An Automated Self-Adjusting Ramp to Entrain and Detrain For Differently Abled In Indian Railway System

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Abstract - *Nowadays, we can observe the physically challenged people who struggled with the public transport system like railways as well as bus transport obviously. Especially in railways, in spite of providing some basic amenities for those people like wheel chairs etc., the entrain and detrain is troubled because of the steps in differently abled compartments. Certainly, it would end up with the accidents in many cases. In order to avoid the same we go for a novel approach with the social mentality. Here we have designed an automated self-adjusting ramp which is compatible with the different heights of the railway platform in southern India where we have surveyed near about 200 and above kilometers thoroughly. Here we are using a rack and pinion mechanism for the improved outcome on the adjustments of the automated ramp. By means of this we can upgrade the entrain and detrain facilities for the differently abled people. We conclude that the ergonomic design of the ramp has provided feasible solutions by the various experiments through software on where the differently able people face the challenges in day today life while using railways.*

Key Words*: *Ergonomic design, Self-adjusting, Rack and pinion mechanism, Automated ramp, Human ergonomics

1. INTRODUCTION

For most differently abled people, public transport is a strenuous option. With lack of basic facilities be it ramps, wheelchair access, lifts and a non-adapting public makes it impossible for them to navigate. The differently abled people facing lot of challenges during entrain and detrain even at the differently abled compartments too. That made us think hard on how we can make a small step towards making our nation & one of its facilities more inclusive and also ensure reduction of accidents. Our approach attempts to address this marginalized group within infrastructure and how our solution can impact their lives & well-being .The highlight of our work will be the automation of the operating system. Utilizing the rack and pinion mechanism the system will adjust to desired level as per height of platform. The slight angle is maintained at 15 degrees which will ensure adequate ergonomics and comfort. The system consists of three sliding frames. Various materials and their properties were studied and aluminum is chosen for its strength, ability to sustain friction and machinability. The main objective was to bring an industrial application of Rack and Pinion in automatic ramp system to entrain and detrain in Indian railways. By introducing a simple and convenient mechanism for ramp system, cost cutting and serviceability were also kept in mind. We also intended to design our ramp system robust so that it could be used in the most exhaustive and unforgiving Railway environments. Thus to sum it up our objective throughout the project was to make our design simple, clean, reliable, robust and cost effective.

1.1 Objectives of Work

1. To make easy entrain and detrain for differently abled people.
2. To minimize external support to navigate wheel chair to the coach.
3. To design a well-developed mechanism, which consists of a slant sheet of aluminum which can provide an easy track for easy wheel chair movement.
4. To bring an industrial application of Rack and Pinion in automatic ramp system to entrain and detrain in Indian railways.

2. FIELD SURVEY

The field survey has been done near about 200 and above kilometers across the Kerala. By which we have measured the maximum and minimum height difference of plat form to the train floor was 35 cm and 75 cm respectively. But from some literature survey, we obtained that these height difference may vary in some stations of Andhra Pradesh where the plat form and railway tracks are in equal level. It is tedious to the physically challenged people for entrain and detrain. Our approach provide the practical solution for the wheel chair movement without hindrance into the trains. This system is well suited with all the platforms, we can adjust that within the designed operating range.

3. METHODOLOGY

3.1. Concept of Working

The system consists of three frames, in which the first and second frames are connected together by hinged support and the second and third frames are in sliding contact. The working concept is that when the system moves outwards, the second frame will come out initially with third frame and gradually make an angle of 70 degrees which is locked, that is no further movement after 70 degree. So that the third frame will automatically come out from second frame and by touching the ground it makes the angle 20 degree with the platform floor which ensures the adequate human ergonomics.

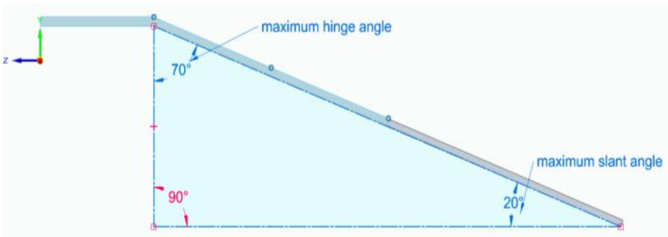

Fig -1: Conceptual view of working

3.2 Principle of Working

Utilizing the rack and pinion mechanism the system will slide to desired level based on the height (platform to train floor).The slant angle is maintained at 200 which will ensure adequate ergonomics & comfort. When the system is switched ON, the motor will drive the pinion gear so that the ramp starts moving outwards. As the ramp moves, the second frame will make slope which is hinged to the first frame. The maximum hinge angle is set to 70^0 to get a slant angle of 20^0 for the ramp. When the height difference is more, the third frame will come out from the second frame which are in sliding contact. When the third frame touches the ground, the ramp system is ready. After entering/departing the differently abled person, the system will automatically adjust to the initial position.

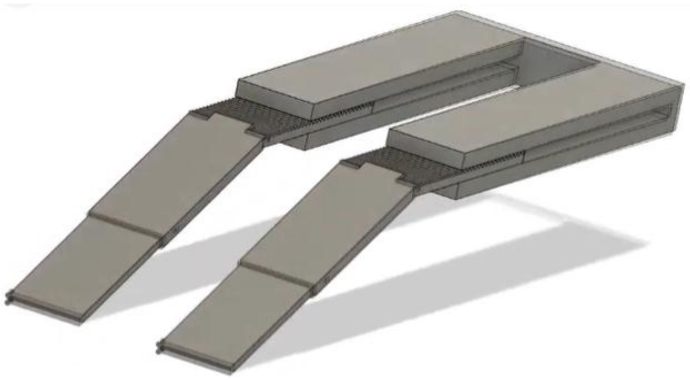

Fig -2: Isometric view of ramp

3.3 Auxiliary Components

***a)* DC power motor: To drive the pinion gear**

A DC motor with specification 500 W 108 rpm 24 V is used in the system to drive the pinion gear. The selected motor can take up to 350 kg smoothly. Usually this motor is used in electric wheel chairs and other electrical drives. Which will run satisfactorily and efficiently with the entire ramp system.

***b)* Battery or Power source**

Here we used a 24 V Lithium Ion battery to give power to the motor. Lithium Ion batteries are generally used in electric vehicles.

***c)* Rack and pinion**

Rack and pinion gear is used to drive the system. Pinion gear is driven by the DC motor by receiving power from the battery. Here we used Straight rack and pinion. Rack and pinion is used to simplify the design and to reduce the complexity in designing instead of using a hydraulic system. Also rack and pinion is cheap, compact, and robust and it requires only less maintenance. So by using rack and pinion we can ensure the safe working of the ramp without any chance of accidents.

***d)* Relays: switches**

Relays are used to ON or OFF the system.

4. CAD MODELLING

The frames of the system are designed with CAD software. Here we used ANSYS analysis software. The structure of the system is designed and analyzed with maximum conditions. The three frames were designed and assembled.

4.1 Frame(S) of The System

The system consists of three frames, in which first and second frames are connected with hinged support and the second and third frames are in sliding contact in order to maintain a slant angle of 20^0.To construct the ramp, the material for the frame is used as aluminium alloys because aluminium alloy are light, tough and resistant to corrosion. Most of the engineering constructions are done with the aluminium alloys due to the above reasons.

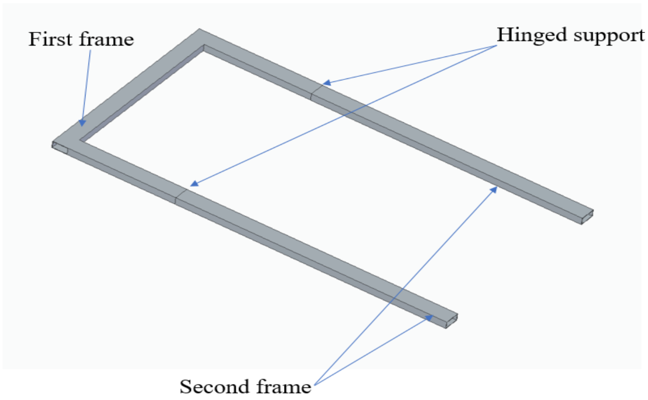

Fig -3: Phase 1

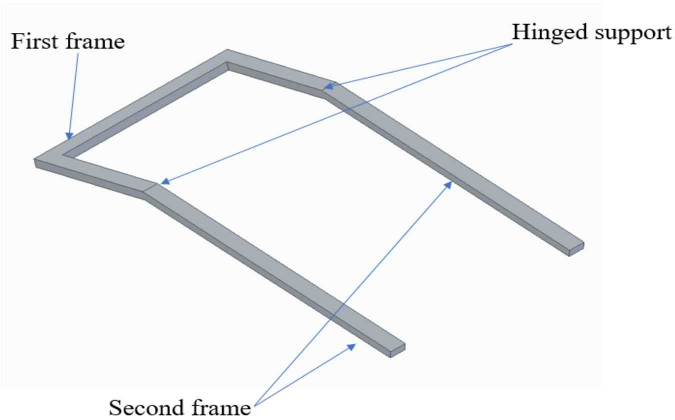

Fig -4: Phase 2

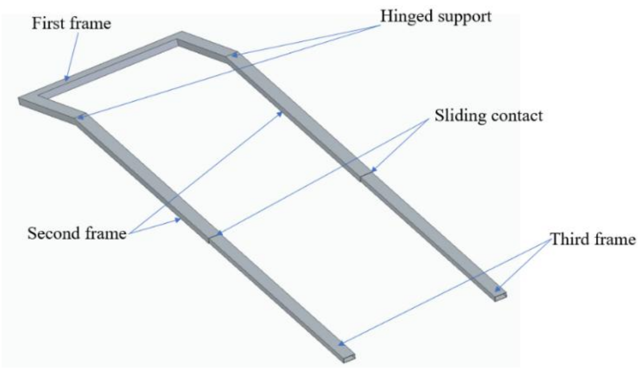

Fig -5: Phase 3

5. DIMENSIONS OF THE RAMP

5.1 Length of the Ramp

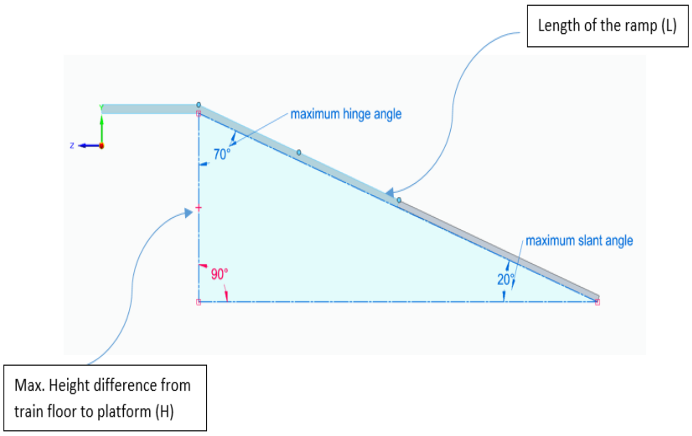

Fig -6: Conceptual view for dimensioning

Let,

The length of the ramp =L

Max. Height difference = H

Then to maintain an angle of 200 at the base area in order to ensure the human ergonomic design, the length of the ramp should be designed on the basis of maximum height difference from train floor to platform.

Then,

$$H=75 \text{ cm}$$

$$\sin(20) = H/L \qquad (1)$$

$$L= H/(\sin(20))$$

$$= 75/\sin 20 = 219.285 \text{ cm}$$

Therefore, the length of the ramp we selected is 220 cm

5.2 Width of the Ramp

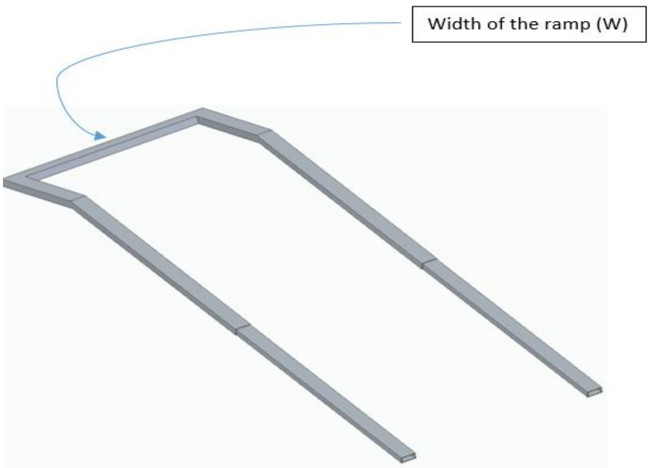

Fig -7: Width of ramp

Here we took the width of the ramp based on a standard wheel chair dimensions. Which is given below:

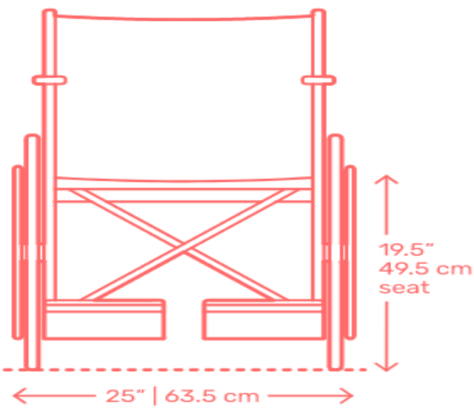

Fig -8: Dimension of standard wheel chair

As in the figure, the standard width of the wheel chair is 63.5 cm. And also we considered the width of train door, as per the measurement done by our self, the door width of Indian trains are 83-85 cm.

Thus we selected the width of the ramp as 85 cm.

5.3 Full Dimensions of the Ramp

The dimensions of the ramp structure are calculated by considering the following factors

a) The maximum height difference from train floor to platform, i.e., 75 cm.

b) Standard dimensions of a wheel chair, it shows that the width of a standard wheel chair is 63.5 cm

c) Standard dimensions of train door in Indian trains. In which the width of train door is 85 cm

Therefore, by considering the above factors, the length of the ramp can be 220 cm to maintain a slant angle of 20 degree at the bottom to ensure human ergonomics (maximum conditions). Length of the ramp is found from the trigonometric relation between max. Height difference and slant angle 20 degree. That is by taking sin (20) from the figure mentioned in the PPT slide no.6, we get the length as 220 cm. Then by considering the standard width of both train door and wheel chair, we took the width of ramp as 85 cm. Therefore the length and width of the ramp are 220 cm and 85 cm respectively.

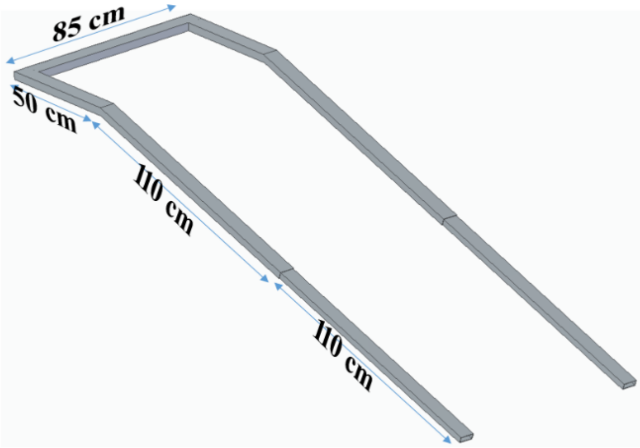

Fig -9: Full dimensions of the ramp

6. RESULTS AND DISCUSSIONS

6.1 Analytical Outcome

For analytical results, we used ANSYS software and the results were obtained after analysis of structure of the system. The results obtained are helpful to choose the material and here we selected aluminium as the material for the ramp, because of its higher machinability and strength. The outcomes are given below,

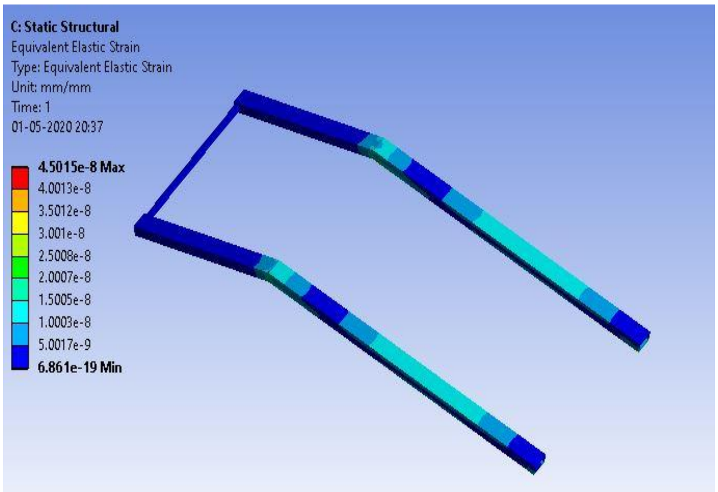

Fig -10: Equivalent elastic strain

Maximum equivalent elastic strain is 4.5015$\times 10^{-8}$ mm/mm

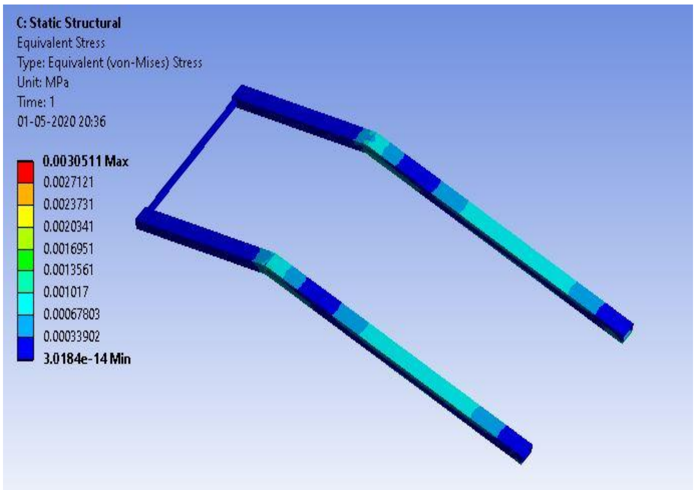

Fig -11: Equivalent Stress

Maximum value for Von-mises stress is 0.0030511 MPa

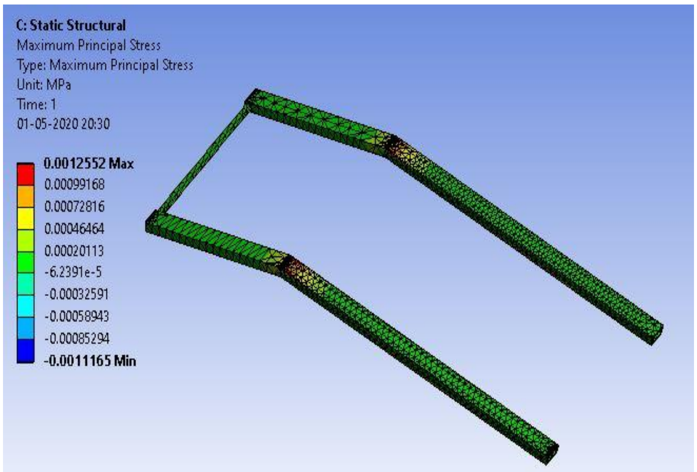

Fig -12: Maximum principal stress

Value for maximum principal stress is 0.0012552 MPa

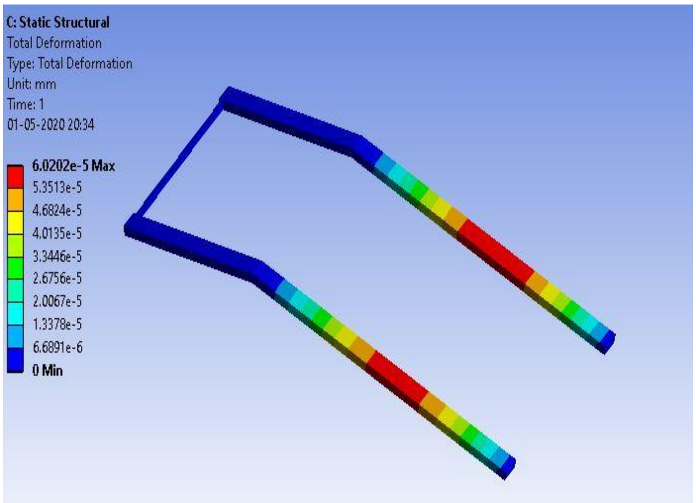

Fig -13: Total deformation

Maximum deformation obtained is 6.0202$\times 10^{-5}$ mm

6.2 Results

The results obtained from the structural analysis are tabulated in the table given below:

Table -1: Results obtained after static analysis

ANALYTICAL RESULTS		
SL.NO	PROPERTIES	VALUES
1	Load applied	1.308$\times 10^{-06}$ MPa
2	Maximum Equivalent Elastic Strain	4.5015$\times 10^{-8}$ mm/mm
3	Maximum Equivalent Stress	0.0030511 MPa
4	Maximum Principal Stress	0.0012552 MPa
5	Total Deformation	6.0202$\times 10^{-5}$ mm

The above results shows that the maximum deformation is 6.0202 x 10^{-5}mm, which is very small. So the design of the system is safe.

7. CONCLUSIONS

The structural analysis of the system is done, and it shows that the design of the ramp is safe and it can take the loads without much deformation. A simple and powerful ramp system is designed and the objectives of the work are realized. There is no complex mechanism to maintain a slant angle which is ensuring adequate ergonomics and comfort. Industrial application of rack and pinion is used to automate the system. By this work, we can ensure the easy movement of wheel chair into the train for differently abled

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