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A LITERATURE REVIEW ON AUTOMATIC STRECHER CUM WHEEL CHAIR

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ABSTRACT—**In India the number of disabled individuals is increasing every year. Mobility aids are useful for patients for transportation and a replacement for walking especially in indoor and outdoor environment. Wheelchairs and stretchers are the most commonly used medical equipment for the transportation of patients. Transferring the patients from wheelchair to stretcher or to the medical bed is always an issue for the attendant or nurse. Understanding the various issues regarding the mobility equipment and introducing a better design will be an asset for the medical field and a helping hand for disabled individuals. 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-:Stretcher, Wheelchair, Automatic converting stretcher into wheelchair

I. INTRODUCTION

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.

II. LITERATURE REVIEW

A lot of work has been done on Automatic Stretcher cum wheel chair. We have focused on design parameters and a detailed literature review is as follows. SukantaRogaet al studied the model works on lead screw mechanism. The main components involved in this project consist of DC gear motor, lead screw, battery, caster wheel, bicyclewheel, two way switch, and a waste lid. At the present position this model is a wheelchair type.Below chair a lead screw which is connected to lids, the links are connected to the bottom side plate and top slide plate

when the lead screw is rotated anti-clockwise; the movement of the link brought the bottom side plate upward and topside plate downwards to convert the wheelchair into stretcher. Newdesign of wheelchair cum stretcher for patient handling has been done. Cost of such type of wheelchair cum stretcherwill be affordable for all type of hospitals and it will be beneficial for patient handling. The product will thus likely be an efficient mobility aid in hospitals. While testing the device, it encountered a problem of height of wheelchair which is not feasible for an average heightperson. In order to solve the problem the height of wheelchair is reduced from both sides in a proportion to be fit foraverage height person.[1]

According to the BibinVarkey, The main components involved in this project consists of hydraulic jack, screw rod, wheel, free wheel, waste lid and braking lever. In this project, we provide two lead screw setup with hinge joint is used to form the stretcher or bend to wheel chair. At thepresent position this model is a wheel chair type. Below the chair we provide two lead screw setup to connect the right or bottomside plate and left or top side plate by using hinge joint. For movement of bottom side plate , rotate the screw handle in counterclockwise direction then hinge goes inwards to form a flat plate. Appropriate wheelchair will leada comfortable living to the user. Performance, safety and dimensions are the three categories which have to be considered whileselecting a manual or powered wheelchair. An excellent approach to the wheelchair selection is to set priorities based on user'smobility and seating needs. It is highly recommended that a novice can consult with theirhabilitation specialists in order to select the appropriate wheelchair. Hydraulic jacks are jacks that are placed in a horizontal position. These jacks push against a lever, which lifts the main lift arm.Bottle jacks have a longer handle than most hydraulic jacks, however, and it is possible to get more lift per stroke with the increasedleverage they provide when compared to regular models of jacks.[2]

According to Sumedh J. Suryawanshi,et al Different methods like FL, DARE analysis and Pugh concept selection method for converting the needs of the customers into a conceptual product are discussed in detail. In this concept a sliding tubular frame is attached to the back rest of the wheelchair. A handle is provided in the back rest so that the user can be pulled it easily and can be converted to stretcher easily. So a proper balance should be maintained in the back side because the centre of gravity of humanbody will be lying in between the seat and back rest portion.Most of the sophisticated electric wheel chairs available in the market arecostlier and do not facilitate lying down for rest. So there was a need for an advanced patient friendly wheel chair system.There are mainly two types of wheel chairs; manual and electric wheel chairs. Electric or powered wheels chairs are selfpropelledtype wheel chairs which uses electric motors for tractions. It consists of a driving unit, steering unit, lifting unit andpower supply in addition to the parts of a normal wheel chair. With electrically powered motors and patient friendly controls thewheelchair can be converted to a stretcher by disabled at will. The driving or traction unit is used for forward and backward movement of the wheel chair, while the steering unit is used for turning. The lifting unit change the front leg support and back
rest into a stretcher.[3]

Kulkarni S. B et al point of view the need for the wheelchairbedsystem in current world. We also studied the differentmechanisms that can be implemented. This paper also sheds
light upon the material selection and the importance ofselecting proper materials.Although these chairs may prove tube costlier than standard chairs available in market, they improve patient's safety and comfort levels. There are two basic ways to implement hydraulics into the system. Firstly, we could use hydraulics as an input tithe mechanical linkages. Alternatively, we could use only hydraulics to transform the chair. Servo motors or step motors move in steps of certainangles. Therefore these motors were used to give input to the mechanical linkages. Servo motors work on electricity; hence they required an external source or a battery to operate. Thisadds additional weight to the already loaded wheelchair; in process making it heavy and difficult to power using hand force. Electric Wheelchairs are those variants which are moved with an electrical motor and the navigational controls generally provided as a joystick on the armrest. These chairs are costlier than the basic wheelchairs due to improvement inTechnological implementations and also aesthetics.[4]

Mr. Richard Simpson, says almost 10% of all individual who are legally blind also have a mobility impairment, the majority is dependent on others mobility. A SPAM (smart power assistance module)is being developed for manual wheelchair for providing mobility for this population independently. The power assist wheelchair that provides for obstacle detection and avoidance for those with low vision. The control will be carried out by the microprocessor and also allow the SPAM to provide a smoother and nuanced control of a wheelchair. Dr. Daniel E. Jolly, says proper preparation should be taken before transferring the patient from bed to wheelchair or vice versa. For paraplegic patients use of sliding boards will be helpful. The best sliding board is made of hard wood, smooth, tapered on ends. Support of belts, two assistance, support straps etc will facilitate easy transfer. Slide into chair of patient should not be there, the optional and safety method for patient transfer is to lift from the wheelchair. To form an

"X" shape cross bracing is a construction technique in which braces are crossed to support a frame. The main feature of this mechanism is the folding facility, which helps to fold a product. This folding technique helps the wheelchair a portable type and can be carried easily with less weight and less space consideration. The wheelchair cum stretcher type of medical equipments in the hospitals are commonly used. Some of the features are like foldable frame, foldable arm rest, foldable and detachable foot rest, dual brake system and detachable and adjustable type of head.[5]

Enlightens us about a sliding tubular frame which is attached to the back rest of the wheelchair. A handle is provided in the back rest so that the user can pull it easily and can convert it into stretcher. Concept 3 gives us an insight to the hydraulic scissor lifter mechanism, so that the height can be adjusted according to the user's convenience. A hydraulic scissor lifter mechanism lifts the entire wheelchair into stretcher. Concept 5 is based on the gear mechanism. According to the rotation of the middle wheel, the front and back seats are rotated in opposite direction and stretcher arrangement is achieved. Pneumatic power for the operation of the wheelchair convertible stretcher although the air supply is some distance away from the product. Backrest: Backrest of wheelchair convertible stretcher is made up of square cross-section (1" X 1") and flat mild steel plates are welded in it. It is attached to the base with hinges and seat back recliner mechanism. Seat: The seat is made up of mild steel of square cross-section (1" X 1") and flat mild steel plates are welded in the frame. It is directly connected to the base of the wheelchair convertible stretcher. Leg rest: Leg rest of wheelchair convertible stretcher is also made up of mild steel square cross-section (1" X 1") and flat mild steel plates are welded in the frame. It is attached to the seat (base) by means of hinges. Foot rest: The footrest is made of the 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. Fig. A and Fig. B shows the initial and final position of seat back recliner mechanism respectively. 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.[6]

RajeevV.R, et al are explained the all units in his paper of stretcher cum wheel chair. Which was DRIVING UNIT -The driving unit is used to move the wheelchair forward and backward. The main parts of the driving unit is the drive motor and the control circuit, the drive motor is a 24v, 300W PMDC motor with gear box connected to it. The output speed that is obtained from the gear box is 100rpm. The control circuit is used to change the direction of movement of the motor shaft. DC motors have the property that if the polarity of the voltage applied to the motor is changed then the direction of turning of the motor shaft will also change. Relay control is used to change the polarity of the voltage applied to the drive motor. POWER SUPPLY-The power to drive the wheel chair is supplied by two 12v, 35Ah batteries. Charging circuit is also provided to charge the batteries and also a charge level indicator is provided in the control panel to know the amount of charge. The batteries can be recharged by connecting the power supply cord provided in the wheelchair to main supply. LIFTING UNIT-Lifting units are used to make the wheel chair to stretcher and back to wheel chair. The main parts of the lifting mechanism are the powered screw jack and the control circuit. There are two powered screw jacks one is connected to the footrest and the other to the backrest. CONTROL UNIT-Control unit is used to control all the parts of the wheelchair. The control panel is connected to the control unit. The control panel is placed in such a way that it can be easily assessed by the person who is using the wheelchair both in wheelchair and stretcher mode.[7]

According to Peter Axelson, 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 their 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 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 mobility for 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, 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, 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.[8]

According to AnandaSankarKundu et al Wheelchair design comprises designing of the motor wheel assembly, a suspension mechanism and a chassis withsufficient load bearing capacity. Fig.1 shows different parts of the developed Omni wheelchair. Along with the frontmotor-wheel assembly mounted with suspension mechanism, the rear and the side motor-wheel assemblies are directlyfixed with the chassis. The motors are positioned in the motor-wheel assembly horizontally with offset. In the frontside of the chassis a pair of footrest is connected. The footrest position can be adjusted vertically with the help ofslots, and a pair of load cell is attached with the footrest for using them as brake pedal optionally.Electronic components of the wheelchair consist of four Buhler DC motors (77W) and their drivers (40V, 20A)from 'Rhino Motion Controls' to drive the motors. These motor drivers accept PWM/DIR input from the controller.The output velocity is proportional to the input PWM duty cycle. The driver measures the speed of the motor fromcurrent harmonics and regulates it by close loop PD control. ACS712-20A current sensor modules are connectedwith individual motors to monitor the current consumption. These sensors analog voltage outputs are connected tothe analog input pins of STM32 microcontroller. Finally the STM32 microcontroller communicates with the mastercontroller (NUC) via serial port.[9]

In the journal "design and development of conceptual wheelchair cum stretcher" Steerage C S, Gopinath C, ManasRanjanMishraintroducing a new design for a wheel chair which can be transformed into a bed. They also introduced new features like documentholder, provision for oxygen cylinder, and rotatable handle into the new wheel chair cum stretcher. With the motivation of savingspace and precluding exertion by the patient they adopted various research methods and it helped them to identify the various issues of the topic, the importance of safety and hygiene and significance of materials and manufacturing process involved in thewhole product. Study shows that it is possible to save 50% space by the wheelchair- cum-stretcher design. The product will thuslikely be an efficient mobility aid in hospitals.Khalid Bin Hasnan describes a design of a novel concept wheelchair with the scaled prototype. A wheelchair-sized bed concept(patent pending) with 3 modes of ability (sitting-lying-standing) is proposed. The design and prototype stage has produced a newdesign of transformable wheelchair in dimension, detail profile, function and features. From scaled prototype, working space ofthe wheelchair at certain position could be obtained from model which would be useful in defining interaction between wheelchair and its real environment.U.D Gulhane and R.J.Dahanke designed and fabricated a new modified wheel chair cum stretcher. A simple parallelogrammechanism has been synthesized for lifting. The mechanism is driven hydraulically. The hydraulic piston can be operated manually as well as

automatically. The chair gets converted into stretcher while lifting automatically. Inverted slider crank mechanism areapplied for the purpose. Five legged support provides required stability to the stretcher. The system can be made manual self driven or motorized. The developed chair is economical as compared to the available modern automatic wheel chairs.[10]

IV. DESIGN AND CALCULATION

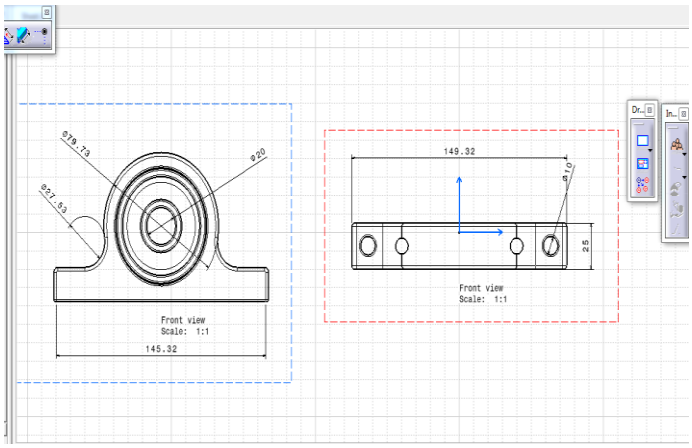

Figure. Design of Bearing

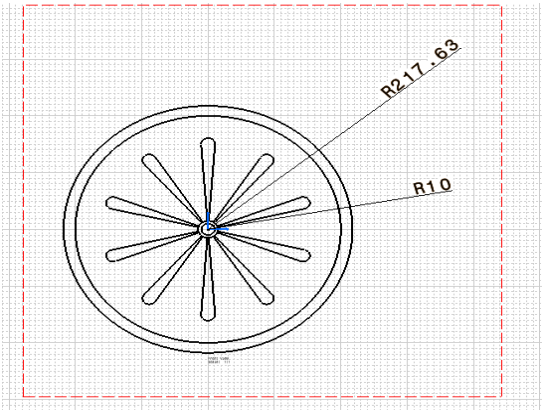

Figure . Design of Wheel

FRAME design:-

Frame length =320mm
Cross section=1”X1”
Material=M.S (Mild Steel
Young’s Modulus (E)=210 GPa
Max.wt=15 kg

Solution:

Max.bending moment M= $(wl^2)/8$
= (15X9.81X320^2)/8
M =1883520 N-mm
B=D=1”=25.4 mm
Thickness=t=3mm
B=d=25.4-3X2=19.4 mm
Moment of inertia,

$I=\frac{(BD^3-bd^3)}{12}$

$=\frac{(25.4^4-19.4^4)}{12}$

= 22882.048 mm^4
Max. DeflectionY=D/2=25.4/2=12.7 mm
We know that,

$\frac{M}{I}=\frac{\sigma}{y}$

Bending stressσ=My/I
=1883520 X 12.7/22882.048
=3793.75N/mm^2

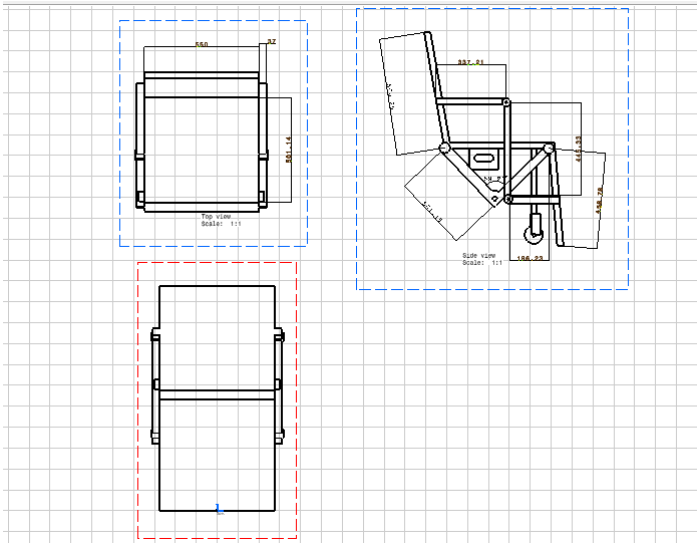

Figure. Design of Frame

Worm gear

Teeth of worm=7
Speed of worm=100 rpm
Speed of gear=14 rpm
Weight=10X9.81=98.1 N
Velocity of motor=0.6 m/s
Velocity ratio=50/7=7.14
Efficiency=(1-0.005) X velocity ratio
=(1-0.005)X7.14
=0.964

Rated power = $\frac{w\ X\ v}{0.975}$

$\frac{98.1\ X\ 0.6}{0.975}$

=61.04 w
Design power:
$P_d=p_r$ X k1
K1=1.2
=61.04 X 1.2
=73.24w

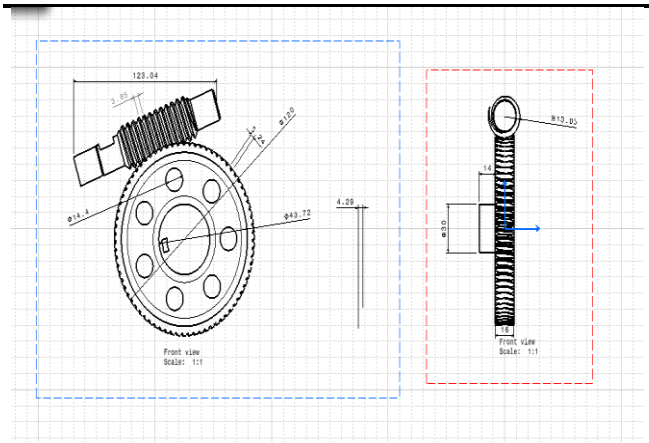

Figure. Design of Worm Gear

For Worm

Normal pressure angle φn=22.5
Pitch diameter of worm =D_w=2.35P_c+10
=2.35 X π X 3+10
=32.14
Face length= L_w = (4.5+0.02T_w) P_c
=(4.5+0.02 X 7)π X 3
=43.73
Depth of tooth=h=0.686Pc
=0.686(π X 3)
=6.46
Addendum=a=0.318 Pc
.....[11]
=0.318 X (π X 3)
=2.99
Hub dia(dh)=1.66Pc+25
=1.66(π X 3)+25
=40.64
Minimum bore diameter of shaft =dw=Pc+16
=(π X 3)+16
=25.42 mm

For Gear

Normal pressure angle (φn)=14.5
Outside dia(D_o)=Gear Dia.(D_g)+1.0315P_c
=150+1.0315(π X 3)
=159.72 mm
Throat dia(D_r)=D_g+1.0636Pc
=150+1.0636 X (π X 3)
=160.02 mm
Face width (b)=2.38Pc+6.25
=2.38X(π X 3)+6.25
=28.68 mm
Radius of gear face(r)=0.882Pc+13.75
=0.882(πX3)+13.75
=22.06 mm
Radius of gear rim(rp)=2.2Pc+13.75
=34.48 mm
Radius of edge (rr)=0.25Pc
=0.25(πX3)
=2.35 mm

Static condition

Torsional force $F_t \leq$ Bending forceF_b.....[11]
Tangential tooth load(F_t)

$$Ft=\frac{\text{design power}}{\text{power velocity}}$$

Where,

$$\text{Velocity } (V_p) = \frac{\pi Dg * Ng}{60*1000}$$

For
VR=7.14
Let No. of Teeth T_w=7
.....[11]
T_g=T_w X VR
=7X7.14
=50
Gear Diameter Dg = m X T_g
=m X 50
="π X 50 X m * (14" / "60) * 1000"
=0.0366 m
F_t=73.24/0.0366m
=1998.25/m
Bending load(Fb)
F_b=S X C_v X b X y X m
Let,
Pressure S =35 kgf/cm=35 X 9.8066=343.21 Kpa
.....(T no-33)

$$C_v=\frac{6+v}{6}=\frac{6+0.6}{6}=1.1$$

Max Deflection Y=0.134+0.0151(ά-14.5)
=0.134+0.0151(22.5-14.5)
=0.4348
Width of Wheel Rim B=2.38 Pc+6.25
=2.38 X (π X m)+6.25
=7.47 m+6.25
F_b=343.21 X 1.1 X (7.47m+6.25)0.4348 X m
=1226.2m^2+1025
Assume
F_t=F_b
1998.25/m =1226.2m^2+1025.93
m=0.94~3
D_g=m X T_g
=3 X 50
=150
b=7.47 X 3+6.25
=28.66

F_t=1998.25/3=666.08
F_b=1226.2m^2+1025
=1226.2 X 3^2+1025
=12060.8N
F_t<<F_b
Hence condition satisfied.

Dynamic condition:

F_d<<F_w
Dynamic load (F_d)
F_d=F_t/cv
F_d=666.52/1.1
=605.52N
Limiting wear strength
F_w=D_g X b X K2
K2=8.8
.....[11]
Dg=m X Tg = 3 X 50=150
F_w=150 X 28.66 X 8.8
=37831.2 N
F_d<<F_w
Hence condition satisfied.

III. CONCLUSION

The paper was purposed for making a review on design and fabrication of multi utility wheel chair that can prevail over the conventional wheel chair. By adopting various research methods helped to identify the various issues of the topic, importance of safety and hygiene and significance of materials and manufacturing process involved in the whole product.Referring to various literature review's we have selected dimensions and as per that design calculations and 3d modelwere done with design software. This Design of Wheel Chair cum Stretcher enables the easier transferring and handling of patients in hospitals without producing any damage to patient's body externally and internally. Thus, the time and effort required for moving the patient is greatly reduced. Modelling software such as cad has helped in visualising the product.

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