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Wheelchair cum Stretcher

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ABSTRACT: Wheel chair is a chair with wheels used to move patients from one location to another location dueto their inability to move or physically disabled. In this project rack and pinion mechanism is used to convert a wheel chair into stretcher and vice versa. On the wheel chair cum stretcher to the adjacent hospital bed effortlessly and efficiently. This design includes cross section of the materials, kinematic analysis, design stretcher, gear design, calculations. The main objectives of this project is easy transformation of the patients from bed to wheel chair and wheel chair to bed. It is designedand fabricated in such a way that it can be used in hospital's as well as at homes.

KEYWORDS: Wheelchair,Patients,Converting

I. INTRODUCTION

Wheel chair is the one of the basic need in the hospitals. Patients transferring device is a mobility aid which allows the person transfer a patient from one location to another.In the world disabilities affected thousands of families. As of today 640 millions people are suffering from disability. New and modified wheel chairs can satisfy the need of disable people rather than the old and conventional ones. Engineers are continuously applying their ideas to make this product more comfortable to patients and staffs. Wheel chair is the one of the easiest modes which serves the purpose of transportation for patients and considered as basic necessities in the hospitals. This design is simple and very much suitable for almost all range of height of beds at hospitals.

shifting of patient from wheelchair to stretcher or the patients will feel discomfort. With the assistance of this wheelchair cum stretcher a patient are often seated on wheelchair on which he also can be operated by converting it to stretcher also it'll be convenient for workers to maneuver a patient, also it'll be easy if we offer a electrical system to regulate the general movement of stretcher cum wheelchair. Understanding the many problems surrounding mobility equipment, a far better design are going to be an asset to the health care industry also as a hand for people with disabilities.

The present project mainly focused a development of wheelchair cum stretcher with ability to transfer patients from normal staircase also with automated electronic control over wheelchair cum bed for movement and functioning. Self-control wheels discovery created huge demand in the market and it was better helping aid for the disabled person.

II. LITERATURE REVIEW

2.1MULTIPURPOSE MEDICAL BED

Jerin Joseph John proposed that “MULTIPURPOSE MEDICAL BED” Our country, India is seeing a huge rise in the number or disabled personalities. Mobility aids are useful for patients for transportation and it’s a substitute for patients for walking in environments both indoor and outdoor. Wheelchairs, stretchers or medical beds are usually employed medical equipment for the transportation of patients.. Thus a need arises for a wheelchair cum stretcher cum bed to facilitate the disabled patient’s mobility and to provide a simple and cheaper an efficient medical equipment for use in the Indian hospitals. Hence our project “MULTIPURPOSE MEDICAL BED” is introduced to solve problems related to the conventional medical care equipment and would be cheap and affordable and could be efficiently used in hospitals to save space, time and to provide improve better care to the required.

2.2 DESIGN AND FABRICATION

Kulkarni S ettal "DESIGN AND FABRICATION OF WHEELCHAIR-TO-BED SYSTEM USING FLUID POWER" Wheelchair is a chair with wheels used to move a patient from one place to another place due to their inability to move. This may be due to the patient being physically disabled, weakness due to their disease or old age. Hence after they arrive back to or when they are moving away from their beds, there is a change from wheelchair to bed or bed to wheelchair. This transition is too long and is proved to be harmful to both the patient and the helper by many studies and surveys. A provision can be provided to convert the wheelchair into a bed using hydraulics system.

III. METHODOLOGY

Design and Fabrication of Wheelchair Cum Stretcher

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Field Survey

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Problem Identification

↓

Design

↓

Material Selection

↓

Fabrication and Assembly

↓

Conclusion

IV. MATERIALS AND COMPONENTS

The major materials and components used for the project is

4.1FRAME

Figure 4.1: Main Frame

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Galvanized iron angler is used as chassis of wheelchair. Galvanized anglers that have undergone.The galvanization process which prevents the steel from older and rusting. Galvanized anglers are pre manufactured steel angler dipped in molten zinc to protect it from the corroding elements. Galvanized angler comes in various type, sizes and length. This product is used in underground piping over ground piping system. Industrial purposes scientific experiences and other uses.

Steel is a ferrous metal, which makes it susceptible to rust and corrosion, the chemical breakdown of the metal object. Galvanization process is the process which steel is dipped into molten zinc in order to coat it with non-rusting protective layer. The zinc's temperature is around 850°F and chemically bonds to the steel. The zinc deteriorates at a much slower rate than steel and it is a affordable metal for galvanizing steel pipes and other items.

Physically galvanized mild steel anglers are slightly darker than steel pipes because of zinc's dark colour. While galvanization doesn't directly strengthen already very strong steel, the zinc coating protects it from breaking down an eventually weakening. Because of this, galvanized steel is used for building sky scrapers to transporting water. Economically, galvanized steel anglers are in-expensive and recyclable.

4.2 RACK AND PINION ARRANGEMENT

Figure 4.2: Rack and Pinion Arrangement

The block is the important part of the unit as it houses the rack and pinion. This block converts the rotary motion into linear motion.The rack is a portion of a gear having an infinite pitch diameter and the line of action is tangent to the pinion.

4.3 SWITCHES

switch is an electrical component it can connect and disconnect the conducting way in an electrical circuit. Switches are main components in a circuit which requires user interaction or control. The most common type of switch is an electromechanical device consist of one or more sets of movable electrical contacts connected to external circuits.Currents form when neutrons move in a flow. For electricity to flow through a household, the current has to pass through circuits. Circuits are made up of a power source and a load. . The role of the electric switch is to regulate the current, that pass between the load and the power source.

Figure 4.3: Switch

4.4 MOTOR

Electric motor is a machine that can converts electrical energy in to mechanical energy. 3A MOTOR n is based on the principle that when n current-carrying conductor is placed in electric field, it feels a magnetic force whose direction is given by Heraing's left hand rule. When a motor is in working, it develops torque and this can produce mechanical rotation. DC motors are also like

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generators classified into stunt wound or series wound or compound wound motors.

4.5 WHEELS

A wheel is a circular component that is intend to rotate on an axle bearing. The wheel is one of the major components of the bucket wheel excavator, which is one of the largest machines. Wheels, in conjunction with axles, allow heavy things to be moved easily facilitating movement or transportation while supporting a load, or performing labour in machines.A wheel can reduces friction by facilitating motion by rolling together with the use of axles. In order to rotate a wheel, a moment needs to be applied to the wheel about its axis, either by way of gravity or by the application of another external force or torque.

4.6 BATTERY

A lead acid battery is a secondary cell, meaning it is rechargeable. It contains plates of lead and leadoxide in a sulfuric acid solution. The leadoxide oxidizes the lead plates, making an electrical current. They contain toxic lead, though, and should be recycled. They are wet cells, and the dangerous acid can spill out. Sealed lead acid batteries are batteries where the sulfuric acid is in a gel which stays in, even when the battery is turned up-side down. As they are inexpensive. Lead-acid batteries are the cheapest rechargeable batteries and it can produce much power

1. lead(TV) oxide + sulfuric acid + extra hydrogen ions - lead(II) sulfate+ water Reactions: at cathode.
2. Lead + extra sulfate ions – lead (II) sulfate at anode.

Figure 4.4: Battery

V. CALCULATIONS

5.1 HUMAN WEIGHT DISTRIBUTION :

- Average weight of human body= 70-80kgs.
- Weight of human body with over-weight=~110kgs.
- Including FOS of 20kgs for person weighing 110kgs= 130kgs.
- Weight of M.S frame being used= 20kgs (approx.).
- Weight of other miscellaneous items acting on the supporting column= 30kgs (approx.).
- Therefore, total load acting on the supporting column= 130+20+30= 180kgs.

Weight distribution of human body at various section of device is shown in table 5.1

Part of Human Body	Weight In (%)	Weight of Human Body Parts (Kg) (If we suppose weight is 150 Kg)
Trunk(Chest, Back and Abdomen)	68.04	102.20
Head and Neck	7.35	10.80
Thigh	11.04	16.78

Foot	1.97	2.89
Lower leg	6.28	9.3
Upper arm	2.74	4.11
Forearm	1.88	2.81
Hand	0.7	0.98

5.2. DETERMINATION OF STANDARD CROSSSECTION FOR SUPPORTING BARS:

As discussed in above section, the total weight or total load = 130 + 50= 180kgs.

⇒Total weight = 180×9.81×1000 = 1765800~1800000N

Weight acting on each bar = 1800000/ 4 = 450kN

Ultimate strength of SS-44OC = 1000MPa

Taking Factor of Safety = 1.25

WKT,

FOS= Ultimate stress / Allowable stress

⇒1.25= 1000/ Allowable stress

⇒Allowable stress= 1000/1.25

⇒Allowable stress= 800MPa

Since,

Allowable stress = Force / Area

⇒Area= 450000/ 800

∴ Area= 562.5 mm^2

Hence, hollow steel with square cross-section having 40mm outer length & 30mm inner length with thickness of 4.5mm is feasible to use for designed load.

∴ Safe cross-section area of hollow bar = $40^2 – 30^2$ =700mm^2

5.3 KINEMATIC ANALYSIS:

During the conversion of device from wheelchair to straight bed the connecting rod bears certain amount of fluctuating load at certain angles. In this section dead weight of backrest and leg rest is calculated first followed by the kinematic analysis and finally the maximum load is considered to design the gear.

• **Load from Backrest:**

Weight of SS material:

Density=Mass / Volume

7800kg/m3 ––– (Std. value)

=7.8× 103kg/m3 = □/ □ (3.1)

Volume of Backrest metal frame = Cross-sectional area × Total length of material used.

= (40×40 −30 × 30) × 3300

= 2.31× 10^6 mm^3= 2.31× 10^{-3} m^3

From Equation (3.1): 7.8 × 10^{-3} = □ / 2.31×10^{-3}

⇒ M = 18.018kg.

Weight of material at Backrest = 18.018×9.81= 176.7565N.

Weight of human upper body part:

Mass of human upper body part from table-2 = 95.04kg.

Weight of the human upper body part = 95.04 × 9.81 = 932.4324N.

Weight of the cushioning and other miscellaneous:

Mass of cushioning and other miscellaneous is 3.5kg (approx.)

Weight of cushioning and other miscellaneous = 3.5× 9.81 =34.335N.

Finally,

Total load from the Backrest = Weight of SS material + Weight of human + Weight of cushion.

= 176.7565+932.342+34.335 =1143.4335≈ 1144N.

Kinematic Analysis on Connecting rod supporting Backrest:

As per the values obtained by the above calculations the net force acting on connecting rod is 1430N which is shown in figure-2

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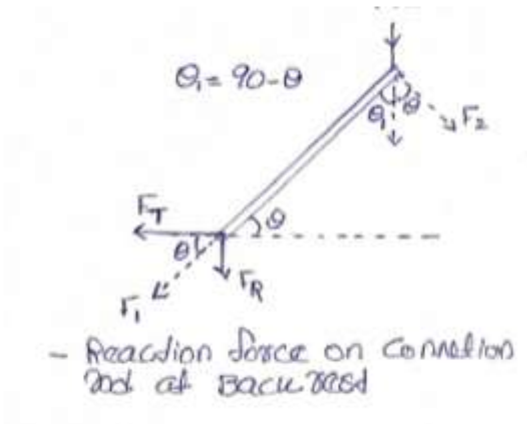

According to the above figure Equations for F_1, F_2, F_T, F_R is given as follows:

F_1= 1144×SinΘ. (3.2)

F_2= 1144×CosΘ. (3.3)

F_T= F1×Cos® (3.4)

F_R= F1×sinΘ. (3.5)

Iteration	**Angle In Degree**	**F_1 in (N)**	**F_2 in (N)**	**FR in (N)**	**FT in (N)**
1	11.2	220.20	1122.2	42.77	216.00
2	18.58	364.51	1084.37	116.14	345.511
3	25.46	491.78	1032.90	211.40	444.02
4	32.34	611.97	966.55	327.36	517.04
5	39.22	723.35	886.28	457.37	560.39
6	46.1	824.31	793.25	593.95	571.57
7	52.98	913.39	688.79	729.27	549.94
8	59.86	989.33	574.41	855.57	496.75
9	66.74	1051.01	451.77	965.58	415.04

10	73.6 5	1097.74	322.04	308.8 1	1052.6 3

According to the above figure Equations for F_1, F_2, F_T, F_R is given as follows:

F_1= 1144×SinΘ. (3.2)

F_2= 1144×CosΘ. (3.3)

F_T= F1×Cos® (3.4)

F_R= F1×sinΘ. (3.5)

By the above tabular column it can be predicted that maximum tangential load acting from the backrest on gear is 1097.74N at 73.65˚.

• Load from the leg rest:

 Density =mass / volume = 7800kg/m^3 –— (Std. value)

Density =7.8× 10^3kg/m^3

Volume of Leg rest metal frame = Cross-sectional area × Total length of material used

= (40× 40 − 30 × 30) × 2530

= 1.771× 10^6 mm^3

=1.771 × 10^{-3} m^3

From Equation (3.1): 7.8× 10^3 = / 1.617×10^{-3}

⇒ M = 13.8138kg.

Weight of material at Leg rest = 13.8138×9.81 = 135.51N.

Weight of the human leg part:

Mass of the human leg part = 9.12kg.

Mass of the human leg part = 9.12× 9.81 = 89.4672N.

Weight of the cushioning and other miscellaneous:

Mass of the cushioning and other miscellaneous =3kg (approx.)

Weight of the cushioning and other miscellaneous = 3×9.81 =29.43N

Finally,

Total load from Leg rest = Wt. of the SS material + Wt. of the Leg. +Wt. of the cushioning.

= 135.51+ 89.4672 + 29 .43 = 254.4N.

Kinematic Analysis on Connecting rod supporting Leg rest:

As per the values obtained by the above calculations the net force acting on connecting rod is 242.62 N which is shown in figure3.

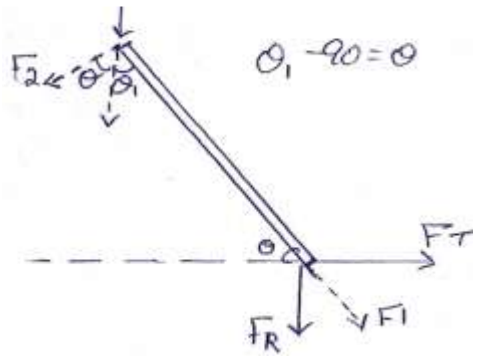

Figure 5.2: Reaction Forces on Connecting Rod at Leg rest

From the above figure Equations for F_1, F_2, F_T, F_R is given as follows:

F_1= 254.4×SinΘ. (3.6)

F_2= 254.4×CosΘ. (3.7)

F_T = F_1×CosΘ (3.8)

F_R = F_1×SinΘ. (3.9)

Weight of the SS material:

F_T= Tangential force on gear.

F_R= Radial force on gear.

Θ= Ranges from 24.08° to 76.19°.

The values of F_1, F_2, F_T and F_R are found and tabulated in Table-4.

Iteration	Angle In Degree	F_1 in (N)	F_2 in (N)	F_r in (N)	F_R in (N)
1	24.08	103.79	232.26	94.75	42.34
2	30.53	129.23	219.13	111.31	65.64
3	37.1	153.45	202.90	122.38	92.56
4	43.61	175.47	184.19	127.04	121.02
5	50.12	195.22	163.11	125.17	149.80
6	56.63	212.45	139.93	116.85	177.42
7	63.14	226.95	114.94	102.53	202.46
8	69.65	238.52	88.46	82.94	223.63
9	76.19	247.04	60.72	58.96	239.89

By the above tabular column it can be predicted that maximum tangential load acting from the leg rest on gear is 127.04 N at 43.61.
Hence, now it can be concluded that the total tangential load acting on the gear is the summation of the maximum tangential force from backrest and leg rest.
i.e.: Load on gear = Load from backrest + load from leg rest
=571.57+ 121.04 =692.61 N.

5.4 POWER, TORQUE & SPEED OF THE GEAR:

For conversion to happen from wheelchair to bed and vice-versa the rack connecting to the connecting rods must displace through a distance of 280 mm in 5 seconds.

Data: (as per design)

Displacement of the rack= 270mm= 0.270m.

Force =692.61N ----- (by kinematic analysis)

Time for displacement= 5secs.

Radius of pinion= 25mm = 0.025m (assumed diameter).

 Power = Work / Time = Force ×Displacement / Time (4.1)

⇒Power= (692.61)*0.270/5

⇒Power=37.40W.

Now,

Torque (T) = Force × Radius of pinion. (4.2)

⇒T=692.61× 0.025

⇒T= 17.31N-m.

Also WKT,

Power = (2×π×N×T)/60 (4.3)

⇒37.40= (2×π×N*17.31)/60

⇒N= 20.632rpm.

∴ For one second speed of Gear or Pinion = 20.632/60 = 0.343rps.

5.5 GEAR DESIGN:

Gear is an essential part of the device since it takes part directly in the conversion of wheelchair to the straight and vice-versa.

The design is made for spur gear with 20° full depth involute.

Data: (as per design)

Displacement of rack= 270mm.

Time taken to displace the rack= 5secs.

For 20°full depth involute, no. of teeth on pinion (z1) =18.

WKT,

Velocity (V) = Displacement (D)/Time (t) (5.1)

⇒ V=270/5= 54mm/sec.

Also,

Velocity (V) = angular velocity (ω) × radius of pinion (r_1) (5.2)

[Assuming radius of pinion (r1) = 24mm]

⇒$V = \omega\times r_1$

⇒54= ω×24

⇒ω = 54/24= 2.25rad/sec.

Speed of pinion (N_1) = □/2π (5.3)

⇒N_1= 2.25×60/2π

⇒N_1= 21.48rpm.

Keeping the velocity ratio (i) = 1.

No. of teeth on gear (z_2) = i×z1= 1×18

Lewis form factor for 20° full depth involute pinion is given by,

y_1= 0.154 - 0.912/z1 = 0.154 - 0.192/18 = 0.103. (5.4)

y_2= 0.154 - 0.192/z2 = 0.154 - 0.192/18 = 0.103. (5.5)

• Identifying the weaker member:

Allowable stress of pinion & gear material σ_o= 207MPa.

Particulars	Allowable stress (σ_o) in MPa	Lewis form factor (y)	σ_o ×y in MPa	Remarks
Pinion	207	0.103	21.32	Weak
Gear	207	0.103	21.32	_

Table 5.4: Identify Weaker Member

Design should be done based on pinion.

• Design:

a) Tangential tooth load:

Ft = 9.55×106×P×Cs/N× r (5.6)

In the above equation,

P= Power=37.40W

C_S= Service factor= 1.5 [for medium shocks of 10 hour/day service].

N= N_1 = 21.48rpm

r = r_1 = d_1/2 = □×z_1/2 = □×18/2 = 9m (5.7)

Equation (5.6) ⇒ Ft =[(9.55×106×37.40×10−3×1.5)/(21.48×9□)]/(21.48×9□)

⇒ Ft =2771/molule (5.8) [where m= module]

b) Lewis equation for tangential tooth load:

Ft= σ_o × b × y × p × K_v (5.9)

Let us take the following factors:

- Lewis form factor(y)= 0.103 [from Equation5.4 & 5.5]
- Face width(b) = 10m (5.10)
- Pitch (p) = πm (5.11)
- C_v = K_v = Velocity factor

Equation (5.9)

⇒F_t= 207 × 10m × 0.103× πm × K_v

⇒F_t= 669.81m^2K_v (5.12)

Equate equations (5.12) & (5.8),

⇒ 669.81m^2K_v =2771/m

⇒m^3K_v=4.14 (5.13)

Now to find module for pinion and gear consider the mean velocity (V_m) as,

$V_m = \pi \times d1 \times N1/60000 = \pi \times m \times 18 \times 21.48/60000 = 0.0202m$ (5.14)

Module (m) = $\sqrt[3]{2 \times (m^3)k_v}$

$\Rightarrow m = \sqrt[3]{2 \times 4.14}$

$\Rightarrow m = 2.1 \approx 3mm$

Equation-7 $\Rightarrow Vm = 0.0201 \times 3 = 0.0603$ mm/sec.

For $V_m \leq 7.5$ m/sec, $K_v = C_v = 3/(3+Vm)$

$\Rightarrow K_v = 3/(3+0.0603) = 0.98$

$\Rightarrow m^3K_v = 3^3 \times 0.98 = 26.486$ (5.15)

For safe design, Equation (5.15) > (5.13)

Hence, Suitable module is 3mm.

- **Dimensions:**
- Pitch diameter of pinion (d_1) = $m \times z_1$ = 3×18= 54mm.
- Pitch diameter of gear (d_2) = $m \times z_2$ = 3×18= 54mm.
- Face width (b) = 10×m= 10×3= 30mm.
- Pitch (p) = π×m = π×3= 9.4247mm.
- Tangential tooth load (F_t) =2771/□ = 2771/3 = 923.66N.
- Addendum of both pinion & gear (h_a) = 1×m =1×3= 3mm.
- Dedendum of both pinion & gear (h_f) = 1.25×m = 1.25×3= 3.75mm.
- Addendum diameter of pinion = d_1+2h_a = 54+2×3= 60mm.
- Addendum diameter of gear = d_2+2h_a = 54+2×3= 60mm.
- Dedendum diameter of pinion = d_1-2h_f = 54 - 2×3.75= 46.5mm.
- Dedendum diameter of gear = d_2-2h_f = 54 - 2×3.75= 46.5mm.

VI. WORKING

Gear racks are used to bring linear motion from a rotating movement.

Gear-rack keeps transverses while the pinion kept stationary and where the pinion rotates on a steady-axis, the gear-rack moves.In the object, rack and pinion is houses at the block and so that is the important part

Figure 6.1: Rack and Pinion

VII. CONCLUSION

The design of chair is compact and useful for several people that area unit disabled with palsy malady. they will build use of this chair with none external aid or a caretaker. thus this is often a multi-functional healthful aid that specialize in the advance and self-reliability of palsy patients. Modifications created within the prevailing instrumentality meant for the disabled ones can he nice use in forthcoming time and that we were in a position apply our theoretical data into apply. All information provided area unit precise to the simplest of our ability,

The project was aimed toward planning and fabrication of chair for palsy patients which will overcome the shortcomings of a ideal chair, with specialize in value reduction and utility. The model presents a chair that's controlled with none electrical elements to supply most functions to palsy patients. The chair may be controlled by the palsy patient alone and lever is employed to steer the chair, creating the movement and management of the chair simple for a palsy patient. this can facilitate the palsy patients to attain social respect from the society by doing little works and can increase mental strength. it'll facilitate the patients to possess relief from palsy condition.

Through the project work, we have a tendency to gained loads of sensible data concerning coming up with. Purchasing, machining and aggregation. we have a tendency to feel that this project objective could be a sensible downside free to the convenient link in between establishment and also the industries.

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