VISVESVARAYA TECHNOLOGICAL UNIVERSITY

BELAGAVI KARNATAKA - 590008

"DESIGN AND FABRICATION OF PATIENT TRANSFER SYSTEM"

SUBMITTED BY

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UNDER THE GUIDANCE OF

Prof. S. B. Yadwad

DEPARTMENT OF MECHANICAL ENGINEERING

KLE Dr. M S. SHESHGIRI

COLLEGE OF ENGINEERING AND TECHNOLOGY

BELAGAVI - 590 008

2022-2023

KLE Dr. M. S. SHESHGIRI
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DEPARTMENT OF MECHANICAL ENGINEERING

CERTIFICATE

"DESIGN AND FABRICATION OF PATIENT TRANSFER SYSTEM"

Submitted by:

SAKSHI UTTURI	*[USN: 2KL19ME064]*
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This is to Certify that the Project Report on **"DESIGN AND FABRICATION OF PATIENT TRANSFER SYSTEM"** satisfies all the requirements for the partial fulfilment for the award of Degree of Bachelor of Engineering in Mechanical Engineering of the Visvesvaraya Technological University, Belagavi during the academic year 2022-23. It is certified that all correction/suggestion for the internal assessment have been incorporated in the report. The project report has been approved as it satisfies the academic requirements in respect of the project work prescribed for the Bachelor of Engineering Degree.

GUIDE	H.O.D.	PRINCIPAL
Prof. S.B.Yadawad	**Dr. C. V. Adake**	**Dr. Basavaraj Katageri**

Name of the Examiners　　　　Signature with date

1.

2.

ABSTRACT

This project report on **"DESIGN AND FABRICATION OF PATIENT TRANSFER SYSTEM"** details the design and fabrication of a patient transfer system aimed at improving the efficiency and safety of patient transfers in healthcare facilities.

The system consists of a bed with a built-in lift mechanism that can raise and lower the patient as well as move them horizontally. The report discusses the design process, including the selection of materials and components, as well as the fabrication and testing of the system.

The system was found to be capable of transferring patients safely and comfortably, with potential applications in hospitals, nursing homes, and other healthcare facilities. Overall, this project demonstrates the feasibility of developing innovative solutions to address common challenges in healthcare

ACKNOWLEDGEMENTS

We would like to thank our Guide **PROF S. B. YADWAD** for the time and efforts he provided throughout the year. Your useful advice and suggestions were really helpful to us during the Project work. In this aspect, we are eternally grateful to you.

We would like to express our profound gratitude to **DR C. V. ADAKE,** HEAD OF THE DEPARTMENT OF MECHANICAL ENGINEERING department, university for their contributions towards the project titled **"DESIGN AND FABRICATION OF PATIENT TRANSFER SYSTEM"**.

We would also like to express our sincere gratitude to our principal, **DR BASAVARAJ G. KATAGERI** for his support and encouragement. Finally, we would like to extend our thanks to the teaching and non-teaching staff of our department for their help.

SAKSHI UTTURI [USN: 2KL19ME064]

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DECLARATION

We, **Sakshi Utturi (2KL19ME064), Neha Kinekar (2KL19ME045), Samarth Kulkarni (2KL19ME065), Om Badagi (2KL19ME050)** hereby declare that the project work entitled **"DESIGN AND FABRICATION OF PATIENT TRANSFER SYSTEM"**, has been independently carried out by us at "BELAGAVI", under the internal guidance of **PROF S. B. Yadawad**, Department of Mechanical Engineering, KLE Dr. M. S. Sheshgiri College of Engineering and Technology, Belagavi, in partial fulfilment for the required award of Bachelor of Engineering in Mechanical Engineering at Visvesvaraya Technological University, Belagavi.

Place: Belagavi

Date: 08/05/23

SAKSHI UTTURI [USN: 2KL19ME064]

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Dr. U T Vijay
Executive Secretary

24th April, 2023

Ref: 7.1.01/SPP/33

To,
The Principal,
K.L.E. Dr. M.S. Sheshgiri College of Engineering & Technology,
Angol Main Road, Udyambag,
Belagavi – 590 008.

Dear Sir/Madam,

Sub : Sanction of Student Project - 46th Series: Year 2022-2023

Project Proposal Reference No. : **46S_BE_2937**
Ref : Project Proposal entitled **DESIGN AND FABRICATION OF PATIENT TRANSFER SYSTEM**

We are pleased to inform that your student project proposal referred above, has been approved by the Council under "Student Project Programme - 46th Series". The project details are as below:

Student(s)	Ms. SAKSHI UTTURI	**Department**	MECHANICAL ENGINEERING
	Ms. NEHA KINEKAR		
	Mr. SAMARTH KULKARNI		
	Mr. OM BADAGI	**Sanctioned Amount (in Rs.)**	7,000.00
Guide(s)	Prof. S. B. YADWAD		

Instructions:

a) The project should be performed based on the objectives of the proposal submitted.
b) Any changes in the project title,objectives or students team is liable for rejection of the project and your institution shall return the sanctioned funds to KSCST.
c) Please quote your project reference number printed above in all your future correspondences.
d) After completing the project, 2 to 3 page write-up (synopsis) needs to be uploaded on to the following Google Forms link https://forms.gle/nWTaJjvrwzp3Wmvt6. The synopsis should include following:
   1) Project Reference Number
   2) Title of the project
   3) Name of the College & Department
   4) Name of the students & Guide(s)
   5) Keywords
   6) Introduction / background (with specific reference to the project, work done earlier, etc) - about 20 lines
   7) Objectives (about 10 lines)

46S_BE_2937

8) Methodology (about 20 lines on materials, methods, details of work carried out, including drawings, diagrams etc)

9) Results and Conclusions (about 20 lines with specific reference to work carried out)

10) Scope for future work (about 20 lines).

e) In case of incompeted projects, the sanctioned amount shall be returned to KSCST.

f) The sanctioned amount will be transferred by NEFT to the bank account provided by the College/Institute.

g) The sponsored projects evaluation will be held in the Nodal Centre/Online Mode and the details of the same will be intimated shortly by email / Website announcement.

h) After completion of the project, soft copy of the project report duly signed by the Principal, the HoD, Guide(s) and studetn(s) shall be uploaded in the following Google Forms Link https://forms.gle/YWz56TrGg7fnSQgc7. The report should be prepared in the format prescribed by the university.

Please visit our website for further announcements / information and for any clarifications please email to spp@kscst.org.in

Thanking you and with best regards,

Yours sincerely,

(U T Vijay)

Copy to:

1) The HoD
   MECHANICAL ENGINEERING
   K.L.E. Dr. M. S. SHESHGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI

2) Prof. S. B. YADWAD
   MECHANICAL ENGINEERING
   K.L.E. Dr. M. S. SHESHGIRI COLLEGE OF ENGINEERING AND TECHNOLOGY, BELAGAVI

3) THE ACCOUNTS OFFICER
   KSCST, BENGALURU

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CHAPTER 1

INTRODUCTION

Design and fabrication of a patient transfer system is an essential process in the healthcare industry. Patient transfer systems are used to move patients who are unable to move themselves from one location to another within a healthcare facility, such as a hospital or nursing home. The system is designed to ensure patient safety and comfort while allowing healthcare professionals to perform their duties effectively. The design and fabrication process of a patient transfer system require careful consideration of various factors, including the patient's needs, the healthcare professional's requirements, and the facility's space and layout.

The primary goal of a patient transfer system is to provide a safe and comfortable means of transporting patients. The system must be designed to support the patient's body and provide adequate cushioning to reduce the risk of injury during transportation. The transfer system should be easy to operate, allowing healthcare professionals to move the patient quickly and efficiently while minimizing the risk of injury.

The design and fabrication process of a patient transfer system starts with the identification of the facility's specific needs. The design team must consider the type of patients that will be transported using the system, the available space, and the budget. The design team must also consider the weight and size of the patient, as well as any special medical requirements that the patient may have.

Once the design team has identified the facility's specific needs, they can start developing a concept for the patient transfer system. This concept includes the selection of equipment required, the layout of the system, and the materials needed to construct the system. The design team must ensure that the system meets all safety and quality standards and that it is durable enough to withstand frequent use.

The fabrication process of the patient transfer system involves the actual construction of the system. The team must use high-quality materials and state-of-the-art manufacturing techniques to ensure that the system meets all safety and quality standards. The finished product must be thoroughly tested to ensure its reliability and durability.

There are several types of patient transfer systems available, including stretchers, wheelchairs, gurneys, lifts, and hoists. Each of these systems has unique features that make them suitable for different situations. For example, stretchers are ideal for transporting patients who are unable to sit up or support their weight, while wheelchairs are ideal for patients who are able to sit up but are unable to walk.

Gurneys are another type of patient transfer system that is commonly used in healthcare facilities. They are similar to stretchers, but they are designed to transport patients over longer distances. Gurneys are equipped with wheels, making them easy to move from one location to another. They are also designed to be adjustable, allowing healthcare professionals to position the patient comfortably during transportation.

Lifts and hoists are also commonly used patient transfer systems. These systems are designed to lift and move patients who are unable to move themselves. They are commonly used in situations where patients need to be moved from a bed to a wheelchair or stretcher, or when patients need to be moved between floors in a multi-story building.

The design and fabrication process of a patient transfer system must consider the patient's needs, the healthcare professional's requirements, and the facility's space and layout. The system should be designed to provide the highest level of safety and comfort for the patient while allowing healthcare professionals to perform their duties effectively. The design team must consider the type of patients that will be transported, the weight and size of the patient, and any special medical requirements that the patient may have.

The materials used to construct the patient transfer system must be of high quality, ensuring that the system can withstand frequent use and meet all safety and quality standards. The finished product must be thoroughly tested to ensure its reliability and durability, providing healthcare professionals with a safe and efficient means of transporting patients.

One of the significant benefits of modern patient transfer systems is the ability to streamline the transfer process and improve efficiency. By using automated systems, medical staff can reduce the time and effort required to move patients between facilities, enabling them to focus on providing care and attention to the patient. Additionally, automated systems can help to reduce the risk of human error, such as miscommunication or improper lifting techniques.

Patient transfer systems can also play a critical role in emergency situations, such as natural disasters, mass casualties, and pandemics. In these situations, the ability to quickly and safely transport patients to appropriate medical facilities can be essential in saving lives and preventing further harm.

Despite the many benefits of patient transfer systems, there are also some potential drawbacks and challenges to consider. For example, these systems can be expensive to purchase and maintain, and may require specialized training for medical staff to use effectively. Additionally, some patients may experience discomfort or anxiety during transport, which can be difficult to manage.

CHAPTER 2

LITERATURE REVIEW

1. F. Wu, H. C. Lee, J. Lee, and H. Y. Lin, "A Smart Patient Transfer System for Healthcare," in IEEE Access, vol. 6, pp. 33467-33476, 2018.

   Abstract: This paper presents a smart patient transfer system for healthcare that utilizes an IoT platform, a machine learning algorithm, and a mobile application to improve the efficiency and safety of patient transfers. The system provides real-time monitoring and analysis of patient data, and automates the transfer process, reducing the risk of injury to both patients and medical staff. A prototype system was developed and evaluated in a hospital setting, demonstrating its potential for improving patient care.

2. K. J. Kim and J. K. Choi, "Development of a Novel Patient Transfer System for Emergency Medical Services," in IEEE Transactions on Industrial Informatics, vol. 14, no. 8, pp. 3472-3480, Aug. 2018.

   Abstract: This paper presents the development of a novel patient transfer system for emergency medical services that uses a pneumatic lift and a unique locking mechanism to secure the patient during transfer. The system was designed to be lightweight, compact, and easy to use in the field. A pilot study was conducted to evaluate the system's effectiveness, demonstrating its potential for improving patient outcomes and reducing the risk of injury to medical staff.

3. L. Liang, S. Li, H. Huang, and W. Zhang, "Design and Evaluation of a Novel Patient Transfer System for Rehabilitation," in IEEE Journal of Translational Engineering in Health and Medicine, vol. 8, pp. 1-9, 2020.

   Abstract: This paper presents the design and evaluation of a novel patient transfer system for rehabilitation that consists of a transfer chair with a height-adjustable seat and a lateral transfer board. The system was designed to improve the efficiency and safety of patient transfers in rehabilitation settings. A usability study was conducted with 12 participants, demonstrating the system's ease of use and potential for improving patient comfort and safety.

4. M. H. Arslan, G. Aydin, and F. G. Okuyucu, "Design of a Portable and Adjustable Patient Transfer System," in IEEE Transactions on Instrumentation and Measurement, vol. 67, no. 2, pp. 443-451, Feb. 2018.

Abstract: This paper presents the design of a portable and adjustable patient transfer system that can be used in various medical settings. The system uses a modular design and can be adjusted to accommodate patients of different sizes and shapes. Tests were conducted to evaluate the system's stability and effectiveness, demonstrating its potential for improving patient outcomes and reducing the risk of injury to medical staff.

5. R. Haque, S. U. Ahmed, and K. M. Akib, "Design and Development of a Smart Patient Transfer System," in IEEE Sensors Journal, vol. 21, no. 2, pp. 2248-2256, Jan.15, 2021.

Abstract: This paper presents the design and development of a smart patient transfer system that uses sensors and wireless communication to improve the efficiency and safety of patient transfers. The system can detect the patient's weight and position and provide real-time feedback to the medical staff, reducing the risk of injury to both patients and medical staff. Tests were conducted to evaluate the system's accuracy and effectiveness, demonstrating its potential for improving patient outcomes in various medical settings.

6. Debojyoti Seth, Debashis Chakraborty, Debosruti Ghosh “Smart Home for Paralyzed Aid”, Volume: 04 Issue: 09 | Sep -2017, IRJET.

Abstract: The paper proposes a scope of aiding a paralyzed person left alone at home. Primarily focusing on Electroencephalogram data of 25 paralyzed people, the study of changes in brain signals while they feel hungry, thirsty, sleepy, mentally excited or stressed is conducted. On continuously monitoring and systematically analyzing the brain signals for a physically challenged person, multiple modules to meet the basic necessities are developed and tested upon. The Electroencephalogram data is preprocessed and classified based on neuro-fuzzy hybrids. The logical decision making is performed by an Internet of Things based platform. All the control modules are fully automated and hardware is driven by a self-learning fuzzy control machine. Results of performed experimentations proved to be really promising and reached an overall accuracy of 89.73% for automating the aiding units to fulfill basic needs of a paralyzed person and we are looking forward to extend the research to design a smart hospital paradigm.

7. Arun S, Mathew John, Adarsh U, Ijas Ahamed Mk, Mohammed Ajmal Kv "Design and Fabrication of Wheelchair for Paraplegia Patients", Volume: 06 Issue: 05 | May 2019 IRJET.

   Abstract: In India the number of paralyzed individuals is increasing every year. Mobility aids are useful for patients for transportation and a replacement for walking especially in indoor and outdoor environment. Transferring the patients from wheel chair to other medium like bed, car etc is always an issue for the attendant or helper. 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 paralyzed individuals. This is an assistive mechanism to provide an easy, safe and convenient way of shifting wheel chair users from wheel chair to other mediums and ease the life of care givers. It drastically reduces the efforts of care giver in handling of patient especially giving transfer. The wheelchair also provides standing mechanism without any electronics components. This is a cost reducing project which helps mainly paralyzed patients to do their daily things.

8. Smitesh Bobde, Ninad Borkar, Saurabh Apte, Shubham Ghuguskar, "Automated Wheelchair Convertible Stretcher", Volume: 04 Issue: 03 | Mar -2017, IRJET.
   Abstract: The challenges faced during transferring the patients exist from ancient times. People who get seriously injured or ill were carried by others by means of wooden stretcher with cloth or leather tied to it. Afterwards they were carried on wheels which reduced the effort of the people carrying the patients. Although we have evolved in the field of healthcare and technology, we are not yet able to address this problem efficiently. Adopting various kinds of research methods helped us to obtain more information about hospital mobility aids and for data collection. Mobility aids are used for transportation of patients. Wheelchairs and stretchers are the most commonly used mobility aids for the movement of patients. Transferring the patients from wheelchair to stretcher or to the medical bed or vice versa is always an issue for the attendant or nurse. There is a revolution of wheelchairs available today driven by needs and desire of man. Hence, we propose a design of Automated Wheelchair Convertible Stretcher which is a boon to the medical field. It is so made that it could be maintained and operated easily either by the patient or by the attendant according to the comfort of the patient. Our study shows that it is possible to save 50% space by the Automated Wheelchair Convertible Stretcher design. The product will thus likely be an efficient mobility aid in hospitals.

CHAPTER 3

PROBLEM IDENTIFICATION

The problem is to improve the efficiency and safety of patient transfers within healthcare facilities. Traditional transfer methods, such as manual lifting and transferring, can put both patients and medical staff at risk of injury, and can lead to delays in patient care and increased healthcare costs.

Current patient transfer systems often have limitations, such as weight capacity and adjustability, which can restrict their use for patients of different sizes and shapes. Additionally, many systems may lack safety features, such as locking mechanisms and sensors, which can further increase the risk of injury during transfer.

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Therefore, there is a need for a patient transfer system that is efficient, safe, and adjustable to accommodate patients of different sizes and shapes. The system should also incorporate safety features to minimize the risk of injury to both patients and medical staff. The design and fabrication of such a system would improve the overall quality of patient care and reduce the risk of injury to medical staff, ultimately leading to better patient outcomes and reduced healthcare costs.

CHAPTER 4

OBJECTIVES OF THE PROJECT

1. **Improving patient safety during transfers:** One of the primary objectives of the patient transfer system is to improve patient safety during transfers. The system should be designed to reduce the risk of injury to patients and medical staff during transfer.
2. **Increasing efficiency:** The patient transfer system should be designed to increase the efficiency of patient transfers. The system should be easy to use and should allow for quick and efficient transfer of patients.
3. **Accommodating different patient sizes and shapes:** Patients come in different sizes and shapes, and the patient transfer system should be designed to accommodate this. The system should be adjustable to accommodate patients of different sizes and shapes.
4. **Improving patient comfort:** Patient comfort is an important consideration during transfers. The patient transfer system should be designed to improve patient comfort during transfer.
5. **Minimizing the risk of damage to medical equipment:** Medical equipment can be easily damaged during transfers. The patient transfer system should be designed to minimize the risk of damage to medical equipment during transfer.
6. **Enhancing the overall patient experience:** The patient transfer system should be designed to enhance the overall patient experience during transfers. The system should be easy to use, comfortable, and efficient, and should make transfers as stress-free as possible for patients.

CHAPTER 5

METHODOLOGY

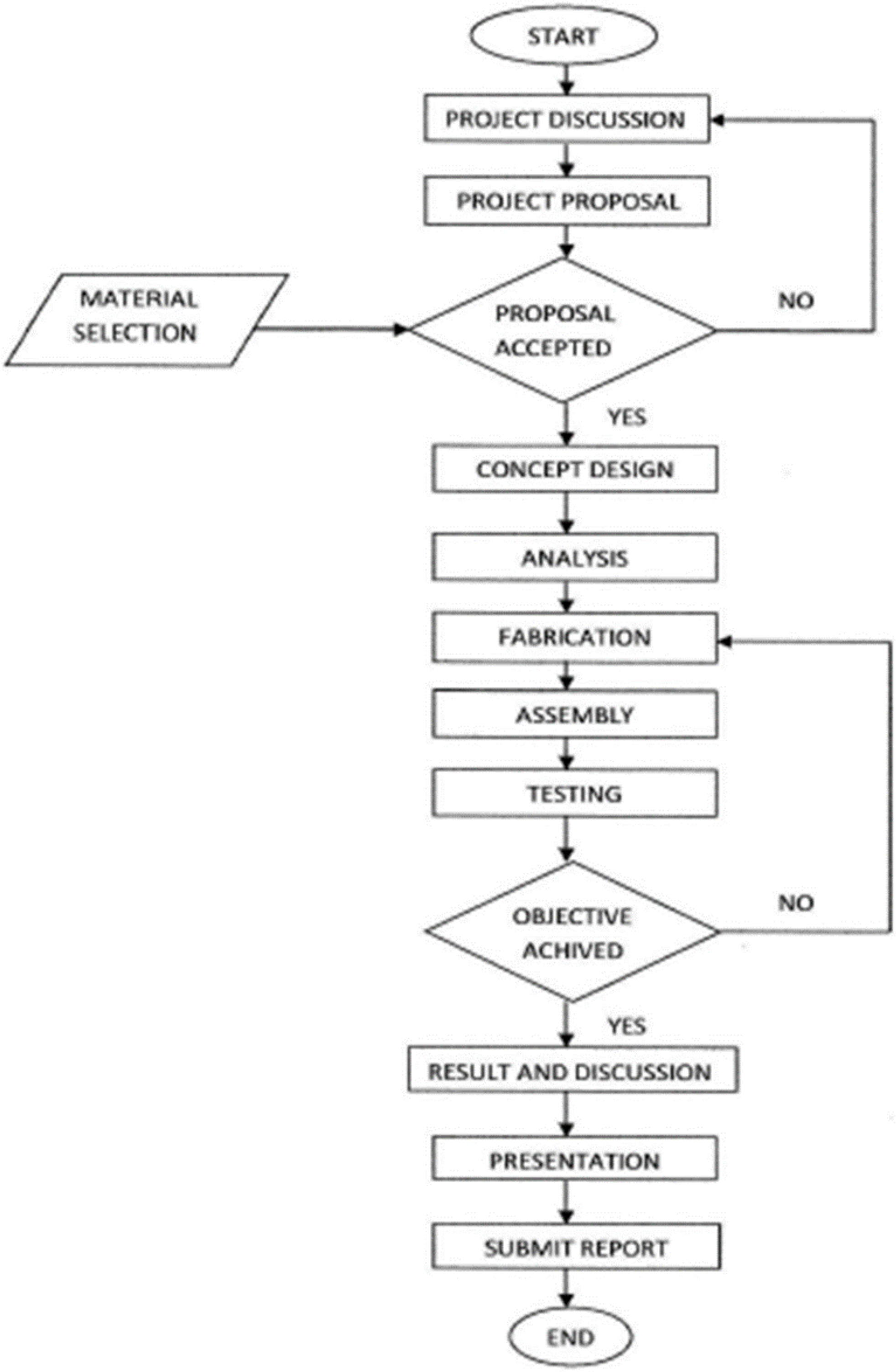


Fig 5.1: Methodology Flow Chart of Patient Transfer System

Methodology of patient transfer system involves the following:

1. **Requirements gathering:** The first step is to gather the requirements of the patient transfer system. This includes understanding the specific needs of the patients, the medical staff, and the facility. Factors such as patient weight, mobility, and the type of medical equipment required must be taken into consideration.

2. **Conceptualization and design:** Based on the requirements, conceptualization and design of the patient transfer system can be done. This includes selecting the type of transfer system, such as a hydraulic or electric lift, and designing the overall structure, including the base, frame, and lifting mechanism.

3. **Prototyping:** Once the design is complete, a prototype of the patient transfer system can be created. This allows for testing and refinement of the design.

4. **Fabrication:** After the prototype has been tested and refined, the final fabrication of the patient transfer system can be done. This involves selecting the appropriate materials, such as steel or aluminum, and manufacturing the components of the transfer system.

5. **Assembly and testing:** Once the components have been fabricated, the patient transfer system can be assembled and tested. This includes ensuring that the lifting mechanism works correctly, that the transfer system is stable and safe, and that it meets all regulatory requirements.

6. **Installation and training:** Finally, the patient transfer system can be installed in the medical facility and training can be provided to the medical staff on how to use the transfer system safely and effectively.

CHAPTER 6

WORKING PRINCIPLE

A patient transfer system is a medical device used to transfer patients from one surface to another, such as from a stretcher to an OT bed. One way to design and fabricate such a system is by using a rack and pinion mechanism.

The working principle of a rack and pinion mechanism is simple. A rack is a straight toothed bar that meshes with a pinion gear. When the pinion gear is rotated, the rack moves in a linear direction. This motion can be used to transfer a load, such as a patient, from one surface to another.

One advantage of using a rack and pinion mechanism for a patient transfer system is that it provides a smooth and controlled transfer of the patient. The linear motion of the rack ensures that the patient remains stable and secure during the transfer, which reduces the risk of injury or discomfort. Additionally, the rack and pinion mechanism are reliable and requires minimal maintenance, which makes it a cost-effective solution for healthcare facilities.

To design a patient transfer system using a rack and pinion mechanism, the system would typically include a frame to support the load, a motor to rotate the pinion gear, and a control system to operate the DC motor. The frame would be designed to support the patient and include a rack mounted on its underside. The pinion gear would be attached to a DC motor, which would be mounted on the frame or a separate support structure.

The control system would be used to rotate the motor and pinion gear, which would cause the rack to move in a linear direction axially. This would allow the patient to be transferred from one surface to another.

BLOCK DIAGRAM

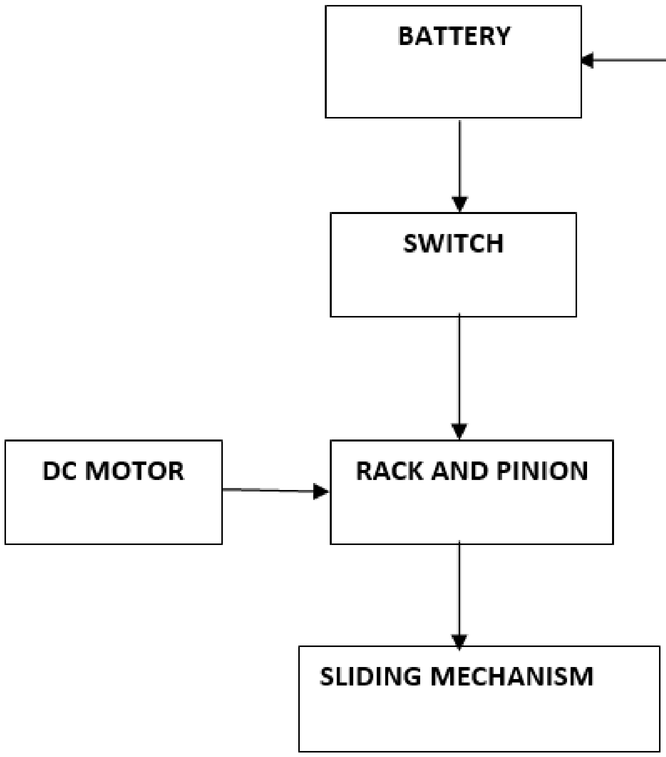


Fig 6.1: Block diagram of working principle of patient transfer system

The patient transfer frame includes a rack mounted on its underside, which is connected to the rack and pinion mechanism. The pinion gear is attached to a motor, which is controlled by a motor driver. The motor driver is part of the motor control system, which includes a control unit, such as a joystick or other input device, to control the movement of the system.

When the control unit is activated, it sends a signal to the motor control system, which rotates the motor and pinion gear. The pinion gear meshes with the rack, causing it to move in a linear direction. The patient transfer frame, which is supported by the rack, moves in tandem with the rack, allowing the patient to be transferred from one surface to another.

These components work together to provide a reliable and efficient way to transfer patients between surfaces, while also ensuring their safety and comfort during the transfer process.

CHAPTER 7

DESIGN PROCEDURE

7.1 General Requirements of Machine Design

1. High productivity.
2. Ability to produce and provide required accuracy of shape and size and also necessary surface finish.
3. Simplicity of design.
4. Safety and convenience of control
5. Low Cost.

7.2 Design Procedure

Before we proceed to the process of manufacturing, it's necessary to have some knowledge about the project design essential to design the project before starting the manufacturing. Maximum cost of producing a part of product is established originally by the designer. The product consists of:

1. Functional Design.
2. Product Design.
3. Engineering Design.

7.3 Design Procedure for a product

When a new product or their elements are to be designed, a designer may proceed as follows:

1. Make a detailed statement of the problems completely; it should be as clear as possible & also of the purpose for which the machine is to be designed
2. Make selection of the possible mechanism which will give the desire motion.
3. Determine the forces acting on it and energy transmitted by each element of the Machine
4. Select the material best suited for each element of the machine.
5. Determine the allowable or design stress considering all the factors that affect the Strength of the machine part.
6. Identify the importance and necessary and application of the machine.
7. Problems with existing requirement of the machine productivity and demand
8. Determine the size of each element with a view to prevent undue distortion or breakage under the applied load.
9. Modify the machine element or parts to agree with the past experience and judgment and to facilitate manufacture.

10. Make assembly and detail drawings of machine with complete specification for the materials and manufacturing methods i.e., accuracy, Surface finish etc.

7.4 Structural Design Methods:

This section describes some of the mathematical technique used by designers of complex structures. Mathematical models and analysis are briefly described and detail description is given of the finite – element method of structural analysis. Solution techniques are presented for static, dynamic & model analysis problems.

Three types of structural models are:

1. **Rigid Members:** The entire structure or parts of the structure are considered to be rigid, hence no deformation can occur in these members.
2. **Flexible members**: The entire structure or parts of the structure are modelled by members that can deform, but in limited ways.
3. **Continuum**: A continuum model of structure is the most general, since few if any mathematical assumptions about the behaviour of the structure need to be made prior to making a continuum model. A continuum member is based on the full three – dimensional equations of continuum models.

In selecting a model of the structure, the designer also must consider type of analysis to be performed. Four typical analyses that designers perform are:

1. **Static equilibrium**: In this analysis the designer is trying to the determine the overall forces and moments that the design will undergo. The analysis is usually done with a rigid member of model of structure and is the simplest analysis to perform.
2. **Deformation:** This analysis is concerned with how much the structure will move when operating under the design loads. This analysis is usually done with flexible members.
3. **Stress**: In this analysis the designers want a very detailed picture of where and at what level the stresses are in the design. This analysis usually done with continuum members.
4. **Frequency**: This analysis is concerned with determining the natural frequencies and made shape of a structure. This analysis can be done with both flexible members of a structure. This analysis can be done with either flexible members or continuum members but now the mass of the members is included in the analysis.

CHAPTER 8

DRAWINGS

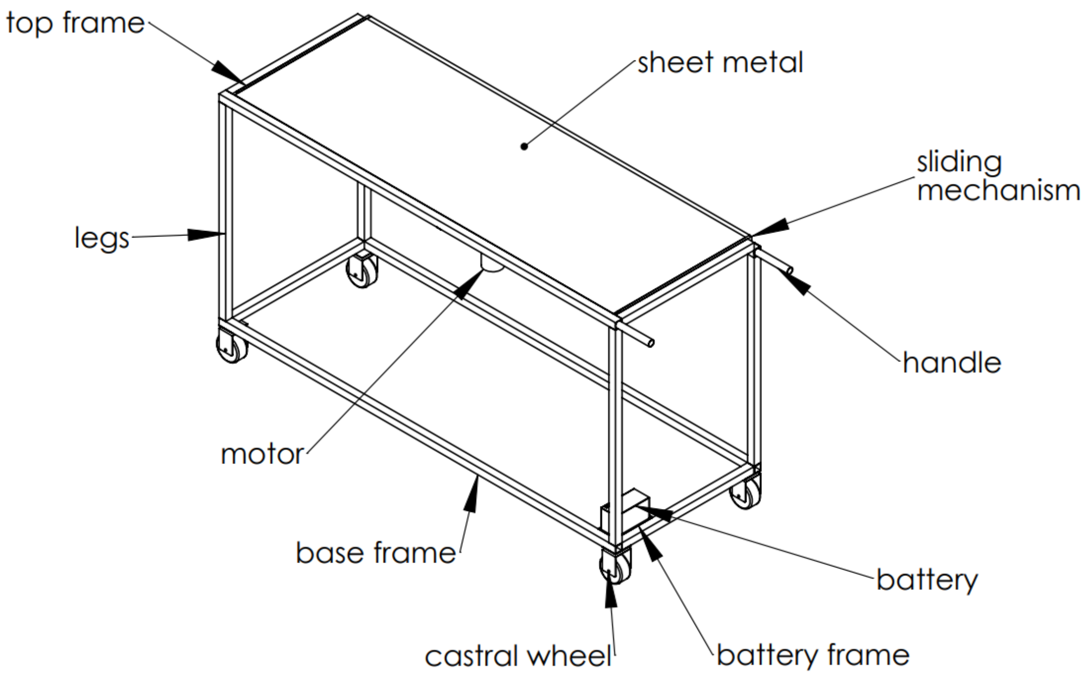


Fig 8.1: Assembly with Nomenclature

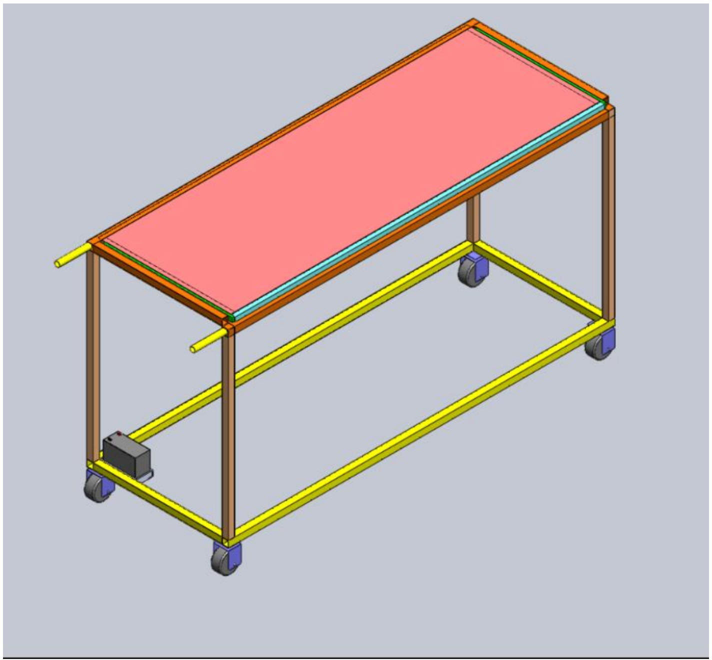


Fig 8.2: 3D Model of Patient Transfer System

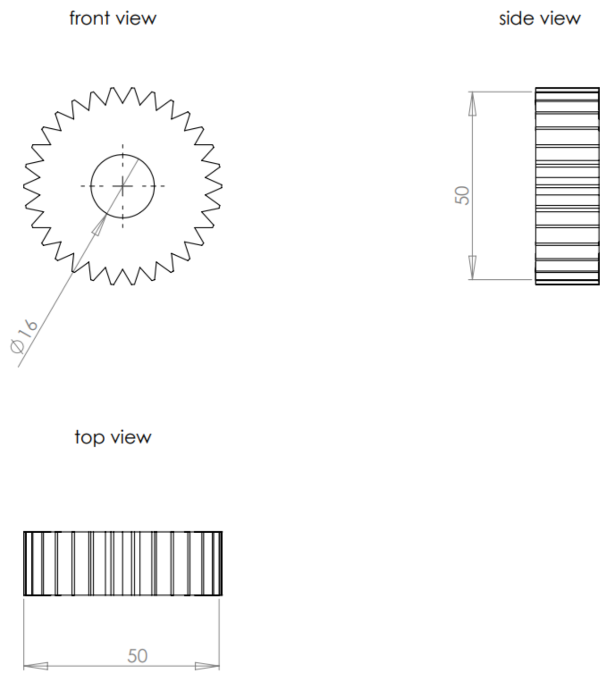


Fig 8.3: Drawing of Pinion

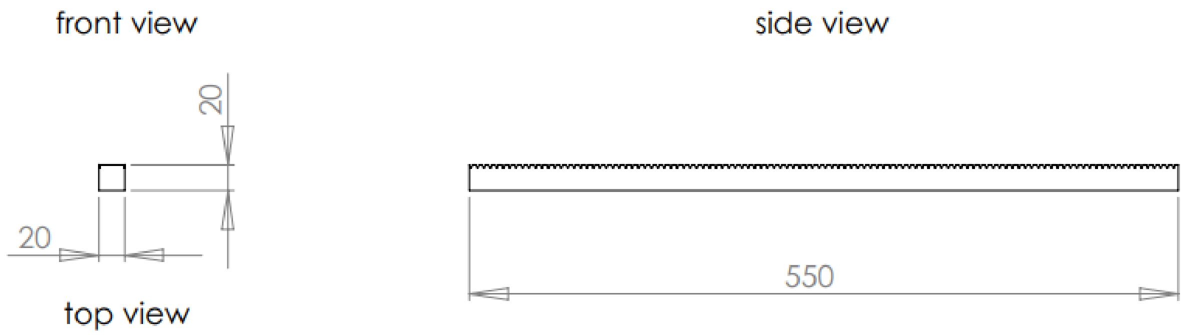


Fig 8.4: Front and Side View of Rack

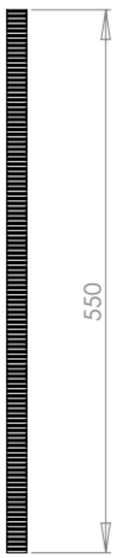


Fig 8.5: Top view of Rack

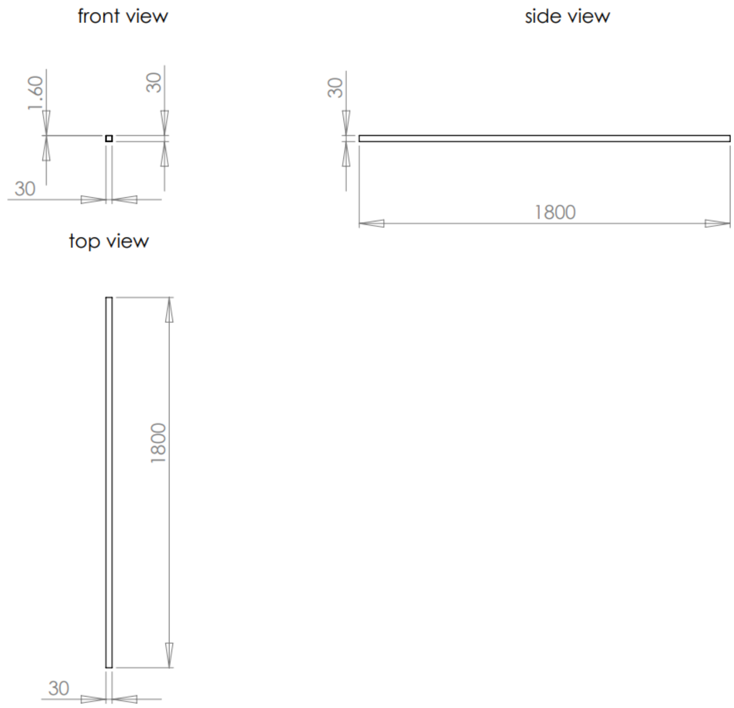


Fig 8.6: Tube (30x1800) Structure of Base

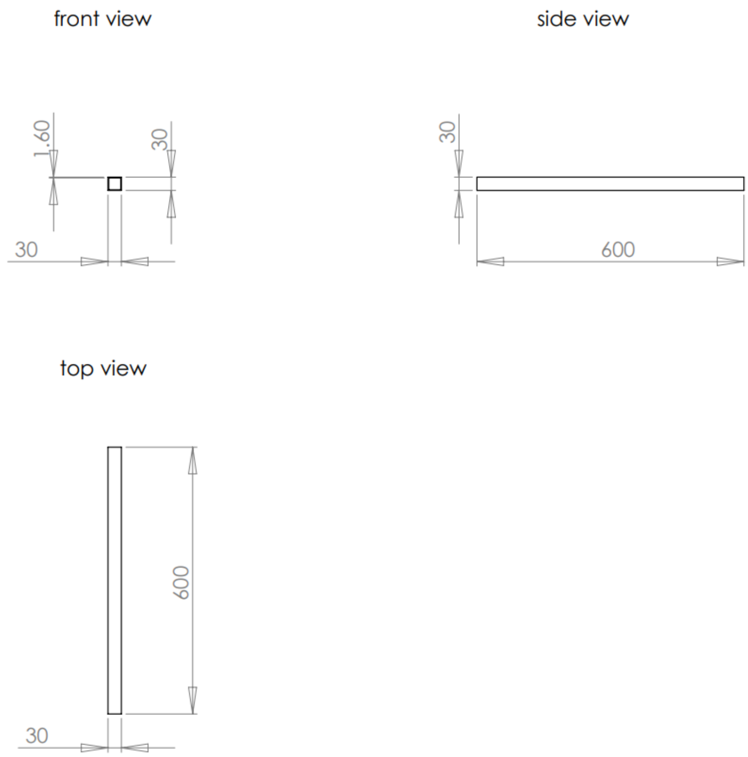


Fig 8.7: Tube (30x600) Structure of Base

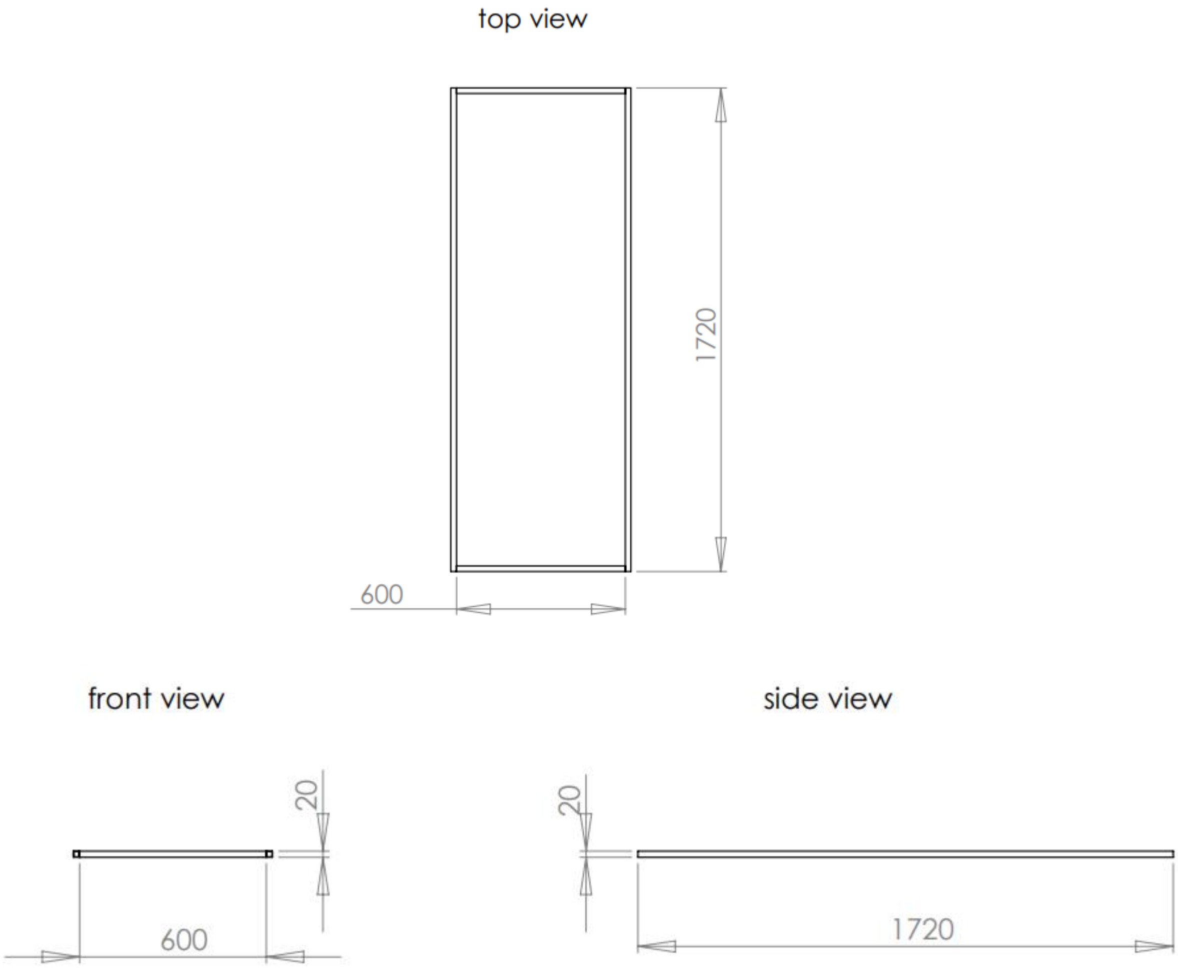


Fig 8.8: Drawing of the frame (1720x600)

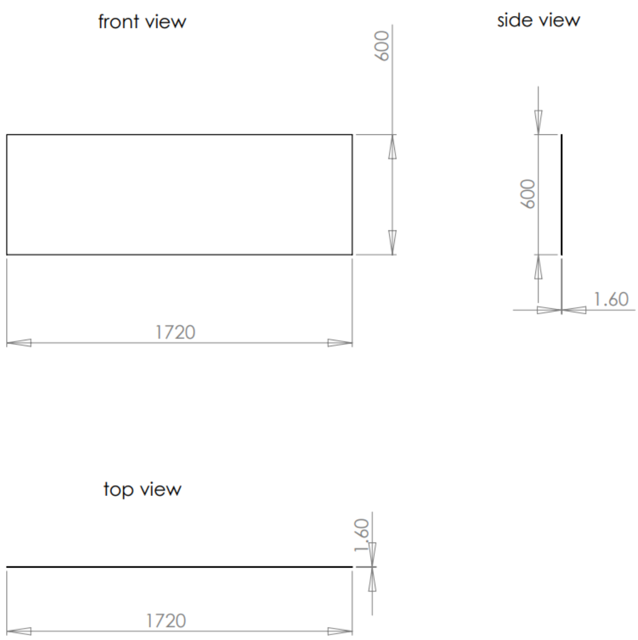


Fig 8.9: Sheet metal

CHAPTER 9

CALCULATIONS

9.1 Load distribution

100kg patient load is acting uniformly on the stretcher base

$б_c = \frac{F}{A} = \frac{25 \times 9.81}{A}$

$б_c = 2 \text{ x } б_t$

Tensile strength for Mild steel considered is 380 MPa

$б_t = \frac{380}{4} = 95\ MPa$

$б_t$ = 95 x 2 = 190 MPa

$380 = \frac{240.25}{A}$

A = 1.58 m^2 = 158 mm^2

Total area of four tubes is 158 mm^2

Tube 30x30

Area = 2 x b x t = 2 x 30 x 3

= 180 mm^2

Area of tube 30x30 is 180 mm^2

Tube 20x20

Area = 2 x b x t = 2 x 20 x 3

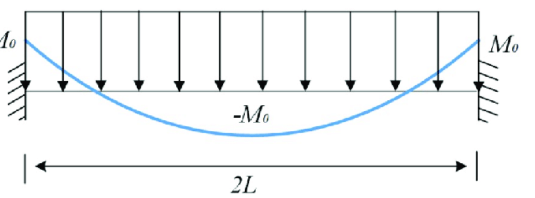
= 120 mm^2

Area of tube 20x20 is 120 mm^2

As area of tube 30x30 is greater than total area. Therefore, **tube 30x30 is selected** as channel to be operated on.

Bending moment

End support centre load:



$\sigma_{max} = \frac{F}{A} + \frac{M}{Z}$

A to B: $M = \frac{1}{2}$ F x

$M = \frac{1}{2}$ x 100 × 9.81 ×900

= 441.45 KNm

= 441.45 x 10^3 Nm

B to C: $M = \frac{1}{2}$ F (L - x)

$M = \frac{1}{2}$ (1800-900) ×100 × 9.81

$M = 441.45 \times 10^3$ Nm

Max Bending Moment, $M = \frac{1}{4}$ x FL

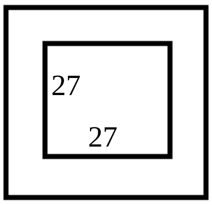
$= \frac{1}{4} \times 100 \times 9.81 \times 1800$

$M = 441.45 \times 10^3$ Nm

Maximum deflection

Max $y = -\frac{1}{48} \frac{FL^3}{EI}$

E = 310 Mpa



$Y = \frac{1}{48} \frac{100 \times 9.81 \times 1.8^3}{210 \times 2.32 \times 10^{-8} \times 10^9}$

$I = \frac{BH^3 - bh^3}{12}$

H = B - t = 30-3 = 27mm

h = D – t = 30-3 = 27mm

$I = \frac{30^4 - 27^4}{12}$

$I = 2.32 \times 10^{-8}$ mm^4

$y = \frac{1}{48} \frac{100 \times 9.81 \times 1.8^3}{10^9 \times 2.32 \times 10^{-8} \times 210}$

y = 0.024 mm

$z = \frac{BH^3 - bh^3}{6H}$

$= \frac{30^4 - 27^4}{6 \times 30}$

z =1547.55 mm^3

σ_{max} = 380Mpa .... Mild steel

$\sigma_{max} = \frac{F}{A} + \frac{M}{Z}$

$= \frac{9.81}{154} + \frac{441.45 \times 10^3}{1547.55}$

σ_{max} = 291.62N/mm^2

$\sigma_{max} < \sigma_y$

Therefore, the design is safe.

9.2 Design of tube

Maximum weight of patient considered is 100kg

Rectangular frame(20x20)

B = 600 mm

L = 1720 mm

H = 20 mm

Volume = B x L x H

= 600 x 1720 x 2 = 2.06×10^{7} mm^{3}

Weight = Volume x density

density = 7.85×10^{-6}

W = $2.06 \times 10^{7} \times 7.85 \times 10^{-6}$

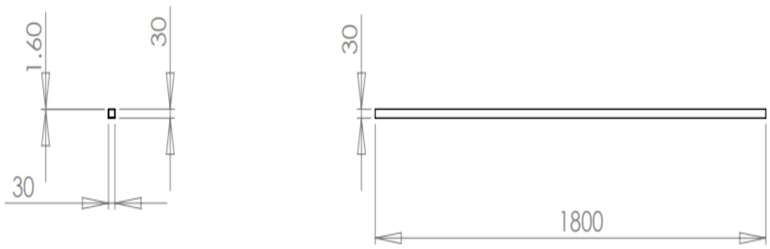
W = 161.71 KN

W = mg

W = 161.71×10^{3} = m x 9.81

M = 16.48 kg

Rectangular frame(30x30)



B = 600 mm

L = 1800 mm

H = 30 mm

Volume = B x L x H

= 600 x 1800 x 30

= 3.24×10^{7}

Weight = Volume x density

density = 7.85×10^{-6}

W = $3.24 \times 10^{7} \times 7.85 \times 10^{-6}$

W = 254.34 KN

W = mg

254.34×10^{3} = m x 9.81

m = 25.92 kg

9.3 Buckling load for tubes

Tube 30x30 for buckling

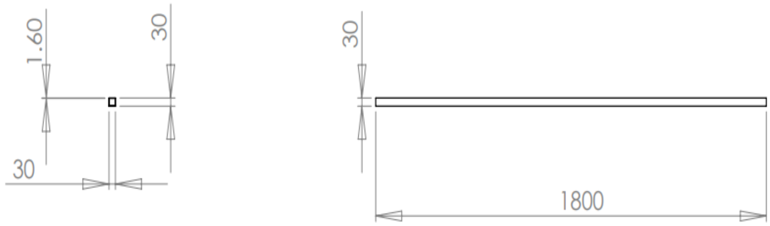
B = 30 mm

D = 30 mm

T = 3mm

b = B – t = 30 – 3 = 27 mm

d = D – t = 30 – 3 = 27 mm



$$I = \frac{BD^3}{12} - \frac{bd^3}{12}$$

$$= \frac{30^4}{12} - \frac{27^4}{12}$$

$$I = 2.32 \times 10^{-8}$$

$$\pi = \frac{22}{7}$$

E = 193×10^9

I = 2.32×10^{-8}

L = 1.8 m

A = 180 mm^2

Buckling load for the member

$$P_E = \frac{\pi^2 EI}{L^2}$$

$$= \frac{\pi^2 \times 193 \times 10^9 \times 2.32 \times 10^{-8}}{1.8^2}$$

$$= 13.62\ KN$$

$б_E$ = $\frac{P_E}{A} = \frac{13.62 \times 10^3}{180}$

= 75.66 Mn/m^2

Since the critical stress is less than the yield stress, therefore the material is safe

Tube 30x30 for buckling

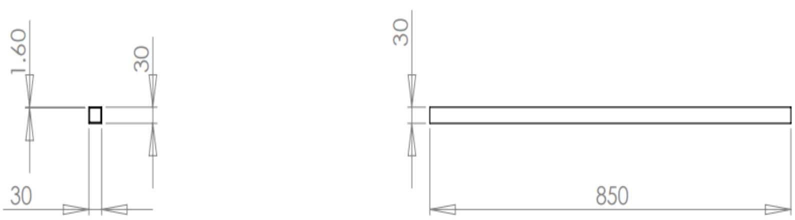
B = 30 mm

D = 30 mm

T = 3mm

b = B – t = 30 – 3 = 27 mm

d = D – t = 30 – 3 = 27 mm



$$I = \frac{BD^3}{12} - \frac{bd^3}{12}$$

$$= \frac{30^4}{12} - \frac{27^4}{12}$$

$I = 2.32 \times 10^{-8}$

$\pi = \frac{22}{7}$

E = 193×10^9

I = 2.32×10^{-8}

L = 0.85 m

A = 180 mm^2

Buckling load for the member

$$P_E = \frac{\pi^2 EI}{L^2}$$

$$= \frac{\pi^2 \times 193 \times 10^9 \times 2.32 \times 10^{-8}}{0.85^2}$$

$$= 61.1\ KN$$

$\sigma_E = \frac{P_E}{A} = \frac{61.1 \times 10^3}{180}$

= 339.46 Mn/m^2

Since the critical stress is less than the yield stress, therefore the material is safe

Tube 20x20 for buckling

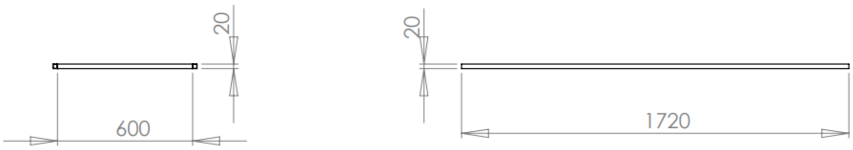
B = 20 mm

D = 20 mm

T = 3mm

b = B – t = 20– 3 = 17 mm

d = D – t = 20 – 3 = 17 mm



$$I = \frac{BD^3}{12} - \frac{bd^3}{12}$$

$$= \frac{20^4}{12} - \frac{17^4}{12}$$

$I = 6.372 \times 10^{-9}$

$\pi = \frac{22}{7}$

E = 193×10^9

I = 6.37×10^{-9}

L = 1.72 m

A = 120 mm^2

Buckling load for the member

$P_E = \frac{\pi^2 EI}{L^2}$

$= \frac{\pi^2 \times 193 \times 10^9 \times 6.37 \times 10^{-9}}{1.72^2}$

$= 4.152\ KN$

б$_E$ = $\frac{P_E}{A} = \frac{4.152 \times 10^3}{120}$

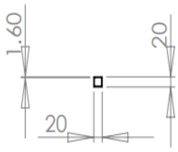
= 34.66 Mn/m^2

<u>Since the critical stress is less than the yield stress, therefore the material is safe</u>

<u>**Tube 20x20 for buckling**</u>

B = 20mm

D = 20mm



T = 3mm

b = B – t = 20– 3 = 17 mm

d = D – t = 20 – 3 = 17 mm

$I = \frac{BD^3}{12} - \frac{bd^3}{12}$

$= \frac{20^4}{12} - \frac{17^4}{12}$

$I = 6.37 \times 10^{-9}$mm^4

$\pi = \frac{22}{7}$

E = 193 $\times$ 10^9 Mpa

I = 6.37 $\times$ 10^{-9} mm^4

L = 0.6 m

A = 120 mm^2

Buckling load for the member

$P_E = \frac{\pi^2 EI}{L^2}$

$= \frac{\pi^2 \times 193 \times 10^9 \times 6.37 \times 10^{-9}}{0.6^2}$

$= 33.70\ KN$

б$_E$ = $\frac{P_E}{A} = \frac{33.70 \times 10^3}{120}$

= 280 Mn/m^2

<u>Since the critical stress is less than the yield stress, therefore the material is safe</u>

9.4 Rack and Pinion

Material C40

Module = 2

Addendum (m)= 2

Dedendum =1.25m = 2.5

Thickness of tooth = $\frac{Pc}{2}$ = 3.14mm

Circular pitch Pc = π x m = 6.28mm

Clearance = 0.25m = 0.25mm

Working depth = 2m = 4 mm

No. of teeth pinion, z = 31

Teeth on rack = 32

dp = mz = 2 × 30 = 60mm

Circumference of gear = 2πR = 2 × 3.142 × 2 = 12.56 mm

Rack length = πm × z = 197 mm

$F = \frac{2T}{d}$

$P = \frac{2\pi NT}{60}$

$T = \frac{P \times 60000}{2\pi \times 80}$

$T = 23.39 \times 10^3$ Nmm

$F_t = \frac{2T}{d}$

$= \frac{2 \times 23.39 \times 10^3}{60}$

F_t = 780N

Beam strength, $F_s = m \times b \times y \times \sigma_d$

σ_d =193.3Nm/m^2

y – Lewis's form factor

$y = 0.175 - \frac{0.95}{z} = 0.144$

Y = y x π = 0.44

$F_S = m \times b \times y \times \sigma_d$

= 2×12×193.3×0.44 = 2079.42 N

Pitch line velocity, $V = \frac{\pi DN}{6000} = \frac{\pi \times 60 \times 70}{60000}$

V = 0.251m/s

Velocity factor, $C_v = \frac{3.05}{3.05+V}$

$= \frac{3.05}{3.05+0.251}$

C_v = 0.92 m/s

$F_d = \frac{k_3 v(Cb+F_t)}{k3V} + \sqrt{Cb + F_t} \quad +F_t$

k_3 = 20.67 b = 12mm

$C = \frac{e}{k_1} \times (\frac{1}{E1} + \frac{1}{E2})$

$E = 210 \times 10^{3}$ GPa F_t = 780N

k_3 = 20.67

k_1= 9 e= 0.1

$C = 1.167 \times 10^{3}$

F_d = 1385.01 N

As, $F_s > F_d$

Hence, the design is safe.

9.4 Welded joint

Checking the strength of the welded joints for safety

The maximum load which the plate can carry for transverse fillet weld is

$P = 0.707 \times S \times L \times f_t$

Where, S = factor of safety, L = contact length = 25mm

The load of shear along with the friction is 50 kg = 500N

Hence, 500 = 0.707 x 3 x 35 x ft

Hence let us find the safe value of 'ft'

Therefore $f_t = \frac{500}{0.707 \times 3 \times 35}$

f_t = 6.73536 N/mm^2

Since the calculated value of the tensile load is very smaller than the permissible value as ft=56 N/mm^2 Hence, welded joint is safe

9.5 Force required to move the base

F(N) = W× f = 50 × 0.2

F = 10N

Torque = F × r (m)

= 10 × 0.6

T = 6 × 10^3 Nm

9.6 Selection of DC motor

N = 80 rpm

T = 6 × 10^3 Nm

P = $\frac{2\pi NT}{60000} = \frac{2\pi \times 80 \times 6 \times 10^3}{60000}$

= 50 Watts

∴ Motor selected is 12V 50Watts whose speed is 80 rpm.

CHAPTER 10

FABRICATION

10.1 Selection of Materials

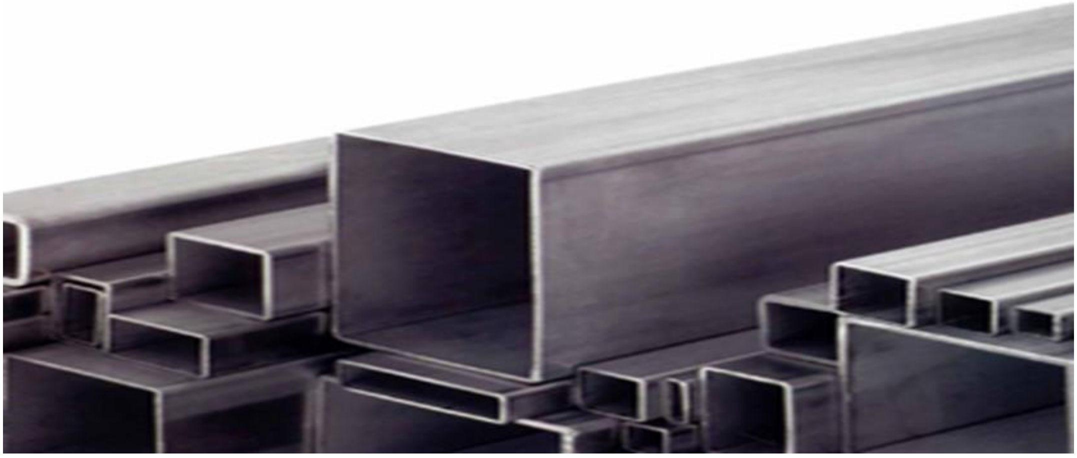


Fig 10.1: Cold rolled steel pipes

Square and rectangular pipes are extensively used in welded steel frames which experience heavy loads from multiple directions. The shape os pipes suit multiple axis loading with having uniform geometry along with two or more cross section axes. This enhances the uniform strength of these pipes, making them better choice of columns. These are manufactured through the process where flat steel plate is slowly changed in shape to achieve round where the edges are presented to weld. Then the edges are welded together to form the master tube. This master tube which is also referred as mother tube goes through a sequence of shaping stands, which form the final square or rectangular shape.

The square sections enhance the reliability of the structure. These are manufactured using graded steel in compliance with set international standards. The square sections are used as support in automotive industry, transmission tower plants, machinery industry, construction industry and many others. These sections are made using high grade steel metal in compliance with international standards. The square section holds superb tensile strength and is rust resistant with ability to offer long working life. The sections are tested on various parameters, which are tensile, bending, flattening and other strengths.

FEATURES OF THE TUBE

- Supreme resistance to torsion.
- High impact strength
- Corrosion resistant
- Easier to transport.
- Good weldability.

- Supreme tensile strength.

RECTANGULAR SECTION

The rectangular sections are constructed using finest steel. These are preferred for their robustness. The rectangular sections have precise dimensions and accuracy, which is one of the trademarks of our high-grade manufacturing abilities. It is tested on several international standards, where tensile strength, flattening, bending, and drift expansions. It is preferred in several industries, such as furniture industry, construction industry, automotive industry and many more.

10.2 Manufacturing Process

Introduction

Manufacturing engineering is a discipline of engineering dealing with different manufacturing practices and the research and development of processes, machines, tools and equipment, dealing with machines that turn raw materials to a new product.

Turning

Turning is the process whereby a single point cutting tool is parallel to the surface. It can be done manually, in a traditional form of lathe, which frequently requires continuous supervision by the operator, or by using a computer controlled and automated lathe which does not. This type of machine tool is referred to as having computer numerical control, better known as CNC and is commonly used with many other types of machine tool besides the lathe.

Drilling

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole in solid materials. The drill bit is a multipoint, end cutting tool. It cuts by applying pressure and rotation to the work piece, which forms chips at the cutting edge.

Grinding

The grinding of solid matters occurs under exposure of mechanical forces that trench the structure by overcoming of the interior bonding forces. After the grinding the state of the solid is changed: the grain size, the grain size disposition and the grain shape.

Grinding may serve the following purposes in engineering:

- increase of the surface area of a solid
- manufacturing of a solid with a desired grain size

Boring

In machining, boring is the process of enlarging a hole that has already been drilled (or cast), by means of a single-point cutting tool (or of a boring head containing several such tools), for example as in boring a cannon barrel. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole. Boring can be viewed as the internal-diameter counterpart to turning, which cuts external diameters.

Welding

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the work pieces to form a bond between them, without melting the work pieces.

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower- melting-point material between the work pieces to form a bond between them, without melting the work pieces. Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding may be performed in many different environments, including open air, under water and in outer space. Welding is a potentially hazardous undertaking and precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes, and exposure to radiation. The main Types of welding used in industry and by home engineers are commonly referred to as MIG welding, Arc welding, Gas welding and TIG welding.

Arc welding

These processes use a welding power supply to create and maintain an electric arc between an electrode and the base material to melt metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is sometimes protected by some type of inert or semi-inert gas, known as a shielding gas, and filler material is sometimes used as well.

We have used Arc-Welding to join trolley parts together. The completed prototype of the trolley is shown in figure:

Fig 10.2: Spot welding

Fig 10.3: Spot welding

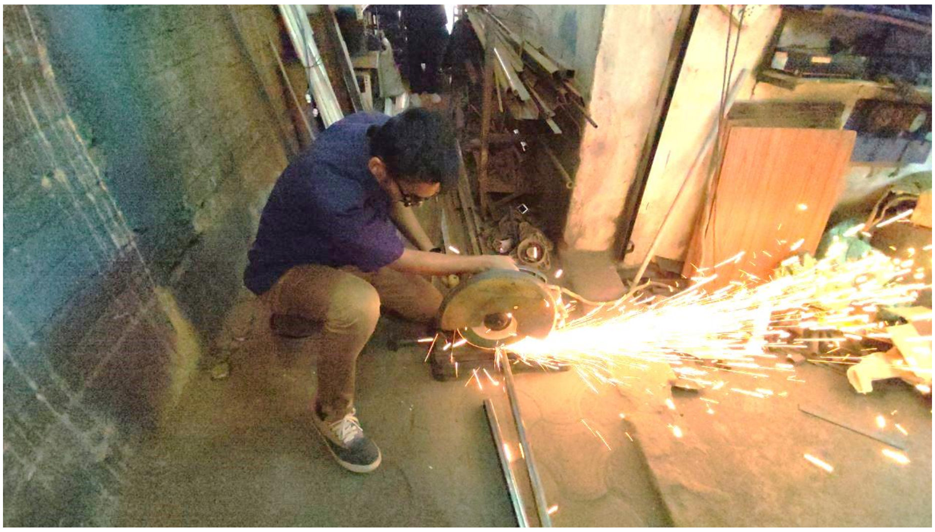


Fig 10.4: Cutting tubes

Fig 10.5: Sliding mechanism

Fig 10.6: Assembled patient transfer system

CHAPTER 11

COST ESTIMATION

Material cost estimation gives the total amount required to collect the raw material which has to be processed or fabricated to desired size and functioning of the components. These materials are divided into two categories:

1) Material for Fabrication: In this the material in obtained in raw condition and is manufactured or processed to finished size for proper functioning of the component.

2) Standard Purchased Parts: This includes the parts which was readily available in the market like Allen screws etc. A list in for-chard by the estimation stating the quality, size & standard parts, the weight of raw material and cost per kg. For the fabricated parts.

11.1 Procedure for Calculation of Material Cost

The general procedure for calculation of material cost estimation is:

1) After designing a project, a bill of material is prepared which is divided into two categories.
    A) Fabricated components.
    B) Standard purchased components.
2) The rates of all standard items are taken and added up.
3) Cost of raw material purchased taken and added up.

Dimension for each part is noted and the volume of the material is calculated by multiplying it with specific gravity of that material to give the weight of the component. The density of mild steel in taken as 7.85 gm/sec.

The weight of material for each part is multiplied by the rate per kg. Of the material to give the material cost for each component.

The summarization of all the cost of the standard products thus the cost of material to be fabricated gives the material cost estimation of that project.

There are three categories of costs:

A) material cost
B) Machining cost
C) Labor cost

PROCEDURE OF CALCULATING MACHINING COST:

Time taken by a particular machine for machining each and every component is calculated including allowances for tiny set up inspection time, centering time etc. because a component cannot have more than one operation. The machining cost is calculated using standard working rates of machine per hours. The time taken by a particular machine for machining every component is multiplied by the machining rate to give the machining cost.

Therefore, total cost includes:

TOTAL COST = MATERIAL COST + MACHINING COST + LABOR COST

COST EXPENDITURE

Materials Cost		
SL No	**Particulars**	**Cost (Rs)**
1	Frame Tube	3000
2	Motor	3000
3	Rack And Pinion	1200
4	Battery	700
5	Toggle Switch	200
6	Caster Wheels	300
7	Guide Wheels	500
8	Lock	200
9	Bush	200
10	Wiring	50
11	Fasteners	300
12	Other Attachments	1000
Process Cost		
1	Machining	300
2	Drilling	100
3	Grinding/Filling	50
4	Welding	2000
5	Oiling	50
6	Painting	500
Other Cost		
1	Project Report	300
2	Miscellaneous	1000
	Total	**Rs 14950 /-**

CHAPTER 12

ADVANTAGES AND APPLICATIONS

12.1 Advantages

Design and fabrication of patient transfer systems offer several advantages, including:

1. **Improved patient safety:** Patient transfer systems are designed to provide a safe and secure means of transferring patients from one location to another. By eliminating manual lifting and reducing the risk of falls or injuries, patient transfer systems can help prevent accidents and ensure the safety of both patients and caregivers.

2. **Increased efficiency:** Patient transfer systems can help streamline the transfer process, making it faster and more efficient. This can help reduce wait times and improve patient throughput, allowing healthcare providers to see more patients and provide more timely care.

3. **Reduced physical strain:** Patient transfer systems can help reduce the physical strain on healthcare providers, which can help prevent injuries and improve staff retention rates. By automating the transfer process, healthcare providers can reduce the amount of physical exertion required to move patients, which can help reduce the risk of back injuries, strains, and other physical ailments.

4. **Improved patient comfort:** Patient transfer systems are designed to provide a comfortable and supportive transfer experience for patients. By reducing the need for manual lifting and providing a stable and secure transfer platform, patients can experience a smoother and more comfortable transfer process.

5. **Customization:** Patient transfer systems can be designed and fabricated to meet the specific needs of individual patients or healthcare facilities. This customization can help ensure that patients receive the best possible care, while also helping healthcare providers optimize their workflow and maximize their resources.

12.2 Applications

The project will focus on four specific applications of the patient transfer system:

1. **Bed-to-bed transfer:** The patient transfer system will enable the safe and comfortable transfer of patients from one bed to another. This feature will be particularly useful for patients who need to be moved between wards, or for those who require transfer to a different bed for medical reasons.

2. **Point-to-point transfer:** The patient transfer system will also facilitate the movement of patients from one location to another within a healthcare facility. This feature will be useful for patients who need to be transported to different areas of the facility for medical procedures or testing.

3. **Operating theatre transfer**: The patient transfer system will be designed to safely and efficiently transfer patients from the operating theater bed to the recovery bed. This feature will be essential for ensuring patient comfort and safety during the post-operative phase.

4. **Scanning bed transfer:** The patient transfer system will also be used to move patients to the scanning bed for diagnostic testing. This feature will ensure that patients are transferred in a safe and comfortable manner, without risking further injury or discomfort.

CHAPTER 13

FUTURE SCOPE

Our project, which involves the design and fabrication of a device for dealing with rusted and unused metals, has a promising future in various medical sectors. Although the initial cost of the device is high, it has low operating costs. Therefore, the savings resulting from its use would make it a cost-effective solution in a short period of time.

The device has the potential for various modifications and improvements to enhance its operational efficiency, making it an attractive option for commercial production. We believe that if marketed properly, it will be widely accepted in the industry.

Overall, our project offers a great deal of scope for further development and improvement. Its cost-effectiveness and potential for modifications make it a valuable asset for any field dealing with rusted and unused metals.

CHAPTER 14

LEARNING OUTCOMES

Some common learning outcomes could include:

- Identifying the various types of patient transfer systems available and their advantages and disadvantages.
- Developing the ability to evaluate the needs of patients and the environment to determine the appropriate transfer system to use.
- Designing a patient transfer system that is safe, effective, and meets the needs of the patient and the caregivers.
- Selecting appropriate materials and components for the construction of the patient transfer system.
- Demonstrating knowledge of safety procedures and regulations related to the use of equipment and materials in the fabrication process.
- Testing and evaluating the patient transfer system to ensure that it meets safety, reliability, and performance standards.

CHAPTER 15

CONCLUSION

The design and fabrication of a patient transfer system that includes a rack and pinion mechanism for sliding motion is a challenging but rewarding task. This system is crucial for hospitals and healthcare facilities as it helps to safely and efficiently transfer patients from one location to another.

After extensive research and analysis, a design was created that incorporated a rack and pinion mechanism to provide the necessary sliding motion. The rack and pinion system were chosen for its simplicity, durability, and precision.

Overall, the patient transfer system with the rack and pinion mechanism for sliding motion is a successful project that has the potential to improve patient care and safety in healthcare facilities. The system provides a reliable and efficient method for transferring patients, and its design and fabrication can serve as a model for future projects.

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