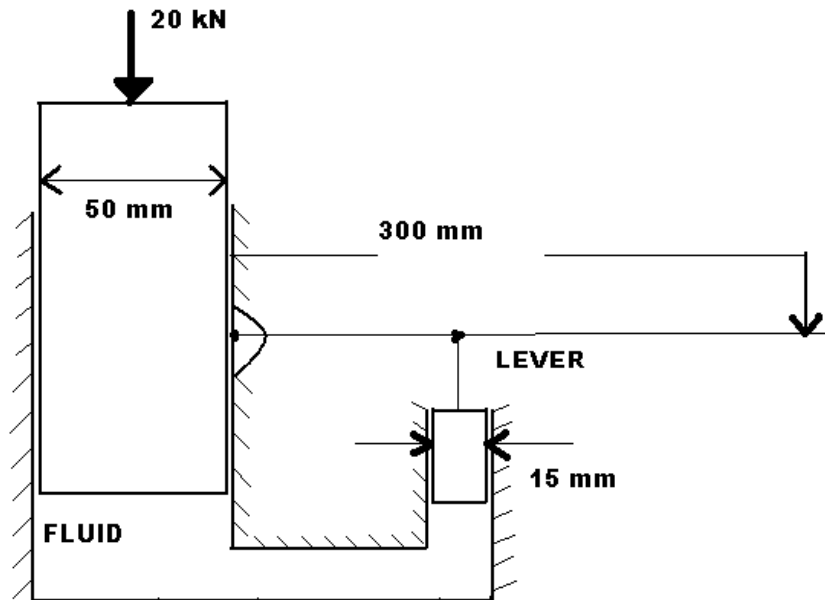


Figure: Block Diagram of wheel chair

XI. HYDRAULIC JACK WORKING & DESIGN

Hydraulic jacks transmit a small mechanical force through one small hydraulic cylinder to a large hydraulic cylinder. This results in a large mechanical force exerted by the larger cylinder (due to Pascal’s principle which states that the pressure in a closed system is the same everywhere). This model uses a hand pump to power the smaller hydraulic cylinder. A circular pipe transmits the hydraulic liquid from the smaller cylinder to the larger cylinder, with a check valve to prevent backflow. The larger cylinder lifts a load. The mass of the load can be changed to investigate the pressures generated in the hydraulic system for applying load lifting the vehicle by hydraulic Jack hand is operated with separate pumping unit and is wiper motor. This Jack is portable and available in various capacities. The pumping unit is connected to the hydraulic jack by means of a rigid connecting flat 0.5 meter long. The approximate lift of the ram is 90 to 120mm. the pumping unit is a single plunger type with detachable handle. But is modified by replacing a flat. The unit is fixed on a metal frame base which is fastened with supporting bars. A pressure release valve is provided on the pumping unit. The load is indicated on piston of hydraulic jack with rise in its mean level.

A hydraulic jack consists of a handle cum lever of 30 cm length and an assembly of given dimensions. In order to that a load of 20 kN be supported by the jack, what should be the force exerted on the handle? The distance between the fulcrum of the lever and the point where the plunger is connected is 25 mm.



Area of cross section of the large piston = $\pi d^2/4$
 $= \pi \times (0.05)^2 / 4$
 $= 0.0196 \text{ m}^2$

Pressure of the hydraulic fluid under the piston should be such as to balance the force applied on the piston.

$P = \frac{20 \times 10000}{0.0196}$
 $= 10.18 \times 10^6 \text{ Nm}^2$

By Pascal’s law of pressure is transmitted undiminished in all directions. The pressure at the bottom of the small piston must be $10.18 \times 10^6 \text{ Nm}^2$.

The force exerted on the small piston must be $= (P \times \pi d^2/4) \text{ N}$
 $= 10.18 \times 10^6 \times \pi \times 0.015^2 / 4$
 $= 1800 \text{ N}$

The force desired to be exerted at the handle of lever should be
 $F = 1800 \times \frac{300}{25} = 21600 \text{ N}$

Torque Required

T = Torque =? Nm

P = Power = 17 watt

N₁ = at low speed = 60 rpm

N₂ = at high speed = 120 rpm

$$T = (P) \div (2\pi N_1)$$

$$T = (P \times 60) \div (2\pi N_2)$$

$$T = (17 \times 60) \div (2 \times \pi \times 60)$$

$$T = 2.78 \text{ Nm}$$

The torque obtained will be maximum at the lower speeds. Hence the same is adopted. Hydraulic Jack plunger actuation length = 28 mm.

XII. ADVANTAGES & DISADVANTAGES**Advantages and disadvantages:**

We believe that each advantage can bring benefits and assistance to those who are using it. Hence for the disadvantages, this is where improvements must be made so that the product will be more reliable and accountable for its user in the future.

12.1. ADVANTAGES:

This wheelchair is able to disintegrate or split on the mainframe which made mobilization of occupant would be much easier & this wheelchair can lift up & down smoothly.

12.2. DISADVANTAGES:

The disadvantages of this wheelchair are that it is too heavy due to the material used to build the wheelchair. Hence, improvements must be made on the material selection in the future so that the product can be lighter and portable

XIII. RESULT DISCUSSION

This chapter, we will explain about the results and findings from the product testing. Based on the data and analysis obtained, we will discuss about the improvements and changes that can be made to this product in order for it to be more reliable, user-friendly and last longer.

13.1. DISCUSSION:

With references and observations made on the data obtained, the first improvements that should be made to this product is the material of the mainframe. Though the mainframe we selected is strong which can support heavy load, it cannot be deny that it made the structure of the wheelchair is too heavy. This causes the wheelchair to be not portable and it is difficult for the occupants to bring this wheelchair whenever they are travelling. So, other material such as stainless steel which is lighter and stronger can be considered as alternatives to the current material. This can ensure the future wheelchair is more portable and user-friendly. The next improvement that should be made on this wheelchair is the lifting mechanism. Bearings should be added to the cylinder so that it can last longer, lift smoother and more durable. The current features on the wheelchair have the probability to go wear as there are frictional force between the cylinder and the mainframe. The next improvement is that we can install electric motor on the wheelchair. With that, the power will be generated by the motor and the occupants will no need to use their own force to move the wheelchair. This can of course bring convenient to the occupants.

13.2. CONCLUSION:

Through this project, it helps develop creativity and critical thinking among us in figuring out solutions to any problems. Problems related to existing projects can be solved through some modifications and fabrications applied to the current design. Innovations made on Hydraulic Wheelchair are not just convenient to the bed ridden patient to move, but also to the guardian. The 'split' feature on the wheelchair will ease the guardian to assist the bed-ridden patient to sit on the wheelchair. The lifting feature also will make it easier for the guardian. The process would save a lot of time and energy compared to last time. There is still room for improvement which can be added to this project to make it more effective, durable and user-friendly. This project has a big potential in market and should be commercialized for advanced research and development.

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