MODELING OF A STAIR CASE LIFT

Submitted in partial fulfilment of the requirements for the award of the degree of

B.TECH

by

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CERTIFICATE

This is to certify that the thesis entitled "**MODELING AND ANALYSIS OF A STAIR CASE LIFT**" submitted by **RAJULAPATI NAVEEN (208W1A03F7), GUDURU VENKATA MARUTHI ABHIRAM (208W1A03C9), MUTHYALA SAI KIRAN (208W1A032E8), MOHAMMAD ABDUL HAADEE IRSHAD (208W1A03E5) and THUMU BHARATH KUMAR (198W1A03B7)** to V. R. Siddhartha Engineering College, Vijayawada under the jurisdiction of JNTU Kakinada in partial fulfillment of the requirements for the award of the degree of **Bachelors of Technology** is a record of bonafide research work carried out by us under your supervision and guidance. This work has not been submitted elsewhere for the award of any degree.

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ABSTRACT

The present work investigates the design the and analysis of a stair case lift, which can be use as Material Handling System. A stair case lift is a mechanical device for lifting people and wheelchairs up and down on the stairs, who may find difficulty in doing so themselves. For sufficiently wide stairs, a rail is mounted to the treads of the stairs. A chair or lifting platform is attached to the rail. A person on the chair or platform is lifted as the chair or platform moves along the rail, old age and goods are to be carried across the stair case. Stair case lift is a type of lift that can be mounted on the stair case without altering civil structure. This lift runs on electric power and consists of a motor, reduction gear box, rope drive, two rails and a sliding chair. In this system we use DC motor for changing the polarity of the power supply which will make the motor run in reverse direction. Advantages over the conventional hydraulic lift are no civil structure and alteration is required, low cost, less bulkiness, less power, less maintenance requires. Easy design, easy installations can be of industrial use too. Moreover, considering some drawbacks due to weight carrying capacity completely depend upon the capacity of motor. There is lot of scope for further modification in the project as using monorail instead of two, use of belt drive or chain drive instead of rope drive, Incorporation and automation/ timer unit which will ease the use of device. Rack and carrier arrangement for using the device for curved stair case and use of work & roller reduction gear assembly.

Key words: Platform, Rails, Wire rope drive, AC motor, civil structure.

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NOMENCLATURE

Symbol	CAPTION
D	Pitch Diameter
H_a	Allowable horse Power
M	Mass of the carriage
F_a	Axial Load on bearing
F_r	Radial Load on bearing
F_s	Factor of safety
P	Power
p	Pitch
W	Total Weight
ηg	Efficiency of the gearbox
ηm	Efficiency of the motor
μ	Coefficient of friction

Chapter 1

INTRODUCTION

1.1 Introduction :

An elevator or lift is vertical transport equipment that efficiently moves people or goods between floors (levels) of a building, or of other structure. Elevators are generally powered by electric motors that either drive traction cables or counter weight systems like a hoist or pump hydraulic fluid to raise a cylindrical piston like a jack. Because of wheelchair access laws, elevators are often a legal requirement in new multi-storey buildings, especially where wheelchair ramps would be impractical.

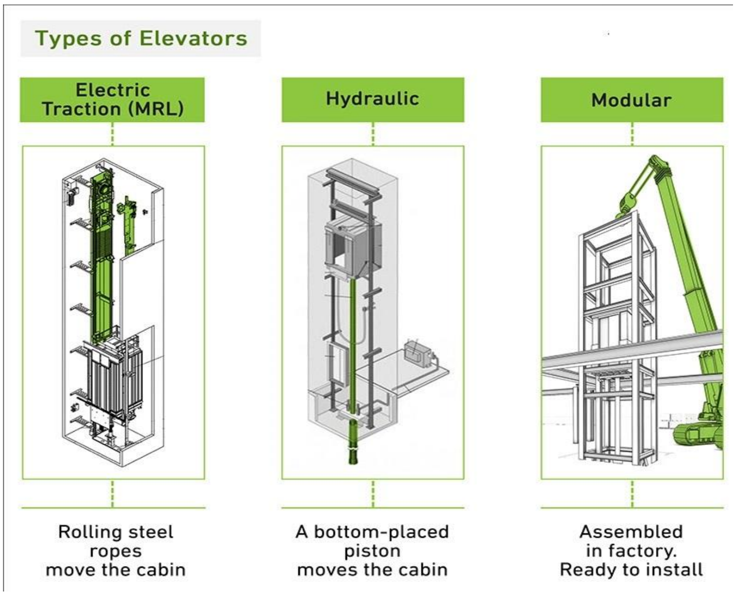

Figure 1.1: Types of Elevators

A stairlift is a mechanical device for lifting people and wheelchairs up and down stairs. For sufficiently wide stairs, a rail is mounted to the treads of the stairs. A chair or lifting platform is attached to the rail. A person on the chair or platform is lifted as the chair or platform moves along the rail. Stairlifts are known variously as chair lifts, stair gliders and by other names. This type of chair lift should not be confuse with the chairlift used by skiers. As the name suggests stair case lift is a type of lift that can be mounted on the stock stair case without altering civil structure. This lift of course runs on electric power and consists of a motor, rails and a sliding chair.

This stair case lift can be mounted stock stair case where the civil structure is not be altered and still handicapped**,** old age people and goods are to be carried across the stair case.

Lifts are invented long back ago. But installation of lift involves ample amount of cost intenous of rails, motor honk, civil structures. If lifts to be installed in the stalk structure then it be alteration cost is too much.

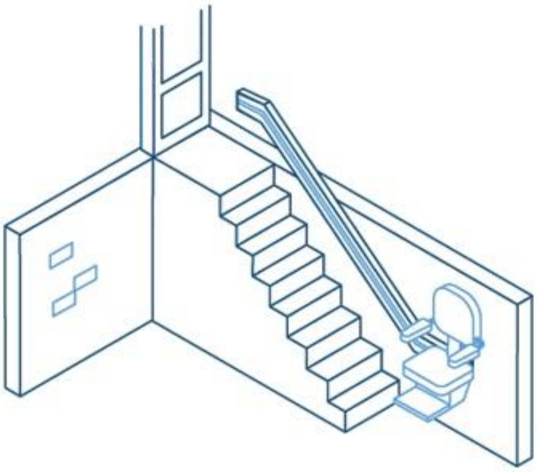

Figure 1.2: Stair case lift

To overcome all these factors and to civil construction cost, the concept of stair case lift come which reduces extra costing associated with the lift mechanism, the benchmark of the system is that this concept is associated with simplifying as well. Some people argue that lifts began as simple rope or chain hoist. A lift is a essentially platform that is either pulled or pushed up by a mechanical means. A modern day lift which consists of a cab (also called a "cage" or "car") mounted on a platform within an enclosed space called a shaft or sometimes a "hoistway".

In the past, lift drive mechanisms were powered by steam and water hydraulic pistons or by hand. In a "traction" lift, cars are pulled up by means of rolling steel ropes over a deeply grooved pulley commonly called a sheave in the industry. The weight of the car is balanced by counter weight. Sometimes two lifts always move synchronously in opposite directions, and they are each other's counterweight.

The friction between the ropes and the pulley furnishes the traction which gives this type of lift its name. Hydraulic lifts use the principles of hydraulics (in the sense of hydraulic power) to pressurize an above ground or in ground piston to raise and lower the car. Roped hydraulics uses a combination of both ropes and hydraulic power to raise and lower cars. Recent innovations include permanent magnet motors, machine room-less rail mounted gearless machines, and microprocessor controls.

The technology used in new installations depends on a variety of factors. Hydraulic lifts are cheaper, but installing cylinders greater than a certain length becomes impractical for very high lift hoist ways. For buildings of much over seven storeys, Traction lifts must be employed instead. Hydraulic lifts are usually slower than traction lifts. Lifts are a candidate for mass customization. There are economies to be made from mass production of the components, but each building comes with its own requirements like different number of floors, dimensions of the well and usage patterns.

1.2 Motivation:

The motivation for this research comes basically from the need of a lifting system which is cost friendly and easy for installation. Typical lifts are very expensive and also the maintenance cost is high. In old buildings where there is no required space for installation a lift or two/three storeyed building, it is much hazardous for a person who is physically disabled to use the stairs. Also, it is difficult to handle heavy weight materials and equipment for lifting.

Stair Lifts can assist people by doing the following:

- Decrease the need for excessive remodeling of a multi-story home.
- Make a multi-story home more fully and completely accessible.
- Assist people who have just suffered an injury or undergone surgery and are temporarily unable to use the stairs unassisted.
- Rentable models of stair lifts can act as a solution for short-term elderly visitors who have difficulty using the stairs.
- Modify a multi-story house in a situation where elderly parents may be moving back in with their kids for assistance and support.
- Allowing wheelchair access to multiple levels of a home.
- Increasing the safety of those who live alone and have decreased mobility.

1.3 Objectives:

This thesis work is designed with an aim with following objectives:

- To develop a lifting system which can be helpful for disabled people.
- To introduce a cost friendly solution for material handling to the upstairs.
- To design a safe lifting system which can easily be installed.
- To give a solution for the old buildings where typical lift cannot be installed.
- To determine the working efficiency and beneficial working of the stairlift.
- To determine the load carrying capacity of the stairlift.

1.4 About Stair Case Lift:

A stair case lift is a safe and secure method for human transportation which is a mechanical device for lifting people up and down stairs. As we know the elevators had been made a lot of developments till now elevators that we see nowadays in the markets or other places. An elevator or lift is vertical transport equipment that efficiently moves people or goods between floors (levels) of a building, or of other structure. Elevators are generally powered by electric motors that either drive traction cables or counterweight systems like a hoist or pump hydraulic fluid to raise a cylindrical piston like a jack. Because of wheelchair access laws, elevators are often a legal requirement in new multi-storey buildings, especially where wheelchair ramps would be impractical. Sometime the elevator needs extra depth underground for installing and especially in the multi storied buildings. In case lift to be installed in the stalk structure then alteration cost will be appreciably high.

The urbanization started some 2 to 3 decades ago and has taken much of the City limits to get compressed nearest to the amenities which resulted in high rise. Most residential buildings were granted the permission to build up to Ground plus 2 or 3 storied, where in Elevator was not installed. Since at that time, it was not considered necessary and people preferred to climb stairs, irrespective of all odds. Consequent to the Life-Style changes, including physical and mental apathy, currently the four store building residents have started to feel the need for having a Elevator in their buildings. But now many factors abide them such as local body governing rules for town planning, constructional requirement and cost of installation of the Elevator.

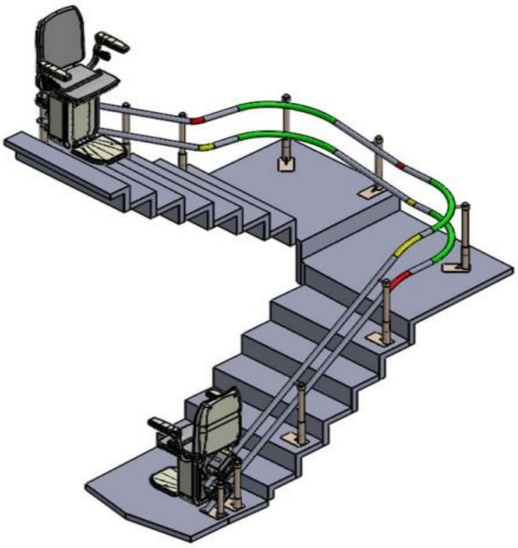

Figure 1.3: Model of Stair case lift

To overcome all these factors and to avoid civil construction/alteration cost the concept of stair case slider/lift comes with being which reduced extra costing associated with the lift mechanism, the benchmark of the system is that this concept is associated with simplifying as well. Some people argue that lifts began as simple rope or chain hoist. A lift is essentially a platform that is either pulled or pushed up by a mechanical means.

For sufficiently wide stairs, a rail is mounted to the side wall of the stairs. A lifting platform is attached to the rail; a person standing on the platform is lifted as the platform moves along the rail. Staircase slider is also known variously as stair-lifts, chair lifts, stair gliders and by other names. This slider of course runs on electric power and consists of a motor, two rails and sliding platform. This stair case slider can be mounted on stock stair case where the civil structure is not be altered; and still handicapped or old age or people with incapability to raise by themselves are to be carried across the stair case.

In the old buildings that do not have elevators or consist of two floors or more must have a device for transportation as we mentioned before. So we made a research to fill this space which is becoming need of the time, because it is easy to install, economic and does not require high maintenance.

1.5 Advantages of a Stairlift:

The main advantages of a stairlift are:

- Stairlifts are not much expensive.
- There is very small amount of cost for maintenance
- It can easily be installed and any change in the stairs is not needed.
- Stairlifts is suitable for any kind of building old or new.
- No extra space is required for installation.
- It can easily be operated.

1.6 FABRICATION AND WORKING:

In this project, the final design was an outcome of a sequential analysis and modification of stages. Stair lifts are easily installed into any situation where the condition of the stair tread is good as the railing that the chair lift uses is attached to the stair tread. A chair lift for stairs can be both battery operated and AC power operated. Stairs present a mobility challenge and often danger for the elderly who are struggling with mobility issues. Falling down stairs are a leading cause of serious injury among the elderly. Purchasing a chair lift for stairs can significantly reduce concerns about falls. A chair lift will not only be a safer method for movement up and down stairs by those with mobility issues but they will also be securing an important degree of independence. The concept of stair case lift is made for transportation of human, goods across stair case.

Figure 1.4: Disabled person on stair case lift

Hence it needs something like chair, platform using which human, goods can be transported, something on which these platforms, chair case run on like rails. Something with which the platform, chair can be made to run across rails such as pulling pushing mechanism, system which involves a motor, a gearbox, a pulley and a rope drive. The rails are two in numbers. These can be mounted on the stalk stair case with clamping with ease. Inside these ‘C’ cross sectioned rails slides are mounted which stud less through the length of rails. These staircases and fixed to each other with the help of structural mechanisms supports the motor and other components like gearbox, pulley, platform, chair, control panel.

Now, on these staircase a motor is mounted which is a out scale down model in 2V DC 2400 rpm speed, which is associated with the gearbox which uses 10 different event gears for reducing speed and inversing torque. On the output of the gearbox is mounted a guide pulley. This output shaft of the gearbox is also used to wheel and moved the rope with the help of which these stair case lift can move upward and downward. Other end of this rope is attached with the upper end of rail. Wherever supply is given to these motor its runs the gearbox which in-return starts winding the rope on its outer start wheels makes the apparent through of the gearbox shouter resulting in pulling of the gearbox and the motor in the direction in which the rope has been fixed. As motor and gearbox along with the platform, chair are mounted on the suitable platform which can be slid e on the rails the entire unit starts moving upwards then human / goods can be motivated very easily. Reversing the supply to the DC motor on changing the polarity of the power supply will make the motor run in reverse direction connected with the earlier, while the later will form the entire assembly run to in downward direction then by making the entire / single must be use for the future purposes.

Figure 1.5: Lifting of old people

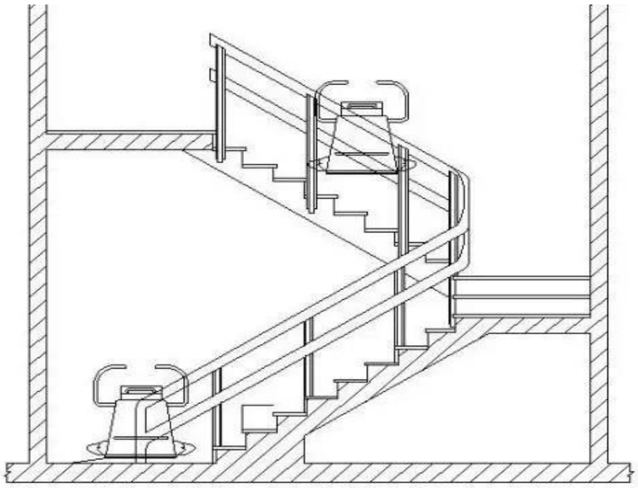

Figure 1.6: stair case lift model

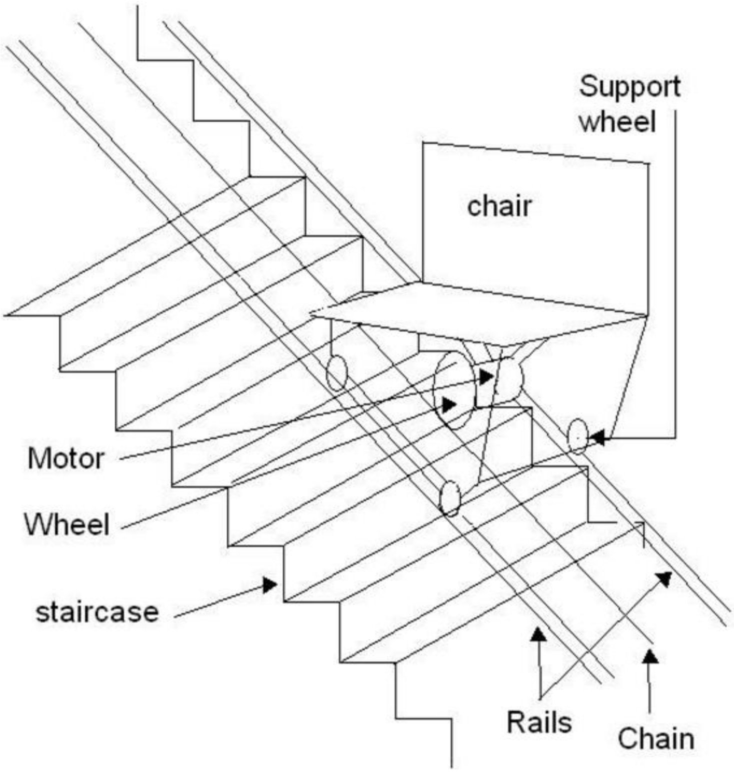

Figure 1.7: stair case lift

Chapter 2
LITERATURE SURVEY

Pengjia Wanga, et al: [1] Modular design, or modularity in design, is a design approach that subdivides a system into smaller parts called modules or skids, that can be independently created and then used in different systems. A modular system can be characterized by functional partitioning into discrete scalable, reusable modules; rigorous use of well-defined modular interfaces; and making use of industry standards for interfaces. Besides reduction in cost (due to less customization, and shorter learning time), and flexibility in design, modularity offers other benefits such as augmentation (adding new solution by merely plugging in a new module), and exclusion. The Use of remanufacture engineering related to design concept of stairlift used over here. By implementing the remanufacturing strategy at the end of the product lifecycle, the enterprise can reduce cost and improve competitiveness largely. If the remanufacturing process is not considered when a product is being designed, it will be difficult to remanufacture the product at the end of its lifecycle, as some of the components and parts could have been worn badly, resulting in a product which cannot be remanufactured. Therefore, it is necessary to consider the remanufacturing characteristics during the phase of product design, to facilitate product reuse, upgrade and maintenance, and to make it easier to disassemble and recover.

Shouhei Shirafujia, et al: [2] Belt drive, as per in machinery, a pair of pulleys attached to usually parallel shafts and connected by an encircling flexible belt that can transmit and modify rotary motion from one shaft to the other. Most belt drives consist of flat leather, rubber, or fabric belts running on cylindrical pulleys or of belts with a V-shaped cross section running on grooved pulleys. This paper focuses on the flexible belt drives used in engineering applications & systems. Flexible belts, cables and ropes have wide applications in engineering, where they are used as belt drives for power transmission between rotating shafts, band breaks to reduce angular speed of rotating machine parts, hoist devices for lifting or lowering loads in construction or mining industry, devices for fastening marine vessels to the dock, conveyors, and magnetic tape drives, etc.

General Specification for Lift, Escalator and Passenger Conveyor Installation in Government Buildings of The Hong Kong Special Administrative Region 2007 Edition: [3] This Book has covered some rules & conditions for better and ethical design and manufacture of stair lift. Platform carriage shall be provided for a stairlift installation to support the platform on the guide rails and direct the platform up and down the guide rail system. The platform carriage shall be provided with handrails to the passenger for easy grabbing. The platform shall be finished with nonslip platform deck and ramp surfaces. The platform shall negotiate vertical and horizontal bends and landing transitions smoothly without transfer of the passenger. A smooth start/stop shall be provided when entering/departing landing zone. The clear height above the platform shall be not less than 2 m long its whole journey. Ramps provided at the platform access edges shall be minimum 150 mm high. Kick plate(s), minimum 150 mm in height, shall be provided at non.

Platform of Design Method for developing mobility-preserving product: [4] Elderly people partly have individual barriers in handling technical systems as well as in the use of public and private spaces. Uncertainty and fear of handling technical systems have to be taken seriously as well as aspects of stigmatization to ensure the acceptability of the product. The user does not want and should not be necessarily confronted with the entire complexity of technical systems. Any forms of barriers in the use of technical aids have to be avoided. Elderly people need a sustainable support by technical systems. The support should be available so far as it is necessary to obtain or to train the performance. Only when this is no longer sufficient to satisfy mobility needs, the technical system should compensate the lost performance (support hierarchy). For the derivation of technical aids a holistic mobility model is required that reflects not only the mobility situation but also considers individual conditions and social factors as well as the characteristics of public and private space more closely. The methodological development of product lines requires an implementation of the analyzed situations of mobility into concrete requirements. With these factors, the requirements related to the product line can be completed in terms of acceptance and concomitantly deliver reference criteria to ensure a process attendant property validation.

Tall Buildings and Elevators: A Review of Recent Technological Advances: [5] Efficient vertical mobility is a critical component of tall building development and construction. This paper investigates recent advances in elevator technology and examines their impact on tall building development. It maps out, organizes, and collates complex and scattered information on multiple aspects of elevator design, and presents them in an accessible and nontechnical discourse. Importantly, the paper contextualizes recent technological innovations by examining their implementations in recent major projects including One World Trade Center in New York; Shanghai Tower in Shanghai; Burj Khalifa in Dubai; Kingdom Tower in Jeddah, Saudi Arabia; and the green retrofit project of the Empire State Building in New York. Further, the paper discusses future vertical transportation models including a vertical subway concept, a space lift, and electromagnetic levitation technology. As these new technological advancements in elevator design empower architects to create new forms and shapes of large-scale, mixed-use developments, this paper concludes by highlighting the need for interdisciplinary research in in corporating elevators in skyscrapers.

Mathematical models used in gear dynamics- A review: [6] With increased demand for high speed machinery, the mathematical modelling of the dynamic analysis of gears has gained importance. Numerous mathematical models have been developed for different purposes in the past three decades. In this paper the mathematical models used in gear dynamics are discussed and a general classification of these models is made. First, the basic characteristics of each class of dynamic models along with the objectives and different parameters considered in modeling are discussed. Then, the early history of the research made on gear dynamics is summarized and a comprehensive survey of the studies involved in mathematical modelling of gears for dynamic analysis is made. Generally, a chronological order is followed in each class studied. The goal is not just to refer to several papers published in this field, but also to give brief information about the models and, sometimes, about the approximations and assumptions made. A considerable number of publications were reviewed and 188 of them are included in the survey

Design and Finite Element Analysis of a Stair Case Material Handling System: [7] This topic deals with the fabrication and analysis of a stair case lift, which can be use as Material Handling System. A stair case lift is a mechanical device for lifting people and wheelchairs up and down on the stairs, who may find difficulty in doing so themselves. In this paper, the final design was an outcome of a sequential analysis and modification of stages. And it was deduced that Stair lifts are easily installed into any situation where the condition of the stair tread is good as the railing that the chair lift uses is attached to the stair tread. During the test run of this project, it was realized that the model would be capable of carrying heavy load without suffering any deformation or local fractures if it would go into real world production at an ideal scale Therefore it can be widely used for home as well as industrial which ensures a promising future to the concept.

2.1 CONCLUSIONS DRAWN FROM LITERATURE SURVEY:

Senior citizens or persons with physical disability, a fall can mean the loss of independence and mobility. Often due to osteoporosis, bones are much more fragile, so a low impact fall can quickly turn into injury. Up to 15% of falls result in injuries, the most serious of which is hip fracture and up to half of all people who have a hip fracture never get back to their previous level of independence. The risk factors for falls among older people can be classified into three categories: intrinsic, extrinsic and exposure to risk (Todd and Skelton, 2004). Intrinsic factors include age, gender, living alone, medicine, medical conditions, impaired mobility and gait, nutritional deficiencies, impaired cognition, visual impairments, and foot problems. Extrinsic factors include poor lighting, slippery floors, uneven surfaces, footwear and clothing, inappropriate walking aids or assistive devices. Exposure to risk concerns levels of activity and inactivity. Intrinsic factors are considered more important among people aged 80 and over (suggesting they are less active) and extrinsic factors more important among older people under 75 (suggesting they are more active). Of all the areas in the home, the staircase is the most frequent place for a fall and is also the most likely place to cause injury. It is common for senior to become anxious on the stairs, even more so if they had a previous falls. This anxiousness can also increase the risk of a fall, which is why remaining calm is so important.

The person might also decide to simply avoid attending those areas where stairs are only means of reach. While effective to a degree, they do not really or fully address the actual issue at hand, which is being able to use the stairs safely and with confidence.

In this context, the focus of considerations related to mobility support by technical systems are elderly people respectively people with performance restrictions. Not only because of the variety in the occurrence of performance restrictions but also by the diversity of biographies (social integration, career, life experiences), elderly people are a very heterogeneous group with diversified needs and requirements for technical systems.

According to Census 2011, India is having 8 % of total population lying in the age group bifurcation of + 60 and 2.21% of total population in the category of people with movement disabilities which make these groups dependent on others to aid them in various chores of day to day life in public and where as in their own homes too. The urbanization started some 20 years ago and has taken much of the City limits to get compressed nearest to the amenities which resulted in high rise. Most residential buildings were granted the permission to build up to Ground plus 2 or 3 storied, wherein Elevator was not installed. Since at that time, it was not considered necessary and people preferred to climb stairs, irrespective of all odds. Consequent to the Life-Style changes, including physical and mental apathy, currently the four storey building residents have started to feel the need for having a Elevator in their buildings. But now many factors abide them such as local body governing rules for town planning, constructional requirement and cost of installation of the Elevator.

Chapter 3
PROBLEM STATEMENT

3.1 PROBLEM STATEMENT:

To design a stairlift which is useful for lifting people having weight up to 120kg, up and down the stairs in desired time who may find it difficult in doing so themselves with the help of optimized driving mechanism for curved track, ensuring complete safety of passenger.

3.2 VISION:

A comprehensive approach to mobility does not only conduce to great potential for innovation for mobility support. The challenge for project development is also to consider the variety of influencing factors that determine the requirements for mobility-aided systems and the associated possibilities for finding solutions. This reviews are preliminary steps, which will assist us taking correct decisions in concern with design and calculation for slider mechanism.

Chapter 4
Design Consideration

4.1 GENERAL CONSIDERATIONS:

Someone with a disability who has a condition that could deteriorate should consider what the best long term solution will be. Although he/she may be able to use a seated stair lift now, it may be wise to consider installing a through-floor lift so that in future the option to travel in a wheelchair is available. It is advisable that the stair lift covers the whole staircase. Some people will attempt to save costs by installing a straight stair lift on a curved staircase and attempt to manage the first or last few steps. However, if their condition deteriorates, they will no longer be able to manage this.

4.2 CONSIDERATIONS FOR STAIR CASE LIFT PARTS:

Rails

Straight rails for use on domestic staircases are usually made from extruded aluminium or steel and come in various cross-sectional shapes. These rails may, typically, weigh over 30 kg, depending on the length. In most applications they are attached to the steps with metal brackets. If a rail crosses a doorway at the bottom of the stairs or causes an obstruction a hinge can be fitted so the end of the rail can be folded back out of the way when not in use.

Figure 4.1: Straight rail

Curved rails are made from materials such as steel or aluminium and come in various cross-sectional shapes according to the designer. Individual designs vary a lot and probably the key criterion is to make the curves with the smallest radius possible so they will wrap tightly around objects such as newel posts. The sections of curved rails usually packaged well to prevent damage in transit and are unwrapped and assembled on site. Rails for wheelchair platform stairlifts may be secured to walls in addition to the step fixings.

Figure 4.2: Curved rail

Carriage

The base portion of a stair lift is generally referred to as the carriage. Consideration should be taken as to the carriage design, such as height of the base, manual versus power swivel of the base, and safety hitches to ensure that the lift won’t start moving until the carriage has been securely locked.

Swivel Base

A base that swivels is very important to the safety of the user. The majority of stair lift base plates face away from the wall or banister, towards the stairwell. If the plate does not swivel, the user may need to get in and out of the carriage from either the top or bottom stair step. Entry and exit into the carriage from the steps as opposed to the landings poses an increased risk of falling. Base plate that swivel allow the user to turn the carriage away from the stairs, towards the landing, so that they may safely sit down and stand up on a flat, level and wide surface. Since the Base plate swivel upon arrival to the top and bottom of the stairwell, there are safety locks that ensure the Base plate will not twist and turn as the carriage is traveling up and down the track.

Height

The height of the chair must be low enough so that the user can sit down and stand up easily. If the chair height is either too high or too low, a disabled user may have trouble getting in and out. Sometimes there are options to adjust the seat at the time of installation to the user's height specifications.

Safety Belts

Most, if not all, stair lift carriages come equipped with a safety belt as a safety precaution. It is important for the user to fasten the safety belt during any time of use to prevent falls from the chair, and wait for the carriage to come to a complete stop.

4.3 POWER AND COST CONSIDERATIONS:

If the track for the stairlift cannot continue beyond the bottom or top step of the staircase because it will obstruct a door, to overcome this problem. This rail may be manually or electrically operated.

Power source

Stair lift can be operated by both DC or AC power source. Stair lifts are available with a battery backup option in case of power failures. We choose DC motor instead of AC motor, it is easier to change the direction of rotation or, polarity in DC motor.

Budget and financial consideration

The cost of a stair lift is based on factors including the staircase type, the features required and the custom specification you choose. Maintenance costs to the user tend to vary depending on the amount of usage the stair lift gets.

4.4 GUIDELINE FOR MEASURING STAIR LIFT:

Measuring your staircase can be an essential easy step process to determine which type of stair lift you may require in your home. As a guide, please follow our guide to finding your staircase type to ensure we give you the right stair lift advice.

Step 1: Side of Stairs, Left or Right

Stand at the bottom of the stairs and look up the staircase to determine if it would go on the left side or the right side of the stairs. The most common side for a stair lift to be installed is the wall side. If the staircase is open plan, then determine which side would be most practical for access to the stair lift from the bottom of the stairs.

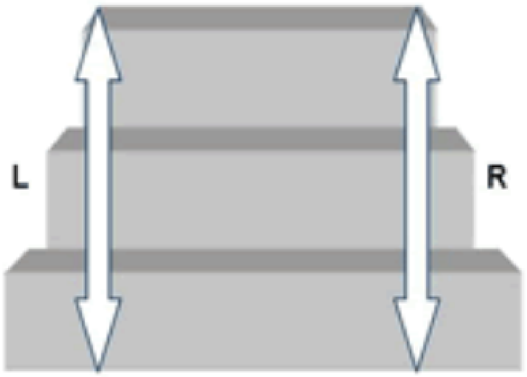

Figure 4.3: Side of stair case lift

Step 2: Measure from The Top Step to The Bottom Floor Area:

Stand at the top of the stairs and measure from the top stair tread (A) and extend your tape measure down the staircase. The tape measure should lightly touch each edge of every stair tread and the tip of the tape measure should be extended right down to the bottom floor area (B) which is past the very first stair tread.

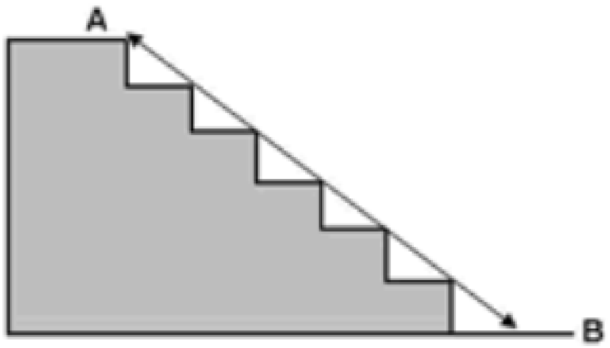

Figure 4.4: Measure from top to bottom

Step 3: Measure Width of Staircase:

Measure the width of the staircase from (C) to (D) making sure you measure from the skirting board and not the wall.

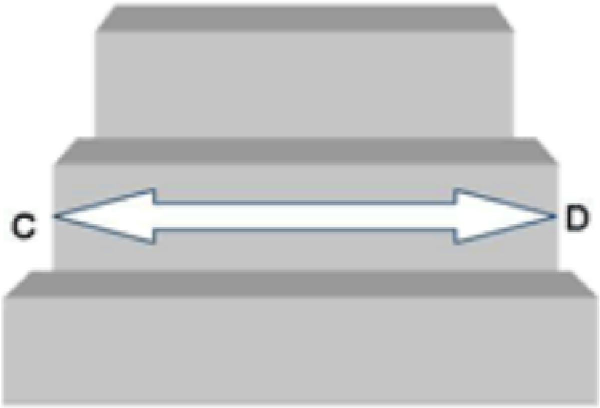

Figure 4.5: Width of Staircase

Step 4: Measure the Bottom Clearing Distance:

Measure from the end of the bottom step (E) to the nearest obstacle (F). This could be a near by door, radiator, wall or cupboard for example. By measuring the clearing distance, it will give you an idea as to how much room is available at the bottom of the stairs. A minimum space is required of around 18"-20" for the stairlift to be parked for getting on and off safely. If the space is limited you may require a hinge track system.

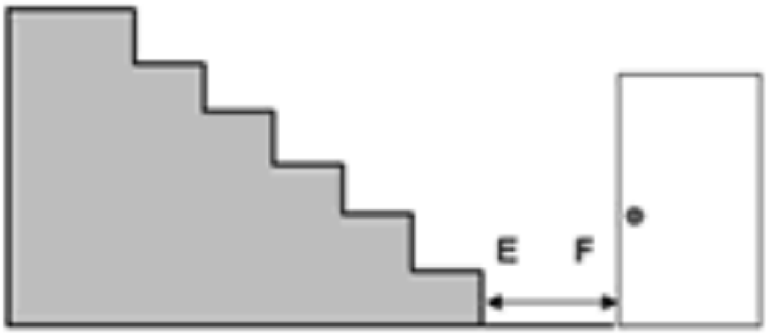

Figure 4.6: Clearance distance

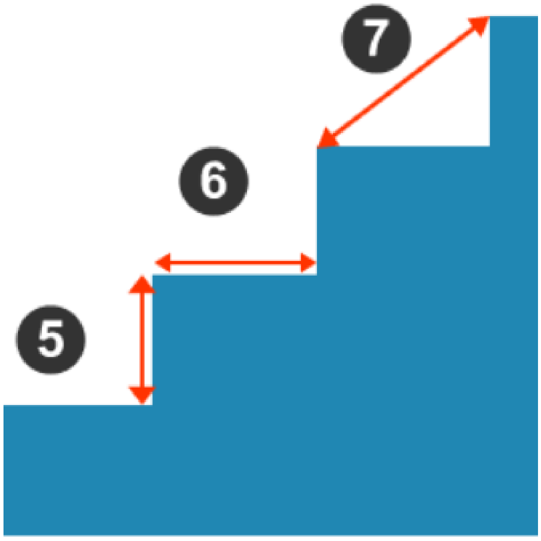

Figure 4.7: Tread Measurements

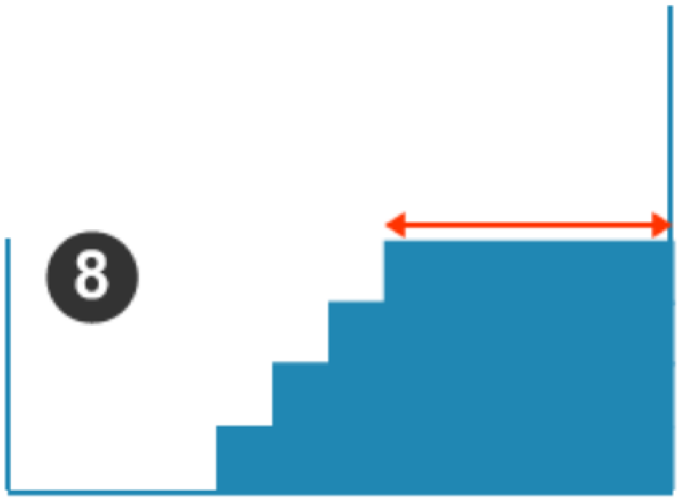

Figure 4.8: Measure from the top step to the nearest door, wall or other obstruction at the top of the stairs.

Chapter 5

MODELING

5.1 INTRODUCTION TO CATIA V5:

CATIA (an acronym of computer aided three-dimensional interactive application) developed by the French company Dassault Systems.

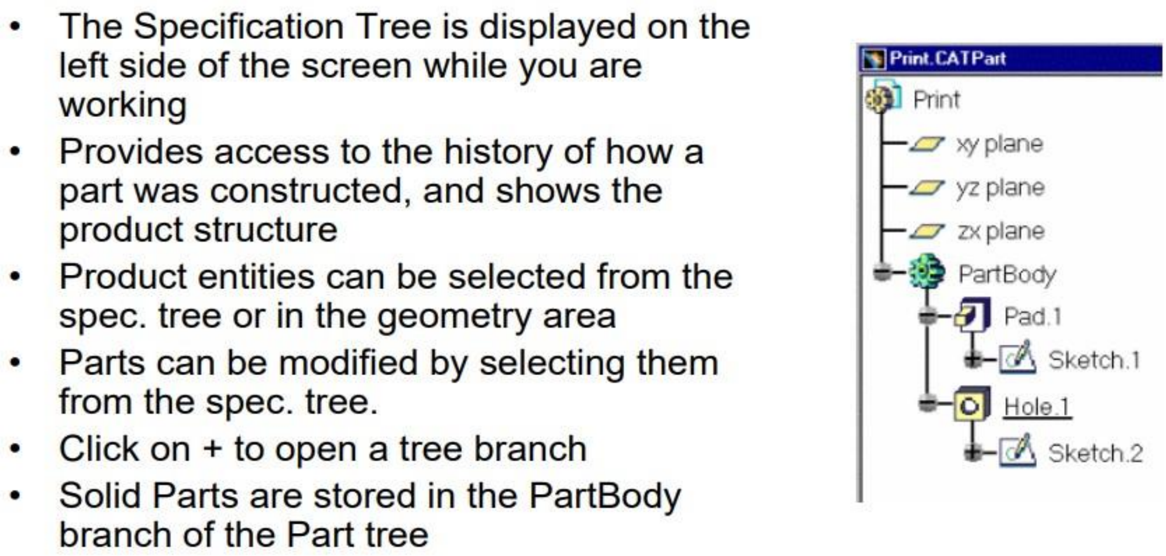

Figure 5.1: Specification Tree

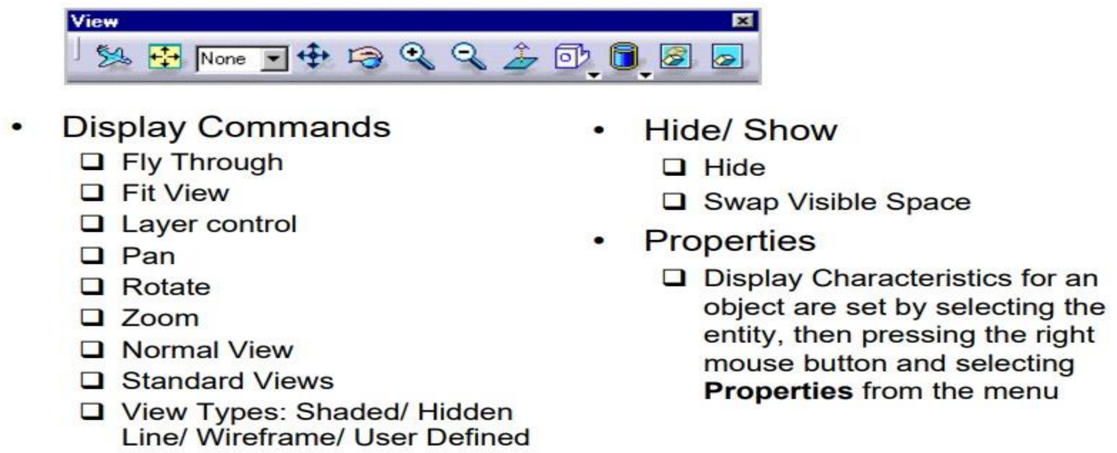

Figure 5.2: View Toolbar

5.2 SKETCHER MODULE:

The Sketcher workbench is a set of tools that helps you create and constrain 2D geometries. Features (pads, pockets, shafts, etc...) may then be created solids or modifications to solids using these 2D profiles. You can access the Sketcher workbench in many ways. Two simple ways are by using the top pull down menu (Start – Mechanical Design – Sketcher), or by selecting the Sketcher icon. When you enter the sketcher, CATIA requires that you choose a plane to sketch on. You can choose this plane either before or after you select the Sketcher icon. To exit the sketcher, select the Exit Workbench icon.

The Sketcher workbench contains the following standard workbench specific toolbars.

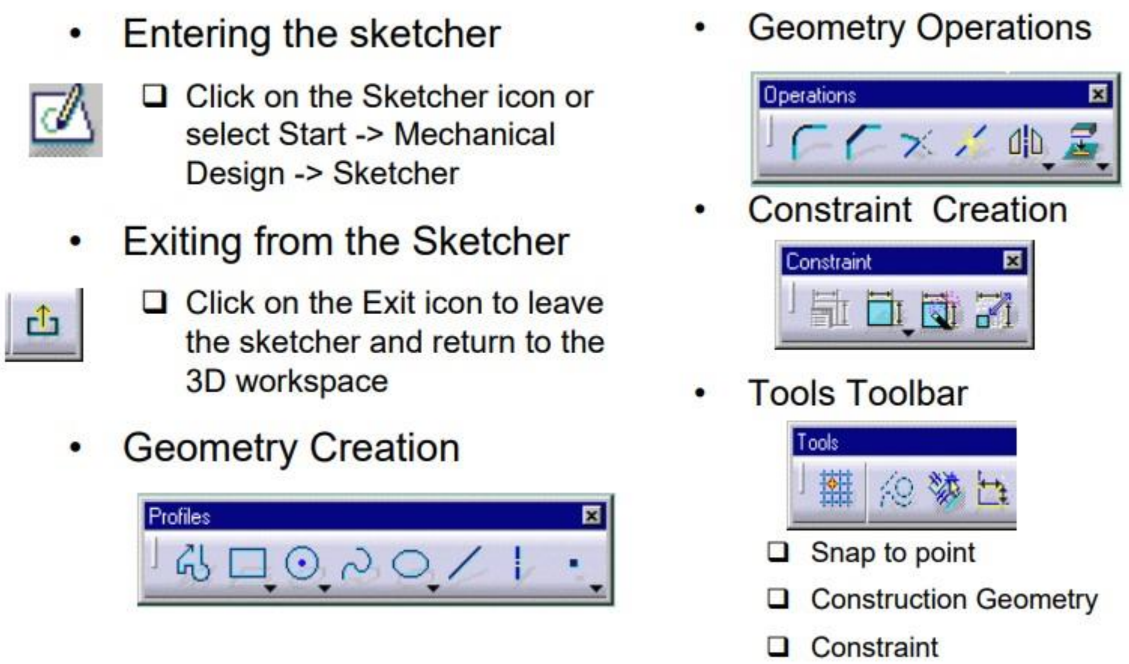

Figure 5.3: Sketcher Module

- **Profile toolbar**: The commands located in this toolbar allow you to create simple geometries (rectangle, circle, line, etc...) and more complex geometries (profile, spline, etc...).
- **Operation toolbar:** Once a profile has been created, it can be modified using commands such as trim, mirror, chamfer, and other commands located in the Operation toolbar.

- **Constraint toolbar:** Profiles may be constrained with dimensional (distances, angles, etc...) or geometrical (tangent, parallel, etc...) constraints using the commands located in the Constraint toolbar.
- **Sketch tools toolbar:** The commands in this toolbar allow you to work in different modes which make sketching easier.

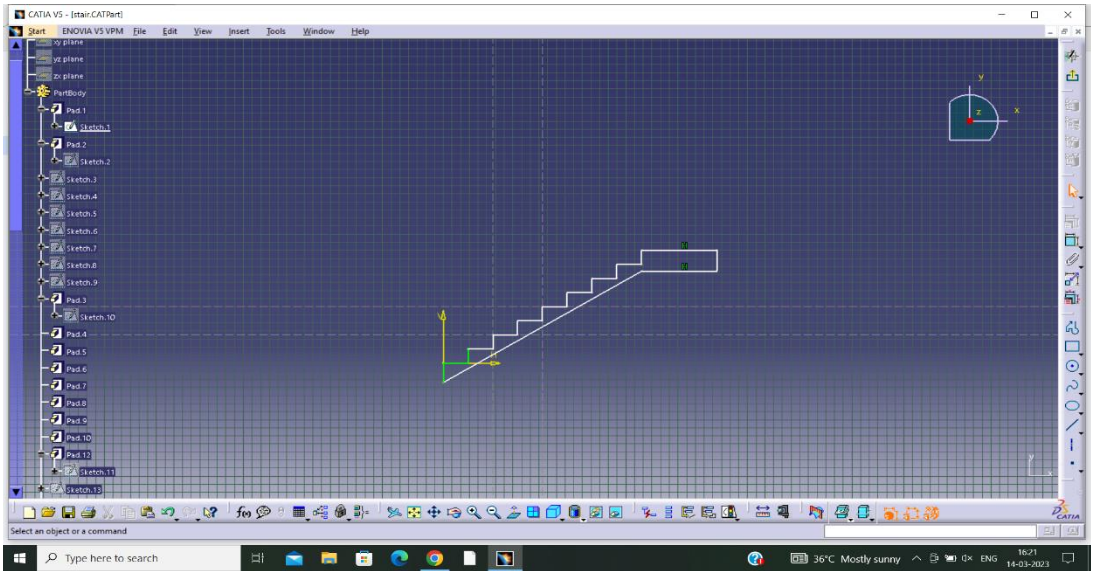

Figure 5.4: Sketcher Design

5.3 PART DESIGN MODULE:

Part design environment is used to create 3D models from the basic 2D sketches created in sketcher environment.

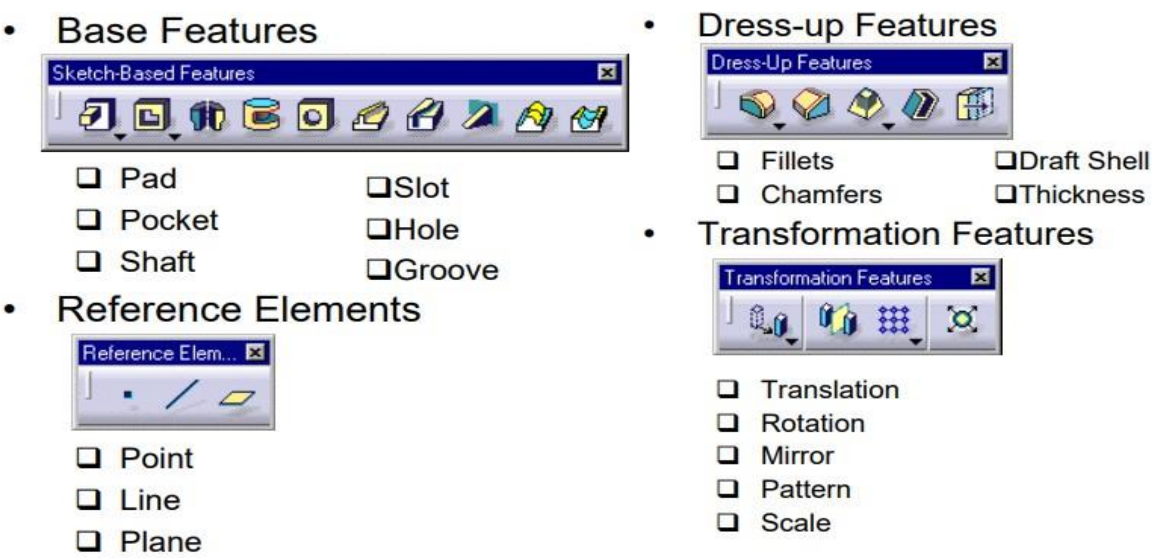

Figure 5.5: Part Design Tools

PAD command

In most CAD software, the equivalent of this is called EXTRUDE, but in CATIA we call it PAD. This command adds material in the third direction, a direction other than the sketch.

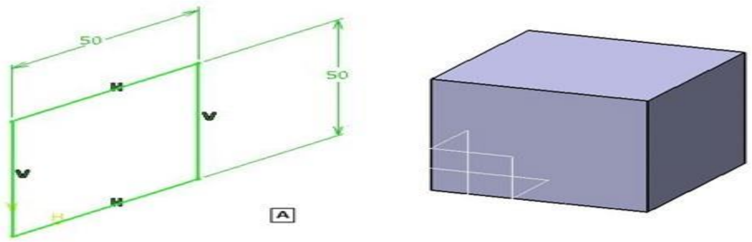

Figure 5.6: PAD operation

POCKET command

The POCKET commands somehow the opposite of PAD command. It simply helps remove geometry belonging to an already create part. On the figure below the POCKET command is helping to create the cylinder hole in the middle of the cube.

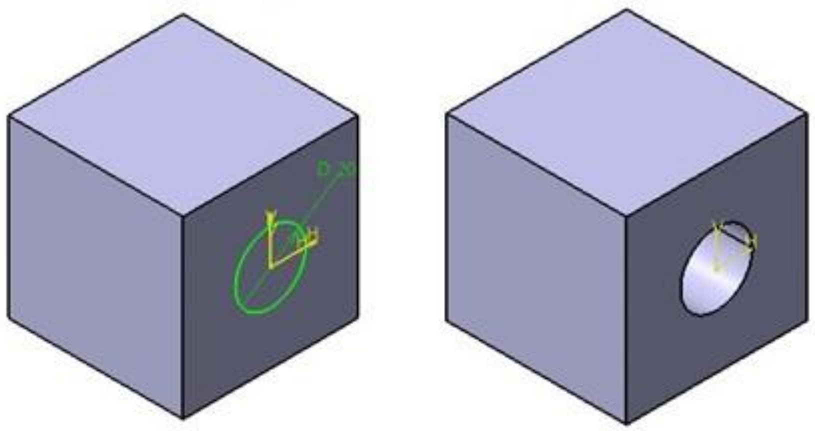

Figure 5.7: POCKET operation

SHAFT command

It is Like revolve command in other CAD software, the SHAFT command is mostly used to make shaft like parts. It requires an axis, around which the sketch will be revolved.

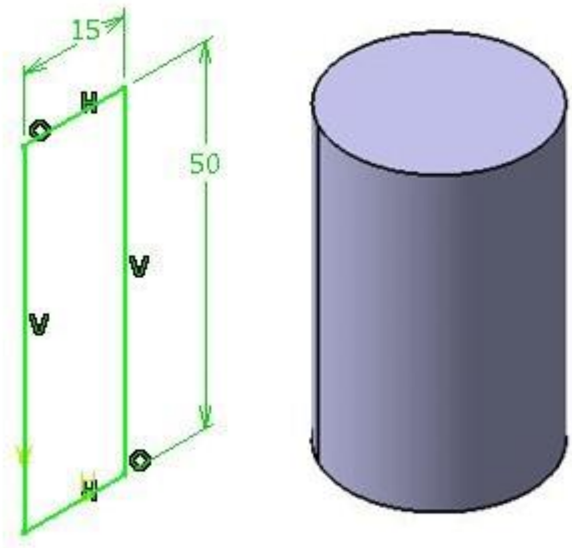

Figure 5.8: SHAFT operation

5.4 DRAFTING MODULE:

Drafting is a process of generating 2D machine drawing for the 3D part models to send it to the manufacturer's.

Catia drafting is of two types

1.Interactive Drafting

2. Generative Drafting

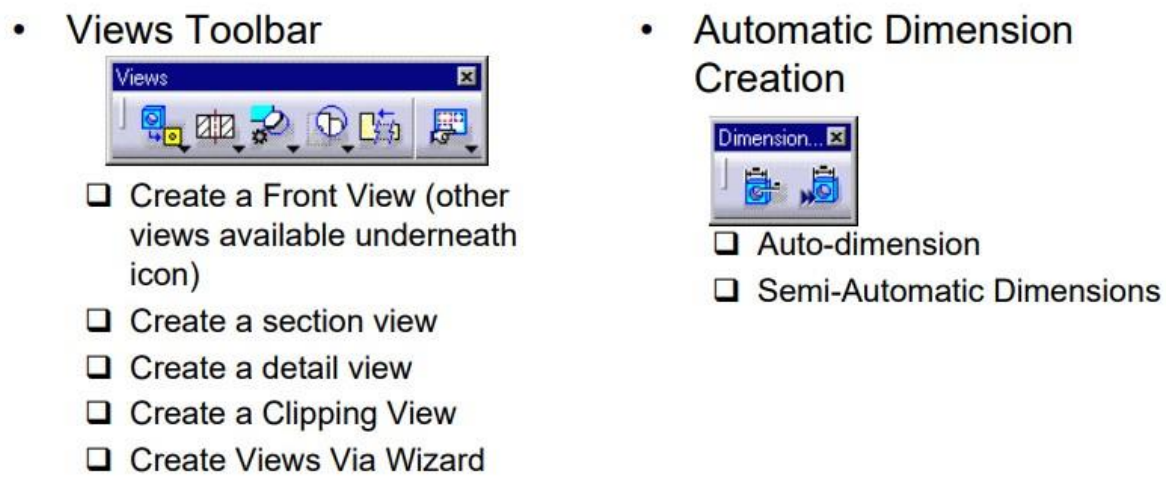

Figure 5.9: Drafting Module

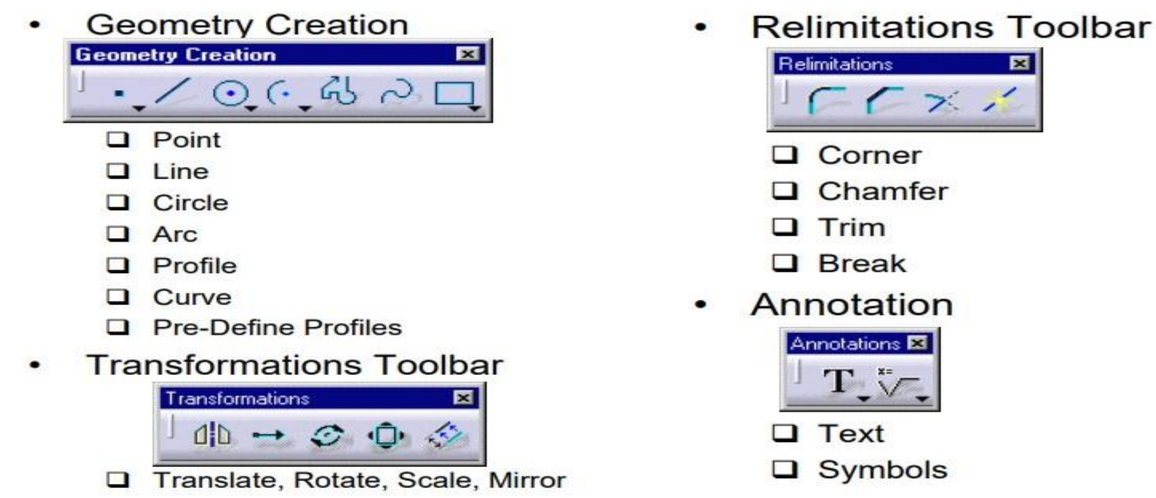

Figure 5.10: Main Drafting Operations

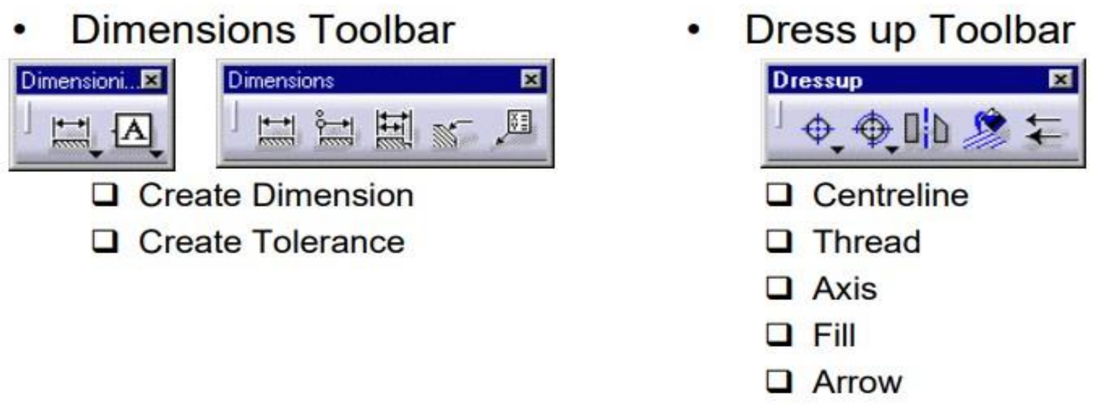

Figure 5.11: Drafting Operations

5.5 MODELS:

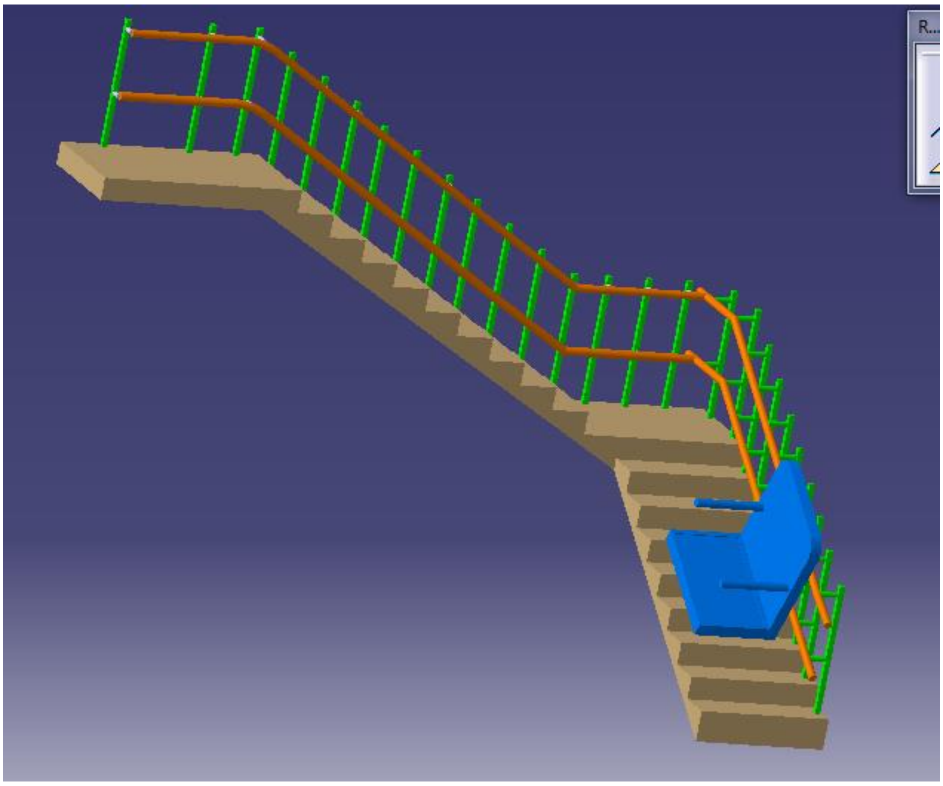

Figure 5.12: Model

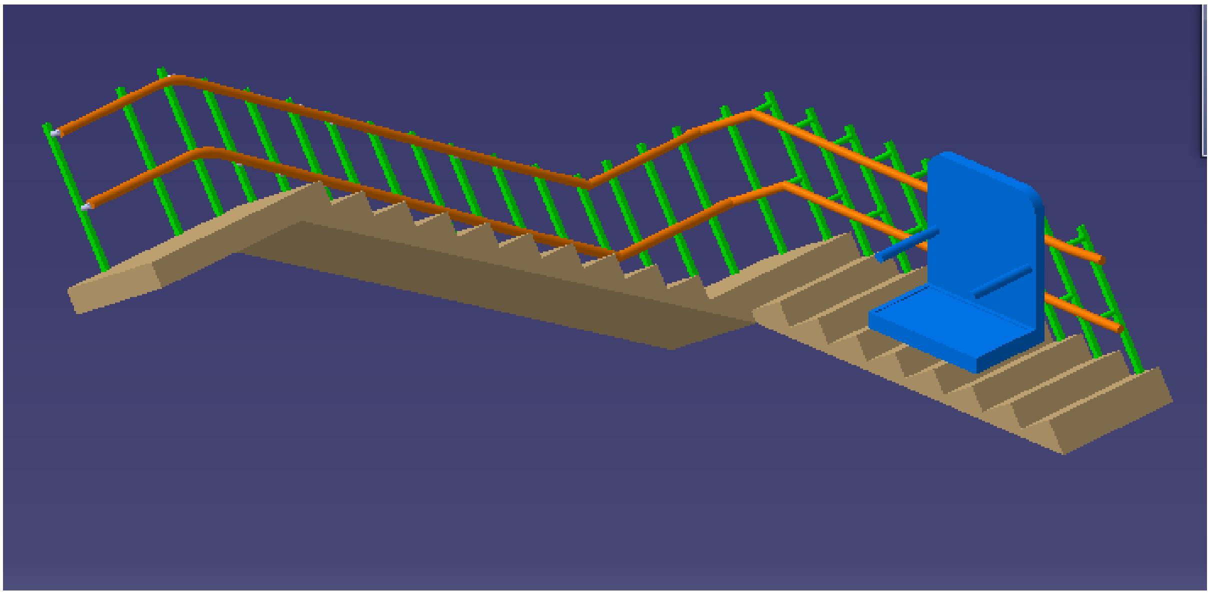

Figure 5.13: Model

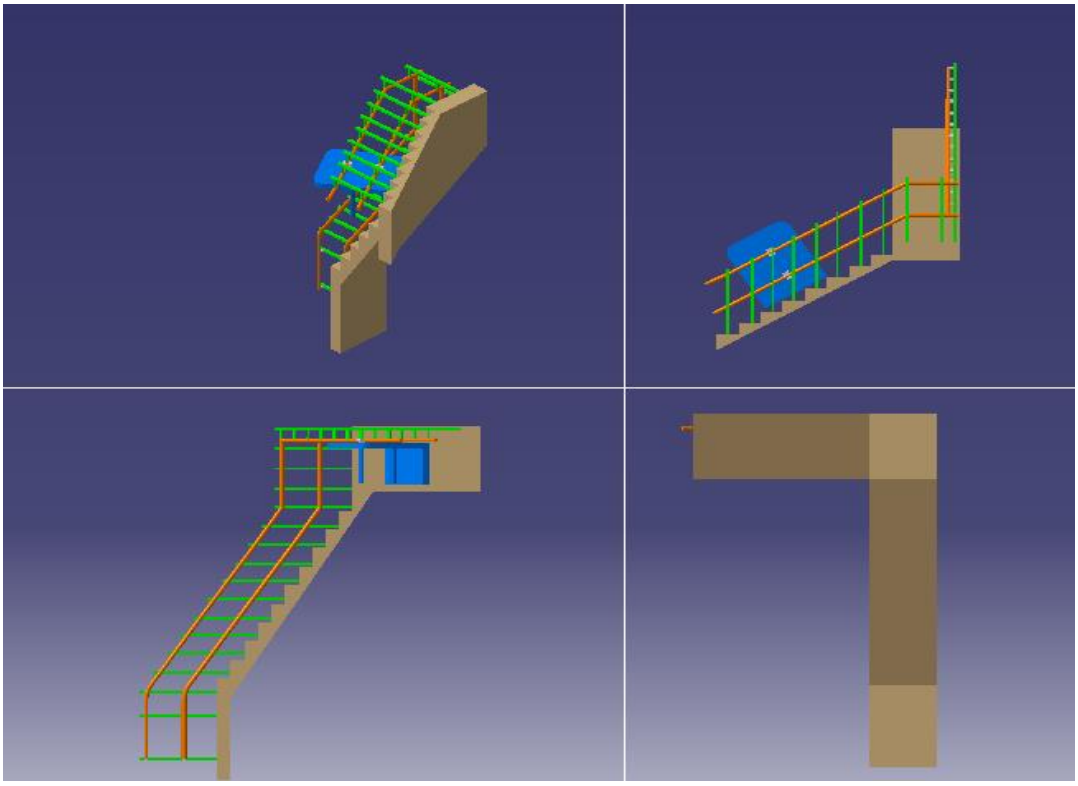

Figure 5.14: All views

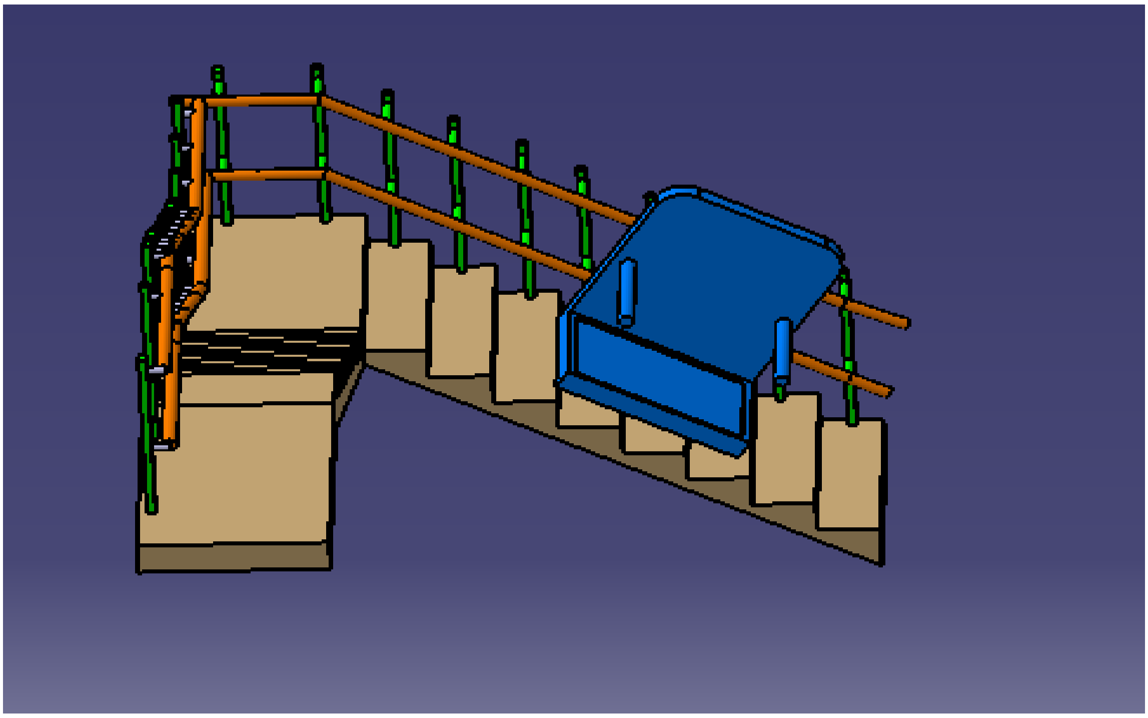

Figure 5.15: zoom in model

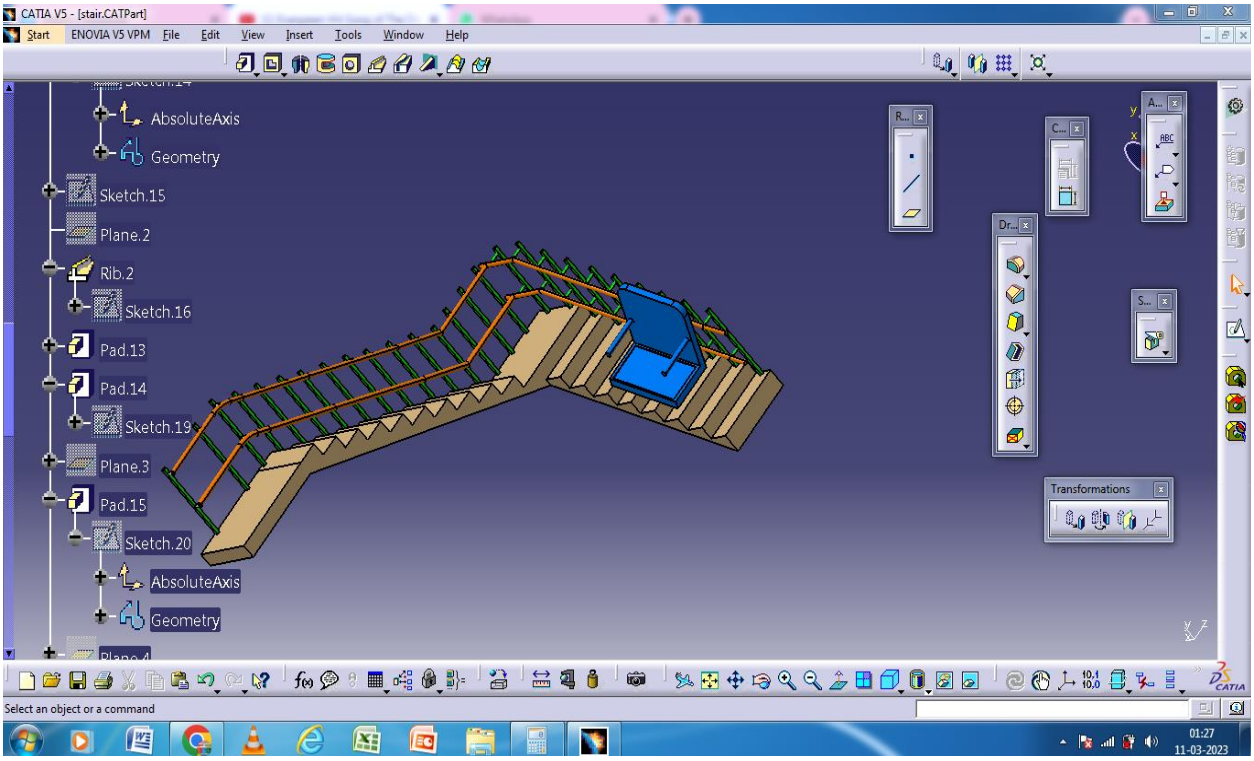

Figure 5.16: Model

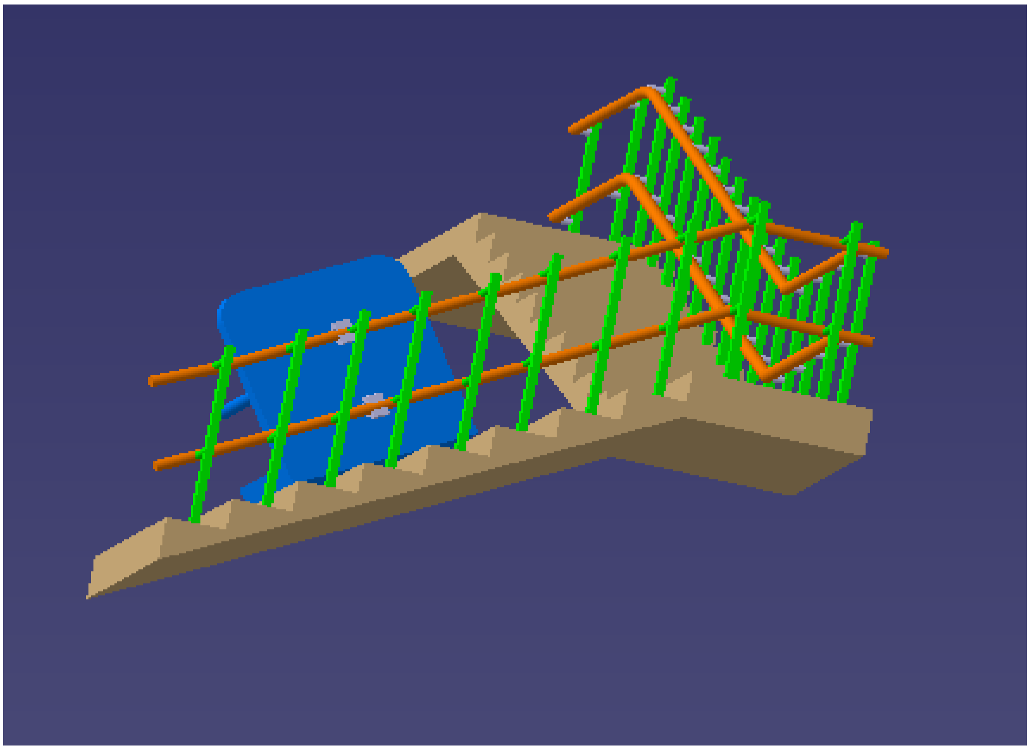

Figure 5.17: Back view

Chapter 6

MAIN COMPONENTS

- The main components which are used in the experimental set up is described below:

6.1 TRACK:

The stair lift track supports the base plate, provides a mechanism to propel the base and guides it up and down the stairway just as a train track guides a train.

The dimensions of a track or rail depends on the dimensions of the stair. The width of the track or rail should be such that enough space is available for people to use the stairs. Carriage and seat are mounted over the rail in a way that these can move up and down following the track.

The strength of the rail has to be good enough to withstand with the weight of carriage and load on the base. Rails are kept fixed upon the stairs. In case of rotary tracking system, the rail is fitted on the wall.

We have used mild steel bar to make the rail required. Steel bars have cross-section of L shape which thickness is about 4 mm. The length of the rail is about 7 ft. We made a structure to place the rail inclined like the slope of the stairs. Two parallel steel bars are connected with some pieces of bar.

Figure 6.1: Track in solidworks

6.2 CARRIAGE:

Carriage is the structure or saddle on which seal and chair is mounted and the carriage moves up and down following the rail. There is a mechanism between track and carriage for the movement of the carriage. The movement can be attained by rope drive, belt pulley drive, rack pinion mechanism, guide wheel linear tracking system or chain drive. Sometimes these mechanisms are used at the bottom of the seat and then no carriage is required.

We use Mild Steel bars to make the structure of the carriage. Steel bars are welded together at required dimension. The width of the carriage is larger than that of the track. This is because the extra area is for mounting the motor and transmission system with the carriage. The chair is mounted on the saddle. The chair is easily removable and the stair lift can be used for material handling.

Figure 6.2: Carriage in solidworks

Four grooved roller bearing are used to move the carriage. The grooves of bearing are in contact with the edge of the rail in both side.

6.3 MOTOR:

An electric motor is analectic machine that converts electric energy into mechanical energy. Motors are mainly two types: AC motor and DC motor.

DC motor:

DC motors are electric motors that are powered by direct current (DC), such as from a battery or DC power supply. Their commutation can be brushed or brushless.

AC motor:

An AC motor is an electric motor driven by an alternating current (AC). The AC motor commonly consists of two basic parts, an outside stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft producing a second rotating magnetic field. Motor is used to provide necessary speed and torque. We are going to use a brushless DC motor for this stairlift.

The Advantages of Using a Brushless DC Motor Is:

- It is much easier to change the polarity in DC motor.
- DC motors with control box kit are available in market. It is very simple to set the controller with the motor.
- Brushless motor has high power to weight ratio.

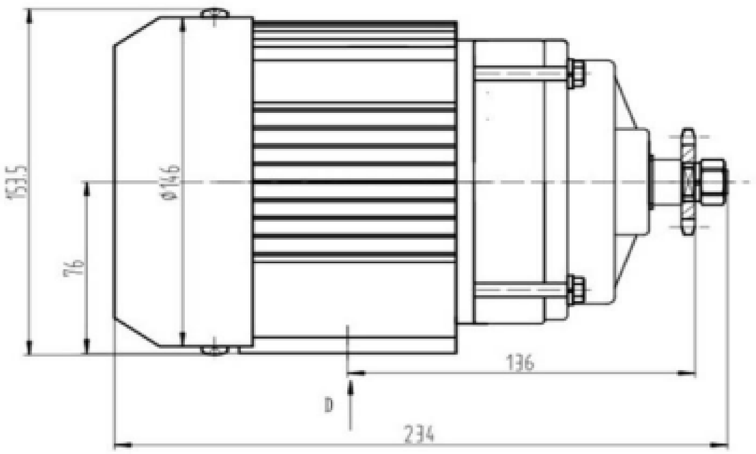

Figure 6.3: Dimension of the BLDC motor

Specification	BLDC motor
Rated output power	750 W
Rated voltage	48V
Rated speed	2800 RPM
No load speed	3100 RPM
No load current	<5.0/4.5A
Efficiency	>80%
Reduction ratio	6:1
Actual speed	450 rpm
Load	about 450-500kg
Applicable Chain	420 Chain

Table 6.1: Specifications of the Motor

6.4 MOTOR SPEED CONTROL:

Because the motor rotates at too high a speed to safely propel the stair lift up the track at type of transmission is employed to reduce the speed while increasing the power available. A worm gearbox is used to reduce the speed found from the motor. A sprocket is attached to the shaft of the motor which transmit power to the input of the gearbox by a chain. The output speed of the gearbox is low and power is transmitted to final chain drive which is mounted with the length of the rail.

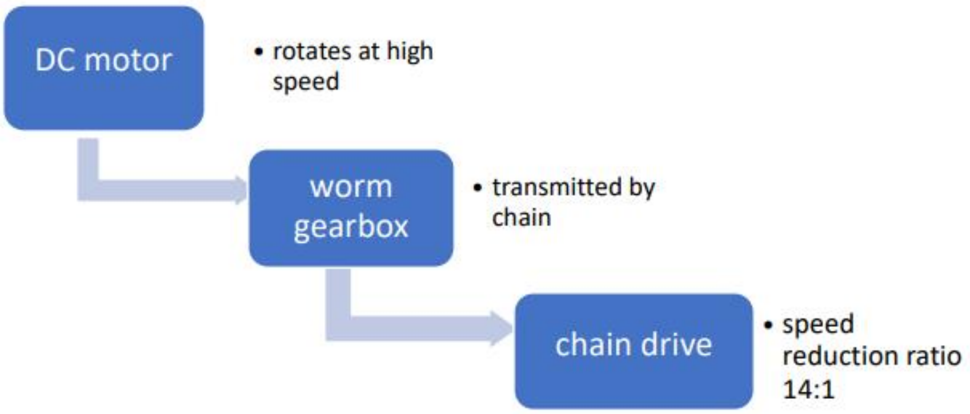

Figure 6.4: Motor Speed Control

6.5 WORM GEARBOX:

A worm drive is a gear arrangement in which a worm meshes with a worm gear. Worm gears are usually used when large speed reductions are needed. The reduction ratio is determined by the number of starts of the worm and number of teeth on the worm gear.

Figure 6.5: Worm Gear-Set

We are going to use a worm drive with reduction ratio is 14:1. The rpm of the motor is very high and it drive the carriage this high speed is unsafe and will cause accident. So, reduction of speed is very important. The worm gear is made of steel and the worm wheel is made of bronze.

6.6 BATTERY:

We need to use four 12V battery for power supply. These batteries can be recharged

Figure 6.6: Battery

6.7 BATTERY CHARGER:

The batteries are charged by a charger which converts 220V AC input in DC output. The batteries are connected among themselves and two junctions are connected to the controller box. There is a charging port in the controller box by which batteries get charged.

Figure 6.7: Battery Charger

Chapter 7
DESIGN PARAMETERS

7.1 MAXIMUM LOAD THAT CAN BE CARRIED BY MOTOR:

$$\text{Efficiency of the motor } \eta = 78\%$$

$$\text{Maximum speed} = 3100 \text{ rpm}$$

$$\text{Gear ratio} = 1:6$$

$$\text{Actual speed} = \frac{3100}{6} = 516.67 \text{ RPM}$$

$$\text{Gear reduction ratio by worm} = 14:1$$

$$\text{Speed at carriage} = \frac{516.67}{14} = 36.9 \text{ RPM}$$

Now, Maximum load that can be carried by motor:

$$p^* \eta_{w\,*}\, \eta_{g} = F^*V$$

$$750 * 0.78 * 0.934 = F * \frac{\pi dN}{60}$$

$$546.39 = \frac{F * \pi * 0.0061 * 36.9}{60}$$

$$F * 0.1178 = 546.39$$

$$\boxed{F = 4638.285 \text{ N}}$$

$$But,\ F = mg$$

$$m = \frac{4638.285}{9.81}$$

$$\boxed{m = 472.91\ kg}$$

7.2 POWER REQUIRED FOR AVERAGE LOAD CARRYING:

$$\text{Let mass of the carriage, motor, Gearbox} = 15\text{kg}$$

$$\text{Average mass to be lifted} = 100\text{kg}$$

$$\text{Total mass, m} = (\text{mass of the carriage, motor, gearbox} + \text{Average mass to be lifted})$$

$$m = (100{+}15)\ \text{kg}$$

$$m = 115\ \text{kg}$$

$$\text{Total weight, } W = mg = 115 \times 9.81 = 1128.15\text{N}$$

$$\text{Coefficient of friction for ball bearing}\ , \mu = 0.002$$

$$\text{Force required, } F = W(\sin\theta + \mu\cos\theta)$$

$$F = 1128.15 \times \sin 4\,0^{\circ} + (0.002 \times 1128.15 \times \cos 4\,0^{\circ})$$

$$\boxed{F = 726.89\text{N}}$$

$$\text{Velocity, } V = \frac{\pi d N}{60} = \frac{(\pi \times 0.061 \times 36.9)}{60}$$

$$\boxed{V = 0.11785\ \frac{m}{s}}$$

$$\text{Power, } P = \frac{(F \times V)}{\eta_m \times \eta_g}$$

$$P = \frac{(726.89 \times 0.11785)}{(0.78 \times 0.934)}$$

$$\boxed{P = 117.586\ \text{W}}$$

7.3 AXIAL AND RADIAL LOAD ON BEARING:

$$\text{Bore diameter} = 17\text{mm}$$

$$\text{For deep groove ball bearing, [22],}$$

$$C = 9.56$$

$$C_0 = 4.50$$

$$\text{Basic loadd bearing, } C = Fe(L)^{\frac{1}{a}}$$

$$\text{here, } a = 3 \text{ for ball bearing}$$

$$\text{now}, L = 60N.\ L_H \text{ revolution}$$

Recommended Bearing life = 20kh

L = 20000 * 60 * 0.00369 mr

$$L = \ 44.28\ \text{mr}$$

$$9.56 = Fe(44.28)^{\frac{1}{3}}$$

$$F_e = 2.70\ \text{kN}$$

$$\text{Let factor of safety, } F_s = 1.2 \times 2.70 = 3.24\text{kN}$$

$$F_e^1 = XVF_r + YF_a$$

$$\text{Dynamic equivalent load for rolling contact bearing,}$$

$$V = \text{a rotation factor} = 1.2$$

$$= XVF\cos\theta + YF\sin\theta$$

$$3.24 = (0.56 \times 1.2 \times F \times \cos 5\,0°) + (1.55 \times F \times \sin 5\,0°)$$

$$3.24 = 1.6192F \Rightarrow F = 2\text{kN}$$

$$F_r = F\cos 5\,0° = 2\cos 5\,0° \ \Rightarrow F_r = 1.29\text{kN}$$

$$F_a = F\sin 5\,0° = 2\sin 5\,0° \ \Longrightarrow F_a = 1.53\text{kN}$$

Chapter 8
SUMMARY AND CONCLUSION

The proposed work is determined for modeling of staircase slider for persons with physical difficulties to climb the stairs by their own. Staircase slider will be a mechanism for home lifting aid that will allow an individual to slide over the staircase as well as can utilize the same staircase for pedestrian purpose also. The slider mechanism will carry an individual up the stairs, attaching directly above the staircase railing. In this case, an individual must remain standing as they use this slider. This design will not require overhead control room and it will not be necessary to have structural alteration to the building. The only basic requirement will be that staircase width should be at least in between 75cm – 100cm in width.

Though making a cost friendly Stairlift had some limitations, it was a good and challenging project for us. Making a stairlift with roller bearing is not a complicated process and all the components are widely available in market. DC motors with control box are now being manufactured for auto rickshaw and this can be directly used in the stairlift. During the Modeling of this project, it was realized that it would capable of carrying heavy load without suffering any deformation or local fractures if it would go into real world production at an ideal scale. Though the initial cost of the project seemed to be a little bit higher but more accurate manufacturing would shorten this.

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