Design of Automatic Ramp for Handicapped People

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Abstract – *As per census 2011, in India out of the 121 Cr population, about 2.68 Cr persons are disabled which is 2.21% of the total population, now in current year it has been increased. Out of which the large percentage of handicapped people travel by bus and train and they find difficulty during transportation. They mainly find difficulty while boarding and alighting from the vehicle. Ingress and egress are troubled because of steps in differently abled compartments. Certainly, it would end up accidents in many cases. These people require safe, affordable, accessible and sustainable transport system. In order to overcome the problems faced by handicapped people during ingress and egress, we go for a novel approach with the social mentality. Here we designed an automated self adjusting ramp for low floor public transit buses. Our target is to develop best solution for the handicapped people to easy board and alight from the low floor public transit buses, taking into account physical and material constraint as well as the passenger safety and easy accessibility of the ramp. To achieve the goals of this project we followed the product design methodology that lead us to final concept of the project. The ramp developed in this project reveals a relatively new concept that is fitting into the space, safety and ease-access requirement of the bus. By means of this we can upgrade the ingress and egress of the buses for wheelchair users. As our main objective is to design & analysis of automatic sliding ramp, 3 D model of this ramp is generated in SOLIDWORKS. Here we conclude that the ergonomic design of the ramp has provided feasible solution by various experiments through software.*

Key Words*:* Ingress, Egress, Self adjusting, Automated Ramp, Passenger Safety, Ergonomic design.

1. INTRODUCTION

In India out of the 121-crore population about 2.68 crore persons are disabled which is 2.21% of the total population. Now, in current year it has been increased which information is given by Census 2011. We are in an era where 'inclusive development' is being emphasised as the right path towards sustainable development focused initiatives for the welfare of disable persons are essential.

The large percentage of handicapped people travel by bus and train and they find difficulty during transportation as they are unable to use a stair that is they mainly find difficulty while boarding and alighting from the vehicle. The ground clearance in public transportation vehicles is more, due to this reason they face problem during boarding and alighting from public transport. Pedestrians also have benefit of such kind of ramp as they eliminate the need to raise the foot or leg to the higher surface.

Existing transportation vehicles in India such as buses or trains, they don't have such kind of mechanism which can help these people. So, we decided to make wheelchair ramp for public transport vehicle such as low floor buses which can operate automatically, quickly & also it must have high strength capability to withstand on heavy load. Actuation is done with the help of motor & sensor.

This ramp can be used for different public transportation vehicle with some changes in design. But in our project, we designed a ramp for low floor buses.

2. EXISTING LITERATURE

A number of research groups have explored various approaches, to the detailed information below, regarding the use of wheelchair ramps for buses. In addition, several research groups sought to modify the ramp for making it disabled friendly. Some of the research papers related to this field are discussed below.

2.1 Edward A. Czech, Winamac; Ronald W. Goodrich, Logansport; Kevin L. Crawford, Winamac (1991):

This study is directed to passive rotary wheelchair lift that is retrofittable in transit vehicles on one door of a double-door side entry of a transit vehicle.

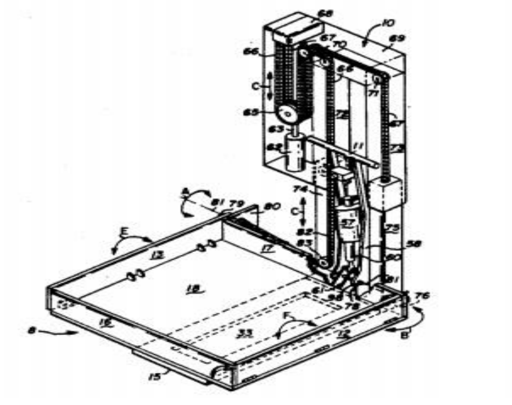

Fig1.Rotory bus lift with power stowable platform

The lift employs in its preferred embodiment a double slide tube having a box frame with a cross header. A hydraulic cylinder actuates a pair of chains, one descending down each lift tube to operate the vertical lift. A manual hand pump is provided in the case of power failure. Secured to the bottom of inner telescoping lift tubes is a plate carrying a power actuator for rotating the lift platform from a deployed horizontal position to a vertical stowed position. The stowed platform is nested against a transit seat and remains behind the closed-door half of the double-door pair. For use by a wheel chair user, both doors are opened and the lift is deployed, rotated and actuated to raise or lower the user to the ground, platform or curb. The actuators can be disconnected for full manual operation in the event of power failure.

2.2 David A. Stanbury; Glenn M. Campbell, both of Winnipeg; Philip J. Fleury, Headingly (1993):

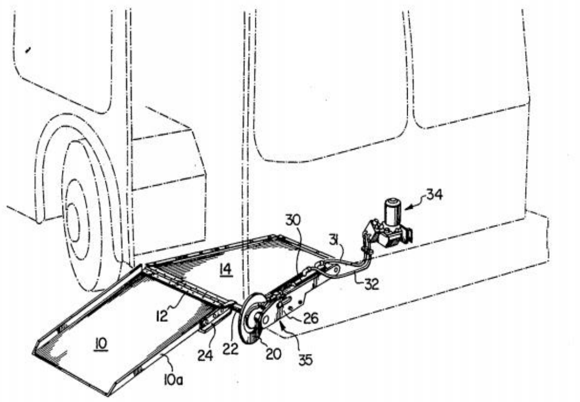

Fig2.Hydraulically operated bus ramp mechanism

A mechanism is provided for deploying a wheelchair ramp at the door of a vehicle, especially a bus, the ramp comprises a simple and inexpensive hydraulic cylinder mechanism, which provides a "float down' feature which permits the ramp to move downward undergravity without the need for operator control and prevents accidental crushing of obstacles that get in the downward path of the ramp. In the event of a power source failure, the ramp can be operated manually without disengaging the drive mechanism. Manual operation requires only that the ramp be lifted to just past the vertical position from which it will "float down" to the final position with the hydraulic system acting as a damper. The mechanism includes a transmission for translating a single hydraulic cylinder stroke into more than 180° of rotation of the ramp.

2.3 Bareria, Piyush; Shin, Gwanseo(2014):

Manual assistance to wheelchair-users while boarding and disembarking a bus may be an important risk factor for musculoskeletal disorders of bus drivers, but no study has yet assessed biomechanical loads associated with the manual assist operations. In this study, off-duty bus drivers simulated wheelchair-user assisting operations using forward and backward strategies for boarding and disembarking ramps. Low-back compression and shear forces, shoulder moments and percent population capable of generating required shoulder moment were estimated using the University of Michigan Three-Dimensional Static Strength Prediction Program. L4-L5 compression force ranged from 401.6 N for forward boarding to 2169.3 N for backward boarding (pulling), and from 2052.4 N for forward disembarking to 434.2 N for backward disembarking (pushing). The shoulder moments were also consistently higher for the pushing tasks.

2.4 Karen L Frost, Gina Bertocci, Craig Smalley (2015):

The findings of this study support the proposed ADA maximum allowable ramp slope of 9.5°. Ramp slopes >9.5° and ramps deployed to street level are associated with a higher frequency of incidents and provision of assistance. Transit agencies should increase awareness among bus operators of the effect kneeling and deployment location (street/sidewalk) have on the ramp slope. In addition, ramp components and the built environment may contribute to incidents. When prescribing WhMDs, skills training must include ascending/descending ramps at slopes encountered during boarding/alighting to ensure safe and independent access to public transit buses.

2.5 Gina Bertocci, Craig Smalley, Amanda Page, Carmen Digiovine (2018):

Fig3.Manual wheelchair ramp

Ascending bus ramps require greater power and pushrim force on steeper ramp slopes, so the amount of force needed to push the wheelchair up is tremendous which presenting a potential barrier to transportation accessibility. So the transit bus ramp slopes encountered during ingress can present a challenge to manual wheelchair users. Given this finding, it is imperative that bus operators minimize ramp slope to assure manual wheelchair users are able to access LATVs.

2.6 Aswin Santhosh, B Nandagopal, Jojo Joseph, Kailas Anilkumar & Premjith S (2020):

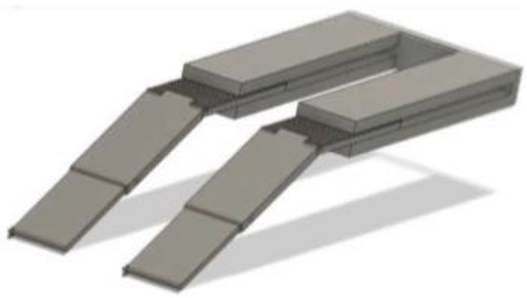

Fig4.Automated Self-Adjusting Ramp

This study aims at an automated self-adjusting ramp which is compatible with the different heights of the railway platform. It consists of rack and pinion mechanism for the improved outcome on the adjustments of the automated ramp. By means of upgradation of the entrain and detrain facilities for the differently abled people. It provided feasible solutions by the various experiments through software on where the differently able people face the challenges using railways.

3. OBJECTIVES

- Easy boarding & alighting for handicapped people in a public transportation vehicle, so that they can easily travel without relying on others & enjoy their human rights & achieve their full potential.
- To make it compact with minimum change in existing design of transport vehicles, so it is easy for vehicle companies to implement into their vehicle. So that manufacturer of any public transport vehicle quickly ready to install such a ramp mechanism.
- To reduce total cost of manufacturing & installation of ramp in public transport & make ramp versatile, durable, and portable.
- Being a responsible citizen, through this project we expect to add some values in this field & present it to the society.

4. METHODOLOGY

The proposed Automatic wheelchair ramp requires design first before analysis. Design & Analysis were carried out is as follows:

- Received an Idea from newspaper
- Visited to the Bus Workshop
- Literature Review & information gathering
- Design Ramp by using SOLIDWORKS
- Analysis of Ramp using an ANSYS with their Result
- Cost Estimation

5. SYSTEM DESCRIPTION

A. System Parts

1. First Plate
   a) Structure
   b) Aluminium sheet
2. Second Plate
   a) Structure
   b) Aluminium sheet
3. Main Body
   a) Structure
4. Rack & pinion mechanism
5. Hinge support channel
6. Handrail
7. Linear Guideways
8. Motor
9. Battery

B. Description of Components:

5.1 First Plate

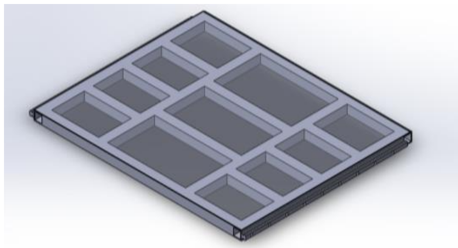

Fig5.First Plate

First plate is mounted inside the second plate of assembly. The first plate is also a movable plate, it having linear motion inside the second plate. The first plate moves forward with the help of rack & pinion mechanism which placed inside the second plate. Here rack is moving & pinion is stationary.

5.2 Second Plate

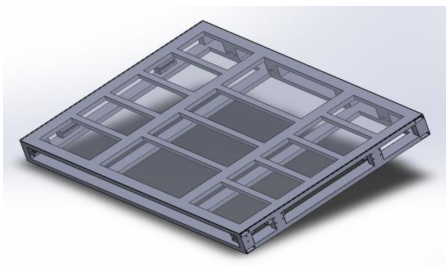

Fig6.Second Plate

The second plate mounted inside the main body of assembly. The second plate is a movable plate, it having linear motion inside the main body. The second plate moves forward with the help of rack and pinion mechanism which placed inside the main plate. Here the rack is stationary & pinion is moving.

5.3 Main Body

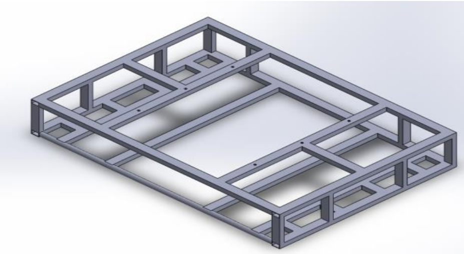

Fig7.Main Body

The main plate means supporting structure of our overall Assembly. The main plate does not have any motion in it, it is stationary which is fixed to the lower part of low floor bus door. It helps to hold the second plate of our assembly. Main plate consists of rack and pinion mechanism in it. Guideways are also provided in the main plate for smooth linear motion of second plate.

5.4 Rack & Pinion Mechanism

Fig8.Rack & Pinion Mechanism

A rack & pinion mechanism is a type of linear actuator that consists of a circular gear (the pinion) engaging with a linear gear (the rack), to give linear motion by conversion of rotational motion. Here the rack & pinion mechanism is used for extension & retraction of ramp.

5.5 Hinge support channel

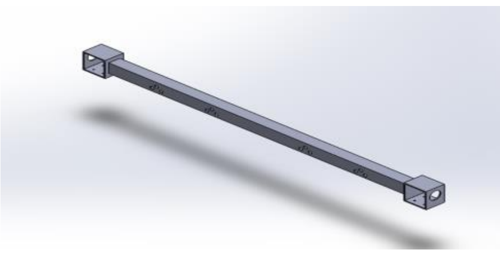

Fig9.Hinge support channel

Hinge is provided in between second plate & hinge support channel to achieve desired tilt. Hinge support channel provides support to hinge & transmit motion from guideways to plate assembly. Motor is fixed into hinge support channel.

5.6 Linear Guideways

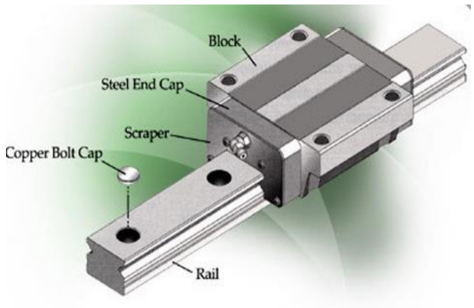

Fig11.Guideways

Linear Guideways are the mechanism which is used for smooth movement of the wheelchair ramp. These are used to slide the first plate inside the second plate & second plate inside main body smoothly.

5.7 Motor

Fig12.Dc servo motor

Motor is generally used to covert electrical energy into mechanical energy. In our project, motor is used to give the rotational motion to the pinion in order to move the plates in forward & backward direction also. Here we used the servomotor for bidirectional motion.

5.8 Battery

Fig13.Battery

Battery is a device that stores the chemical energy & converts it into electrical energy. Battery is used to provide electric current to the motor.

C. System construction & working

The ramp is made up of three main structural components and other minor elements for the movement of these structural elements. These three components namely main body, second plate & first plate. First plate and second plate are moving components of ramp where they both can slide linearly with in the main body. Main body accommodate these two plates and it is fixed to the bus floor. Second plate accommodate the first plate. Both the main plate and second plate consist of rack & pinion mechanism for the movement of the second plate and first plate. Guideways are provided for smooth sliding of the plates. For the second plate motion, the pinion is mounted on the motor which is enclosed by housing attached to the bar inside the main plate which is hinged to second plate. For the sliding of second plate in the main body, the pinion which is coupled with motor is moving and rack is stationary. For the motion of first plate, the motor is fixed at front right end of second plate. The first plate is moving smoothly into the second plate because of the guideways and the first plate has rack attached to it at right end, which is then attached with pinion of motor. So, when the motor starts rotating the pinion which is stationary, the rack will move in linear direction. So, the first plate will start sliding forward.

When the door is open, driver presses the activation button which is place in driver cabin, to move the ramp from it's retracted position to extended position. Sensors are provided to detect the presence of any object or living being, if not then both the motor will start rotating simultaneously. Motors which is enclosed in the housing rotate the pinion on the rack to slide the second plate forward. Same will happen with first plate as it will start coming out from the second plate. But the only difference in the mechanism is that for the second plate motion the rack is stationary and motor hub has linear motion and for the first plate motion the motor or pinion is stationary and rack has linear motion. When the both plates are at extended position, they are supposed to be maintain max 15° angle with the ground. So, for this tilt, hinges are provided on second plate. Now to retract the plate same process will happen in reverse direction as motor will rotate in reverse direction.

6. FUTURE SCOPE

1. A visual stop display that can be seen by the wheelchair passenger.
2. By the use of mobile application, driver can know whether there is any disable person is waiting on the bus stop or not. So that the driver can press the button to open the wheelchair ramp for disable people only.
3. Development of ramp for train which can be retracted quickly as per consideration of people's safety and halt timing of train.

7. CONCLUSION

We completed design of the ramp. The overall cost of the ramp is less than existing ramps. Our ramp can sustain up to 300 kg load.

So finally, it is a system which would be economical efficient, robust, and well sized to be fit into minimum space on the bus with minimum changes in existing design of transport buses. We hope our project will help disable people by providing freedom, which they were restricting.

8. REFERENCES

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