Design & Fabrication of Train Staircase for Easy Accessibility of passengers to achieve low level platform.

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ABSTRACT

Automatic Staircase Using Pneumatic Actuators & IR Sensors serves to automate the mechanism of Staircase operation using Pneumatic, controller and infrared sensor technology. The methodology applied in the project is divided into three parts, firstly designing and fabrication of the Staircase with the calculated dimensions, secondly, developing a controller for door operation and thirdly, interfacing the different components to work together in a cohesive manner to adjust the height of Staircase at each platform level. When a platform comes in or goes out of the range of the sensor, a signal is sent to the controller which controls the electro-pneumatic circuit to open or close the Staircase as per required height of steps. The significance of this system is automation of the Staircase which can be customized according to the use. Based on the results obtained an actual working prototype was designed and a suitable large scale will develop taking into account the platform height conditions.

Keyword: - Automatic staircase, platform height, Electro-Pneumatics Control, IR Proximity sensor, Train.

1. INTRODUCTION

Presently, Indian Railways (IR) AC 3-Tier Sleeper Coaches of ICF design to CSC-1722 have a floor height of 1320 mm from rail level and have a customized design of complete entraining/ detraining arrangement including door with fixing arrangement, footsteps and door handle compatible with platform of height 760mm to 840mm from rail level in such a way that passenger during entraining from platform to coach floor uses a vertically straight parallel foot-steps and similarly during detraining from coach floor to platform. The Challenge is design a mechanism of operation of a convenient method of train access from low level platforms in a failsafe mode. The innovations may particularly look at opportunities of easy retro-fitment and seamless integration in the current design of coaches serving different age groups and physical capabilities. The Challenge aims to encourage creation of innovative, easy to use designs and solution that can enable convenient access to all kinds of passengers (of diverse ages and special requirements) without infringing the current constraints of fixed infrastructure at the station and along the trackside.

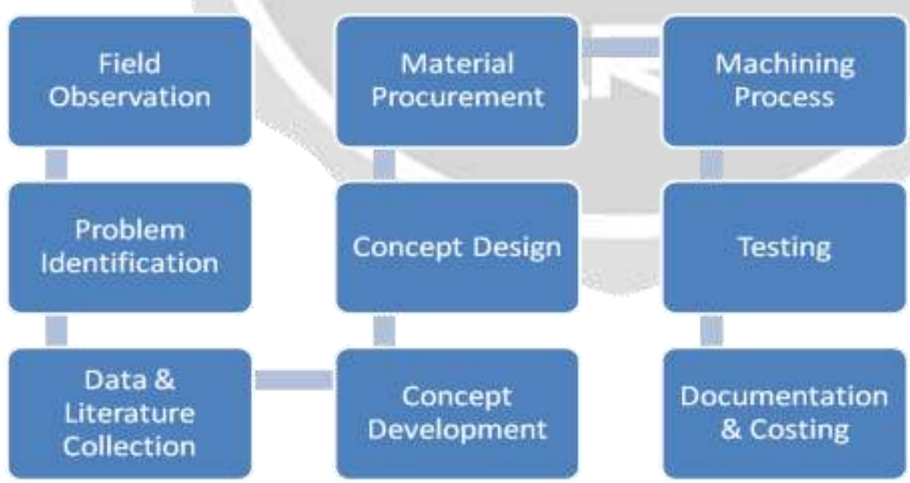
In places where there is a space restriction, a foldable stair can be used. In accordance with this, we have simulated a mechanism in which the unfolding and folding of the stair is due to the linear motion of the slider at one end. The effect of the change in length of connecting rod that converts linear motion to rotary motion is to be analyzed. The foldable stair mechanism consists of links arranged in vertical and horizontal manner that make up the stair like arrangement. These links are connected with each other using revolute joints. The crank in the crank and slider mechanism, which pulls the entire set of links up or down makes the stair like arrangement. This crank also acts like an input link for the four-bar mechanism. This folding and unfolding of the stair resemble the scissor like structure. The crank is connected to the connecting rod through a revolute joint, which moves due to the actuation of the slider. The slider moves linearly due to the translator motion exhibited by the linear actuator. The construction of the mechanism is as shown in Fig 1. Two sets of this planar mechanism are placed parallel to each other at an offset distance. The horizontal links in the two sets are connected together by using a bar over which the foot of the user is placed.

Locomotive is any type of self-propelled vehicle used by railroad to pull or push other type of rolling stock, including passengers, freight. An India is an extensive country. Now day’s railway playing a vital role in transport of freight and passengers. Trains are the veins of our country. Indian railway network is one of the largest railway networks in the world. Today the growth is phenomenal and the network have a route length of 62,458 Km, with 7116 station. It has fleet of 8268 locomotive 29,501 Coaches, 3291 Electronic multiple units & 3, 46,394 wagons. Today energy conservation is the need of every industry, transportation field. So we have taken challenge to make project in this Train field to support energy conservation system. Pneumatic systems form the most primitive and distinct class of mechanical control engineering. They are classified under the term 'Fluid Power Control', which describes any process or device that converts, transmits, distributes or controls power through the use of pressurized gas or liquid. In a pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical work in an appropriate controlled sequence using control valves and actuators. Pneumatic systems are well suited for the automation of a simple repetitive task. The working fluid is abundant in nature and hence the running and maintenance cost of these systems are exceptionally low. All fluids have the ability to translate and transfigure and hence pneumatic systems permit variety of power conversion with minimal mechanical hardware. Conversion of various combinations of motions like rotary-rotary, linear-rotary and linear-linear is possible. The simplicity in design, durability and compact size of pneumatic systems make them well suited for automobile applications.

1.1 Objectives:

To overcome this problem, mention above, we have to design the Automatic staircase System with electro-pneumatic control which has following objectives:
1) To increase the sureness of safety while walking down the train.
2) To reduce the chances of injuries & accidents in train travelling.
3) To performed the most rigid operation with high automatic height adjustable staircase. To improve the safety while passengers walk out from train at local villages stations where staircase height is not match with ground.
4) To adjustment staircase height with proper design & development of stairs.

2. METHODOLOGY



The methodology is divided in different parts, under different titles. The above flow chart shows the sequential operation/steps which are performed during the project process.

3. SYSTEM DEVELOPMENT

3.1 Pneumatic System Introduction

Pneumatic systems form the most primitive and distinct class of mechanical control engineering. They are classified under the term 'Fluid Power Control', which describes any process or device that converts, transmits, distributes or controls power through the use of pressurized gas or liquid. In a pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical work in an appropriate controlled sequence using control valves and actuators. Pneumatic systems are well suited for the automation of a simple repetitive task. The working fluid is abundant in nature and hence the running and maintenance cost of these systems are exceptionally low. All fluids have the ability to translate and transfigure and hence pneumatic systems permit variety of power conversion with minimal mechanical hardware.

The major components of the pneumatic systems are:
1. A compressor of appropriate capacity to meet the compressed air requirements.
2. A receiver to store the compressed air.
3. Air distribution lines to distribute the air to various components of the system.
4. Filter lubricator regulator (FLR) unit for conditioning of air and regulation of pressure.
5. Pneumatic control valves to regulate control & monitor the air energy.
6. Pneumatic actuators & Air driers.

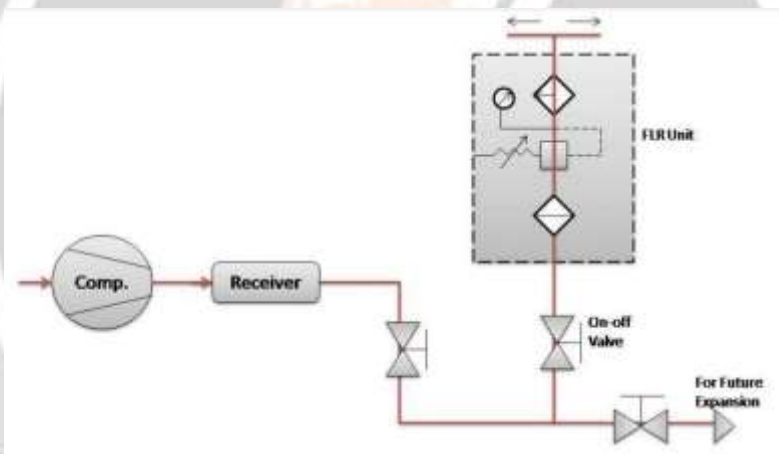


Fig -1: Basic Pneumatic System

3.2. Parts of Height Adjustable Train Staircase Mechanism:

1. Frame
2. Double Acting Cylinders
3. Pneumatic Pipe Fittings
4. Pneumatic Connectors, Reducer and Collector
5. Solenoid type 5/2 Direction Control Valve
6. Relay Board
7. IR Sensor

Fig -2: Actual Model & Parts of Staircase Mechanism

3.3. WORKING

This project consists of pneumatic control staircase system which is mounted on base end side of movable boogie platform on M.S. frame stand. A compressed air is supply through compressor using solenoid direction control valve DCV from remote air tank to double acting cylinder and automatic staircase adjust the particular required height with the application of IR sensor operation when it senses the particular height steps will stretch or contract as per required platform height. When it is required to operate the staircase system, we need to operate the solenoid direction control valve automatically with the application of sensor by 12 Volt batteries. The air is passes through direction control valve to actuate the staircase height. The boogie operated manually for giving motion for showing actual working as per different platform height. Here we use pneumatic double acting cylinder which having two ports for inlet and outlet of compressed air. Double acting cylinders are available in variety of sizes with low cost application in pneumatics.

4. DESIGN CALCULATIONS

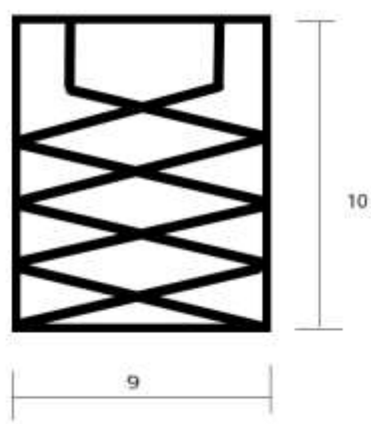


Fig -3: Scissor Mechanism

4.1. Material used and Their Properties:

The materials used in this project are detailed as follows

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

Carbon – 0.05% to 0.08%

Tensile strength – 420/550 MPA

Yield strength – 275/350 MPA

4.2. Double Acting Cylinder Design

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/mm^2.

Therefore, we selected 25mm diametric cylinder.

Let us we consider double acting cylinder Ø25X 50 (Diameter X Stroke)

If we increase the pressure of air as per formula pressure is directly proportional to the force.

Material of the cylinder is Aluminum.

Sut =Ultimate tensile strength = 200N/mm2

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

di = Inner diameter of cylinder =25mm

Consider,

Double acting cylinder Ø25X 50 (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/mm2,

μ = 0.29,

ri = 12.5mm.

t = 0.806 mm.

Available thickness t = 1 mm, Piston diameter= 25mm, Stroke diameter= 50mm, Piston rod diameter= 12mm.

Let, A= Force area of cross-section of piston.

A= 490.87 mm^2

Apr= Force area of cross-section of piston on rod side.
Apr= 377.776 mm^2

Piston force acting during forward stroke.
Fa = 490.87 N

Piston force acting during return stroke.
Fr = 377.776 N.

Time required to complete stroke is 2 second.
Linear velocity of piston V= 25mm/sec.

5. PROCESS SHEETS

5.1. PART NAME: Supporting Frame

SR.NO.	OPERATION	MACHINE	TOOL	TIME
1	Cutting the material as per our required size. 450mm x 800mm x 200mm.	Cutting machine	Cutting machine	30 min
2	Welding the frame as per required size.	Welding machine	Arc Welding tool	45 min
3	Drilling the plate as per our required size for bearing. 8 Nos. Ø10 mm. for plywood fittings	Drill machine	Drilling tool	20 min

5.2. PART NAME: Staircase

SR.NO.	OPERATION	MACHINE	TOOL	TIME
1	Cutting the M.S. plate material as per our required size. 200 mm X 300 mm X 5mm.	Cutting machine	Cutting machine	80 min
2	Drilling the plates as per required for bolting.	Drilling machine	Drilling machine	30 min
3	Welding the pipe to the M.S. Bar as per required size.	Welding machine	Arc Welding tool	25 min

Part weight – 5 kg

Part material – M.S.

Part quantity – 1

Part size – 200 mm X 300 mm X 5mm.

6. CONCLUSIONS

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institution and the industries.

We are proud that we have completed the work with the limited time successfully. The “DESIGN AND FABRICATION OF TRAIN STAIRCASE FOR EASY ACCESSIBILITY OF PASSENGERS TO ACHIEVE LOW LEVEL PLATFORM” system is working with satisfactory conditions. We were able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities. In conclusion of remarks of our project work, let us add a few more lines about our project work.

Thus we have developed an "HEIGHT ADJUSTABLE TRAIN STAIRCASE MECHANISM" which helps to achieve low level platform to the passengers. We have automated the mechanism using IR Sensor. This project reviews all the studies up to this date and hope our product will get optimum acceptance in the market. By using more techniques, they can be modified and developed according to the applications. In this we have used piston-cylinders and pneumatic control with required specifications. But if we want to develop actual model of stairs that is to be used in the train, we can use the piston-cylinders and hydraulic or pneumatic controls with higher stroke and capacity to increase the efficiency of the system.

7. ACKNOWLEDGEMENT

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