Design and development of multi drop auto-walk

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Abstract. At present environment, especially in the urban cities, peoples are very busy and moving continuously and rapidly. With the advancement in technologies, there is a huge opportunity to full fill this people flow experience. Autowalk which is also called as walkalator or movelator is a device used as a mode for transporting the peoples horizontally or laterally from one point to another. The proposed device consists of a pulley with belt arrangement or can be a pallet type of arrangement which is being driven by a motor. Autowalk available in the market today can only transport the people from one point to another, however, for the place where people has to move in a wide spread direction, rather than the point to point there is a need for some devices or some modifications in the existing setup to satisfy those needs. In this multidrop autowalk the people flow traffic is optimized by providing the sub-platform which moves simultaneously along with the main lane. This multidrop autowalk can be widely used in departmental stores, airports, shopping malls, theme park, exhibitions, etc.

1. Introduction

The world population is getting increased day by day. People keep on moving from place to place all over the world, especially in urban cities where people keep moving very often, especially for jobs, education, medical treatment, modern life, entertainment and etc. When we talk about the modern facilities particularly the urban cities where the target area where they are widely populated and the people flow is rapid. Though various modes of transportation are available in our day to day life, still they are not sufficient enough to meet the people need. In busy environment and busy lifestyle they want to move quickly. Transports like car, bus, train and flight people can use for a longer distance. People flow within a short distance we have auxiliary equipment’s like battery cars, elevators, escalators, mini autos, auto moving car and etc. Due to urbanization and growing population mega structures are required to transport a person’s one place to another place within railway station, airport and bus stand. Those internal movements include both horizontal and vertical moment. To meet these requirements our market has currently has the following products Elevator - For vertical movement to carry people from top to bottom with intermediate stops at each landings. Escalator - For vertical movement, however, this is used to carry people in a continuous manner with the incline runway
Moving walk - For horizontal movement which is used to carry the people in a continuous manner from one end to another without any intermediate stop. Amsterdam Airport Terminal is one of the biggest airport in the World more than 46.1 million peoples using this airport transportation per year. In 2025 expected this rate will increase to 85 million peoples. In order to overcome traffic several moving walks introduced, however the people were using the pedestal, walk still match with the average quantity of people using this moving walk. The main reason is the time consumption and the use of moving walk only for a short distance, so to overcome such situation automated moving walkway were introduced where theses auto walk was accelerated with the high speed to move the passengers very fast from different locations in a timely manner. Accelerated moving walk was built with metal conveyor or a sliding metal pallet, that continuously move the passenger by accelerating from a low speed at the entrance to the high speed of the middle and again decelerating the speed at the exit. Acceleration and deceleration are achieved by implementing various mechanisms to vary the speed. 

Basic Principle behind this automated, accelerated moving what is the belt conveyor system such as inline accelerating belts, sliding parallelograms, sliding pallets and accelerating/decelerating rollers with a high-speed belt [1]. Based on its history and development, the chain is a mechanical belt running over sprockets that can be used to transmit power from one point to another point. Chain strips are machine elements that are subjected to extreme service conditions such as high tensile loads, frictions etc. Influence of manufacturing process parameters of chain governed [2]. The modern trend and gap in each class of the problem were discussed and forthcoming guidelines in terms of both modeling and solution approaches are given to Urban Transportation Network Design Problem (UTNDP), which includes both the Road Network Design Problem (RNDP) and the Public Transit Network Design Problem (PTNDP). Provided a bigger picture of transportation network design problems, allow comparisons of formulation approaches and solution methods of different problems in various classes of UTNDP, and encourage cross fertilization between the RNDP and PTNDP research [3, 8]. Corridors with and without moving walkways, the most common of airport automated pedestrian movement systems, are erected. Pedestrian movements in various airport terminal corridors are empirically observed, and observed walking speeds are compared with those of research performed in other transportation terminals. Furthermore, the effects on walking speeds of observable characteristics of pedestrians and the surrounding environment are investigated. The effect of moving walkways on pedestrian walking speeds and estimating the travel time of pedestrians on moving walkways under various traffic-flow conditions is derived. Application of the methodology using empirically collected data reveals interesting results about the movement of pedestrians through corridors with moving walkways. The analysis presented may be used to estimate expected travel times in airport corridors, and to examine the effects of potential infrastructure investments on such times. The goal of such an analysis is to improve the quality of service at the airport terminal, particularly for the pedestrians who traverse its corridors [4, 9]. In the Indian railway structure for physically challenged persons and aged citizens are use trams and flyovers to cross the railway platforms they are feel very difficult. To overcome this problem, a programmed mobile platform was proposed. The multipurpose Platform is combined in the middle of the railway tracks in the side of the intersection Platform. At the point when there is no train landing in the station, the multipurpose Platform will be opened and consequently moving like lift. The physically challenged people will utilize the moving Platform to pass the intersection Platforms. At the time of train is arriving, moving Platforms will be shut. The train entry sign will be declared in a voice framework and demonstrated by LED signal. This framework gives a superior answer for exchanging of physically challenged people
in one Platform to another Platform without utilizing fly overs and metros [5, 10]. In a developing State, mixed flow of the Ahmadabad urban road traffic is most obvious characteristic at pedestrian crossing where conflicts between the pedestrians and motor vehicle occur frequently. The adequacy of pedestrian facilities, pedestrian surveys is were done and also check the Level of service of the existing pedestrian facilities are evaluated for the existing condition as per the guideline of HCM 2000 and guidelines of pedestrian facility IRC 103:2012 and suggestion is given with design required for the pedestrian skywalk. There are a number of places in Ahmadabad which is suffering from heavy traffic. In “Kalupur Railway Station” was focused which is facing the problems. Hence providing a skywalk movement will be smooth, safely and have comfortable journey for the pedestrian [6, 7]. In Indian railway junctions, Howrah Junction a biggest one, it consists of 23 platforms and 26 racks, located on the west bank of the Hooghly River Kolkata which serves more than 1 million passengers per year. It has largest and busiest platforms in India. Trains from different location of the country will start or stop at different platform terminals. Busy urban life creates a need for better mode of transportation which saves time and physical strain for them. Technology solutions offered by the current market is not feasible to solve the people transportation on the over bridge platform. Current auto walk working provide only the transportation from one point to another, with actual scenario there is a requirement for multiple stops for the passengers to get down to the intermediate platforms. However providing separate auto walk device for each and every intermediate platform is not feasible solution also this is one of the complicated arrangements which consume lot of energy and cost is more. About 50% to 60% of people using railways are of aged category and physically challenged people, walking such as long distance between platforms is very difficult which again drives a need for an alternative solution.

2. Methodology

Aim of this work is to provide the passengers multiple stops for getting down at different platforms. It can be achieved by introducing a sub system along with the main system. Here the main system will provide the people movement form end to another the sub system will provide the way to down in between the platform. Below layout will give the idea for basic concept behind multi drop auto walk. The subsystem will move along with the main system. However the subsystem is not going to get operated independently rather it will move simultaneously along with the main system the speed, direction and the movement will be similar to the main system. This can be achieved by using common system for a couple to system for both main system and sub system shown in figure1

![Figure 1. Autowalk Layout](image-url)
This is similar to the passengers travelling in moving flight, moving bus and moving train where the passengers can walk inside even the vehicle is in moving state. Similarly the passenger can walk on the conventional auto walk. Passengers can take a cross from main system to the subsystem or vice versa. Thus auto can provide the way for passengers to get down at different locations. Based on the literature survey alternative solution were obtained the chain type arrangement is good with power consumption, smooth in operation and better pulling capacity. Hence chain drive system is suitable for auto walk. In this chain drive system instead roller chain slated chain with an L-strap attached were used, it couple the two path ways as well as transmit power from shaft to pathway. In order to maintain the stiffness in the space where the passenger will stand plates were used. These plates are attached with L-strap of the chain by means of bolt as shown in Figure 2. Main drive system will have a chain arrangement running continuously from one end to the other end. The sub system will provide an intermediate support. However they are made to touch/roll over the sprockets attached to the intermediate shaft provided between the driver and driven shaft. The power is transmitted from this main system to the subsystem by means of rotating shaft with bracket.

![Figure 2. L strap chain with plate](image)

3. Parameters calculations

Let us assume the following inputs

- Capacity – 120 persons travelling over the auto walk @ a time.
- Total Distance – 75m.
- Velocity - 0.75m/s

Total Load = number of passenger x weight of single passenger x FOS
= 120 x 75 x 1.75
= 15750 ~ 16000 Kg.

Force to be transmitted = Mass x Acceleration due to gravity
= 16000 x 9.81
= 156 KN.

Power = (Force x Velocity) / 1000
= (156 x 0.75) / 1000
= 80 KW

Assume number of teeth $Z_1=Z_2=10$
Similarly speed ratio $N_1=N_2=1$

Pitch = 200 mm [from the TSUBAKI catalog]

Total load acing on the drive $P_T = P_t + P_C + P_S$

Tangential force $P_t = (1020 \times \text{Power})/\text{Velocity}$
= $(1020 \times 80)/0.75$
Centrifugal Tension $P_C = \text{Mass of chain} \times \text{Velocity}^2$

$= 21.64 \times 0.75^2 \ \{\text{mass of chain from std. catalog}\}$

$= 12N$

Tension due to sagging $P_s = k \times w \times a$

$= 6 \times 21.64 \times 9.81 \times 0.75 \ \{w = ma, \ k=6\}$

$= 95529.7 N$

Total load acting on the drive $P_T = 108.8 + 12 + 95529.7$

$= 204341 N$

Design load $= k_s \times P_T$

$k_s = k_1 \times k_2 \times k_3 \times k_4 \times k_5 \times k_6$

where,

Load factor $k_1 = 1.25$ (for variable load with mild shock)

Factor for distance regulation $k_2 = 1.25$ (fixed center distance)

Factor for sprocket center distance $k_3 = 1.25$ (based on pitch)

Factor for sprocket position $k_4 = 1$ (horizontal position)

Lubrication factor $k_5 = 1.5$ (Periodic)

Rating factor $k_6 = 1.5$ (Continuous running)

therefore $k_s = 1.25 \times 1.25 \times 1.25 \times 1 \times 1.5 \times 1.5$

$= 4.39$

Design load $= 4.39 \times 204341$

$= 897 KN$

Induced stress ($\sigma$) $= (P_t \times k_s)/A$

$= (108800 \times 4.39)/21.64$

$= 22071 \text{ N/mm}^2$

Length of the chain

Number of links $I_p = 2a_p + \{(z_1+z_2)/2\} + \{(z_2-z_1)/6.28\} / a_p$

Where,

$a_p = \text{Center distance} / \text{Pitch}$

$= 75000/200$

$= 375$

$I_p = [375 \times 2] + 10$

$= 760 \text{ links}$

Length of chain $= 760 \times 200$

$= 152000mm$

Smaller diameter of the sprocket $d_i = \text{pitch} / \{\sin(180/z_1)\}$

$= 200/\{\sin(180/10)\}$

$= 647mm$

Outer diameter of the sprocket $d_o = 691mm$

Shaft diameter $= 80mm \ \{\text{form the manufactures catalog}\}$

Let us assume the plate thickness as 10mm

Plate area $= 0.4 \times 1.2 = 0.48m^2$

therefore weight of the plate $= 38kg$
Number of plates = Number of links/2
= 760/2
= 380

Total weight of the plate = 380 x 38 = 14440kg
Gross weight = 14440 + 16000
= 30440 kg

Stress induced \( (\sigma) \) = length / area
= 30440/180
= 165N/mm² < 440N/mm² form the manufacturers catalog.

So design is safe.

4. Main Components of Auto-walk

4.1 Frame/Truss

Generally frame is made up of concrete structure or steel welded or bolted to form a big structure shown in Figure 3. Designing of frame is critical criteria because of weight of the equipment is more and entire loaded acted over the frame.

![Figure 3. Frame Structure](image)

4.2 Chain

Generally while selecting the chain and sprocket assembly we will be looking into the durability of the component as they are going to run continuously over a period of time. As the time increases the material may get wear. So by using the material specification for the conveyor chain this can be solved. In this work were used chain and sprocket from TSUBAKI shown in figure 4. Reason behind the choosing of manufacturer is to choose the chain specification for our design. Chain plate carrying the cantilever support is also of different type by its size Number of links in the chain can be calculated based on the travel length of the platform.

![Figure 4. Slated Chain](image)

4.3 Skirting

When the passenger is entering into the auto walk, there will be a gap between the stationary platform and the moving walk, we cannot keep this gap as open as it is risky to leave as open. So we have to fill
the gap. At the same time the arrangement will have a step like setup will not be comfortable. So we are going to keep a component known as skirting shown in Figure 5 similar to the one available conventional escalator.

![Figure 5. Skirting](image)

5. Comparison between auto walk and Multi drop auto walk

Table 1. Comparison of autowalk and Multi drop auto walk

| S.No | Auto walk | Multi-drop Auto walk |
|------|-----------|---------------------|
| 1. | Only point to point transportation is possible | Passengers can take a drop at intermediate locations too |
| 2. | Number of passengers traveling at a time is less | Number of passengers traveling at a time is more comparatively, as it has a wide spread space for carrying the passenger. |
| 3. | Design is complicated, more difficulty in installation | Simple design, easy to install |
| 4. | Restricted to the modification in its specification | Flexible design, we can design the components based on the application where we going to use. |
| 5. | Cost is more, as it has many components & complicated robust design | Cost effective - Components proposed in this design is simple as similar to the conveyor model. |
| 6. | Weight of the device is less, as it use composites for steps & rollers | Weight is more due to slat chain & plate assembly. |

6. Conclusions

In this work mainly concentrated on developing a solution for the transportation on go over bridge in railway station and successfully designed and developed a prototype model of multi drop auto system where the passengers can get down at the intermediate stops to take over there trains in different platforms of the railway station. Install these types of devices in busy areas the people flow we can achieved a quick, sale & comfortable transportation for the people in a mega structures like airport, bus stand, railway station, museums etc. Consider a scenario where the technology solution seems to be mandatory for use like handicapped person need to take the train from one of the intermediate platform. so as he enters the railway station, he can either use the battery car if the distance from platform to escalator or elevator is more or he can use the lift/escalator immediately to reach the top of the over bridge. Immediately he can step into the multi drop off and get down near the entry of respective platform again from top of bridge he can take the escalator to reach down to the platform. Thus the modern technologies provide a comfort solution in transportation. No doubt the development and advancement in technology and the simultaneous growth in people modern lifestyle
always give a way for a demand in solution for a better lifestyle. And this attempt will give be a mark on development path meeting such need.

7. Reference

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