DESIGN & FABRICATION OF AUTOMATIC LEVEL ADJUSTABLE STRETCHER

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ABSTRACT

In India mobility aids are useful for patients for transportation and a replacement for walking especially in indoor and outdoor environment. Stretchers are the most commonly used medical equipment for the transportation of patients. Transferring the patients from stretcher or to the medical bed is always an issue for the attendant or nurse during climbing inclined surface. 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 moving on inclined surface. There is a need for a level adjusting stretcher to facilitate the disabled patient's mobility and to provide novel medical equipment for use in the Indian hospitals. Adopting various kinds of research methods helped to obtain more information about hospital mobility aids and for data collection. It has been observed that every year the numbers of disabled individuals are increasing by different kinds of accidents. The presently old stretcher designed is not meeting the user's need. From the identified need, new features like level adjustable stretcher which can be introduced.

Keywords: medical equipment, level adjustment, stretcher, patient's transportation.

INTRODUCTION

Hospital beds used by health care professionals are operated manually in most cases, which require some physical effort. In last few decades it is mainly focused that minimizing risks caused by among others mistakes and indisposition of the medical personnel occurring during the transport of patients in life-threatening conditions. Solutions include automation of bed movement by means of motorized devices, for both functional and transport purposes. In addition, it concerns devices that will allow the transfer of a patient from one bed to another or from a bed to a wheelchair, devices providing periodic automatic change of a lying patient's position in order to prevent the emergence of bedsores and advanced automated wheelchairs. The technical development of this kind of devices and their application in the hospital environment are facing many difficulties and limitations. This work presents a design solution for the hospital bed height adjustment mechanism developed within the objectives related to the requirements set for one of the hospitals. The main objective for the mechanism design is to provide comfort and safety for the patient as well as for the medical personnel when performing diagnostic tests.

A hospital bed specially designed for patients or others in need of some form of health care. These beds have special features both for the comfort and well-being of patient and for the convenience of health care workers. Common features include adjustable height for the entire bed, the head and the feet, adjustable side rails and electronic buttons to operate both the bed and nearby devices. While designing hospital beds the most important parameter is safety of patient

PROBLEM STATEMENT

It is generally observed that, during patient carrying on stretcher in inclined slope ramp, the stability of patient is not maintained. To overcome this problem we are going to design and manufacture automatic position adjusting bed, to improve patients comfort and safety.

OBJECTIVES

1. Our plan is to research existing model's hospital beds and to analyze the components and functions of each. We will also survey to determine additional features that could be useful in a modern hospital bed and then begin the design process
2. To improve quality, safety, efficiency and effectiveness and to provide safe and therapeutic environment.
3. Incorporate more flexible design to minimize the risk and impact of patient falls. To provide stability and easy to use controls for the patient but is also built to satisfy the needs of patient.
4. To have a position convenient for resuscitation in case of emergency this ensures patients safety. Improve the aesthetics of bed while maintain no additional costly components

SCOPE OF THE PROJECT

Flat beds cause improper spinal alignment which causes great discomfort during movement in stairs. In some cases, viz. slope, irregular road surfaces, ups and downs on the corridors, bed becomes inclined. To make a stretcher for the ease of transportation & to provide comfort during operation.

METHODOLOGY

1. Finding and collection of research paper and related case studies, detail study of research paper
2. Describe the area in which innovation or project can be done, finalize the idea for the project, Design and modelling software required for the same.
3. To generate virtual model in modelling software and analyze different condition occurring while loading.
4. Find and collect material or component required for the project, check the suitability of the collected devices such as sensors.
5. Final actual setup of project.

LITERATURE REVIEW

A] Fajobi M. O., Awoyemi E. A. and Onawumi A. S.,Ergonomic Evaluation of Hospital Bed Design and Anthropometric Characterization of Adult Patients in Nigeria, By studying this research paper we conclude that there are various problems encountered in the process of sleeping. It also reveals the prevalence study has reveal the of back pain fatigue, blood circulation disorder , sleep discomfort of patients. They have done a survey on Nigerian peoples. Peoples are selected from different ages, weights, different height and from different fields. And by considering need of all of them they have conclude some dimensions for the beds. [1]

B] Md. Ariful Islam, Md. Asadujjaman, Md. Nuruzzaman and Md. Mosharraf Hossain, Ergonomics Consideration for Hospital Bed Design: A Case Study in Bangladesh, From this research paper we have studied that which factors are responsible for discomfort on hospital beds. They conduct a test at rajshahi medical college and hospital, Bangladesh. Data of 35 doctors and 35 patients has been collected to determine the relationship between patients' physical demand and anthropometric factors related to normal hospital bed through

independent test. They have calculated mean and standard deviation and correlation equation have calculated for some pairs of data set. [2]

C] Ireneusz Malujda, Dominik Wilczyński, Krzysztof Talaśka, Dominik Wojtkowiak, Maciej Szulc Study of the prototype mechanism of height adjustment of the bed in hospital bed, from this research paper we have understood the in most cases beds are operated manually which requires some physical effort. So by using bed neck height adjustment mechanism they can provide safety and comfort for the patients also reduces fatigue of the worker. They have design a height adjustment mechanism by using hydraulic cylinder and done a kinematic analysis on the design and they manufacture a hospital bed. [3]

D] Güzide Güzelbey Esengün & Cem Alppay Guzide Esengun:"A study on examining user comfort in hospital beds". From this research paper we have studied the comfort related problems on hospital beds. This study is constructed in two main parts. In the first part hospital beds comfort evaluation tool is determined with help data from various sources such as literature review, a product design decomposition and a semi structured interview study. In second part, based on this criterion, a hospital bed comfort checklist is developed. This study is used in order to have a broader view about comfort evaluation from different products and different areas. [4]

DESIGN

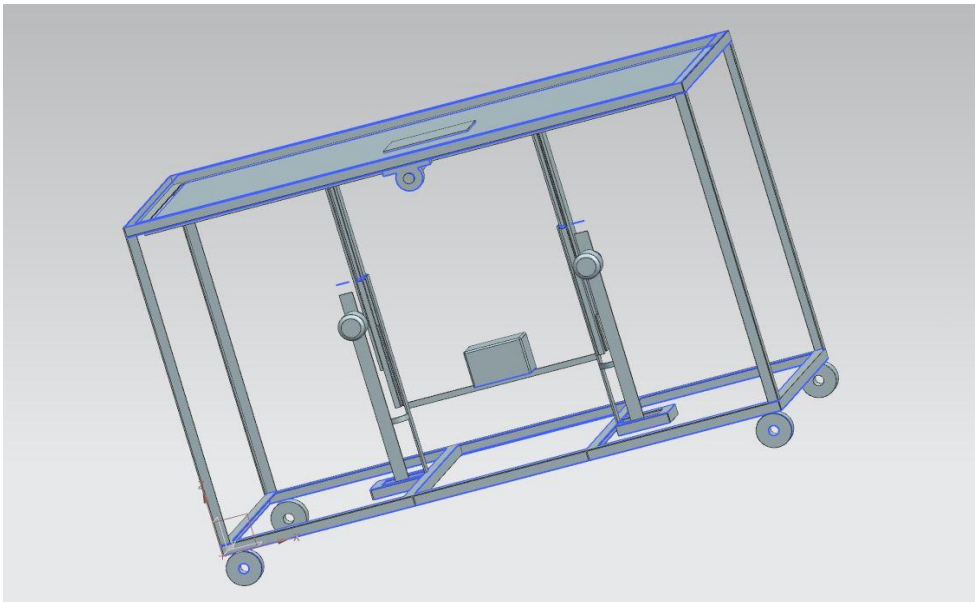

Fig. System Design

System Development :

Calculation:

1. **Central Shaft design**:

For shaft material C40 P.No. 1.12.DDB.

Sut = 680Mpa.

$$\tau \text{ max} = \frac{\text{Sut}}{2 \text{ x FOS}} = \frac{680}{2 \text{ x } 2} = 170 \text{ N/mm}^2$$

Design torque T = Force X distance from center.

= (2 x 9.81) x 450

T = 8829 N.mm

T = 8.829N.m

Tensional shear stress $T = \Pi/16 \times \tau \times d^3$

$T = \Pi/16 \times \tau \times d^3$

$8829 = \Pi/16 \times 170 \times d^3$

d =6.419mm **select d=10 mm.**

2. Selection of Ball Bearing:

In selection of ball bearing the main governing factor is the system design of the drive i.e.; the size of the ball bearing is of major importance; hence we shall first select an appropriate ball bearing. Taking into consideration convenience of mounting of ball bearing. As shaft diameter is 10 mm so we have welded a supporter of shaft 10mm to it & selected a ball bearing having shaft outer dia-10mm ball bearing to support the shaft of 10mm.

Total radial load on bearings **= Assume = 2kg = 19.62 N**

Radial load on each bearing **Fr** = 19.62 /2

= 9.81 N.

Equivalent dynamic load

Pe = V.Fr.Ka

= 1 X 9.81 X 1.5

Pe = 14.715 N

bearing life is,

$$\mathbf{L^{10} = \frac{Lh10 \times 60 \times n}{10^6}}$$

L_{h10} from graph 4.6 PSG Design data book for 10 rpm maximum speed of ball bearing is 200000 Hours.

$$\mathbf{L^{10} = \frac{31500 \times 60 \times 10}{10^6}}$$

L^{10} = 120 millions of revolutions.

$$L^{10} = \left(\frac{C}{Pe}\right)^{\left(\frac{10}{3}\right)}$$

$$C = (L10)^{\left(\frac{10}{3}\right)} \times Pe$$

$C = (120)^{(0.3)} \times 14.715$

C = 71.43 N. ≤ 4000 N (Bearing is Safe)

PSG Design data book P.No. 4.13.

3. Spur gear system:

No teeth on pinion Zp=25

Material of gear & pinion both are nylon, DDB. P No.1.41.

Sut p =82 N/ mm^2

Application factor ka = 2

Load distribution factor km= 1

Factor of safety Nf = 1.5

BHN = 24

Power P = 50 Watt.

Np= 60 rpm

Beam strength (δb)

6bp $= \frac{Sup}{3} = \frac{82}{3} = 27.33\ N/mm^2$

Assuming 20^0 full depth involution system,

Yp=0.484 - $\frac{2.87}{Zp}$=0.484 - $\frac{2.87}{25}$ = 0.3692

Now, δ_{bp} . Yp = 27.33 ×0.3692= 10.0902 N/mm^2

Estimate the module on based on beam strength,

Sb ≥ P eff

Sb = beam strength

P eff = effective load on pinion.

Sb = P eff x FOS

P eff = Pt

Pt = Tangential load on pinion.

P eff = Pt = $\frac{2\ X\ maximum\ torque}{No.of\ teeth\ X\ module}$

$= \frac{2\ X\ Mt}{Z\ X\ m}$

$= \frac{2\ X\ 7.95\ X\ 1000}{25\ X\ m}$

P eff = Pt = $\frac{636}{m}$ = N.mm ---------- (1)

Beam strength of pinion.

Sb = module X face width X Max. bending Load X Lewis factor

Sb= m x b x $\frac{Sut}{3}$ x Yg b = 10m

m= $\frac{\frac{Cs}{Cv}\ Pt\ X\ Fs}{b\ X \frac{Sut}{3}\ x\ Yg}$

= $\frac{\frac{636}{m}\ X\ 1.5}{10m\ X\ 27.33\ x\ 0.3692}$ Solving by above equation

m= $\frac{954}{100\ m^2}$

m^3 = 9.4546

m = 2.1145mm.

Select module of Indian standard P.No. 1026. R.S. Khurmi.

4. **Dimensions of gear -**

m = 2.5

Z_P = 25

B = 10 m = 2.5 mm

Dp = m×zp = 2.5×25=62.5mm

ha = 1m = 2.5mm

hf = 1.2m = 3 mm

5. Motor selection:

F = for e to be applied on each slide = 1 kg = 9.81 N. (Assume)

T = Torque transmitted by the motor N.m.

Design torque T = Force X distance from center.

= 9.81 x 450

T = 4414.5 N.mm

T = 4.4145N.m

P = Power of motor

N = Speed of the motor = 60 rpm. (Assume)

$$P = \frac{2 \Pi N T}{60}$$

$$= \frac{2 \Pi \times 60 \times 4.415}{60}$$

P = 27.73 Watt.

Thus selecting a motor of the following specifications

- **12V DC motor**
- **Power =50 watt**
- **Speed= 60 rpm**

Motor Torque

$$P = \frac{2 \Pi N T}{60}$$

$$T = \frac{60 \times 50}{2 \Pi \times 60}$$

T = 7.96N-m

Power is transmitted from the motor shaft to the rack by means of a pinion gear.

CONCLUSION

While concluding this report, we feel quite fulfill in having completed the project assignment well on time, we had enormous practical experience on fulfilment of the manufacturing schedules of the working project model. We are therefore, happy to state that the in calculation of mechanical aptitude proved to be a very useful purpose. Although the design criterions imposed challenging problems which, however were overcome by us due to availability of good reference books. The selection of choice raw materials helped us in machining of the various components to very close tolerance and thereby minimizing the level of balancing problem. All motor mountings and couplings were properly adjusted. In the future, we would like to expand features & application of large scale model in order optimize its performance. Needless to emphasis here that we had lift no stone unturned in

our potential efforts during machining, fabrication and assembly work of the project model to our entire satisfaction to solve the problem in industrial field for social welfare.

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