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Design of Modified mattresses for patient handling in Hospital

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Abstract

In present day, we see in maximum hospital, transfer of patient from one place to another place that time require maximum labor work. during patient handling, patient and hospital staff suffers from many problems like stresses are produced in the body, some time it occur that sleep down the patient. It is required to eliminate such types of possibilities

The present research work proposes a design and development of modified mattresses for patient handling. By using such modification we can easily transfer the patient from one place to another without any problem. We can totally eliminate the problem occur at the time of handling of patients. By using design of modified mattresses and stretcher, we can develop the mattresses and stretcher without any defect.

Keywords: Modified mattresses, Trolley cum Stretcher, Hospital bed.

Introduction

Now In hospital we see the, for various checkups, patient transfer from one place to another place. As per the demand required for better living quality of immobilized patients, for that should be improved the hospital mattresses for patient handling. Generally immobilized patients transfer by labour or nursing staff. Patients handling in various places are a labour intensive work. It is very dangerous for patient and hospital staff, if all transfer activity not done in exact manner. Mostly hospitals use fully atomized beds & stretcher for the patient handling. These are costly and cannot be affordable to all the hospital. At the time of patient handling, the stresses generated in patient & staffs are same for all the hospital. Our aim to provide a better solution for patient handling.

According to recent survey in hospital, it found that, 38% of nursing staff and labour suffers work from back injuries , 12% of nursing staff and labour suffer from low back pain at average age 39. Any other staffs suffer from any other various injuries.

The present working proposes designing of a new trolley cum stretcher along with the modified mattresses which will totally eliminate the handling of immobilized patients.

Identification of Problem
Present Method of Patient Handling

In hospital The patient transfer from various places like from Ambulance to O.T./ ICCU/X-ray centers /MR scan / Sonography can be proceed through various stages.

Patient transfer From accident spot to Stretcher:-
When accident is happen. Patient Transfer From accident spot to stretcher.

patient transfer From Stretcher to Ambulance:-
The patient handles from stretcher to ambulance by using three to four persons.

Patient transfer From Ambulance to Hospital stretcher:-
When patient come in hospital after accident, after that patient move from ambulance to stretcher by using man power.

patient transfer From Stretcher to bed at O.P.D.:-
After that Patient move from ambulance to O.P.D. ward by using stretcher with the help of three to four persons.

Patient transfer From O.P.D to ICCU/ward bed:-
After that Patient transfer in other places By using Stretcher with the help of labour As per The requirement like O.P.D. To ICCU/Ward Bed.

Patient transfer From From O.P.D. to X-Ray centre / MRI / SCAN / Pathology centre :-
Then after Patient transfer from one place to another for checkups like O.P.D. to X-Ray

Centre/ MRI / SCAN / Pathology centre.

Patient transfer Back to the bed of ICCD/Ward bed :-
Lastly patient is move back by following
Reverse above Steps.
Present method of Patient handling from Ambulance to stretcher

Step I:-

Step II:-

Step III:-

Step IV:-

Fig1:- Present method of patient transfer

This is the general method which is adopted in hospital when accidental case comes.

The Problem Associated with above Patient handling

- When the patient is required to move on the same floor, he is wrapped in cotton bed sheet and sifted by three to four labour . Due to the handling, stresses are generated in the body of both i.e. patient as well as the nursing staff. Some time cramp may be produced in backbone and other parts of the human body.
- During manual handling of the patient various accessories like blood transmission facility, oxygen supply, saline facility, are not available and this may create various problem if the patient is in serious condition.
- When the patient is to be transfer from one place to another place, that time if the movement of the patient is on inclined plane that time chances to sleep down the patient from stretcher.

The above problems produced at the timing of patient handling which can be eliminated by developing a new trolley to handle the patients and modifying hospital mattresses.

Formulation of Problems
As per the demand of safely patient handling and for better living quality of patients we can improve the hospital mattresses. Movement of unmovable patients is usually the work of labor. Transfer of patients in various places is a labor or hospital staff work and which is very dangerous for patient, if inappropriate patient handling is not done.
For safely movement of patient we proposed the following assembly of trolley cum stretcher and modified mattresses.
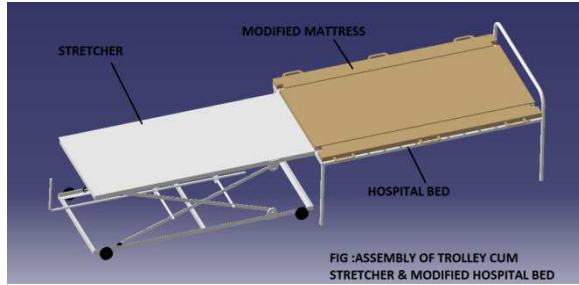
Fig 2: Assembly of modified Mattresses and trolley cum stretcher

To move the patient from trolley to hospital bed following procedure is adopted.

Step-I-
Bring the trolley to near the hospital bed and match the height level with hospital bed by using scissor mechanism and screw jack mechanism.

Step-II-
When levels is match with hospital bed then after take the patient with new modified mattress from stretcher.

Step-III-
With the help of modified mattress When patient take from stretcher, then after patient settle down on hospital bed.

Step-IV-
The same procedure can be adopted for transfer of patient.

Trolley cum stretcher
By using such type of modified stretcher we can done the up-down movement of stretcher. Due to such type of arrangement we can easily match the height level of stretcher with the hospital bed. In this we provide the scissor mechanism with screw jack mechanism. Scissor mechanism is used for adjusting the height of Trolley.
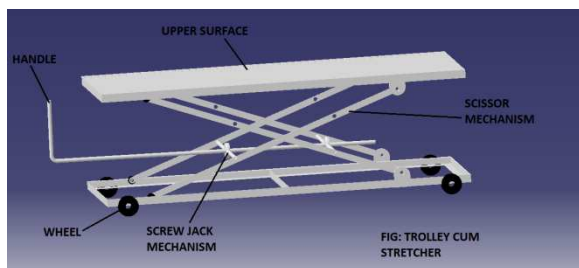

Fig 3 : Trolley cum stretcher

The clockwise rotation of handle increases the height level of trolley. This whole mechanism plays the role by lead screw, mechanism used to lift heavy weight to considerable height. The height of trolley is required to be adjusted according to the height level of hospital bed/ sonography bed /operation table bed.

Modified Hospital Mattresses
The main aim of design of trolley cum stretcher and modified hospital bed is to minimize the manual handling of patient.

In this we use the modified stretcher. For the modification of the hospital mattress we used the layer of foam and aluminum square tube. In this aluminum square tube play the very important role at the time of patient handling. Due to aluminum square tube mattress cannot form sagging shape. It maintains the straightness of mattress.
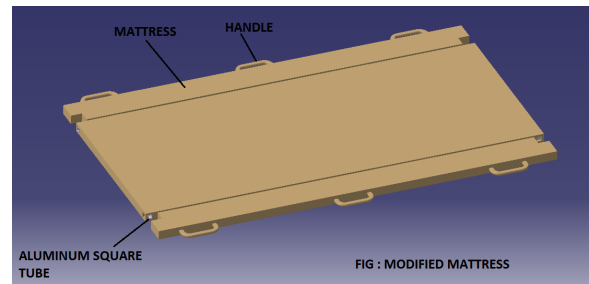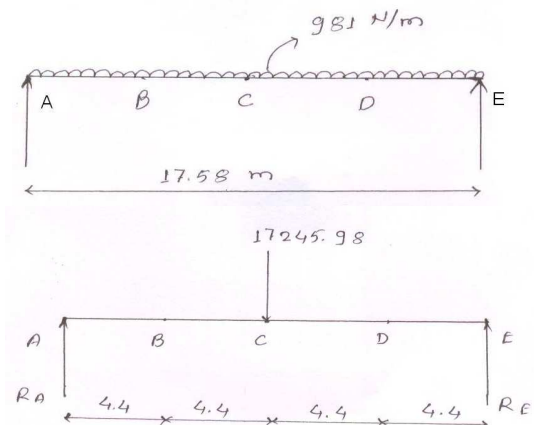

Fig 4 : Modified mattresses

As per the demand of safely transfer of patient from bed to stretcher or stretcher to bed, by using aluminum square tube we modified the mattresses. As per the demand mattress should be light weighted.

- **Design of trolley cum stretcher and modified mattresses.**
- **Bending moment and shear force of rectangular square beam.**

Find out reaction forces
RA = (-RE X 17.58) + (17245.98 X 8.8) = 0
RE = 8622.99 N-M
RA + RE = 17245.98 N-M

RA = 8622.99 N-M
Find out the shear forces
    PT. E = -8622.99 N-M
    PT. D = -8622.99 N-M
    PT. C = -8622.99 + 17245.98 = 8622.99 N-M
    PT.B = -8622.99 + 17245 =8622.99 N-M
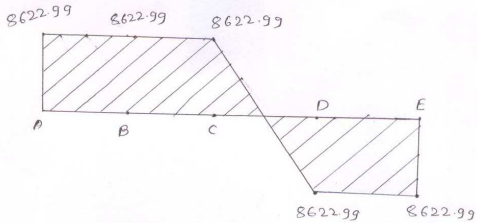   PT.A = -8622.99 + 17245.98 = 8622.99 NM
Shear force diagram

Fig 5 :- Shear force diagram

Bending moment of various point
    PT.E = 0 N-M
    PT. D = (-8622.99 X 4.4) = -37941.2 N-M
    PT.C = (-8622.99 X 13.2) + (17245.98 X 4.4) =
    -37941.2 N-M
    PT. A = 0 N-M
Bending moment diagram
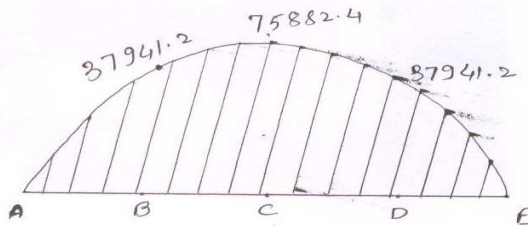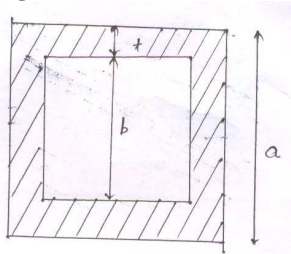

Fig 6 :- Bending moment diagram
Maximum bending moment occur at
PT. C = 75882.4 N-M

- **Design of aluminium square tube for 75882.4 N-M bending moment.**

Bending formula
$$\frac{M}{I} = \frac{6}{Y}$$
Moment of inertia for square tube =
I = (a^4 – b^4)/12
Section modulus for square tube =
z = (a^4 – b^4)/6a
Distance from axis to extreme fibre = y =a/2
Stress = 6 = f/a

= 981/(1758 x 512) = 2.17 x 10^-13 n/mm^2
Put all the value in equation
$$\frac{M}{I} = \frac{6}{Y}$$
(75882.4 / (a^4 – b^4)/12)   = 2.17 x 10^-13 /
(a / 2)
Assume thickness of square tube = t = 3mm
Then a = b+3
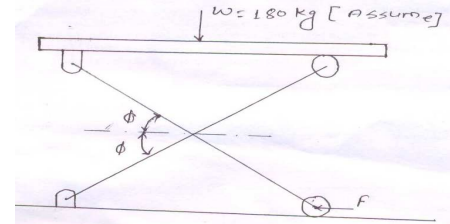Put all value in above equation
b = 30 mm
a = 33 mm
Required square tube is 33 x 33 x 3 mm.
Design of scissor jack.

Forced provided by jack screw
F = (w + W) / 2 tan φ
Where,
F = force provided by jack screw
W = total wt. of object & load platform
L = length of each scissor arm
W = total wt. of scissor arm
φ = angle between scissor arm
4.3.3.1 Calculate the wt. of scissor arm

    Wt. of scissor arm = mass x gravity
    Where dimension of the scissor arm
    Width of arm = 30 mm
    Thickness of arm = 2mm
    Length of arm = 1225 mm
    Angle between arm = 25 deg.
    Material of arm = mild steel
    Density of mild steel = 7850 kg/m^3
    Wt. of the four arm = 4 x 5.62 = 22.49 kg
Calculate the force required by lead screw.
    F = (w + W) / 2 tan φ
    = (180 + 22.49) / 2 tan 25
    F = 217.2 N
Design of lead screw
    Given
    W = 220 N
    Lift distance = l = 150 mm
    Material = mild steel
    Syt = 448 mpa
    Sys = 224 mpa
    E = 184 x 10^3 mpa
    Sdt = 448 / fos = 448 / 2 = 224
    Sds = 224/2 = 112

4.3.4.1 Calculate the torque req. to raise the load
Using rankines formula for columns

$$Syt = (Fcr/A)[1 + (1/an)(l/k)^2]$$

Where,

$A = \pi/4 \times dc^2$

$K = dc/4$

$L = 150$ mm

$n = 0.25$

$a = \pi^2 \times e/syt = (\pi^2 \times 184 \times 10^3) / 448 = 4053.58$

fcr = 220/2 (for both end fixed)

fcr = 110 N

DC = 3.26 = 3.5 MM

From the chart of normal series square thread

For dc = 3.5 mm

Dm = 4 mm

Pithch = p = 0.5 mm

Torque required to raise the load

$$T = (Fxdm/2)[(l + \pi udm)/(\pi dm - ul)]$$

Where f = 220 n

Dm = 4 mm

L = np = 1 x 0.5 = 0.5 mm

n = no. of start = 1

u = safe value = 0.26

T = 135.133 x 1063 N-MM

4.3.4.2 Calculate the stresses

1. Compressive stresses $(\sigma c) = 4f/\pi dc^2$
   $= (4 \times 220)/\pi / 3.5^2 = 22$ mpa
2. Max. shear stress$(\tau max) = 16T/\pi DC^3 = (16 \times 135.133)/\pi \times 3.5^3 = 16.05$ MPA
3. Principal stress $(\sigma 12)$
   $= (\sigma c/2) + \sqrt{(\sigma c^2 + tmax^2)}$
   $=(22/2) + \sqrt{(22^2 + 16.05^2)}=38.23$ mpa

4.3.4.3 Calculate the handle diameter

Sdt = σb = m/z   z= $(\pi d^3)/32$

Sdt = M/$(\pi d^3/32)$ = MX32/(πD^3)

Torque will be acting as bending moment

Sdt = (T X 32)/πd^3

$224 = (135.133 \times 10^3 \times 32)/\pi D^3$

d = 18.31 mm

Select the diameter of handle

d = 20mm

Conclusion & Further Suggested Work

Advantages of Trolley cum Stretcher & Modified mattresses

1) By using such type of modified trolley we can minimize the problem occur during patient handling
2) By using such type of modified trolley we can reduce the stresses produced in nursing staff

Limitations of Trolley cum Stretcher

1) Initially The cost of this project will be high because required to replace all the conventional hospital bed with new one bed.

2) Extra care has to take at the time of patient transfer.

Conclusions

As per the above describe information we concluded that now day More hospitals are use fully atomized hospital beds & stretcher for the patient handling and such type of fully automated instrument are very costly and cannot be affordable to all the hospital owner. During the handling, stresses developed in patient & staffs are same for all the hospital. Our aim to eliminate all such type of possibility which occurs during patient handling and for that required to provide a better solution for the handling of patient to these hospitals whose are having limitations for the use fully automated beds & stretcher. As per the above problem generated at the time of patient handling we provide modified mattresses for patient handling and Cost of such type of mattresses is affordable for all type of hospital and it is beneficial for patient handling.

Future Work

1) Development of trolley cum stretcher.
2) Development of modified mattresses

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