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DESIGN AND ANALYSIS OF PATIENT LIFTER MACHINE

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Abstract

One of the most crucial elements of the medical recovery process is the management and transportation of patients. Patient handling and lifting mistakes can result in serious injuries to the patient. For example, lifting, transferring, repositioning, and moving patients without using the right techniques or handling equipment might result in musculoskeletal injuries. Additionally, lifting patients can hurt the nurses and other hospital workers and demand more manpower (stronger people). While handling and transporting patients, both the nursing staff and the patient may grow weary. In order to safely lift, lower, or move patients with the least amount of labor and with the least amount of risk, we have developed a flexible patient handling.

Keywords: Hydraulic, handling, transport, lift/lower, patient

1. INTRODUCTION

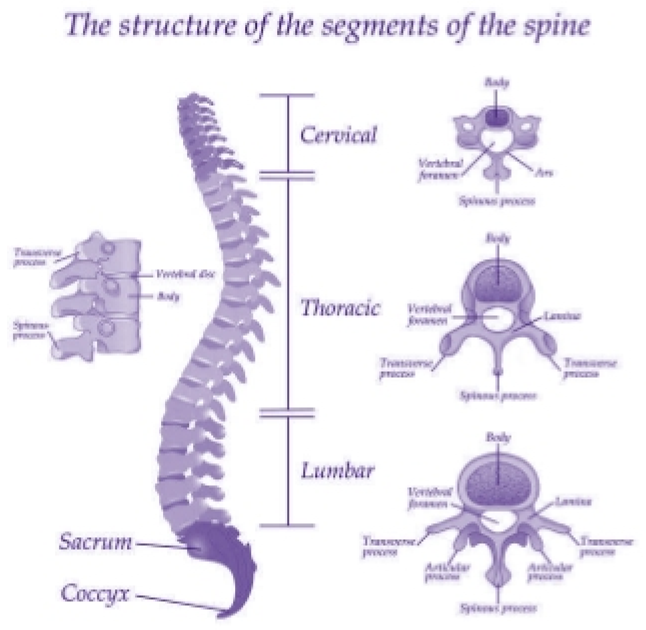
Systems of health care are crucial to a high standard of living. Any nation, even a developing one like India, needs to provide adequate healthcare services, but due to the country's enormous population, doing so is a challenging and complex undertaking. The following is the current state of Indian healthcare.

• The majority of hospitals in India document medical details manually, making it challenging to manage the massive amount of data produced. Patient records are hard to access in larger facilities.

• In the Eleventh and Twelfth Five-Year Plans, the government has made significant progress on strengthening the healthcare system. The following chapter discusses the actions that the government has taken. However, access to healthcare varies throughout states and population demographic groups.

Although patient handling accidents involving healthcare personnel and patients are completely avoidable, they nevertheless cost health care organizations a lot of money in many different nations. Despite this information, managing high-risk patients persists, and healthcare firms are routinely among the top three worst-performing industries in terms of employee disabilities. The dearth of instruments for assessing patient handling systems is one element that leads to this predicament. When changing standard procedures, health care organizations need a solid evidence base, particularly when it affects patient care. Injury rates and audit scores have been used by organizations to assess patient handling system components; however, these indicators are meant to measure results, not system components per se. In addition, workplace culture is not assessed or tracked by audits or injury rates.

Fig. 1:



Design Analysis & Calculations

A 5-point support is proposed to lift the patient. These five points will be located as shown in Fig. 1.

1. Neck joint,

2. Spinal cord (2 supports)

3. Pelvic joints,

4. Ball-socket joint of knee muscle extensions.

- We use a hydraulic system to ensure effortless lifting and lowering with the least amount of effort. The apparatus is equipped with a hydraulic cylinder and pump. With the use of this hydraulic system, the patient can be raised or lowered. The purpose of the pump is to raise or lower the patient by amplifying the operator's physical force.
- The use of a hydraulic system allows for gradual and smooth lift and lowering of the patient, improving patient delicacy and lowering the possibility of bone or muscle damage.
- There is a wheel base available for moving the device with or without the patient.
- The device's design prevents it from toppling over or losing equilibrium by maintaining its center of gravity at all times.
- The patient is carried on a bed that is seven feet long. This guarantees the patient's safe handling and transportation. In order to ensure the safety of the patient being lifted, we are attempting to achieve a balance where the center of gravity is positioned at the base frame.
- A hydraulic cylinder equivalent with a lifting capacity of approximately 2.5 tons is computed for utilization .(Taking into account the safety factor 5)
- Every joint in the structure is arc welded, and the right level of welding finesse will be achieved.

Data Analysis

The average weight of the patients and the relative lifting force needed to raise them are displayed in the table 1 below.

Table :1

Sr. No.	Age	Weight of patient(Kg)	Relative lifting force(N)
01	10 – 18	32 TO 64	320 to 640
02	18 – 45	45 to 80	450 TO 850
03	45 – 84	55 to 74	550 to 740

Maximum Lifting Capacity

Hydraulic Cylinder lifting capacity – 1500 Kg or 14715
Length of Lifting Arm – 750 mm
Type of joint – Pivot

- Load at 50 Kg = 490.5 N

Effective Load at the cylinder = Length of arm x Load
= 0.75 m x 490.5 N
= 367.8 N-m

Considering Factor of safety of 5

Load to be lifted by cylinder = Effective load x 5

= 367.8 x 5

= 1839 N

- Load at 100 Kg = 981 N

Effective Load at the cylinder = Length of arm x Load
= 0.75 m x 981 N
= 735.75 N-m

Considering Factor of safety of 5

Load to be lifted by cylinder = Effective load x 5
= 735.75 x 5
= 3678 N-m

- Load at 100 Kg = 981 N

Effective Load at the cylinder = Length of arm x Load
= 0.75 m x 981 N
= 735.75 N-m

Considering Factor of safety of 5
Load to be lifted by cylinder = Effective load x 5
= 735.75 x 5
= 3678 N-m

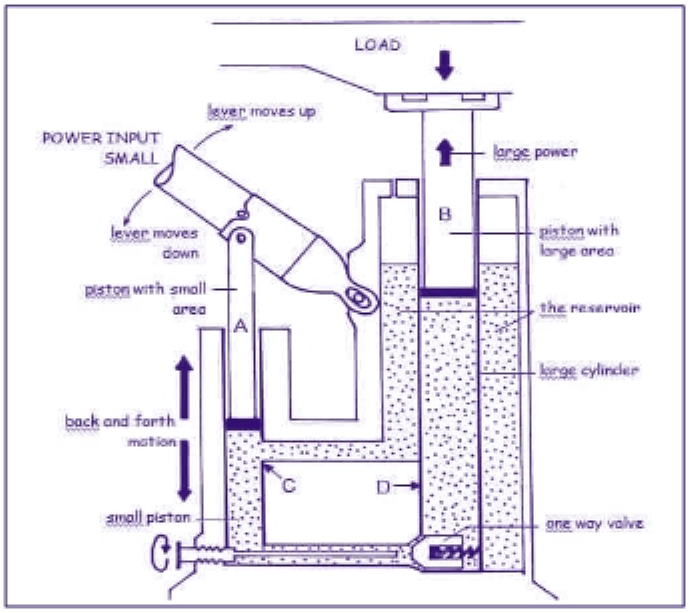
- Load at 200 Kg = 1962 N

Effective Load at the cylinder = Length of arm x Load
= 0.75 m x 1962 N
= 1471.5 N-m

Considering Factor of safety of 5
Load to be lifted by cylinder = Effective load x 5
= 1471.5 x 5
= 7357.5 N-m

Maximum load that can be lifted by device = 14715 N
Effective Load at 50 Kg = 1839 N
Effective Load at 100 Kg = 3678 N
Effective Load at 200 Kg = 7357.5 N
Effective Load at 400 Kg = 14715 N
Hence Max load lifting capacity of the device (with a FOS of 5) is 400 Kg

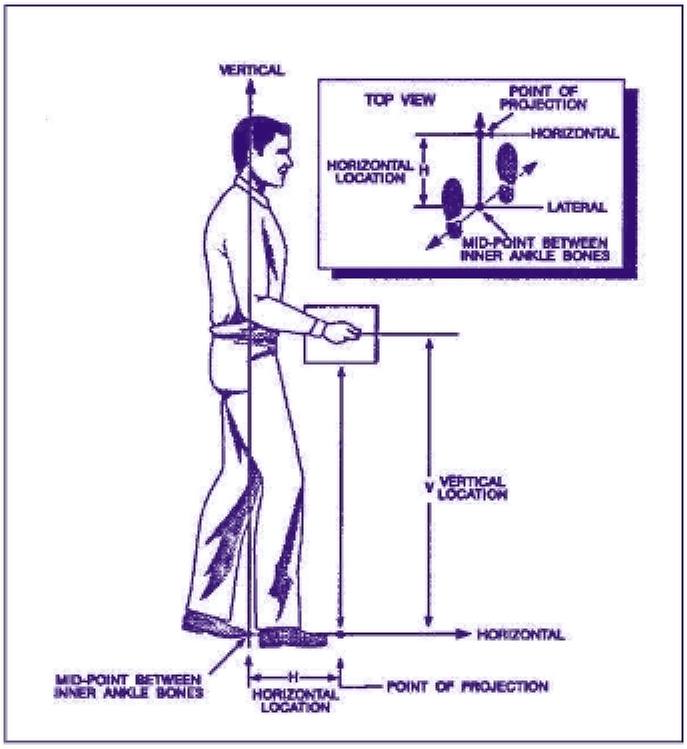
Fig. 2:



The layout of the handling and control components

One of the project's key components is handling and controlling the device. To guarantee that handling is done with the least amount of effort, the ideal height must be reached. Through Fig. 2, there are some human characteristics that guarantee the greatest force applied with the least amount of effort. The image below The ideal pushing height and the average footstep length covered in each step are shown in Fig. 3.The handle's implied sine angle allows the user to exert maximum force with minimal effort. The lateral force is dependent on the angle of inertia.

Fig. 3:



Operating Principle

- A1800 x 900 mm base frame is constructed with 40 mm OD square pipe, which has a thickness of 1.5 mm. The base frame is fabricated using the arc welding process.
- To ensure proper constraint of any momentum incurred within the column, a 50 mm x 50 mm side vertical box column is erected on the base frame. The column is welded to the base frame and has cantilever and lateral supports.
- To obtain a longitudinal degree of freedom, a lifting arm is attached to a vertical column by pivoting its base against the column. As a result, the lifting arm can only move in one direction—that is, up or down.
- A horizontal cuboid with a locking mechanism, constructed from MS Angle measuring 35x35x5 mm, is welded at the end of the arm. To support the lifting bed, a horizontal support beam is inserted through this cuboid.
- The lifting bed is then fastened to the apparatus using forged and cast hooks that are fastened to the beam. These motion-constrained hooks guarantee a secure grip on the bed and prevent the bed from moving.
- The lifting bed has a greater lifting capacity and is made of synthetic nylon straps woven both vertically and horizontally to ensure strength. In order to guarantee appropriate load distribution and enable the patient to be handled with ease, these straps are woven together..
- These beds are made to ensure that the patient is comfortable to some extent while being handled and does not experience any discomfort.
- At the base of the lifting arm is a hydraulic element that allows the handler to lift and lower the patient with the least amount of effort.
- There is a handle to raise and lower the patient.
- Patients can therefore be handled safely because the procedure ensures a smooth landing and lifting of the patient.

RESULTS

BUCKLING STRENGTH OF LIFTING ARM

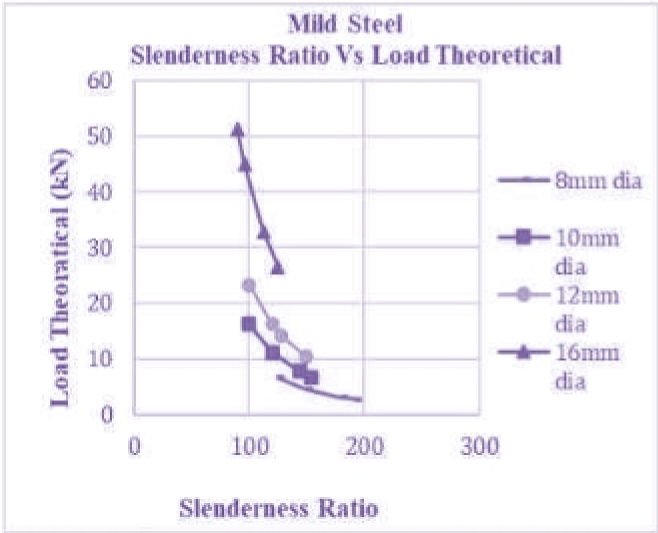


Chart -1: Mild Steel Slenderness Ratio Vs Load Theoretical

Table 2:

SR NO.	WEIGHT OF PATIENT	TIME REQUIRED TO LIFT (AT MAX HEIGHT)
1.	48 kg	7.7 Sec
2.	63 Kg	7.8 Sec
3.	78 Kg	8.0 Sec
4.	92 Kg	9.1 Sec
5.	108 Kg	9.4 Sec

Table 3:

SR NO.	WEIGHT OF PATIENT	TIME REQUIRED TO LOWER (AT MAX HEIGHT)
1.	48 kg	5.0 Sec
2.	63 Kg	4.7 Sec
3.	78 Kg	4.6 Sec
4.	92 Kg	4.1 Sec
5.	108 Kg	4.0 Sec

CONCLUSION

- We have effectively devised and manufactured the automated patient lifter apparatus.
- Hydraulics, mechanical stresses and analysis, manufacturing processes, and medical analogies of the human body are some of the components that make up the learning process.
- Considering the factor of safety of five, we have observed that the maximum load that can be lifted is 400 kg. We have effectively acquired a variety of practical skills related to project management and will endeavor to apply them in our upcoming endeavors.

FUTURE SCOPE

- As of right now, all manual operations for our device—such as lifting the patient and moving or handling this—require some effort. We intend to motorize the entire apparatus so that managing the patient won't require any manual labor.
- Since the necessary costs and fabrication are high, we would like to lower the manufacturing cost.
- In the future, a fully motorized automated lifting and lowering mechanism will be available.

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