Design And Development Of Entry System For Physical Disabl ed Persons in Bus

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Abstract

Generally, at many places there is no provision for disable people to climb the stairs with the help of this mechanized stairs the person will able to do it. The objectives to transmute the staircase into ramp or platform, so that lame or disable people can make use of it. It is a amalgamation of stairs and ramp so it can use alternately whenever needed, it is a type of portative stairs. Involvement of such mechanized things will help to reduce human work. The main rationale behind working on this topic is to reduce human effort in day-to-day life and vanquish the difficulties. The work is done to bring the conceptual idea into reality. The main concept of mechanized stairs is creating a combination of stair and ramp by implementing mechanical linkages, different mechanism so that it can cbeuse simultaneously as a stair or ramp as per use or need. As per contemplate there is a major predicament for disable people for climbing stairs so this idea was conceptualized by integrating with mechanical systems. By considering the concept the fabrication was carried out to prepare the stairs by fulfilling three basic requirements economic viability, technical feasibility and social acceptance.

Key Words:*Ergonomics, Convertible Stair Case, Ramp, disable people problem solving.*

INTRODUCTION:

Generally, at many places there is no provision for disable people to climb the stairs with the help of this mechanized stairs the person will able to do it. The objectiveis to transmute the staircase into ramp or platform, so that lame or disable people can make use of it. It is a amalgamation of stairs and ramp so it can use alternately whenever needed, it is a type of portative stairs. Involvement of such mechanized things will help to reduce human work. The main rationale behind working on this topic is to reduce human effort in day-to-day life and vanquish the difficulties. The work is done to bring the conceptual idea into reality. [1]There are many old and physically disable peoples in the world and it is difficult for them to climb stairs as compared to normal persons. So to help them and to help the persons who cannot afford lift as their houses are small, the project is made. The most concern of this project is to fabricate a mechanism which will lift them up and put them down whenever they want and at very low budget. A stair with escalator is a mechanical device for lifting people up & down. Rail is mounted on the stairs on which a platform is attached. The platform is lifted by a simple mechanism of rope & pulley by it is lifted. Person gets on the platform is lifted when he/she switch on the plug the motor starts, after that the shaft of motor is connected to gearbox (speed reducer) by the Oldham's coupling. The outlet shaft of gearbox is connected to another Oldham's coupling which transmits the power to the spindle to wind or unwind the rope. Winding the rope will lift the platform up & unwinding will make the platform go down.[2]

A Stair is a combination of steps by which people may pass from one level to another. It is a contiguous set connecting two floor or surface on different level. Stairs are constructional design to bridge up the two platforms which are not on the same level. Stair case may be of different design like straight, circular as per execution or

constructional design they are used. Some alternatives tostairs are elevators, stair lifts and inclined moving walk ways. Ergonomically and for safety perception, stairs must
have good construction so that people can comfortably utilize them.[4]Advancements in technology made disabled people to lead an independent life and play a more productive role in society. Stairways into buildings present a significant environmental barrier for those with mobility impairments, including older adults. A number of home access solutions that allow users to safely enter and exit the home exist, however these all have some limitations. The purpose of this work was to develop a novel, an inclusive home access solution that integrates a staircase and a lift
into one device [5].

1.1. Problem Statement:

The main concept of mechanized stairs is creating a combination of stair and ramp by implementing mechanical linkages, different mechanism so that it can beuse simultaneously as a stair or ramp as per use or need. As per contemplate there is a major predicament fordisable people for climbing stairs so this idea wasconceptualized by integrating with mechanical systems.

1.2. Objectives of work:

1. To understand the concept, design & development of ConvertibleStair Case&Ramp to find further scope for improvement.
2. To find the possible ways of Stair Case& Ramp structure enhancement.
3. To optimize the possible combinations of Stair Case&Ramp this will be helpful for disable people problem solving.
4. To find ergonomics ways of making Convertible Stair Case to Ramp for disable people.

1.3. Scope:

By considering the concept the design &fabrication of Convertible Stair Case toRampwillcarry outto prepare the stairs by fulfilling three basic requirements economic viability, technical feasibility and socialacceptance for disable people.

1.4. Project Planning/Schedule of activities:

Sr.No.	Activity	Deadline
1	Group formation and finalization of title	August, 2022
2	Literature review	September, 2022
3	Proposed solution	October, 2022
4	Design of experiment/components	November, 2022
5	Manufacturing/assembly	December, 2022
6	Trials/Experiments	January, 2023
7	Analysis/rework	February, 2023
8	Report writing	March, 2023

In previous chapter detailed information of the introduction as well as the problem definition are discussed. To solve all the problems discussed above we are producing a new system, as our project titled **"Design and Development of Convertible Stair Case into Ramp for Physical Disabled Persons."**under this topic in our academic year 2022 – 2023, we are preparing a working model of a Convertible Stair Case.

We have proposed a methodology to solve the problems. Our methodology is divided in different parts, under different titles.

Sequence of proposed methodology is as follows –

1. Proposed Methodology 1 –Basic Information & Literature survey about Convertible Stair Case.
2. Proposed Methodology 2 – Selection of Components for Convertible Stair Case.
3. Proposed Methodology 3 - Design of Convertible Stair Case system.
4. Proposed Methodology 4 – CAD modeling& Fabrication of Convertible Stair Case system.
5. Proposed Methodology 5 – Assembly & Testing of Convertible Stair Case system.

1. Proposed Methodology 1:Basic Information & Literature survey.

This project report discusses about how to use literature data & identify the problems from field. By studying the literature of previously available system that help in maximizing the output by minimizing the effort, cost, time & money in future develop new machine.

2. Proposed Methodology 2:Identify &Design of Machine Components Available in Market.

This project work will first introduce the background of the study. Presents the design constraints that influence on the use, efficiency & benefits their impacts on machine. After that machine parts design all different existing machine assembly units will done to make a probable machine model.

3. Proposed Methodology 3:Selection of Components for Machine as per design specifications.

We will discuss the construction & working of system components. Various resources and factors were considered for getting the information on the project: First, the requirement of the field is to identify. The specification of the material is thought according to the need. Then, the allocation of budget is taken into consideration. Different research papers were read, we visited many markets & fields. Guidance was taken from College staff regarding the initial research of project. The Resources/Consumable required are: The main components of machine are to be purchase.

4. Proposed Methodology 4:CAD modeling& Fabrication of Machine parts.

This project work will start to manufacture after purchasing of required specification material & making sample simulations which will be easy for visualization. After that manufacturing procedure of machine will be done, after this cost estimation of machine will calculate.

5. Proposed Methodology 5:Assembly & Testing of Machine.

Finally, after complete manufacturing procedure, will test the working model which will satisfy probable objectives or not. After that complete working & satisfied testing will discuss advantages & applications of the machine while performing satisfied operation with complete report writing.

2.LITRATURE REVIEW

David R. Bassett, Ray Browning, Scott A. Conger, Dana L. Wolff, and Jennifer I. Flynn, done the work on, Architectural Design and Physical Activity: An Observational Study of Staircase and Elevator Use in Different Buildings, according to his study,The indoor built environment has the potential to influence levels of physical activity. However, the extent to which architectural design in commercial buildings can influence the percentage of people choosing to use the stairs versus elevators is unknown. The purpose of this study was to determine if buildings with

Centrally located, accessible, and aesthetically pleasing staircases result in a greater percentage of people taking the stairs. Methods: Direct observations of stair and elevator use were conducted in 3 buildings on a university. One of

the buildings had a bank of 4 centrally located elevators and a fire escape stairwell behind a steel door. The other 2 buildings had centrally located staircases and out-of-the-way elevators.

The percentage of people who ascended the stairs was 8.1% in the elevator-centric building, compared with 72.8% and 81.1% in the 2 stair-centric buildings (P < .001). In addition, the percentage of people who descended the stairs was 10.8% in the first building, compared with 89.5% and 93.7% in the stair-centric buildings (P < .001). Conclusions: The results of the current study suggest that if buildings are constructed with centrally located, accessible, and aesthetically pleasing staircases, a greater percentage of people will choose to take the stairs.In summary, this study's observational data suggest that centrally located, accessible and aesthetically pleasing staircase design contribute to increased stair use. We compared the percentage of people using the stairs in two buildings with well-designed staircases to another building with a centrally located bank of elevators and a narrow, fire-escape stairwell. The percentage of stair users was several times greater for the stair-centric buildings, compared with the elevator-centric buildings. If implemented on a widespread basis, this architectural design change could boost population levels of physical activity and reduce electricity use. [1]

Vyankatesh B. Emche, Nikhil G Lokhande, Amit S.Ghade, Chetan A Samarth, done the work on, Development of Stairs with Escalator (Stair lift), according to his study,This Paper deals with fabrication of stairs with escalator (stair lift) which consist of rope and pulley mechanism which liftsup and down the platform to move person. This helps the person to facing difficulties in climbing stairs. We propose equipment whichbe handled easily by the person, since it is a mechanical engineering project. Our major requirement was that to make the project atlow budget as compared to lift with low maintenance without risk of power cut & human life.There are many old and physically disable peoples in the world and it is difficult for them to climb stairs as compared to normal persons.So to help them and to help the persons who cannot afford lift as their houses are small, the project is made. The most concern of thisproject is to fabricate a mechanism which will lift them up and put them down whenever they want and at very low budget.stair with escalator is a mechanical device for lifting people up & down. Rail is mounted on the stairs on which a platform is attached.The platform is lifted by a simple mechanism of rope & pulley by it is lifted.Person gets on the platform is lifted when he/she switch on the plug the motor starts, after that the shaft of motor is connected to gearbox(speed reducer) by the Oldham's coupling. The outlet shaft of gearbox is connected to another Oldham's coupling which transmits thepower to the spindle to wind or unwind the rope. Winding the rope will lift the platform up & unwinding will make the platform go down.There are advancements in very fields like software technology, more safety feature, and manually operated, etc. They want to developcountry; they must have to use stair lift which should be affordable and easily operated in our Homes, Hospitals, Apartments, Old –Age Homes, etc.Hence, they found the best way for climbing stairs through the stair lifts which is more beneficial for Old age or Handicapped people in their life. This Design of stairs with escalators (stair lift) enables the easier transporting and handling of person or a object in various places with very low price and low maintenance and can be fixed on any type of stairs. While in design if the platform is replaced by seat more comfort and safety is possible and can be used is instead of lifts in small houses.[2]

Will Y. Lin, done the work on, Article- Automatic Generation of High-Accuracy Stair Paths for Straight, Spiral, and Winder Stairs Using IFC-Based Models, according to his study,The indoor space model is the foundation of most indoor location-based services (LBS).A complete indoor space model includes floor-level paths and non-level paths.The latter includespassages connecting diferent floors or elevations such as stairs, elevators, escalators, and ramps.Most related studies have merely discussed the modeling and generation of floor-level paths,while those considering non-level paths usually simplify the formation and generation of non-levelpaths, especially stairs, which play an important role in emergency evacuation and response. Althoughthe algorithm proposed by i-GIT approach, which considers both floor-level and non-level paths,can automatically generate paths of straight stairs, it is not applicable to the spiral stairs andwinder stairs that are common in town houses and other public buildings. This study proposes anovel approach to generate high-accuracy stair paths that can support straight, spiral, and winderstairs. To implement and verify the proposed algorithm, 54 straight and spiral stairs provided byAutodesk Revit' social website and three self-built winder stairs are used as test cases. The testresults show that the algorithm can successfully produce the stair paths of most test cases (49/50),which comprehensively extend the applicability of the proposed algorithm.[3]

Sumedh Ingle, Anshul Gupta, Rohit Chauhan, Kamlesh Naik. done the work on, Design and Fabrication of Mechanized Stair, according to his study,Generally at many places there is no provisionfor disable people to climb

the stairs with the help of thismechanized stairs the person will able to do it. The objectiveis to transmute the staircase into ramp or platform, so thatlame or disable people can make use of it. It is aamalgamation of stairs and ramp so it can use alternatelywhenever needed, it is a type of portative stairs.Involvement of such mechanized things will help to reduce
human work. The main rationale behind working on this topic is to reduce human effort in day to day life and vanquish the difficulties. The work is done to bring the
conceptual idea into reality.Experience through recent studies reveals that ramp and
stairs are used separately, by introducing mechanized stairs it can be used with ease and it is practically beneficial. Various other mechanisms can also implement for the same process, it can be automated by using electric motors for giving motion to worm rod. By using different materials strength, load bearing capacity, resistant to weather can be improve. Sensor and alarms can be installed for safety purpose.[4]

K.Navya, B.Pavan Kumar, G.Hema Mounika, B.Vineeth, K Prabhakara Rao, I A Pasha, done the work on, Smart Stair Lift For Disabled And Elderly, according to his study,The main objective of this project is to develop anindoor as well as outdoor stair lift. A stair lift is a chairthat glides up and down a staircase on a motorized rail.While going up and down the stairs safety is the primaryconcern, the present day, top quality lifts include manyfeatures to maximize comfort, ease of use andattractiveness in the home, which is a safe and affordablesolution to overcome the unique needs and challenges thatpeople experience on the stairs. Stair lift, the mobilechair-like mobility device attached on one side ofstairways, allows to improve access for aged between floorsat homes, and to make many people with mobilityproblems live independently through the internet of things.Hence, we are designing a single rail stair elevator toreduce production costs as well as construction time thatis required in case of escalators and elevators.In this paper, thay proposed an IOT based system, which providesthe easy way for aged and physically handicapped for mobility overstairs.After getting phone connected to the system, easily usingthe application which is on your phone one can ascend or descendover the stairs. In the automatic mode, smart positioning of thesensor enables sliding over the stairs even easier with least effortsmade by human. Architecture is cost effective and portable within less time This system can be advanced to have a battery back
in case of any power issues. This system can be implemented on straight stairs only, and can be further modified for even turns.[5]

Jannel Lyn F. Domondon, Rajan Paul C. Garcia, Noriel A. Clavo, Maria Teresa B. Mendoza, Mary Anne C. Sevilla, done the work on, Design and Development of a Convertible Stair-Ramp System, according to his study,This design project aimed to provide a solution that addresses material handling and safety issues. Ladders are structures used for going up or down that consist of series of bars or steps between two upright lengths made of metal. Rigid ladders, which are self-supporting or leaned in a vertical surface and flexible ladders are hung from the top, are some types of ladders that are commonly used. The design concept of this industrial ladder is that the stairs can be converted into ramp and vice versa, and combined in a single system. The materials used for the design were aluminum, and a jalousie mechanism, which is known to be lightweight yet sturdy and corrosive. The primary function of this ladder is mainly to be a staircase for going up or down, but it can also be converted to a ramp for industrial use. This design project matched with the need for stairs or inclined plane. Results of the study suggested that the advantage of the new design over the traditional ladders are: First, it is portable and can be easily transported or carry alone within the trip; second, the material handling, particularly loading and unloading of goods will be more comfortable and safer. Since it is convertible to a ramp, the porters can use strollers or forklift that would aid them in carrying the loads to or from the truck, instead of using stairs alone. To create a better and final design, the proponents evaluate different constraints such as environmental, safety, usability, economic and manufacturability, and use Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to assess the nine design options.[6]

3. CONSTRUCTION

Convertible Staircase to Ramp projectis mainly consists of mainly following components;

3.1. Frame:

The frame is of MS material. The frame of our system is basically used to support the pneumatic components mounted on it. That is Piston cylinder, D.C.V, flow control valve, switches are mounted on frame.

3.2. Double acting cylinders:

Cylinders are linear actuators which convert fluid power into mechanical power. They are also known as JACKS or RAMS. Hydraulic cylinders are used at high temperature and produce large forces and precise movement. For this reason they are constructed of strong materials such as steel and designed to withstand large forces. Because gas is an expensive substance, it is dangerous to use pneumatic cylinders at high pressures so they are limited to about 10 bar pressure. Consequently they are constructed from lighter materials such as aluminum and brass. Because gas is a compressible substance, the motion of a pneumatic cylinder is hard to control precisely. The basic theory for hydraulic and pneumatic cylinder is same. Parameters consider during the design of cylinder.

Piston diameter(mm) : 32,40,50,63,80,100
Std. Stroke(mm) : 25,50,80,100,125,160,200,250,300,320.
Medium : Compressed air-filtered-lubricated
Medium Temp. : 5˚-60˚1c
Working Pressure : 0.5-10 bar

- Considering Double Acting Cylinder of,
  Piston Dia. (D) = 25mm
  Stroke Length (L) = 100mm
  Dia. Of Rod (d) = 10mm

Fig.3.1. Double acting cylinder.

3.3. Pneumatic pipe fittings:

Pneumatic tubing is also available in a number of other materials both with and without reinforcement for use in standard applications. SMC fittings incorporate a positive tube seal while the fitting is under pressure which allows polyurethane tubing to be used.Tubing is available in sizes of 1/8", 5/32", 3/16", 1/4", 5/16", 3/8", and 1/2". Metric tubing sizes of 3.2, 4, 6, 8, 10, 12, and 16mm are available.

Tubing Series:
Polyurethane Tubing : TAU, TCU, TFU, TIUB, TU
Nylon Tubing : T, TAS, TIA, TISA, TRS, TS
Spark Resistant Tubing : TRB, TRTU
Coaxial Tubing : TW
Polyolefin Tubing : TP
Moisture Control Tubing : IDK

This can be used for connection of pneumatic system with total drill assemble.

Fig.3.2. Pneumatic hoses and fittings.

3.4. Pneumatic connectors, reducer and hose collector:

In our pneumatic system there are two types of connectors used; one is the hose connector and the other is the reducer.

Fig.3.3. Hose Collector & Connector.

3.5. Solenoid type 5/2DCV valve:

A valve is a device that regulates the flow of fluid (gases, liquids, fluidized solids or slurries) by opening and closing or partially obstructing passage ways. A 5/2 way directional valve from the name itself has 5 ports equally spaced and 2 flow positions. It can be used to isolate and simultaneously bypass a passage way for the fluid which for example should retract or extend a double acting cylinder. There is variety of ways to have this valve actuated.

A solenoid valve is commonly used, a lever can be manually twist or pinch to actuate the valve, an internal or external hydraulic or pneumatic pilot to move the shaft inside, sometimes with a spring return on the other end so it will go back to its original position when pressure is gone, or a combination of any of the mention above.

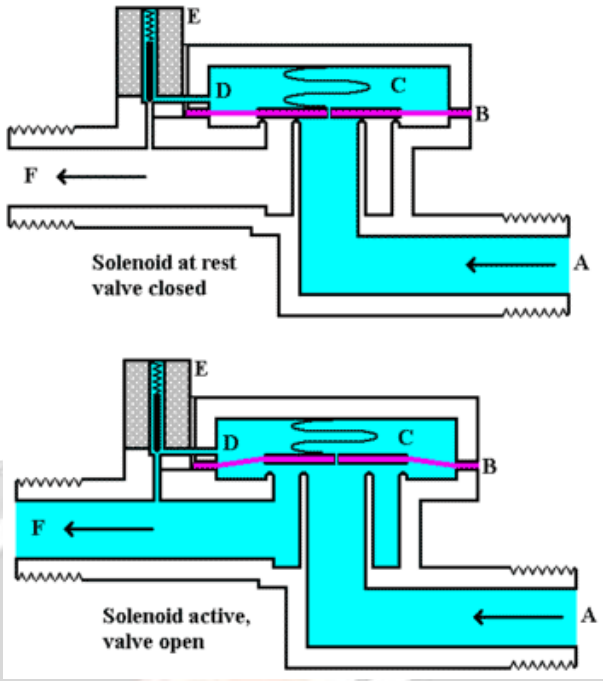


Fig.3.4. Solenoid valve operational principle.

A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mecha nical energy which, in turn, opens or closes the valve mechanically. A Direct Acting valve has only a small flow circ uit, shown within section E of this diagram (this section is mentioned below as a pilot valve). This Diaphragm Pilote d Valve multiplies this small flow by using it to control the flow through a much larger orifice. Solenoid valve may use metal seals or rubber seals, and may also have electrical interfaces to allow for easy control. A spring may be us ed to hold the valve opened or closed while the valve is not activated. The diagram to the right shows the design of a basic valve. If we look at the top figure we can see the valve in its closed state. The water under pressure enters at A . B is an elastic diaphragm and above it is a weak spring pushing it down.

The function of this spring is irrelevant for now as the valve would stay closed even without it. The diaphragm has a pinhole through its center which allows a very small amount of water to flow through it. This water fills the cavity C on the other side of the diaphragm so that pressure is equal on both sides of the diaphragm. While the pressure is the same on both sides of the diaphragm, the force is greater on the upper side which forces the valve shut against the in coming pressure. By looking at the figure we can see the surface being acted upon is greater on the upper side which results in greater force. On the upper side the pressure is acting on the entire surface of the diaphragm while on the l ower side it is only acting on the incoming pipe. This result in the valve being securely shut to any flow and, the gre ater the input pressure, the greater the shutting force will be.

Fig. 3.5.5/2 Solenoid valve.

3.6. Relay board:

In most of the high end industrial application devices have relays for their effective working. Relays are simple switches which are operated both electrically and mechanically. Relays consist of a n electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. There are also other operating

principles for its working. But they differ according to their applications. Most of the devices have the application of relays. The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits. There are only four main parts in a relay.

Fig.3.6. Relay switch.

3.7. Push Button:

A push button switch is a small, sealed mechanism that completes an electric circuit when you press on it. When it's on, a small metal spring inside makes contact with two wires, allowing electricity to flow. When it's off, the spring retracts, contact is interrupted, and current won't flow.

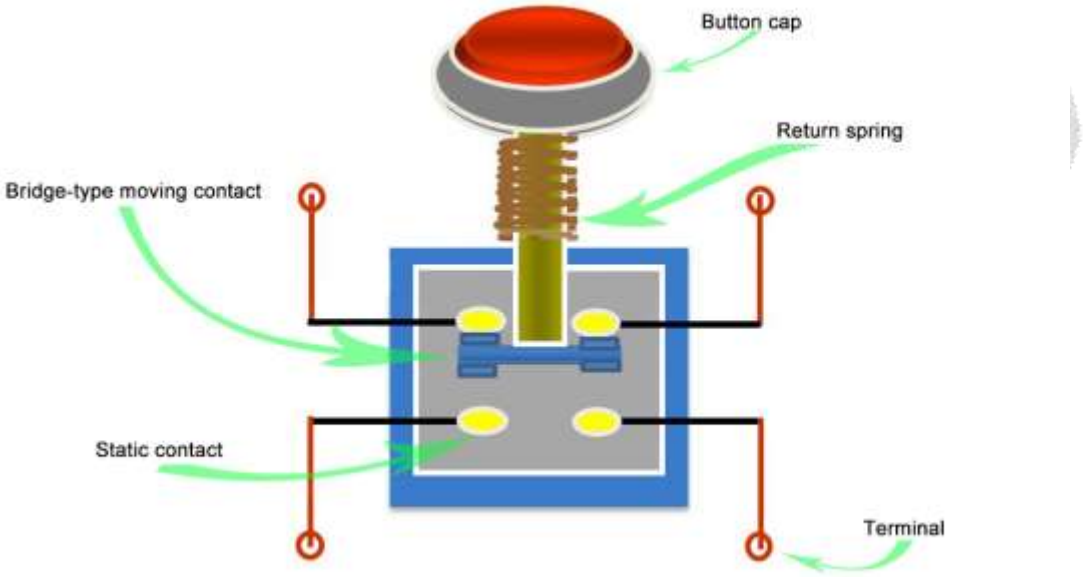


Fig.3.7. Push Button.

3.8. Battery:

The batteries are used as a storage device for solar energy which can be further converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage, for small units with output less than one kilowatt. Batteries seem to be the only technically and economically available storage means. Since both the photo- voltaic system and batteries are high in capital costs, it is necessary that the overall system be optimized with respect to available energy and local demand pattern. To be economically attractive the storage of solar electricity requires a battery with following particular combination of properties:

Specification of Battery:
Battery type – Lead AcidBattery 12V8Ahr.
Charging time - 1 to 1.5 Hours

Fig.3.8. Battery.

4.WORKING OF CONVERTIBLE STAIRS TO RAMPS.

The main concept of convertible stairs to rampssystem is create a combination of stair and ramp by implementing mechanical linkages, different mechanism & pneumatic components. So that it can be use simultaneously as a stair or ramp as per use or need. As per contemplate there is a major predicament for disable people for climbing stairs so this idea was conceptualized by integrating with pneumatic systems. By considering the concept the fabrication was carried out to prepare the stairs by fulfilling three basic requirements economic viability, technical feasibility and social acceptance.It consists of main body which is a right angle triangle support structure which holds and supports all the parts. All the load of the body and element is sustained by adjustable stand. Motion to the treads is provided with the help of pneumatic & mechanical linkages structure, which are mounted over the frame.

When we apply switch to ON the solenoid valve, the air is passes to double acting cylinder which motion is directly translated to the motion of the treads. Stairs are totally based on pneumatic mechanism which provide up and slant motion to the tread. In general condition it can be used as normal stairs, when cylinder forwardmotion is provided to the linkages and the same motion is gained by the stairs which is meshed with the ramp structure. On converting into stairs it is provided with the self-locking system with the help of pneumatics.

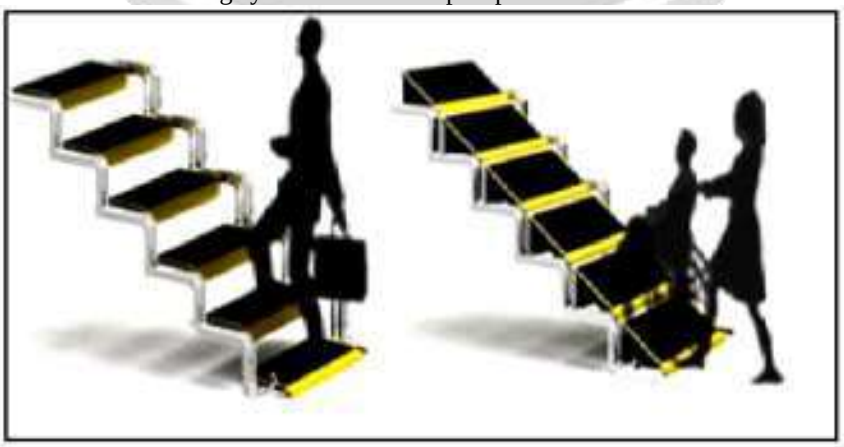
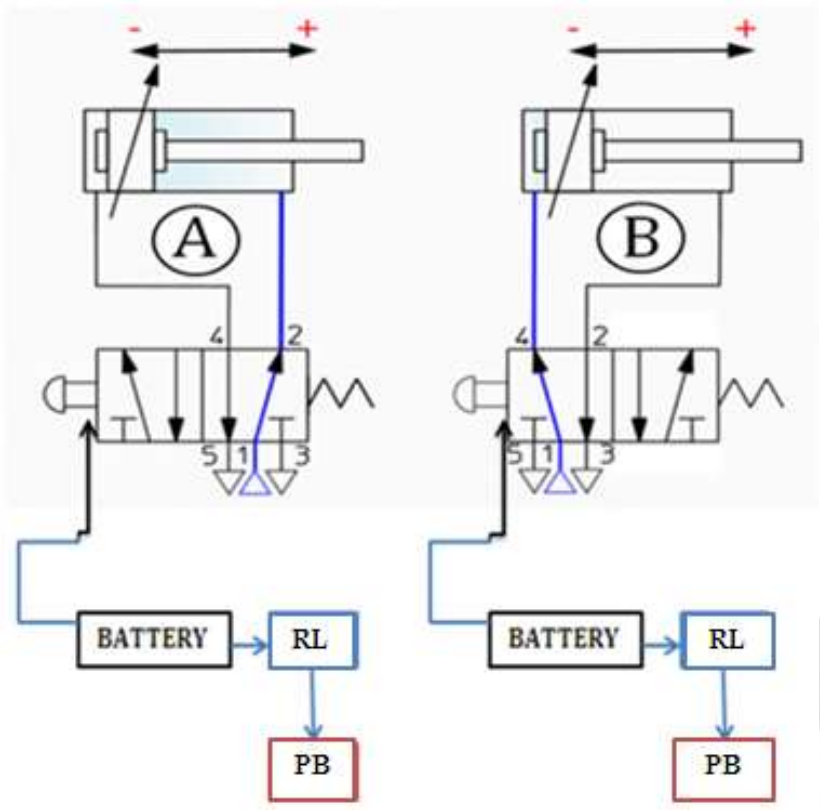


Fig.4.1. Conceptual Design of Convertible Staircase to Ramp.



A.Staircase Position **B. Ramp Position**

Fig.4.2. Pneumatic Circuit Diagram of Convertible Staircase to Rampproject.

5.DESIGN

5.1. Generalmetallurgical specification: -

The ferrous raw material used is all the project models confirm to Emergency Number Series ". The specification of the chemical properties and the physical properties of ferrous material were formulated in 1939 during world war two. The metallurgy of these ferrous materials was liberalized in order to meet the requirements of steel speedily for manufacturing weapons and armaments at very quick rate. These specifications are designed by "EN – NO" and should be confused with the British, American, Germen standards or with the Indian standard I.S.S No. All the EN specifications confirm to data books or Indian steel manufactures such as TISCO, ISCO, Hindustan steel, Mahindra Ugine, etc. The EN-NO is still prevalent and understood better by the local steel suppliers. The "Emergency Series" start with EN – 0 to EN – 48 as the properties go on increasing from lowest to highest grades. EN – 0 is softest iron and is called flon cutting steel, Deed steel or wrought iron. It is soft and ductile failing in compressive to Rockwell 'C' scale called shortly RC – Number.

5.2. Materials used and their properties:

The materials used in this project are detailed as follows

a) Low Carbon steel - EN – 1 to EN – 3

(Mild Steel) Carbon – 0.05% to 0.08%

Tensile strength – 420/550 MPA

Yield strength – 275/350 MPA

5.3. Approach to mechanical design of system.

In design the of parts we shall adopt the following approach;

Selection of appropriate material.

- Assuming an appropriate dimension as per system design.
- Design check for failure of component under any possible system of forces.

Mechanical design: In mechanical design the components are listed down and stored on the basis of their procurement in two categories.

- Design parts
- Parts to be purchased.

For designed parts detailed design is done and dimensions there obtained are compared to next dimensions which are already available in market. This simplifies the assembly as well as the post production and maintenance work. The various tolerances on work are specified. The process charts are prepared and passed to manufacturing stage. The parts to be purchased directly are selected from various catalogues and are specified so as to have case of procurement. In mechanical design at the first stage selection of appropriate material for the part to be designed for specific application is done. This selection is based on standard catalogues or data books;

eg:- (PSG DESIGN DATA BOOKS) (SKF BEARING CATALOGUE) etc.

5.4. Double acting cylinder Design:

Considerations made during the design and fabrication of a double acting cylinder was as follows,
The pneumatic cylinder willbe used for operation of staircase. The total load acting on cylinder consists of Mass to be put on lift,
F = 5 kg. = 5 x 9.81 N = 49.05 N. (Sample weight assume)
For cylinder design we use pressure will be,2 bar i.e. 0.2 N/mm²
Therefore,

$$P = \frac{F}{A}$$

$$0.2 = \frac{49.05}{2\ X\ \frac{\pi}{4}D^2}$$

D = 12.49 mm.

D = 25 mm.

Therefore, we selected 25mm diametric cylinder.**(Application Basis)**

Let us we consider double acting cylinder Ø25X 100 (Diameter X Stroke)

NOTE: if we increase the pressure of air as per formula pressure is directly proportional to the force.

If , **PF** ⇧ ⇧

Design of Pneumatic Cylinder:

Clavarino's equation for closed end cylinder at both ends. For ductile material use to determine the thickness of cylinder.

Let,

Material of the cylinder is Aluminum.

$$t = r_i \left[\frac{\sigma_t + (1 - 2\mu) P}{\sigma_t - (1 + \mu) P} \right]^{\frac{1}{2}} - 1$$

S_{ut} =Ultimate tensile strength = **200N/mm^2**

μ = Poisson's Ratio for the cylinder material =**0.29 (std-)**

di = Inner diameter of cylinder =**25mm**

Consider,

Double acting cylinder Ø**25X 100 (Diameter X Stroke)**

ri =12.5mm

By assuming pressure in working cylinder is, **P = 10 bar = 1 N/mm^2**

So according to Clavarino's equation,

For closed end cylinder at both ends to determine the thickness of cylinder.

Assume,

p = 10 bar = 1 N/mm^2

μ = 0.29

r_i = 12.5mm.

$$t = r_i \left[\sqrt{\frac{\sigma_t + (1 - 2\mu) P}{\sigma_t - (1 + \mu) P}} - 1 \right]$$

$$t = 12.5 \times \left[\sqrt{\frac{133.34 + 1 [1 - (2 \times 0.29)]}{133.34 - 1 (1 + 0.29)}} - 1 \right]$$

$$t = 12.5 \times \left[\sqrt{\frac{133.76}{132.05}} - 1 \right]$$

t = 0.806 mm.

Available thickness, **t = 1 mm**

Piston dia- = 25mm

Stroke dia- = 100mm

Pistion rod dia- = 12mm.

Let,

A= Force area of cross-section of piston.

$A = \frac{\pi}{4} (D^2)$ mm^2

$A = \frac{\pi}{4} (25^2)$ mm^2

A= 490.87 mm^2

A_{PR}= Force area of cross-section of piston on rod side.

$A_{PR} = \frac{\pi}{4} (D^2 - d^2)$ mm^2

$A_{PR} = \frac{\pi}{4} (25^2 - 12^2)$ mm^2

A_{PR}= 377.776 mm^2

Piston force acting during forward stroke.

$$\mathbf{F_a = P \times \frac{\pi}{4} (D^2)}$$

= 1 X 490.87

$$\mathbf{F_a = 490.87\ N.}$$

Piston force acting during return stroke.

$$\mathbf{F_R = P \times \frac{\pi}{4} (D^2 - d^2)}$$

= 1 X 377.776

$$\mathbf{F_R = 377.776\ N.}$$

Time required to complete stroke is 2 second.

Linear velocity of piston $\mathbf{V = \frac{L}{t}}$

$$= \frac{100}{2}$$

= 50 mm/sec.

5.5.Design of reaction forces on steps:

Assume load on step will be maximum 5kg.

Ra = Reaction at A Point.

Rb = Reaction at B Point.

Σ Fy = 0

Ra + Rb = 0

Σ M @ a =0

(5 x 100) – (Rb x 100) =0

Rb = 5kg = 49.05N

Ra = 5kg = 49.05N

(Ref.: Engineering mechanics, Dr. R.S. Khurmi, Fifth edition, support reaction, p.no.101)

5.6.Design of riveted joints:

Assume a total riveted joint on the staircase is 6.

Total load on all staircase will 5 kg divided on these 3 stairs. Assume load on each step will be maximum 1.66 kg.

F = 1.66X 9.81 = 16.35N.

The material for rivet is C40 DDB P. No 1.10.

Yield strength $\mathbf{S_{ut}}$= 680 N/mm^2

Tensile stress $\boldsymbol{\sigma t} = \frac{\mathbf{Syt}}{\boldsymbol{FOS}} = \frac{\mathbf{680}}{\mathbf{2}} =$ 340N/mm^2

Shear stress $\boldsymbol{\tau = 0.5\ \sigma t}$ = 170N/mm^2

Select a rivet 12mm dia. from table 9.3. p.no.297 R.S.Khurmi.

Dia. of hole of rivet d = 13mm

Permissible shear stress for rivet material $\boldsymbol{\tau}$= 170N/mm^2

Single shear- P.No.291, 292 R.S.Khurmi.

Shearing Area As = $\frac{\Pi}{4}$X $\mathbf{d^2}$

= $\frac{\Pi}{4}$X 13^2

As= **132.73 mm^2**

Shearing resistance or pull required to shear off the rivets per pitch length:

$\mathbf{Ps = n\ x \frac{\Pi}{4} X\ d^2\ X\ \tau}$

16.35 = 2 x $\frac{\Pi}{4}$ X 13^2 X τ

$\boldsymbol{\tau}$ **= 0.0616N/mm^2 ≤ 170 N/mm^2 (Safe)**

Crushing stress:

Crushing area Ac = d x t

Thickness of plate t = 5mm

Ac = 13 x 5 = 65 mm^2

Total Crushing area Ac = n x d x t

= 2 x 13 x 5

Ac =130**mm^2**

Crushing resistance: Pc = n x d x t x σ_c

16.35= 2 x 13 x 5 x σ_c

σ_c = 0.1257**$\leq$ 340 N/mm^2 (Safe)**

6.ADVANTAGES& APPLICATIONS

6.1. Advantages:

1) An automatic convertible staircaseto ramp control is implemented with very simple hardware and easy control.
2) Human intervention while automatic convertible staircaseto ramp can be easy which reduce accidents of physically disable & old edge people.
3) It will give better comfort of traveling over stairs as compared to another type of staircasesystems. This system has higher safety as compared to others staircase in safety point of view.
4) There are very rare chances of an accident during down the staircase or ramp.

6.2.Applications:

It is used for adjustable automatic convertible staircase to ramp control in buses.

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