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ELECTRICAL AND MECHANICAL ENGINEERING

DESIGN, ANALYSIS AND FABRICATION OF A SEMI-AUTOMATED MEDICAL BED WITH ASSISTED PATIENT CARE TRANSFER SYSTEM

A PROJECT REPORT

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ABSTRACT

Bed is the one piece of equipment nearly everyone working in, or using health care service will come into contact with so the right bed can enhance the quality of life of those who use them. When the patient come from operation theater after he goes through difficult surgery operation or suffered from hard fractures, so the patient transfer process very difficult and painful. So, the aim of this study is to design a motorized patient bed to move patient carefully without needing many medical staff. Low-cost bed is designed for a patient. Bed is attached to the linear screw and motor with high torque and suitable speed. This bed is electrically operated with 12V supply. The patient's bed is pushed to the second bed by using conveyer belt.

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CHAPTER 1: INTRODUCTION

1.1 Project Overview

The use and demand of medical bed is becoming increasingly popular for hospitals, health care centers and at homes in the recent times. The term medical bed is defined as "*bed used for patients (as in a hospital) that can be adjusted specially to raise the head end, foot end, or middle as required*". The use of special medical bed is widely important in hospitals and health care centers because it forms basis for fast, safe and injury less recovery of patient. Moreover, Medical beds have other advantages of durability, enhanced sleep comfort, reduced stress on caregiver etc. There are many types of medical beds, each of which has its own pros and cons. We have selected the semi-automated medical bed that is well suited for hospitals and homes. This type of medical bed has manual height control but automated leg and head adjustment. It requires an attendant to operate. We have simulated the medical bed on solid works which is quite effective and efficient tool to model structure. Here we have applied different loads and analyzed the effect on the motor's speed. The output is finally displayed in form of table and graphs.

1.2 Problem Statement

The problem statement of our project is:

"To transfer the patient from one bed to another without any chances of injury."

A single patient at rest is our target. Electric beds combine comfort and functionality to make life easier for users and caregivers carrying out any duties. The electrical bed plugs into an outlet, and the user controls it with a remote attached to the side of the bed. The drive system must operate with a VDE-approved power source – 220V, 50/60Hz mains socket. The power drives the user's ability to put the bed in different positions, eliminating the physical labour one would need to operate a semi-electric or manual hospital bed. Adjustable positioning allows the user to increase the backrest elevation to up to 90 degrees. The lower part of the bed can also be adjusted, which can help increase comfort and circulation in the lower limbs. The power makes hospital beds easy to adjust. The user can reshape the position themselves using a hand controller without relying on a health care worker or family member to do it for them. On top of the control, one has over the bed's feet and head, they can also change the height of an electric bed. If they need to get out of bed, they can lower the mattress to make the process safer; it can then rise to let caregivers reach the patient. The added freedom of movement can improve the user's feelings of independence. For caregivers, there are safety features to keep patients secure. The hand controller, for instance, has a locking function on the back of the device, which the caregiver can operate with a key switch.

1.3 Approach

There are multiple methodologies to approach this problem statement of patient transfer. However, the basic working principles of patient transfer remain the same. Since our basic consideration is to design and analyze the transfer system, we can model our project in two possible ways:

1. Lateral movement of bed.
2. Horizontal movement of bed

Both of these approaches transfer the patient with same accuracy and hence results can be verified from ANSYS or MATLAB.

1.4 Methodology

The mission for this project was to design a reliable hospital bed for use in Pakistan that can be manufactured domestically. With the completion of this project, we hoped that our bed design could be widely used throughout hospitals in Pakistan. We hope that by domestically manufacturing the bed, the price of the bed will be drastically reduced and allow for affordable modern health care to be provided to a significant portion of population.

Initially, we gathered literature from a number of resources regarding existing bed designs from nations with reputations for manufacturing reputable beds such as the United States and Japan and from a nation with a poor history of bed design. Upon collection of existing designs, we developed design matrices to determine what made a reliable hospital bed and which qualities the bed of our choice would employ and then developed CAD drawings using Solids Works. Once successful completion of blueprints was developed, we manufactured a working prototype of our bed and then ran cross analyses for structural stability, stress resistance and other mechanical properties to ensure the bed's safety.

The team's ultimate goal of designing a reliable domestic hospital bed will be achieved through the subsequent completion of the following goals.

1. To analyse all existing bed products and determine which are of the highest quality in relationship to price.
2. To fabricate our own design for lateral movement.
3. To manufacture a prototype of our bed alterations.
4. To determine and support the overall quality of the hospital bed.

1.5 Goals and Objectives

The goals and objectives of our project is:

1. To understand the functionality of medical bed
2. To study and explore the hospital bed applications for patient safety and care
3. To understand the theory and working principle of different patient transfer systems
4. To implement the knowledge gained by different transfer systems to fabricate a new transfer system
5. To design and analyze a functional transfer system of patient
6. To fabricate a fully functional medical bed for the patients

1.6 Specifications

Since our project is an small scale project designed for young children, therefore, there are multiple specifications given based on it.

1. The size of the bed is 4*3 foot.
2. The height of the bed is manually adjusted.
3. Maximum load carrying capacity is 15kg.
4. The bed is having wheels so it can be moved anywhere easily.
5. The bed can be used with the existing medical bed in hospital.

1.7 Organization of Thesis

The project thesis starts with stating the application of medical bed, highlighting the purpose and need to model and study the project. It then states the basics of hospital beds, types of hospital beds including special medical beds. The use of lateral transfer of patients in our case is justified in a detailed manner. Furthermore, the thesis highlights the requirement of such transfer system in our hospitals. The calculated and simulation results are also included. Along with that, the hardware applications are mentioned to emphasize the prospects of the project.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

In healthcare, around 5000 manual handling injuries are reported each year handling injury accounts for 40% of all sickness A Royal College of Nursing (RCN) study identified that 52% of manual handing accidents involve hospital beds. Typically, they happen while moving patients up or down the bed, helping them to sit up or turning them in bed. A hospital bed or hospital cot is a bed specially designed for hospitalized patients or others in need of some form of health care. These beds have special features both for the comfort and well-being of the 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 other nearby electronic device. Type of medical beds Hospital beds and other similar types of beds such as nursing care beds are used not only in hospitals, but in other health care facilities and settings, such as nursing homes, assisted living facilities, outpatient clinics, and in home health care. Beds with adjustable side rails first appeared in Britain sometime between 1815 and 1825.[1]. In 1874 the mattress company Andrew West and Son, Cincinnati, Ohio, registered a patent for a type of mattress frame with a hinged head that could be elevated, a predecessor of the modern-day hospital bed. [2]. Dr. Willis D. Gatch (1878-1954), Chair of the Department of Surgery at the Indiana University School of Medicine, invented this Gatch bed or the adjustable hospital bed. So, if you are looking for the inventor of the modern adjustable hospital bed, I would say Willis Gatch the modern push-button hospital bed was invented in 1945, and it originally included a built-in toilet in hopes of eliminating the bedpan. [3] Side rails, if not built properly, can be of risk for patient entrapment. In the United States, more than 300 deaths were reported as a result of this between 1985 and 2004 [4]. As a result, the Food and Drug Administration has set guidelines regarding the safety of side rails. [5]. WHO defines a hospital bed as a bed that is regularly maintained and staffed for the accommodation and full-time care of a succession of inpatients and is situated in wards or a part of the hospital where continuous medical care for inpatients is provided. The total of such beds constitutes the normally available bed complement of the hospital. Counts of available hospital beds exclude cots for neonates, day care beds, provisional and temporary beds, beds in storerooms, and beds for special purposes such as dialysis or delivery. Total inpatient hospital beds are all hospital beds which are regularly maintained and staffed and immediately available for the care of admitted patients.

2.2 Type of medical bed

There are 5 main types of medical beds (manual, semi-electric and full electric) and others that are more specialized (such as bariatric beds).

2.2.1. Manual:

Hand cranks are used to raise and lower the head and the foot of the bed as well as to adjust the height of the bed. These beds are the most economical and a good choice for people that do not require frequent repositioning. Hand cranks are typically found at the foot of the bed and require a person that is physically capable to operate.

Fig(2.1) :Manual medical bed

2.2.2. Semi-electric

An electric motor is used to raise and lower the head and foot portion of the bed .patients and caregivers adjust the positioning by pressing buttons on a hand pendant. the height of the bed is adjusted manually with a hand crank and will require some one that is physically able use it. Semi- electrical beds are ideal for people that do not require the height of the bed to be adjusted often but will benefit from tough of a button positioning.

Fig(2.2) :Semi-Electric medical bed

2.2.3.Full Electric:

Height and positioning of the bed is controlled by the patient and/or caregiver with a hand pendant and does not require the use of a hand crank (unless there is a power outage, but many beds now have a back-up battery that would power the bed in emergency situations). Full electric beds make it easier for patients to get in and out of bed or raise the bed to a comfortable height for the caregiver to tend to the patient or to change linens.

Fig(2.3) :Fully Electric medical bed

Often full electric beds have more positions available such as Trendelenburg, reverse Trendelenburg and cardiac chair positions.

Trendelenburg position: The position where the patient is lying on flat on their back and the bed deck and mattress are tilted so the patient’s feet are higher than their head by 15 to 30 degrees. Trendelenburg position may help with circulation.

Reverse Trendelenburg position: The position where the patient is lying flat on their back and tilted so that their head is positioned higher than the feet by 15 to 30 degrees. This position may help with pressure relief and breathing.

Cardiac chair: Cardiac chairs were first designed to help people recover from heart surgery or respiratory illnesses. Studies have shown that heart surgery patients tend to recover faster when they spend a portion of the day in an upright, seated position but have to reach that position slowly and with the least amount of movement. It is easier for patients to breathe and circulation may be improved in a seated position. Cardiac chairs move from a flat position into a seated position with minimal movement to the patient and at a speed controlled by the patient or caregiver. A hospital bed with this position available means that the bed can reach an upright, seated position in the same way.

2.2.4. Adjustable Hospital Beds

Adjustable Hospital Beds come in a wide variety of options; they are beds that are designed to look like normal beds but include the functions of a home hospital bed. These beds come in a variety of sizes – all the way from twin to king. If you are looking to furnish a room with a hospital bed as a permanent feature and want aesthetic value, adjustable hospital beds are the way to go.

Fig(2.4) :Adjustable medical bed

2.2.5. Specialty Hospital Beds

Specialty hospital beds are upscale hospital beds with features that most closely resemble the beds you will see in a hospital. With plastic railings, advanced positioning options, staff-embedded controls and whisper-quiet operation, these hospital beds bring the latest technological advances to the homecare setting. If you are looking to purchase a specially hospital bed, you will be paying more than a standard electric hospital bed – however, you will get what you pay for: an upgraded level of features and quality.

Fig(2.5) :Special medical bed

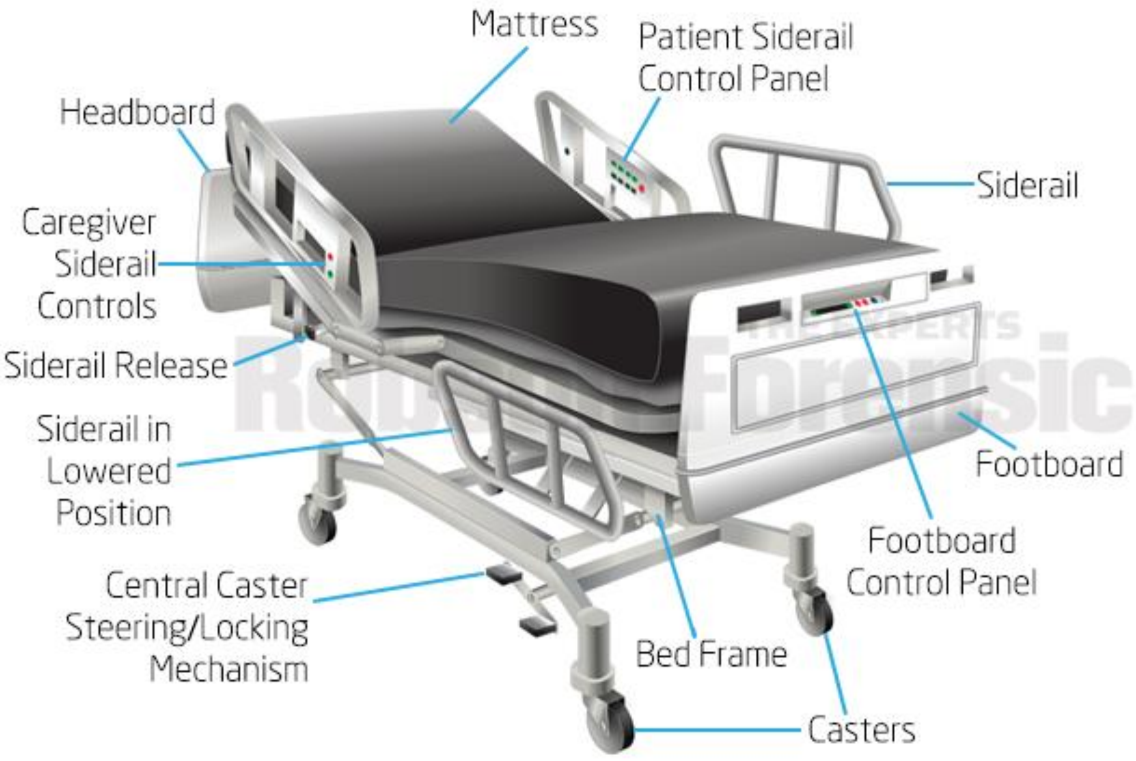
2.3 Use of medical beds in Hospitals

Hospital beds are designed and constructed to provide safety, comfort, and mobility for a broad range of patients with varying conditions and treatment plans. While the adaptability and versatility of hospital beds and related safety devices allow caregivers to meet the diverse needs of their patients; care must be taken to ensure necessary user training, inspection protocols, and routine maintenance and safety checks are followed.

2.3.1 Hospital bed anatomy & safety features

Bed frame features such as height and position adjustments, casters, and adjustable bed rails distinguish hospital beds from standard beds. Modern hospital beds incorporate a range of safety features that are designed to protect against fall and pressure injuries, assist with patient positioning and mobility, and alert caregivers of a potential mishap. The benefits of these safety features can only be realized through proper training of caregivers and reinforcement of safety protocols.

Patient height, weight, ability to move, diagnosis, and comorbidities must be considered when choosing a hospital bed. After identifying a bed that meets the anthropometric and capacity needs of the patient, providers utilize risk assessment tools (such as the Morse Fall Scale and Braden Risk Assessment Tool) to determine if a patient requires a specialized bed with safety features to assist in preventing falls and/or pressure injuries.



Fig(2.6) :Medical bed Anatomy

2.3.2 Adjustable settings

Adjustable height settings are a fundamental safety feature of hospital beds. Raising the bed height can reduce the need for patient assistance when standing from a sitting position. Adjusting the bed height can enable a patient to improve balance while seated at the edge of the bed, and lowering the bed height to its lowest height position can reduce the severity of injury in the event of a fall.

Hospital bed frames are usually repositionable in segments. The head of the bed can often be raised independent of the segment of the bed supporting the lower extremities. An additional function enables the knee portion of the bed to be elevated, thereby preventing a patient from sliding into a slouched posture when the head of the bed is elevated. Proper positioning affects the quality of a patient’s respirations and is essential for patients suffering from pulmonary compromise due to disease, illness, or injury. Caution, however, must be used when using the adjustable settings on a hospital bed when seating a patient on the edge of the bed as it can create an uneven surface affecting seated balance.

2.3.3 Hospital bed mattress options

Hospital beds commonly have a standard mattress consisting of foam and springs, encased in a protective impermeable cover. To accommodate specific patient needs, several alternative surface options are available. The most common alternative mattress is known as an "air mattress." Air mattresses are one intervention commonly assigned to patients having wounds or at risk for pressure injury. Air mattresses are usually powered by external blowers which enable the air pressure within the mattress to be increased or decreased, thereby adjusting the firmness of the mattress. When adjusted appropriately, air mattresses allow a patient to partially 'sink' into the mattress accomplishing distribution of pressure over a greater surface area of a patient's body. When adjusted too firm or too soft, however, the intended benefits of an air mattress can be negated and lead to new or progression of existing pressure injuries.

While air mattresses can offer the patient improved skin protection, they can be more difficult for patient transfer due to surface instability and lower surface friction. Air mattress characteristics and features vary by manufacturer, and should be considered when selecting this intervention to address patient risks.

Settings such as bed height, mattress positioning, and firmness are utilized to maximize comfort and safety for the individual patient's needs. Some specialty mattresses include options for rotation, oscillation, and percussion to assist with managing respiratory secretions. Alternative bed surfaces can optimize skin protection; however they do require appropriate operator settings and do not replace regular repositioning which would relieve pressure on vulnerable areas.

2.3.4 Hospital bed rails & safety devices

Rails on hospital beds are adjustable and are often used to assist in turning and repositioning patients, providing a secure hold grasp for patients, and reducing the risk of fall injuries. However, rails are also associated with strangulation and entrapment injuries, pressure injuries, and more serious fall incidents if a patient climbs/rolls over the barrier or if the rails are not appropriately positioned. Bed rails are not intended as attachment points for restraints. Assessment by the patient's health care team is necessary to determine if and how rails should be utilized to keep the patient safe.

Additional safety devices used in conjunction with hospital beds include floor safety mats, alarms, bolsters, and lighting. Floor mats can be used to attenuate impact in the event of a fall and various alarms can be used to notify health care providers if a patient has left the bed or changed positions. Bolsters or wedges are used for positioning to reduce pressure injuries, and can also provide safety against falls. Specialized lighting can be used to reduce patient confusion associated with waking in a dark unlit room. The patient's care team is responsible for determining the necessary and appropriate hospital bed safety devices that meet the individualized needs of the patient.

2.3.5 Maintenance and inspections

Hospital beds are considered Durable Medical Equipment (DME) and require routine inspection and maintenance. Federal or State laws and regulations (including Life Safety Code requirements adopted as part of Federal regulations) may either require that equipment maintenance (including maintenance, inspection and testing) be performed in accordance with the manufacturer's recommendations, or establish other maintenance requirements. Bed manufacturers and the Department of Health and Human Services direct owners to have hospital beds inspected by a qualified professional, such as a clinical or biomedical technician or engineer.

1. Common areas for inspection and maintenance include:
2. Bed rails for proper positioning and stability
3. Brakes for engagement and ability to prevent unintended motion during transfers
4. Casters for swivel and roll during transport
5. Mattresses for condition and ability to maintain intended position and surface pressures.

2.4 Lateral transfer of patients

Transfers are defined as moving a patient from one flat surface to another, such as from a bed to a stretcher. Types of hospital transfers include bed to stretcher, bed to wheelchair, wheelchair to chair, and wheelchair to toilet, and vice versa.

A bed to stretcher transfer requires a minimum of three to four people, depending on the size of the patient and the size and strength of the health care providers. Patients who require this type of transfer are generally immobile or acutely ill and may be unable to assist with the transfer.

Patient care transfer can be defined as moving a patient from one flat surface to another. The most common patient transfers are from a bed to a stretcher and from a bed to a wheelchair. While seemingly intuitive, successful patient transfers rely on understanding each patient's specific needs while simultaneously adhering to evidence-based guidelines. Patient care transfer can also be defined as transferring patients within the same facility and between facilities.

Patient care transfers are an essential yet often neglected aspect of patient care. Patient care transfers are an indispensable aspect of patient care, requiring rigorous adherence to clinical guidelines. Proper transfers are based on the concept that focuses on maintaining continuity of care both during and after the transfer.

Fig(2.7) :Lateral Patient Transfer

Depending on the complexity, patients often receive care in multiple settings during and after hospitalization. While some aspects of patient transport vary depending on the patient's status, intrahospital transports are inevitable, particularly in critically ill patients. Poorly organized patient transfers can result in increased morbidity and mortality and should be performed with careful attention.

2.4.1 Procedure and problems with lateral transfers

A traditional lateral transfer is performed hundreds of times a day throughout all hospital departments, including ICU, imaging, emergency, surgery, and other medical units. Total care patients are unable to move their body weight from one surface to another. This situation results in the nursing staff physically moving the patient.

This move is performed in one of two ways. With the first method, the nursing staff grabs a hold of a sheet that is positioned underneath the patient. All staff members lift up on the draw sheet and physically lift the patient to another surface. In cases where fewer staff members are present, nurses use a plastic board and pull the draw sheet underneath the patient onto the other surface.

Both of these methods require a great deal of movement and strength from the nursing staff. This typically results in nursing injury in the form of back pain. With so many medical staffers undergoing musculoskeletal injuries, it has become clear that manual patient handling tasks need to be replaced with more efficient methods.

After the pre-transfer checklist is complete, the transfer from a bed to a stretcher may be performed according to the following steps:

1. Identify the number of staff required for the transfer (typically 3-4 providers for a bed-to-stretcher transfer)

2. Explain what the patient can do to help the procedure (hands crossed over the chest, chin tucked, etc.) and obtain necessary supplies

3. Raise/lower the bed to a safe working height, lock the brakes, lower guard rails, and position the patient closest to the side of the bed where the transfer will take place

4. Place a sheet on top of the slider board; this is used to transfer the patient onto the stretcher and decrease friction.

5. Roll the patient over to the side opposite to the stretcher and place the slider board underneath the patient, such that the board is between the patient and the bed

6. Roll the patient back into the supine position, make sure the patient is cantered on the slider board and that the feet are in a straight position

7. Bring the stretcher to the side of the bed near the patient and position the stretcher slightly lower than the bed. Lock the brakes of the stretcher.

8. Position the healthcare team such that the patient’s weight is distributed evenly

I. Two on the side of the stretcher, grasping the sheet placed over the slide board

II. One at the head of the bed, grasping the pillow and the sheet.

III. One at the far side of the patient, between the chest and the hips

IV. An additional one can be at the foot of the bed.

9. The leader of the healthcare team will initiate the transfer, counting 1, 2, 3

    I. The provider on the far side of the bed will push the patient.

    II. The two providers on the side of the stretcher will shift their weight from front to back, bringing the patient with them by pulling the sheet.

    III. Meanwhile, the providers at the head and foot of the bed will ensure that the patient is secured, lifting the head/shoulders and feet, respectively.

10. Continue to slide the patient until the patient is on the stretcher's centre.

11. Remove the slide board from underneath the patient by rolling the patient over to the side opposite the bed. Make sure the patient is comfortable and covered with sheets.

12. Raise the guard rails and adjust the stretcher height.

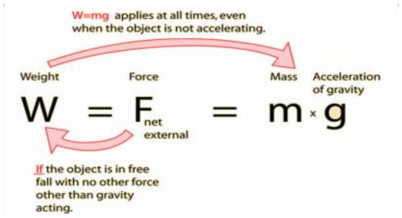
Chapter 3 Theory

3.1. Mass and Weight

The mass of an object is a fundamental property of the object; a numerical measure of its inertia; a fundamental measure of the amount of matter in the object. Definition of mass often seem circular because it is such a fundamental quantity that it is hard to define in terms of, length, and time. The usual symbol for mass is m and its SI unit is the kilogram. While the mass is normally considered to be an unchanging property of an object, at speeds approaching the speed of light one must considered the increase in the relativistic mass

3.1.1 The weight

Weight is defined as the force of gravity on the object and may be calculated as the mass times the acceleration of gravity w= mg. Since the weight is a force, its SI unit is the newton. For an object in free fall, so that gravity is the only force acting on it, then the expression for weight follows from Newton's second law.



Fig(3.1) :Relationship between Weight, Force and Mass

3.2. Force:

One of the foundation concepts of physics, a force may be thought of as any influence which tends to change the motion of an object. Our present understanding is that there are four fundamental forces in the universe, the gravity force, the nuclear weak force, the electromagnetic force, and the nuclear strong force in ascending order of strength. In mechanics, forces are seen as the causes of linear motion, whereas the causes of rotational motion are called torques. The action of forces in causing motion is described by

Newton's Laws under ordinary conditions, although there are notable exceptions. Forces are inherently vector quantities, requiring vector addition to combine them. The SI unit for force is the Newton, which is defined by Newton = kg m/s2 as may be seen from Newton's second law.

3.3. Causes of Motion

The influences which cause changes in the motion of objects are forces and torques. The effects of forces on objects are described by Newton's Laws. A force may be defined as any influence which tends to change the motion of an object. The relationship between force, mass, and acceleration is given by Newton's Second Law:

F=ma---------------------(1)

Newton's First Law states that an object will continue at rest or in motion in a straight line at constant velocity unless acted upon by an external force. Newton's Third Law states that all forces in nature occur in pairs of forces which are equal in magnitude and opposite in direction.

3.4. Density

Density is defined as mass per unit volume. Data can be entered into any of the boxes below. Specifying any two of the quantities determines the third. After you have entered values for two, click on the text representing to third to calculate its value.

$$P=\frac{m}{V} \text{ --------------------(2)}$$

3.5. speed

What's the difference between two identical objects traveling at different speeds? Nearly everyone knows that the one moving faster (the one with the greater speed) will go farther than the one moving slower in the same amount of time. Either that or they'll tell you that the one moving faster will get where it's going sooner than the slower one. Whatever speed is, it involves both distance and time. "Faster" means either "farther" (greater distance) or " sooner" (less time).

3.6. The velocity

In order to calculate the speed of an object we need to know how far it's gone and how long it took to get there. the velocity the rate of change of displacement with time.

Rotational speed (or speed of revolution) of an object rotating around an axis is the number of turns of the object divided by time, specified as revolutions per minute (rpm), cycles per second (cps), radians per second (rad/s) Tangential speed v, rotational speed ω and radial distance r, are related by the following equation:

$$\mathbf{V=2\pi\ r\ \omega} \text{ ------------------(3)}$$

$$\mathbf{V=r\ \omega} \text{---------------------(4)}$$

An algebraic rearrangement of this equation allows us to solve for rotational speed:

$$\omega = \frac{V}{2\pi} \text{-----------------------(5)}$$

$$\omega = \frac{V}{r} \text{-----------------------(6)}$$

Thus, the tangential speed will be directly proportional to r when all parts of a system simultaneously have the same ω, as for a wheel, disk, or rigid wand. It is important to note that the direct proportionality of v to r is not valid for the planets, because the planets have different rotational speeds (ω).

3.8. The Friction

Friction is the force resisting the relative motion of solid surfaces, fluid layers, and material elements sliding against each other. There are several types of friction:

- Fluid friction
- Lubricated friction
- Skin friction
- Internal friction and dry friction

Friction is divided into

1.Static Friction Formula

2.Kinetic Friction Formula

3.8.1. Static Friction Formula

Static friction is a force that keeps an object at rest. It must be overcome to start moving the object. Once an object is in motion, it experiences kinetic friction. If a small amount of force is applied to an object, the static friction has an equal magnitude in the opposite direction. If the force is increased, at some point the value of the maximum static friction will be reached, and the object will move. The coefficient of static friction is assigned the Greek letter "mu" (μ), with a subscript "s". The maximum force of static friction is μs times the normal force on an object.

$$\boldsymbol{F_s \leq \mu_s\ \eta}\text{----------------}\mathbf{(6)}$$

$$\boldsymbol{F_{s\,max} = \mu_s\ \eta}\text{-------------}\mathbf{(7)}$$

F_s = force of static friction

μ_s = coefficient of static friction

η = normal force (Greek letter "eta")

≤ means "less than or equal to"

$F_{s\,max}$ = maximum force of static friction

3.8.2. Kinetic Friction Formula

Kinetic friction is a force that acts between moving surfaces. An object that is being moved over a surface will experience a force in the opposite direction as its movement. The magnitude of the force depends on the coefficient of kinetic friction between the two kinds of material. Every combination is different. The coefficient of kinetic friction is assigned the Greek letter "mu" (μ), with a subscript "k". The force of kinetic friction is μk times the normal force on an object, and is expressed in units of Newtons (N).

$$f_k = \mu_k \eta\text{--------------------}(8)$$

f_k = force of kinetic friction

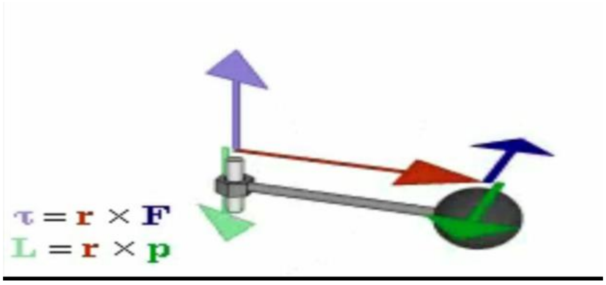
μ_k = coefficient of kinetic friction

η = normal force (Greek letter "eta")

3.9. The Torque

Torque, moment, or moment of force is the rotational equivalent of linear force.[1] The concept originated with the studies of Archimedes on the usage of levers. Just as a linear force is a push or a pull, a torque can be thought of as a twist to an object. The symbol for torque is typically τ, the lowercase Greek letter tau. When being referred to as moment of force, it is commonly denoted by M.

Relationship between force F, torque τ, linear momentum p, and angular momentum L in a system which has rotation constrained to only one plane (forces and moments due to gravity and friction not considered)



Fig(3.2) :Relation between Torque and Force

In three dimensions, the torque is a pseudovector; for point particles, it is given by the cross product of the position vector (distance vector) and the force vector. The magnitude of torque of a rigid body depends on three quantities: the force applied, the lever arm vector connecting the origin to the point of force application, and the angle between the force and lever arm vectors. In symbols:

$$\tau = r \times F \text{---------------------(9)}$$

$$\tau = ||r||\ ||F|| \sin\theta \text{----------------(10)}$$

r is the position vector (a vector from the origin of the coordinate system defined to the point where the force is applied) F is the force vector, The SI unit for torque is N·m.

4. CHAPTER FOUR: DESIGN

4.1 Previous Designs

Regularly changing lateral position for bed ridden patients can provide certain benefits and shorten the length of stay for patients in hospital has been studied for years [1-3]. For immobilized patients, this treatment would decrease the potential to get sequential illness such as pressure sore and constipation etc. A low air loss based rotational products like air mattress are usually used for this purpose. However, air mattress is vulnerable for sharp objects, which are frequently used in medical treatment in hospital. Therefore, mechanical apparatus which incorporated or separated from main bed and utilize bed sheet as media to turn patient laterally were introduced. Comparing with air mattress, the mechanical apparatus could be more rigid and reliable, but air mattress could be light weighting and flexible. Several apparatuses for transferring immobilized patient were seen in hospital. A hoist-like device separated from main bed, to lift patient, or a second bed, put aside of main bed, to carry the patient by a pulling device operated by caregiver was used during transferring process. The last is lifting mechanism, installed on the ceiling, to convey patient from main bed to another bed or wheelchair.

4.2 Selecting the Best Bed Design

After we had completely reviewed all of the existing products available from companies in Jordan and Pakistan it was time to select a bed design. This bed design would be the one that most closely fit our ideal design for use in hospitals. We went about deciding on the bed design by comparing the beds currently available.

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In order to properly assess a bed design for the demands of the hospital, we had to develop and appropriate matrix for evaluation. Each bed was ranked on a scale of 1-10 and each category had a certain percentage of importance for the overall function of the bed. The most important consideration was the satisfaction of the Curatorial Industry Standards to minimize ambiguities between what the hospitals used and the recommendations of the government. Durability and safety provided the second most important components for design intent because current beds produced in industry are frowned upon for their proneness to failure while the safety of patients and staff is an obvious necessity. Poor durability of the beds increases their maintenance requirements thus, contributing to additional costs, another important consideration in the bed design.

Manufacturability, cost and ease of operation provided the next largest sets of data for comparison. Manufacturability, or the opportunity to easily reproduce the bed is an important component so that a high number of beds may be mass produced.

A list and brief summary for each measure considered in the performance and determination of a good bed is as follows:

4.2.1 Curatorial Industry Standards:

Includes recommendations for articulation angles, size of safety rails and end rails, height variances for bed, etc. This is the most important consideration because most beds in world follow these standards and they are a large component of hospitals' inclination to purchasing certain medical/surgical beds.

4.2.2 Durability:

Durability includes the longevity and lifespan of the bed under normal working conditions, ranging anywhere from two years to twenty. Durability considers the material(s) the bed frame is designed from, the reliability of the type of motors used in electronic beds, and the ease and cost of reparability amongst other functions.

4.2.3 Safety:

The safety of the hospital bed designs is a large consideration at 15% because if the beds provided by hospitals do not promote a healthy lifestyle for recovery the length of stay for the patients may be longer, injury may result to patient and/or staff and lawsuit liabilities are an option. The safety of each bed was determined by the material selections, compliance with CIS and FDA standards, stress analyses on the weakest sections of the beds and the functions provided in case of emergency, for instance the ability to achieve the Trendelenburg position.

4.2.4 Ease of Manufacturing:

Ease of manufacturing is a significant consideration in bed design for a number of reasons, most notably the resultant profit margin that would result from the production ratio, number of workers needed, development of unique parts, etc. Manufacturability was determined by the reproducible components on each bed, difficulty for assembly, estimated number of workers to complete each bed and approximation of time for completion of each bed.

4.2.5 Ease of Operation:

Today's fast-paced world requires expediting processes as much as possible and in the hectic and crowded Chinese atmosphere, there is little time to waste while working in the hospital. One of the ways to reduce the nurse-to-patient time ratio is to make the beds easy to operate and easy to learn to operate. Although electronic beds have an advantage because the motors can move faster than any human, the hand cranked beds should be simple to use and as quick and efficient as possible.

4.2.6 Ease of Transportation:

The ability to relocate a bed for surgeries, medical emergencies, room changes and other necessities is a concept very lowly regarded in American hospitals which have very limited spatial constraint problems. Chinese hospitals however are filled to capacity and the navigability of the hospital beds is rather important to fit as many beds as possible into an area. Transportation therefore considered not only the ease to move a particular bed, but also the space required to move each bed.

4.2.7 Electric Functions:

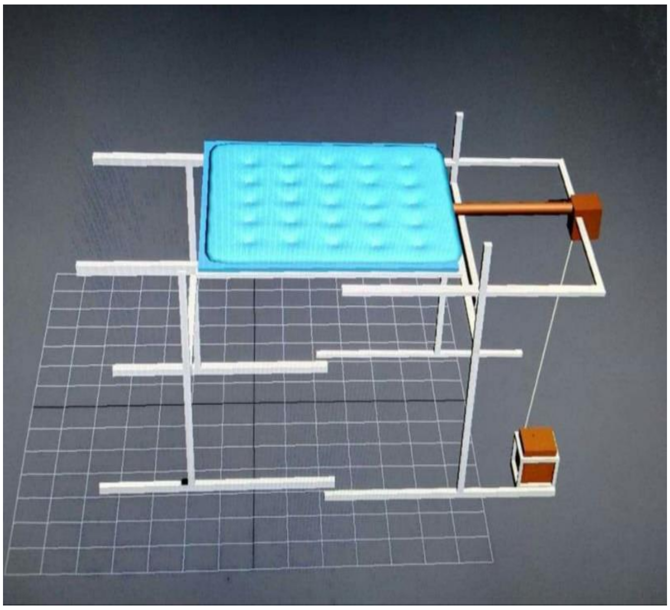
Although all the American hospital beds we researched had electric functions to operate them, many Chinese hospitals use hand-cranked beds. The inclusion of electric functions in beds today makes it easier for patients to achieve more comfort as they themselves can often adjust their own beds to the patient's own comfort levels.

4.3 Design idea

The design idea came from observing the movement of patient conveyance by stretcher, which structure provides possibility to change lateral position of patient by rising up just one side of parallel bar and also to transfer patient by moving two parallel bars aside simultaneously. If an interfacial mechanism can be linked with the parallel bars, the changing lateral position and transferring of patient could be combined together. Once the patient was transported aside of main bed, an auxiliary bed should be attached with main bed.

4.3.1 Main Bed Mechanism

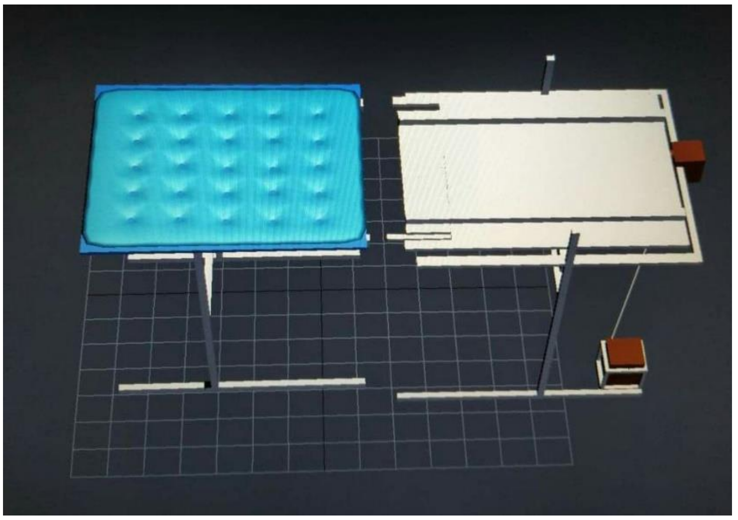
The patient bed in the hospital is usually equipped with function such as changing lying to sitting gesture, if the function of changing lateral position, especially for larger rotation degree, wants to be added, extra mechanism seems to be inevitable. In this work, the main bed surface is divided into two pieces, The base and conveyer, the electric actuated sticks drive both of them, which provide patient to sit up and to tilt legs in comfortable sitting gesture The extra mechanisms were installed in the front and the end of the main bed.



Fig(4.1) :shows the 3D model of the project

4.3.2 Mechanism for Changing Lateral Position of Patient

The lifting mechanism includes two parallel bars on two sides of a hospital bed, and a bed sheet connected to the parallel bars by means of the easy detached and secured fastener such as zippers are incorporated with four supporting rods. In each supporting rods is passed into a respective one of the hollow straight supporting rods of the main bed frame. A propping part and a fastening element are fitted on the supporting rods in order to connect with parallel bars. Each of the supporting rods has a position limiting block fitted to its lower end. The limiting block has a pressing stick part which sticks out through the lengthwise extending guide hole of the respective ones of the hollow straight supporting rods of the main bed frame; provide power for making the supporting rods move up and down through the transmission rod.



Fig(4.2) :shows the portable plate total transferred from the bed to the second be

CHAPTER 5: ANALYSIS AND CALCULATION

5.1Structure Analysis

Now we will do the analysis of the complete bed starting from stretcher frame, upper and lower base plate, Motors, Lead screw and links.

Stretcher Frame:

Moment of Inertia about XX axis

$$I_{XX} = \frac{bh^3}{12} + \frac{\pi}{64}(D^4 - d^4) - \frac{bh^3}{12} - \frac{\pi d^4}{64}$$

$$I_{XX} = 4.58752 \times 10^{10} + 5438.1 - 33333.33 - 15707.96$$ ---------------------12

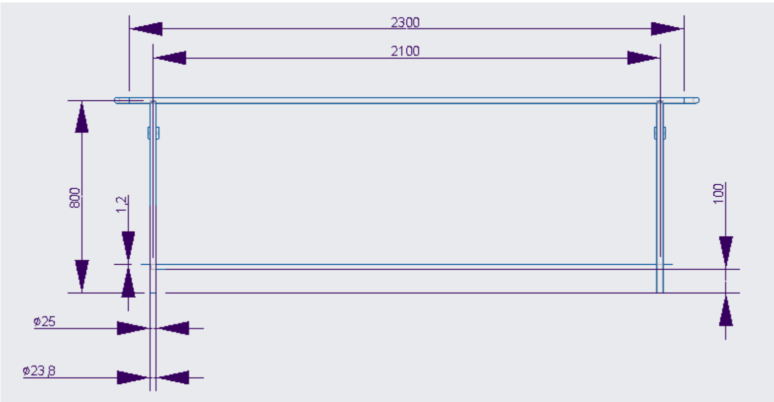
$$I_{XX} = 4.58751 \times 10^{10} mm^4$$

Moment of Inertia about XY axis

$$I_{Xy} = \frac{bh^3}{12} + \frac{\pi}{64}(D^4 - d^4) - \frac{bh^3}{12} - \frac{\pi d^4}{64}$$ ---------------------13

$$= 4.9392 \times 10^{11} + 5438.1 - 52083.33 - 15707.96$$

$$I_{XY} = 4.93919 \times 10^{10} mm^4$$



Fig(5.1) :Dimension of structure

5.2 Base and Upper plate Rectangular Plate:

i. $2100 \times 600 \times 15 \Rightarrow$ volume ------------14

$= 2100 \times 600 \times 15$

Volume $= 18.9 \times 10^6\ mm^3$

ii. $2100 \times 65 \times 20 \Rightarrow$ volume

$= 2.73 \times 10^6\ mm^3 \times 2$Volume $= 5.46 \times 10^6\ mm^3$

ii. $2100 \times 65 \times 20 \Rightarrow$ volume

$= 0.78 \times 10^6\ mm^3 \times 2$

Volume $= 1.56 \times 10^6\ mm^3$

5.3 Rectangular:

$$150\times20\times20 \Longrightarrow \text{Volume} = 0.6\times10^{2}\times2 = 1.20\times10^{5}mm^{3}$$

$$\text{Total volume} = [(18.9\times10^{6}) + (5.46\times10^{6}) + (1.56\times10^{6})] - [(0.12566\times10^{5}) + (0.04523\times10^{5}) + (0.20\times10^{5})]$$

$$= [25.9\times10^{6}] - [1.37089\times10^{5}]$$

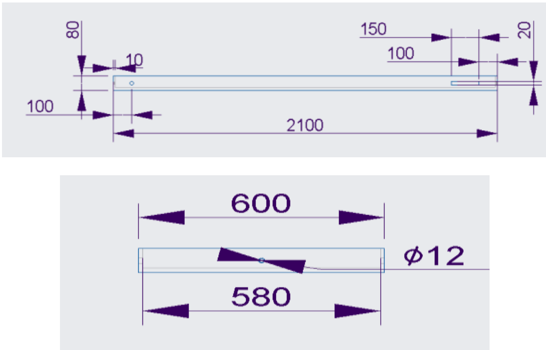
$$\text{Total volume} = 25.789\times10^{6}\ mm^{3}$$

$$\text{Weight} = \text{volume}\times\text{density}$$

$$= 25.789\times10^{6}\times7.85\times10^{-6}$$

$$\text{Weight} = 202\ \text{kg}\times9.81$$

$$\text{Weight, W} = 1985\ \text{N}$$



Fig(5.2) :Dimension of base

5.4 Lead Screw:

Power screw is the ultimate component that takes up the load that is to be lifted or lowered by lift. It also delivers torque from the motor to the nut and also prevents falling of the lift due to its own weight.

Link length is assumed to be 385 mm.

In minimum position,

Therefore, cos θ = 1900

1910 $\Longrightarrow = \theta = 5.86$

It can be seen from the above figure that maximum pull on the power screw occurs when lift is in lowermost position.

Considering force diagram

$$\frac{W}{2} = P\times\sin90^{\circ}$$

$$\Longrightarrow P = \frac{109.49}{2\times\sin5.86}$$

$$\approx 9721N$$

$$\Longrightarrow H = P\times\sin\frac{5.86}{9721}\times536\times\cos5.86^{\circ}$$

$$\text{H}\approx 9670\text{N}$$

Magnitude of pull on square –threaded screw, F = 9670 N

Let d_c = Core diameter of the screw

$$\therefore 1970 = \frac{\pi}{4} \times (d_c)^2 \times \sigma_t \frac{\pi}{4} \times (d_c)^2 \times \sigma_t$$ -----------------------------17

But this diameter is too small to be achieved. That is why a standard diameter can be taken which is greater than the above value.

Assume dc = 12 mm

Nominal Outer Diameter,

do = dc + p =12 + 2 = 14 mm

Mean Diameter,

$$d = d_o - \frac{P}{2} = 14 - 1 = 13mm$$ ---18

Let= α Helix angle

$$\tan\alpha = \frac{P}{\pi \times d} = \frac{2}{\pi \times 13} = 0.0489$$

$$\text{Assume } \mu = \tan\phi = 0.20$$

WKT effort required to rotate the screw while increasing height,

$$P = W + \tan(\alpha + \phi)$$
$$= W \times \left(\frac{\tan\alpha + \tan\phi}{1 - \tan\alpha\tan\phi}\right)$$
$$= 1970 \times \left(\frac{0.0489 + 0.20}{1 + 0.0489 + 0.20}\right)$$
$$= 9670 \times 0.2514$$
$$\text{P} = 2431N$$

Torque required in rotating the screw.

$$T = P \times \frac{d}{2} = 2431 \times \frac{13}{2} = 15801.5N - mm$$

Torsional Shear Stress,

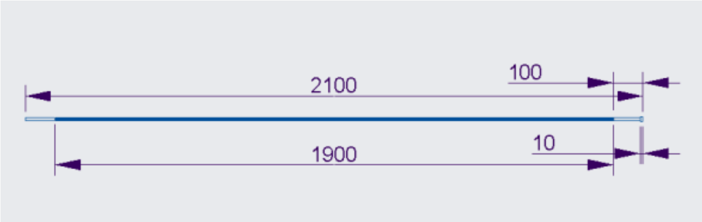
$$\tau = \frac{16 \times 15801.5}{\pi \times 12^2} = 46\frac{N}{mm^2}$$

Maximum Principal Stress,

$$\sigma_{t(\max)} = \frac{\sigma_t}{2} + \frac{1}{2} \times \sqrt{(\sigma_t)^2 + 4 \times \tau^2}$$

$$= \frac{85}{2} + \frac{1}{2} \times \sqrt{(85)^2 + 4 \times 46^2}$$

$$= 105 \frac{N}{mm^2}$$

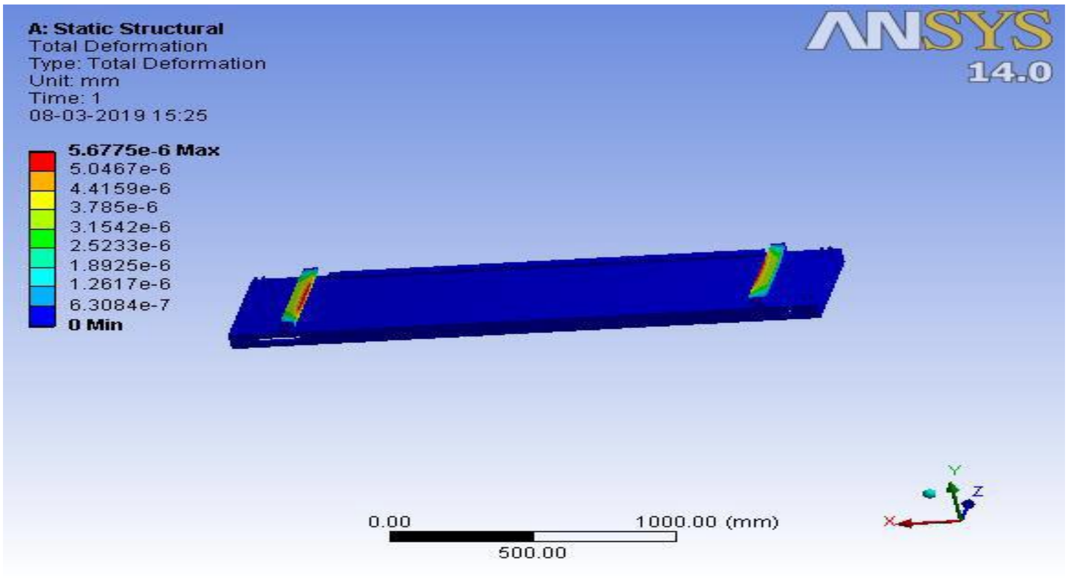


Fig(5.3) :Dimension of Lead screws

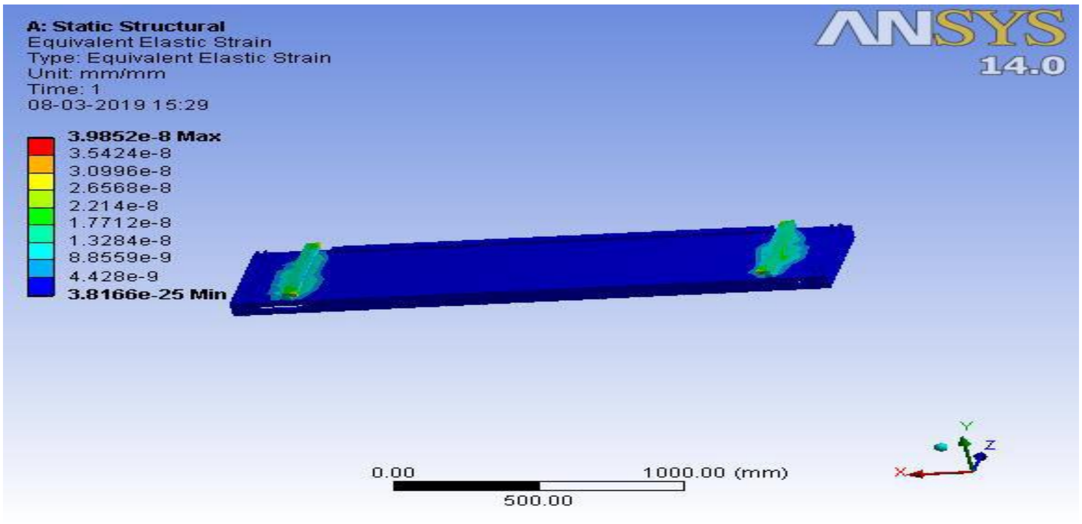
5.5 Upper Plate:

Parameter	Length	Width	Thickness
Values	1220mm	800	80mm

Table.2. Dimension Details of Upper plate



Fig(5.4) :Ansys Analysis of Upper plate



Fig(5.5) :Equivalent Elastic Strain

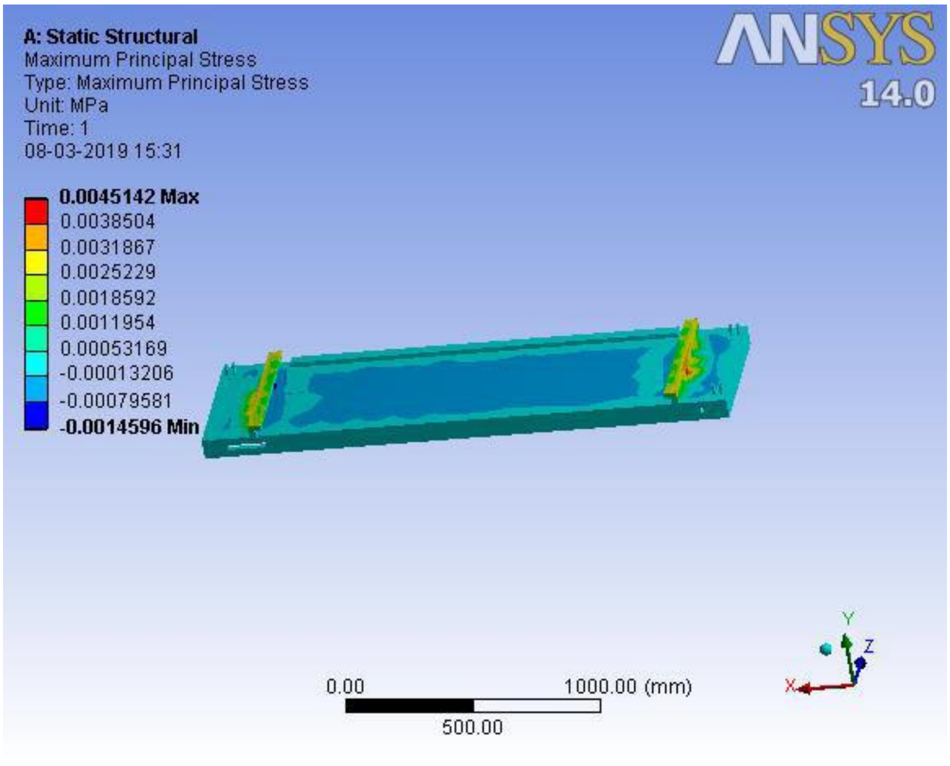


Fig (5.5): Maximum Principle Stress

Table.1. Analysis Details of Upper Plate

Type	**Total Deformation**	**Equivalent Elastic Strain**	**Maximum Principle Stress**
Minimum	**0**	3.8166e-025	-1.4596e-003MPa
Maximum	5.6775e-006mm	3.9852e-008	4.5142e-003MPa

5.6. Link

Table.2. Dimension Details of Link

Parameter	Length	Width	Thickness
Values	910mm	50mm	10mm

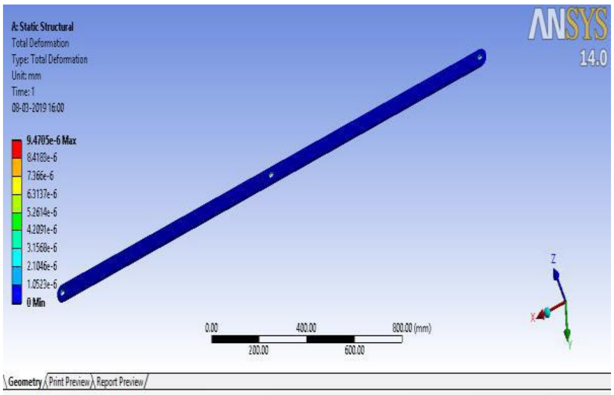
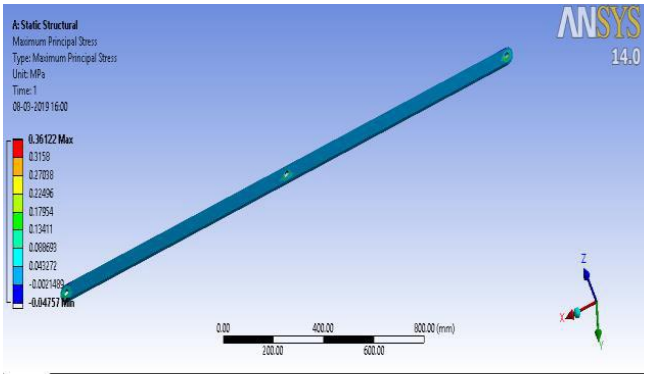
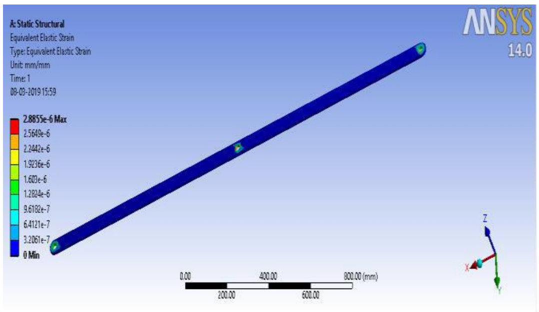


Fig (5.6): Total Deformation of Links



Fig(5.7): Maximum Principle stress



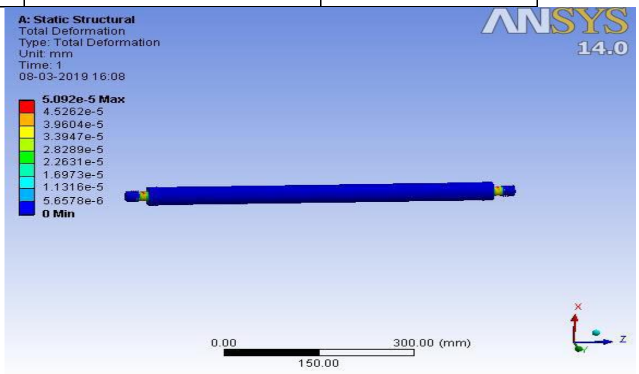
Fig(5.8) :Equivalent Elastic Strain

Table.3. Analysis Details of Link

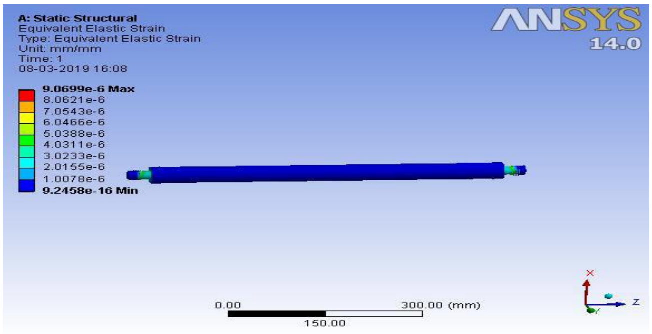
Type	**Total Deformation**	**Equivalent Elastic Strain**	**Maximum Principle Stress**
Minimum	**0**	0	4.757e-2 MPa
Maximum	9.4705e-006mm	2.88655e-008	0.36122 MPa

<u>5.7 Conveyer Rollers.</u>

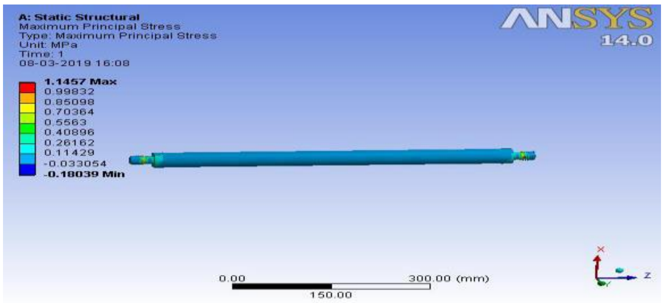
Parameter	Length	Diameter
Values	500mm	25mm



Fig(5.9) :Total Deformation of Rollers



Fig(5.10): Maximum Principle stress



Fig(5.11) :Equivalent Elastic Strain

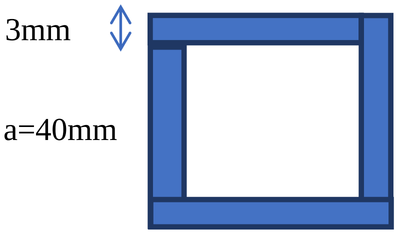
Table.4. Analysis Details of Rollers

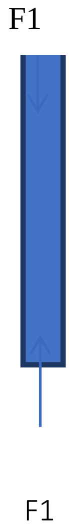
Type	**Total Deformation**	**Equivalent Elastic Strain**	**Maximum Principle Stress**
Minimum	**0**	**9.2458e-016**	0.1803 MPa
Maximum	5.092e-005mm	9.0699e-006	1.1457 MPa

With the help of Current research, we briefed out the basic Design procedure of the bed transfer system working on the Principle of Lead Screw, conveyer belt and Sliding mechanism. The Design analysis on ANSYS has also shown that the design is safe under certain accepted parameters. Also, modification can be implemented for optimizing the design and further analysis can carried out by finding other important parameters related to bed.

5.8 Material Analysis

5.8.1: Cross section area





Fig(5.12) :Free Body Diagram of Structure

A=ab-((a-6)(b-6))

A=40×40-((40-6)(40-6))

A=444mm^2

Normal stress =29.43/444

=66.29 N/mm^2

---

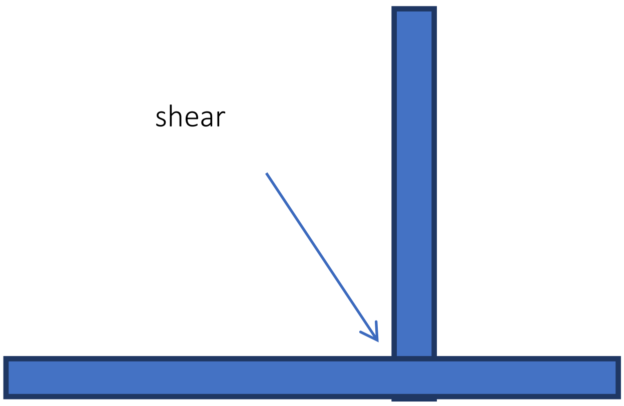
shear stress =$\frac{f}{A}$------------(13)

F1: the parallel loads of cross section area

A:cross section area

Shrar stress =29.43/444

=66.29 N/mm^2



5.8.2 Bending moment of upper part

bed mass =4.5kg

force of each slid =44.14 KN

F1=F2=FT/2 =22.07KN

Bending moment = F×r

F: axial loads arm length of slid

If r=0   without the movement of bed

M=F×0=0

If r=20 cm   with the movement of bed

M=22.07×20= 441.4 KN/cm

If r=45 cm

M=22.07 × 45 =993.15 KN/cm

Patient mass=12 kg

The total mass   bed=4.5 kg , patient =12kg , motor=1.5 kg

Total mass =18 kg

Total force =176.58 KN

Force of each side =FT/2

F1=F2=88.29 KN

∑Ma=0

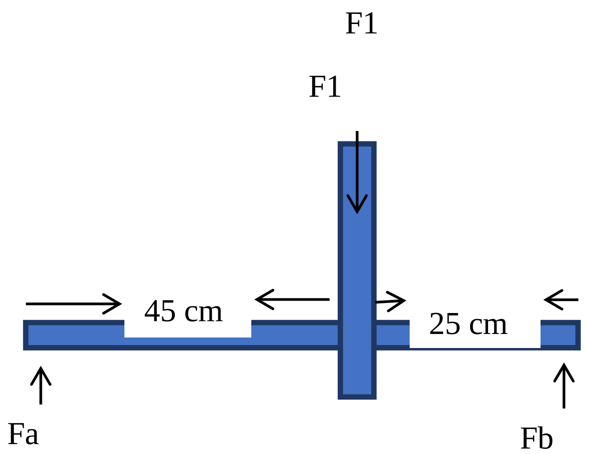
Fb×70=F1×45

Fb=56.75 KN

∑Mb =0

Fa×70=F1×25

Fa=31.58 KN



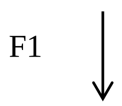
5.8.3strength of materials

a) Normal stress =F1/A

=88.29 KN/444 mm^2

=198.85 N/mm^2

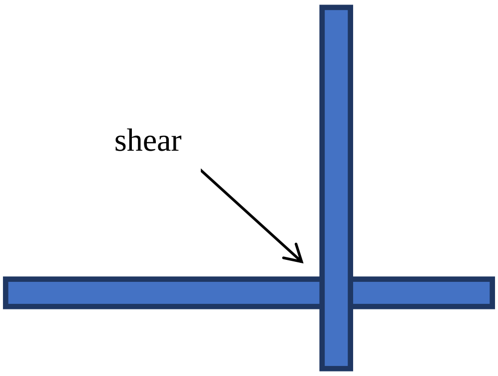
b) Shear stress



shear stress $=\frac{f}{A}$------------**(13)**

=83.29/444 =198.85 N/mm^2

C) bending moment with patent mass =12kg



In upper part ,the mass bed =4.5 kg and patient =12 kg

The total mass =16.5 kg and total force = 161.86 KN

Force of each side =F1/2= 80.93 KN

Bending moment =F1×r

If r=0 without movement

M=0

If r=20 cm

M=80.93×20=1618.65 kN.m

If r=45 cm

M=80.93×45=3641.85 KN.m

5.9 Motor Analysis

Effect of mass on motor speed. Each specific mass has a specific time for the transfer operation

Table 5 :Relationship between the mass and time

Mass	Time
2 kg	0.50 min.
5 kg	1.00 min.
7 kg	1.04 min.
10 kg	1.12 min.
12 kg	1.25 min.

The value of the displacement or arm length of motor 45cm values the velocity will be as in the table (3. 2). According to the equation:

$$V=\frac{distance}{time}\text{--------------}(14)$$

V=2/0.5=90cm/min.

Table 6: relationship between the mass and velocity

Mass	Velocity
2 kg	90.00 cm/min.
5 kg	45.00 cm/min.
7 kg	43.26 cm/min.
10 kg	40.17 cm/min.
12 kg	36.00 cm/min.

Table 7: relationship between the mass and force

Mass	Force
2 kg	63.76 KN
5 kg	93.19 KN
7 kg	112.81 KN
10 kg	142.2 KN
12 kg	161.86 KN

Table 8 : relationship between the mass and torque

Mass	Torque
2 kg	28.69 KN.m
5 kg	41.93 KN.m
7 kg	50.76 KN.m
10 kg	64.00 KN.m
12 kg	72.83 KN.m

5.8.1 Summary discussion of table

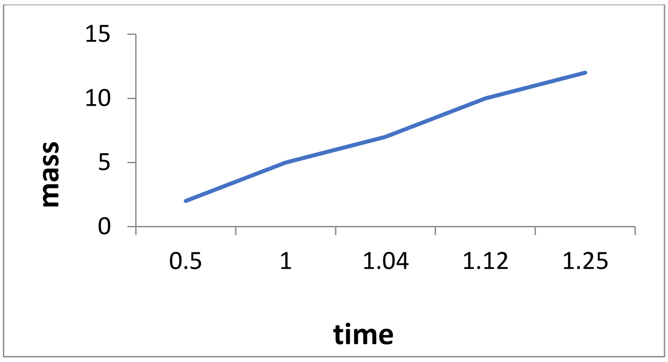


Fig (5.12) relationship between the mass and time

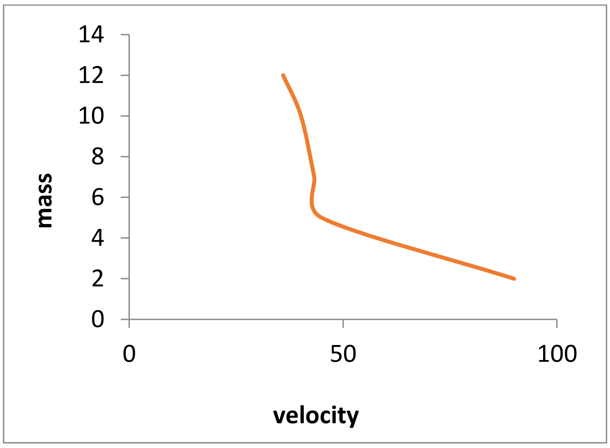


Fig (5.13) relationship between the mass and velocity

CHAPTER 6: FABRICATION

In this chapter we will discuss the components of the project.

6.1-Components of the project:

The structure we have two structure beds with linear lead screw and conveyer belt attached using a base.

6.1.1 Main motor:

Power window motor (Wira)

Features & details

1. Voltage Rating: 12VDC.
2. Rated Speed: 120 RPM.
3. Rated Torque: 2.9N.m (30kgf.cm)
4. Rated Current: less than 15A at 12V.
5. Stall Torque (Locked): 9.8N.m (100kg.cm)
6. Stall Current (Locked): less than 28A at 12V.
7. This is motor meant for driving car's window as the name says.

Fig (6.1) Wira Motor

6.1.2 Conveyer Belt Motor

Conveyer belt motor which we have used is a gear motor the details and specifications are as follow:

Features & details

1. Voltage Rating: 12VDC.
2. Rated Speed: 60 RPM.
3. Rated Torque: 2.5 Nm
4. Rated Current: less than 15A at 12V.
5. Stall Torque (Locked): 14.6 Nm
6. Stall Current (Locked): less than 28A at 12V.

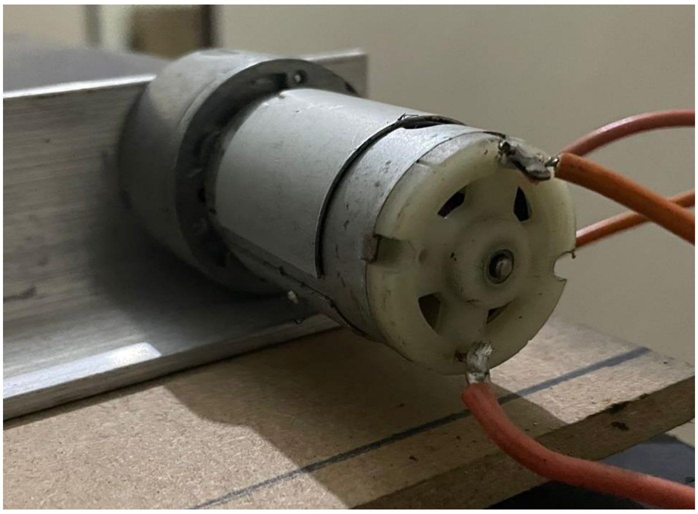


Fig (6.2) Gear Motor

6.1.3 Lead screw

We have used lead screw to move the main platform of the bed

Features & details

Length: 18 inches

Diameter: ¾ inch

Rotation speed: 120 RPM

Motor: Wira

Fig (6.3) Lead Screw

6.1.4 Conveyer Belt

We have used Conveyer belt with ½ inch pipe and its is powered by gear motor. Belt material is rubber which will provide required friction while transferring the patient.

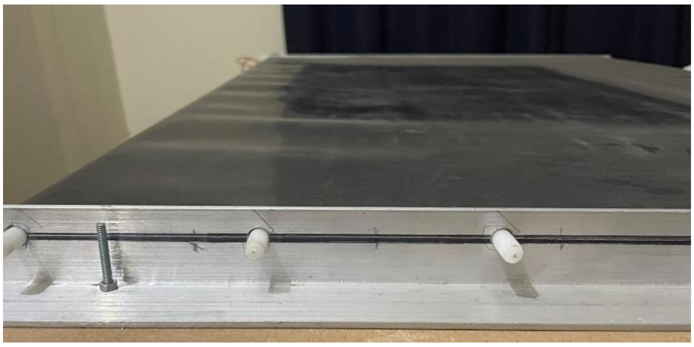


Fig (6.4) Conveyer belt

6.1.5 Slide out Rail

Slide out rail of 18-inch length is used for sliding the bed outwards

Fig (6.5) Slide Out Rail

6.1.6 Wheels

Rubber, lockable wheels are used in the project with diameter of 2.5 inch for easy and smooth movement of the bed.

Fig (6.6) Rubber wheels+

6.2 Finished product

The Finished Product is a fully operational medical bed with patient transfer mechanism. 12volt supply is used for the motors and other electronics. All the mechanical fittings are being done from a workshop and all the electrical wiring is done by group members.

Fig (6.7) Front View of finished product

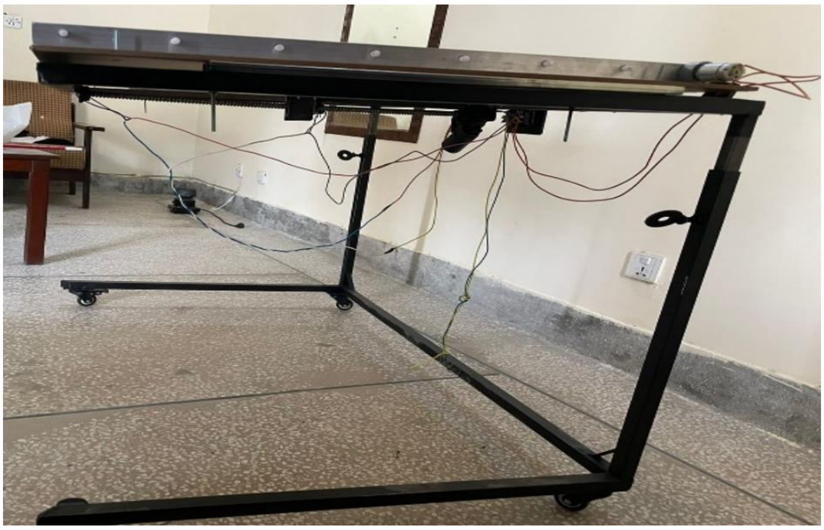


Fig (6.8) Side View of finished product

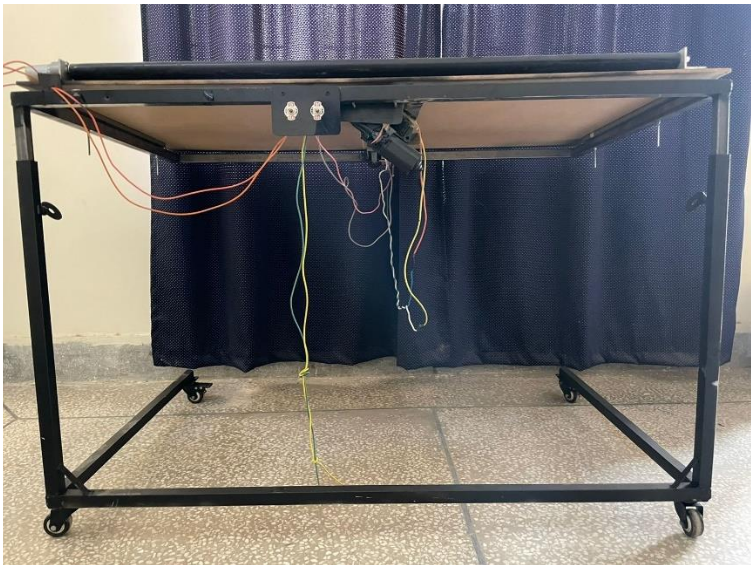


Fig (6.9) Back View of finished product

CHAPTER 7: CONCLUSION AND FUTURE WORK

7.1 Conclusion

A market that pushes towards even safer medical beds and that lateral transfer as a killer application, is driving technology to the finding of new solutions based on the presented design. Patient transfer has been a field of study since the late 70's, but the solution was only deemed possible in luxury and top-notch hospitals and health care centers. Now, with the increasing development of new low-cost devices and technologies, the scope has switched to a wide-market implementation of such systems. Thus, the market is in need of new low-cost solutions that ease any of the patient suffering, and the trigger of this work is providing an introduction to the field from which further steps can be studied.
In the beginning, the deployment of the medical bed was introduced with defined parameters and measurements. However, as more capabilities were discovered, new open lines were tackled including the design a transfer system that is supported by the hardware. The intention was to provide a system-wide view through the whole process of the patient transfer introduction because the interest laid in not only assessing the bed from one point of view but more of showing how the different disciplines in the field of biotechnology jointly conform a complex system especially the medical sector.

In Chapter 2 a general introduction to the field of hospital beds has been given and the well-known patient beds have been presented. This chapter represented the theoretical basis on which the forthcoming sections have been developed.

Chapter 3 is the general description and comprehension of the theory related to our project that has been tested and simulated on the software explaining both the approaches that are the software approach using solid works and Ansys.

Chapter 4 deals with the design description for the model and explains the concept of medical bed designing phenomena. It also contains the required specification imposed by the safety department.

Chapters 5 represent the analysis medical bed. At the beginning of chapter three the definition of an experimental set-up arises some needs such as a characterized target and a controlled environment where measurements can be used to extract interesting results.

The final result of the designed medical bed, after simulations in both the approaches and a comparison of the result of range is presented in the chapter.

Chapter 6 is all about the fabrication of our project including components used assembled product pictures.

7.2 Future Work

In the future we can move the patient bed through the sound (for example right and left), through the circuit electrically programmed and also we can control this bed through the EEG signals.

The bed can be moved manually by adding a manual motor. We can develop the bed by the weight of carrying the weights more and that using a motor bear more puncture

Use convenient bedding on the bed to make the patient more comfortable during his stay in the hospital, for example the bed moves more movement.

Disseminate design on hospitals so as to raise the value of the patient and to raise the attention to health because the health and safety patient above everything.

Electrical motors can be added to move bed and patient more effortlessly.

Head and foot rest adjustment can be added to increase patient's comfort.

Heart sensors, pulse rate sensors and other electrical appliances can be added to the bed to give more ease to medical staff.

References:

[1]: Who Invented The Hospital Bed?". askdeb.com. Retrieved 2015-03-08.

[2]: National Association of Bedding Manufacturers, March 1964, Nation's Oldest Family-Held Bedding Firm: Adam Wuest, Inc

[3]: LIFE. Time Inc. p. 92. ISSN 0024-3019. Retrieved 2015-03-08

[4]: FDA Proposes Hospital Bed Entrapment Rules". consumeraffairs.com. Retrieved 2015-03-0

[5]: "Hospital Bed Safety (HBSW)". Archived from the original on 2006-06-22. Retrieved 2015-03-08

[6]: Mitsumoto, H. (2009). Amyotrophic Lateral Sclerosis: A Guide for Patients and Families:Third Edition. Demos Medical Publishing. p. 125. ISBN 9781935281191. Retrieved 2015-03-08.

[7]: Lachenbruch C, Kennerly S. Interface pressure and shear comparison between air-fluidized and conventional surfaces. In: Proceedings of the 18th Annual Clinical Symposium on Wound Care (CSWC). Las Vegas; October 2003.

[8]: Corr J 'Electric profiling beds will improve care and save money in the long term Nursing Times 2005 101 (48)13, as cited in Fergusson Burt L 'The potential benefits of the introduction of electric profiling beds in preference to manually height adjustable King's Fund beds within the NHS: A literature review' The Column 2007 19 (2) 12

[9]: Mitchell J, Jones J, McNair B and McClenhan J Better beds for health care report of Report of the King's Fund Centenary Bed Project 1998 ISBN 978 1 8571720

[10]. Anupam Chaturvedi1, Prof. Jyoti Mishra2, Prof. Vijay Parmar3,"An Improved Scissor Lift working on Lead Screw Mechanism",Volume 4, Issue 2, February -2017.

[11]. Kripak.Varanasi and Samir.a, Nayfeh**,** "The Dynamic of Lead Screw Drives in low order modelling and experiments", Aug 05, 2004.

[12]. Jaydeep m. Bhatt,Milan j. Pandya,M.E. Student (Thermal Engineering), Mechanical Engineering Department,"design and analysis of an aerial scissor lift". NOV 12-2013.

[13].Aman B. kotwal1,Mangesh N. Gavhane2, Sachin S. kushare3, 4Yuvraj U.Aher, *Prof. R. S Chuadhari,* Prof. H.S. Deore, "Design and Analysis of Lead Screw for Fixture", (IJMTER) Volume 2, Issue 7, July – 2015.

[14]. Jaydeep m. Bhatt,Milan j. Pandya, M.E. Student (Thermal Engineering), Mechanical Engineering Department," design and analysis of an aerial scissor lift". NOV 12-2013.

[15]. Alison L. LaBonte,1,2kevin M. Brown3, and Yuri Fialko4, "hydrological detection and finite element modeling of a slow slip event in the Costa Rica prism toe " Received

16 May 2008; received 11 December 2008; accepted 22 January 2009; Published 9 April 2009.
[16]. Christopher S. Pan, A.H., Michael, McCann, Mei-Li Lin, Kevin Fearn, Paul Keane, Aerial lift fall injuries: A surveillance and evaluation approach for targeting prevention activities. Journal of Safety Research,2007.
[17]. S.Mingzhou, G.Qiang, G.Bing, Finite element analysis of steel members under cyclic loading, Finite Elements in Analysis and Design. 39 (1) (2002).
[18]. Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co,2010.
[19]. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition,2002.