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Wheelchair cum Stretcher

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Abstract*- Wheelchair and stretcher are very commonly used in the hospitals, airports, railway station, shopping malls, etc. This design here, is a modified wheel chair cum stretcher depending on the needs. This machine can be used to convert the wheel chair into a stretcher according the requirements. This can be accessed manually. The chair gets converted into a stretcher when the levers are engaged. The stretchers can be converted from the main frame according to the convenience of the patient as well the doctors, making it easier to access the patient with less effort and transporting. The folding mechanism makes it easier to store large number of stretcher put into the form of chairs in comparatively less space. The number of patients in world is increasing day by day. So in hospitals patients need to be shifted from wheelchair to stretcher, stretcher to beds, bed to wheelchair, or vice versa; which creates unsafe conditions for patients. 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 hospitals.

KeyWords- Wheelchair, Strecher

I. INTRODUCTION

A wheelchair is a chair with wheels. The device comes in variations allowing either manual propulsion by the seated occupant turning the rear wheels by hand, or electric propulsion by motors. There are often handles behind the seat to allow it to be pushed by another person. Wheelchairs are used by people for whom walking is difficult or impossible due to illness, injury, or disability. People who have difficulty sitting and walking often make use of a wheel bench. Chair and wheel were the earliest inventions of man. A wheelchair is a wheeled mobility device designed especially for disabled individuals. 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. Early wheelchairs were intended only to help a disabled individual to move from one place to another but today the wheelchairs are considered as not only for the transportation purpose but also a way to express users' individuality. In India the number of disabled population had a tremendous augment in the past few years. Huge amount of people have congenital disabilities, another few percentages are the victim of accidents and various kind of mobility devices are inevitable part of their life.

A mobility aid is a device designed to assist walking or otherwise improve the mobility of people with mobility impairment. There are various walking aids which can help with impaired ability to walk and wheelchairs or mobility scooters for more severe disability or longer journeys which would otherwise be undertaken on foot. For people who are blind or visually impaired the white cane and guide dog have a long history of use. Other aids can help with mobility or transfer within a building or where there are changes of level. Traditionally the phrase "mobility aid" has applied mainly to low technology mechanical devices. The term also appears in government documents, for example dealing with tax concessions of various kinds. It refers to those devices whose use enables a freedom of movement similar to that of unassisted walking or standing up from a chair. Manual wheelchairs are those moved by the user or an attend an. By controlling the push rims, users can travel forward and backward at speeds dictated by the amount of force they are able to apply, they can also turn left or right and negotiate small dips and rises that lie ahead. A wheelbase chair, otherwise known as a scooter, has four small wheels extending from a low platform. The type of chair mounted on this platform varies according to the disability and needs of the user; some are even molded from a cast taken of the user's most appropriate sitting position. The controls of the wheelbase chair are mounted on a frame that curves upward from the front of the platform to a height and position convenient for the user. A horizontal steering bar is attached across the top of the frame. A stretcher is a medical device to carry patients for a short duration of time. A stretcher contains a surface which support for carrying patients, and has handles on either side along its length to help carry it. A stretcher is a moving bed with wheels, designed to transfer patient who can't walk or stand with the help of others assistance. In accident cases and the people who are in critical stages are transfer in stretcher from one place to other place. Itis simple in design with metal bed at top for lay the patient, supported by metal frame with swivel caster wheels. Stretchers have been used since antiquity, on battlefields and in emergency situations, where wheeled vehicles are hindered by rough terrain. In their simplest form, they generally consisted of a canvas sling with long edges sewn to themselves to form pockets through with wooden poles could be slid. Today there are a wide variety of stretchers available, involving lightweight materials, attachments so that it can be fitted to other contraptions.Traditionally the phrase "mobility aid" has applied mainly to low technology mechanical devices. The term also appears in government documents, for example dealing with tax concessions of various kinds. It refers to those devices whose use enables a freedom of

movement similar to that of unassisted walking or standing up from a chair.

Modern day wheel chairs contain light materials, microprocessor controlled and many more sophisticated systems. There is a revolution of wheelchairs available today driven by needs and desire or man today. The future expects a better range of wheelchairs that could suit the imagination of the human mind and serve the needy.The basic structure of the wheelchair contains various parts. In simple words its nothing but a set of wheels attached to a chair.There are some important things a wheelchair must contain. A seat must be comfortable, so that the person does not get tired sitting on it for a long time. It must contain a backrest that provides a good lumbar support. It must have an arm rest at an optimum height and a also a foot rest. The most important think is it must have brakes for the wheels.Since the birth of the wheelchair there have been many modifications in its design. Today there exists a huge variety of wheelchairs- manually, electric, or self-propelled, foldable or rigid. Apart from these they are classified based on their usage, standing wheelchair, sports wheelchair, mobility scooters, bathroom wheelchair, steps climbing wheelchair etc. The range of wheelchairs reflects the demand to meet individual needs.

The objective of the work are.

- Developed stretcher cum wheel chair is capable to transfer patient easily from bed to stretcher and vice versa by attendant or nurse. Mobility in both positions as on wheel chair as well as stretcher is possible very easily.
- Providing convertable stretcher which will make it easy for shifting the patient.
- After the stretcher is detached, the usefulness of the base as wheelchair.
- Making a prototype model using limited materials and scarps. Therefore, reduction in cost.

II. DESCRIPTION

The major component involved in the construction of the WHEELCHAIR CUM STRETCHER are:

- Chassis
- Rear wheel
- Casters
- Bolt and Nut
- Main base structure
- Bearing
- Lead Screw

A. Chassis

The base is basically a platform or it can also be called as a support for the entire assembly. The base is constructed with the help of channels made of metals such as aluminum, stainless steel, mild steel etc. In the design of this wheelchair, the base consists of a structure called as a frame made of mild steel.

A sheet of metal is fixed on the top surface of the frame which acts as a platform for the person to sit. The sheet is basically welded to the frame with the help of welding method. The type of welding employed in this design is arc welding. When the sheet metal is combined with frame it forms a rigid structure so called as base.

Fig 1: Chassis

B. Rear wheels

The rear wheel which is connected to each other using the shaft, so as to keep it in alignment. The wheel is of diameter 69mm. This wheel will be holding the weight of whole body including the human weight

Fig 2: Rear wheels with the shaft

C. Casters

The caster wheels are attached to the body of the chair with the help of end bearing and bearing caps. The wheel is made up of fiber wheel inch diameter. A caster (or castor) is an undriven, single, double, or compound wheel that is designed to be mounted to the bottom of a larger object (the "vehicle") so as to enable that object to be easily moved. They are available in various sizes, and are commonly made of rubber, plastic, nylon, aluminum, or stainless steel.

Here we are providing with two caster wheels in the front for proper balancing and also for changing direction as convenient.

Fig 3: front caster wheel

D. Main base structure

This is the main base with the seat platform on it. Here the base is welded to the shaft of the wheels. The wheels are attached using the nut and bolts, so its removable. The casters are also bolted to the base leg, so as to keep it removable in case we need to change the caster.

Fig 4: Complete base structure

E. Bearings

The bearings are pressed smoothly to fit into the shaft because if hammered the bearing may develop cracks. Bearing is made of steel material and bearing cap is mild steel.Ball and roller bearings are used widely in instruments and machines in order to minimize the friction and power loss. While the concept of the ball bearing dates back at least to Leonardo da Vinci, their design and manufacture has become remarkably sophisticated. This technology was bought to its present state of perfection only after a long period of research and development. The benefits of such specialized research can be obtained when it is possible to use a standardized bearing of the proper size type

Fig 5: Bearings

F. Lead Screw arrangement:

A lead screw turns rotary motion into linear motion combining a screw and a nut where the screw thread is in direct contact with the nut thread. Lead screws are used in a very broad range of applications, sold as individual products or incorporated into screw jacks and electro-mechanical actuators.

Fig 6: Arrangment of rack and pinion

III. DESIGN SPECIFICATIONS AND CALCULATIONS

A. ANALYSING THE PROBLEM

Fig 7: Basic manual wheelchair parts

This is a basic model of wheelchair that are commonly used. These can only be used to move the patients in a seating posture with limited comfort. It's difficult to move the patients to a separate stretcher. This design basically consists of limited mobility. Here it is difficult for the patients by themselves to move on to a bed in need of some sleep and comfort.

- The main problem we faced is, which type of material we should use, after few failures we conclude that low weight and high strength material we should use.
- Strength of frame of the wheelchair base to hold heavy body.
- Strength of structure of the stretcher.
- How many linkages.
- Placing of the mechanism.
- Proper spacing for alteration in design during development.
- Placing of wheels.
- Locking system for the stretcher to wheelchair.
- Joints and hinges.

B. DESIGN CALCULATION

Material Used for Development

1) M.S. hollow bar of total length 15m

2) M.S. hollow bar of diameter 20mm

3) M.S. L shape 1" of length 6m

4) G A Coated M.S sheet of 2 mm thickness 3*(50*50).

5) M.S. Plate of 2mm

6) Bolt and nut of 10 mm diameter and 2 inches' length

7) Caster – 6 pieces

8) One pair of Wheels of diameter 69cm

9) Sponge (foam)

10) Leather cover

Load calculations

- **Load on the wheels**

Weight of Body =35 kg

Weight of Body (Newton)=343.43N

Weight of the Human = 120kg=1177.20 N

Weight of Lead Screw = 0.3 kg 2.943N Force =

[343.43+2.943+1177.20] =1523.573 N

Force on each wheel

Force F1 = F2 =Force/4 = 1523.573/4 =380.893 N

- **Load on Back Rest**

Link inclination = 20 degree

Human weight = 40 kg

Weight of the frame = 10 Kg

Force = (40+ 9.3) * 9.81= 483.63 N

Force actual = F* sin 20 = 263N

- **Load on Leg Rest**

Link inclination= 10 degree

Human weight = 15kg

Weight of the frame – 10 kg

Force = (40+10) M * 9.81 = 490.5 N

Force actual = 266.8254 N

C. Stress Calculation

❖ **Stress on front casters**

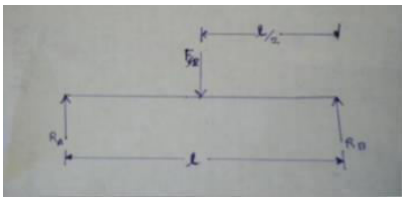

Fig 8:Force distribution front caster

Front wheel shaft diameter(d1) = 10 mm

➢ Bending stress

$\sigma_b = M_y / I$

Moment = Ff1*(L/2) =

380.893*20=7617.865N.mm Y=d1/2=5mm

$I = \frac{\pi}{64} d1^4 = 490.8739\ mm^4$

$\sigma_b = 79.13927\ N/mm^2$

➢ Shear stress

$\tau = \frac{TR}{J}$

Torque(T)=FF1*(L/2)=
380.893*20=7617.865N.mm R=d1/2=5mm

$J = \frac{\pi}{32} d1^4 = 981.7478\ mm^4$

$\tau = 39.56\ N/mm^2$

❖ **Stress on rear wheel**

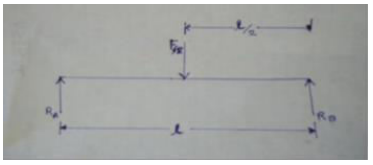

Fig 9: Force distribution on rear wheel

Rear wheel shaft diameter(d2) = 10 mm

➢ Bending stress

$\sigma_b = My / I$

Moment = Ff1*(L/2) = 380.893*50=19044.66N.mm

Y=d1/2=5mm

$I = \frac{\pi}{64} d1^4 = 490.8739 \text{ mm}4$

$\sigma_b = 197.848 \text{ N/mm}^2$

➢ Shear stress

$\tau = \frac{TR}{j}$

Torque(T) = FF2* (L / 2) = 380.893 N *50 =

19044.66 N.mm

R = d2/2 = 5 mm

$J = \frac{\pi}{32} d1^4$

$= 981.7478 \text{ mm}^4$

$\tau = 98.92 \text{ N/mm}^2$

D. Factor of Safety

$$F.O.S. = \frac{ultimate\ tensile\ stress\ on\ material}{maximun\ stress\ generated\ in\ material}$$

$$= \frac{500}{197.848}$$

= 2.52

Fig 10: 3D Final Assembly Wheelchair cum stretcher

IV. RESULTS AND DISCUSSIONS

The conventional wheelchair cum stretcher has numerous drawbacks and its expensive too. The available wheelchair doesn't provide the provision for stretcher. So to overcome all this drawbacks, this new model of wheelchair cum stretcher is designed. The advantages of this design compared to conventional wheelchair are listed below.

- Maintenance is easy and hence make it more effective.
- Convertable stretcher is provided, giving comfort in transferring the patient from one bed to another.
- Even after detaching, the base can be used as a chair.
- Construction of this design is simple.
- The extra wheels on the stretcher will be helpful to use it as trolley.
- This model is cheaper than the model in the market.

V. CONCLUSIONS

The mechanism is designed and developed in order to reduce the human fatigue. Wheelchairs are now considered not only means of transportation but also as a way to allow users to express their individuality. Also allowing the helper of nurse to ease in handling the patient in severe cases. When the patient is required to transfer from bed to wheel chair from one place to hospital or any other place it becomes very difficult by nursing staff as well as patient also. Due to the transferring from bed to wheel chair or vice versa, stresses are developed in the body of patient and as well as nursing.The above problems which are generated at the timing of patient transferring from bed to wheel chair can be eliminated by developing new design of stretcher cum wheelchair i.e. providing the wheelchair cum stretcher with a covertable stretcher which can operated easily as well as used as a trolley when needed.The cost of this design may be little higher than the common wheelchair, but this design has many more features that can be helpful for the patient as well as the nursing staffs. Also we have understood that there are many scope for future improvements.

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