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Design and Fabrication of Stretcher cum Wheelchair

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Abstract *:* Mobilityaids are useful for disabled patients for transportation and a replacement for walking especially in indoor and outdoor environment. Wheel chairs and stretchers are the most commonly used medical equipment for the transportation of patients. Transferring the patients from wheelchair to stretcher or to the bed is always an issue for the patients and for the attendants as well. This may even results in musculoskeletald is orders to those who are not trained to do soespecially, when it comes to the caretakers. So there is a need for a wheelchair cum stretcher to facilitate the disabled patient's mobility and to provide novel medical equipment for use in the Indian hospitals

Keywords: Electricity Mobility aid, Ratchet mechanism,Wheelchair cum stretcher

1. Introduction

A wheelchair is a wheeled by mobility device designed especially for disabled individuals. The device is propelled either manually or via various automated systems. Wheelchairs are used by that people for whom walking is impossible due to some problems physiological or physical. Huge amount of people have congenital disabilities, so the percentage of the victim of accidents and that is the inevitable part of their life. Mobility scooters for more severe disability or longer journeys are used. Mobilizing or shifting of patient from wheelchair to stretcher or vice versa causes discomfort. With the help of this wheelchair cum stretcher a patient can be seated on wheelchair on which he can also be operated by converting it to stretcher also it will be convenient for hospital staff to move a patient, also it will be easy if we provide a electrical system to control the overall movement and functioning of stretcher cum wheelchair. Understanding various issues regarding mobility equipment, the better design will be an asset for medical field and helping hand for disabled individual. The present project proposes a development of wheelchair cum stretcher with ability to transfer patients from normal staircase also with automated electronic control over stretcher cum wheelchair for movement and functioning. Self-proceed wheels invention was created enormous demand in the market and it was better helping aid for the disabled individuals. These will be one of the walking aids which can help with impaired ability to walk using wheelchairs for the disabled peoples.

2. Literature survey

A wheelchair is chair with wheels, designed to help the disabled individuals. Stretchers are mobility devices used to transport the patients from one place to other. These both medical mobility aids are used in hospitals and clinics for helping the patients. Stretchers are simple in construction and the patient needs the support of an assistant to transport from one place to other. Whereas wheelchair is designed in such a way that either patient can control the device manually or with the help of someone's assistance.

According to Peter Axelson[1], selection of an appropriate wheelchair will lead a comfortable living to the user. Performance, safety and dimensions are the three categories which have to be considered while selecting a manual or powered wheelchair. An excellent approach to the wheelchair selection is to set priorities based on user's mobility and seating needs. It is highly recommended that a novice can consult with there habilitation specialists in order to select the appropriate wheelchair.

James Kauzlarich [2], says self excited vibrations one of the most interesting topics in the field of vibrations and is the science prevailing caster wheel shimmy. Self excited vibration is characterized by vibration that is produced by the motion of the system like wheelchair speed. It can be observed that in most of the cheapest wheelchairs, the design of the casters makes use of a sliding frictional damper in the spindle support to improve the shimmy characteristics. Understanding the theory of damping for the casters show how shimmy prevention works in ultra-light and powered wheelchairs.

Richard Simpson [3], studied almost 10% of all individual who are legally blind also have a mobility impairment and majority of these individuals are dependent on others mobility. A smart power assistance module (SPAM) for manual wheelchair is being developed to provide independent mobilityfor this population. The power assist wheelchair that provides for obstacle detection and avoidance for those with visual

impairments.The control of the wheelchair will be carried out by the microprocessor and also allow the SPAM to provide a smoother and advanced control.

According to Rory Cooper [4], rehabilitation is a humanistic profession. Measurement of the user and wheelchair are critical to achieving maximum functional mobility. He says Biomechanics and ergonomics provide the information necessary to understand many aspects of wheelchair use. These factors affect seating comfort and posture, propulsion, efficiency and pain. Proper seating is an important aspect of wheelchair selection, and wheelchair cushions provide pressure relief and some postural support.

Daniel Jolly [5], proved proper preparation should be taken before transferring the patient from wheelchair to bed or vice versa. Use of sliding boards will be helpful for paraplegic patients. The best sliding board is made of hard wood, smooth, tapered on ends. Support of two assistance, support straps, belts etc will facilitate easy transfer. The patient should not be slide into chair, lift from the wheelchair and transfer is the optional and safety method for patient transfer.

Amos Winter, [6], discussed following the mechanical principles will be helpful for a better design. Understanding the centre of gravity location is important in wheelchair design. Weight should be the other important factor for wheelchair design. Reducing weight will results the comfortable use for the user and also lowers material cost. The best strategy is to maximize the strength and minimize the weight of the frame tubing. Calculating the moment of inertia and weight results the best strength and can be used to make the strongest frame at the least weight.

DebkumarChakrabarti [7], says primary consideration should be given for comfort, so that people can sit for long time without feeling any physical discomfort. Considering the suitable materials for seat surface, frame and can makea comfortable seating for the design. Without considering the ergonomics and application can make a diverse effect to the user. Seat cushions are so important in the design of wheelchair.

3 Working principle

The working of wheelchair convertible stretcher is so simple that the patient feels comfortable during the transformation from wheelchair into stretcher and vice versa.

- In operation when the wheelchair is to be converted into stretcher the operation starts with rotating the ratchet lever. The lever is connected to the backrest with radial spring.
- After rotating the lever, the gear in the seat back recliner mechanism un-meshes and due to the weight on the backrest it will gradually lower down. This will convert the wheelchair into the stretcher.
- Now if we have to convert the stretcher into wheelchair, again rotating the lever of the seat back recliner mechanism. By applying light load on the back rest, the backrest will also rise up till its original position.

The main components used to fabricate the model are:

- Ratchet mechanism
- Armrest
- Backrest
- Leg support
- Seat cushions
- Tires
- Caster tire

3.1 Ratchet Mechanism

A ratchet is a mechanical device that allows continuous linear or rotary motion in only one direction while preventing motion in the opposite direction.Ratchets are widely used in machinery and tools. Though something of misnomer, “ratchet” is also often used to refer to ratcheting socket wrenches.

3.2 Armrest

Armrest is places to rest your arms when you are not moving. They can be wraparound, full-length or desk-length, fixed or height-adjustable, removable or flip-back. Fit is important because armrest position can alter the way you propel your wheelchair. Many individuals choose not to have armrests because they don’t like the way they look or they get in the way of propulsion.

3.3 Backrest

Sling backrests are the most common, but provide little postural support. Adjustable tension backrests can provide more support and can be adjusted over time. Rigid backrests provide the best support, but may make it more difficult to collapse the chair. The weight and height of the backrest are important. In general, the

lighter the better, with carbon fibre backrests being a nice option. If support is not needed, a lower backrest is better as it does not get in the way of pushing.

3.4 Leg Support

Leg support is the place where it support your legs in wheelchair. They can be fixed, and folded.

3.5 Seat Cushions

Cushionscome in a huge and ever-changing array of different types and materials and comprise a major topic unto itself. While pressure relief is an important consideration when selecting a cushion, you should also keep in mind that you want a firm base and a light-weight cushion. A firm base refers to feeling stable, not sliding on the cushion when reaching for an object or propelling your chair.

3.6 Tiers

Tires are most commonly air-filled (pneumatic) and therefore lightweight. They also require maintenance and can puncture. If you maintain them, this is usually the best choice. Pneumatic tires may instead be filled with solid foam inserts; these won't puncture but are slightly heavier and don't perform as well. Solid tires are low-cost and no-maintenance, but make for an uncomfortable ride and are not usually recommended.

3.7 Caster Tier

The caster tier provides the contact between the caster and the ground. Tire materials vary from solid plastic to Pneumatic. The firmer the material the greater the maneuverability, the softer the material the more cushioned the ride.

4 Design specification and calculation

The design specifications and calculations of wheelchair is shown below:

4.1 Design Specifications of Wheelchair

The design specification is given in the below TABLE1.

Table1. Design specification

Componetns	**Material**	**Dimension**
Backrest	Mild steel Square pipe (3/4")	Width-46 cm Length- 91 cm
Seating Portion	Mild steel Square pipe (3/4")	Width-46 cm Length-56
Leg support	Mild steel Square pipe (3/4")	Width-46 cm Length- 46cm
Wheels (big)	Aluminum alloy	Diameter- 66 cm
Wheels (small)	Plastic	Diameter- 12 cm
Ratchet	Stainless steel	Diameter- 15 cm Width- 5 cm Teeth- 40 nos.

4.2 Load Calculations

Human weight consideration for calculating load is given in the TABLE 2.

Table 2. Human weight considerations

Different Part of Human Body	**Weight In (%)**	**Weight of Human Body Parts (Kg) (If we suppose weight is 80 KG)**
Trunk (Chest, Back and Abdomen)	50.8	40.64
Thigh	9.88	7.904
Head	7.30	5.84
Lower leg	4.65	3.72
Upper arm	2.7	2.16
Forearm	1.60	1.28
Foot	1.45	1.16
Hand	0.66	0.528
Others	20.96	16.768

The following are the load calculation according to the TABLE 2.

- Load on front casters

Weight of body : W = 23.25 Kg
= 228.08 N
Weight of frame: W_f = 10.3845
Inclination angle : $\theta = 10^0$
Force $_{front\ (vertical)}$:F_{fv} = Weight of body+ Weight of frame
= 347.12 N
Force $_{front\ (incline)}$:$F_{fi} = F_{fv} \times \cos\theta$ (1)
= 341.84 N

- Force on each caster

Force : $F = \frac{F\ vertical}{2}$ (2)
= 170.91 N

- Load on rear wheels

Weight of body : W = 23.25 Kg
= 228.08 N
Weight of human body : W_1 = 80 Kg
= 784.8 N
Inclination angle : $\theta = 20^0$
Force $_{rear\ (vertical)}$:F_{rv}=Weight of body + Weight of human body
= 1012.8 N
Force $_{rear\ (incline)}$: $F_{ri} = F_{rv} \times \cos\theta$ (3)
= 951.795 N

- Force on each wheel

Force :$F = \frac{F\ vertical}{2}$ (4)
= 475.89 N

- Load on backrest portion

Link inclination : $\alpha = 30^0$
Weight of human body (back) :W_b = 40 Kg
Weight of frame :W_f = 15Kg
Force : F = (40+15) x 9.81
= 539.55 N
Force $_{actual}$:$F_a = F \times \sin\alpha$ (5)
= 269.76 N

- Load on leg support portion

Link inclination : $\beta = 55^0$

Weight of human body (leg) = 15 kg

Weight of frame = 10 Kg

Force : F = (15+10) x9.81

= 245.25

Force $_{actual}$:F_a= F x sinβ (6)

= 50.17 N

5. Fabrication details

a) Firstly manufacturing the frame as per our design.

- Back rest: Back rest of wheelchair convertible stretcher is made up of square cross- section and flat mild steel plates are welded in it.
- Seat: The seat is made up of mild steel of cross- section and flat mild steel plates are welded in the frame. It is directly connected to the base of the wheelchair convertible stretcher.
- Leg support: Leg support of wheelchair convertible stretcher is also made up of mild steel square cross-section and flat mild steel plates are welded in the frame.
- Foot rest: The foot rest is made up of mild steel square cross-section by bending its edges and is welded at the bottom of the leg rest.
- Seat back recliner mechanism: The seat back recliner mechanism is rigidly attached to the seat and backrest by means of nuts and bolts. This mechanism helps in locking of backrest and leg rest at some specific angles.
- Hinges: These are the most important part of wheelchair convertible stretcher. It is connected in between backrest and seat (base) and in between seat (base) and leg rest. It is connected in order to convert wheelchair into stretcher and vice versa.
- Fasteners: These are used to connect the linkages and to fix the seat back recliner mechanism rigidly which helps in the process of conversion of wheelchair into stretcher and vice versa.

b) After that manufacture the back attachment and leg attachment by using pipe.

c) Connect that attachment at pivoting to the frame.

d) Connecting link is connected to leg attachment and at the base nut is connected.Wheels are connected to the base of the frame.

The proposed model is shown in which Fig.1 shows the front view of wheelchair mode and Fig.2 shows the top view of stretcher mode.

Fig.1 wheelchair mode

Fig.2 stretcher mode

6. Result and validation

The proposed stretcher cum wheelchair model has clearly shown that the mechanism used to perform reclining and lifting backrest is more efficient, economical and effective. The stretcher cum wheelchair eliminates the steps of transferring of patients from wheelchair to stretcher or vice versa.

In this model ratchet mechanism is used for lifting and reclining of backrest. But it can carry a load of 85Kg. To carry more load ratchet mechanism can be replaced by motors. The proposed model does not required external power. This model consume less space as well as less maintanence.

7. Advantages and applications

The advantages, disadvantages, applications and future scope of this proposed model are:

7.1Advantages

The advantages are as follows:

- Increases the comfort level of patient and patient handling staff.
- Prevent damages to patient while transferring from wheelchair to stretcher.
- Occupy less space.
- Easily converts from wheelchair to stretcher & vice versa.
- Emergency & serious patients who should not be moved or disturbed from their position can be shifted.
- Shifting of patient is reduced i.e. stretcher is not needed anymore.

7.2Applications

The applications are as follows:

- Most useful in hospitals.
- Most useful in old age homes.

8. Conclusions

This paper was intended to develop a concept of wheelchair convertible stretcher with the motivation of saving space and prevent exertion of patient as well as by making sure that the patient does not get hurt. The mechanism and safety of patient were our main priorities while designing the stretcher cum wheelchair. Our study shows that it is possible to save 50% space by using stretcher cum wheelchair rather than using wheelchair and stretcher separately.

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