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"Movable pathway"

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Abstract:Transportation in metropolitan and cosmopolitan cities is becoming more and more inconvenient and cumbersome to the public both, as well as to the authorities due to heavy traffic especially in congested areas during peak hours which ultimately results in pollution of air as well as noise. Pedestrians at these areas are facing several problems henceforth to overcome these problems, an automated moving walkway is proposed in place of ordinary footpaths. Until now moving walkways were employed at limited places like airports, metro stations, theme parks at which are mainly indoor applications. The proposed moving walkway moves at a constant speed in all operating conditions. A series of AC caged induction motors with frequency modulation control is developed for the drive system. The entire system operates as a closed loop by collecting feedback from sensors and regenerative drive systems for better operation and reduced power consumption. The proposed system is scaled and developed as a CAD model in CATIA V5 R18 by considering an existing walkway specification. The drive characteristics and simulations of the walkway are deployed and analysed using MATLAB SIMULINK.

Keywords. The Transportation System, Accelerating Speeds, Moving Walkway, Public Drive Simulation

1. INTRODUCTION

In recent times many countries across the globe were experiencing rapid growth in their smart cities and metropolitan places due to which a surge of people has been shifting to these areas for improving their living standards. This resulted in the drastic utilization of infrastructural resources between the habitants in the city exceeding its normal utilization limits. The usage of own, public, private transportation is a common sight in every city which increases congestion and pollution. It also affects the pedestrians in these areas as it is very difficult and tiresome for them to travel on footpaths beside the vehicular traffic. Usage of private vehicles like cars and motorbikes has become more common in India as the increasing sales of the light automobiles in the recent academic years explains it. Many people tend to use own vehicles instead of public transportation due to several reasons [7].

In India all state road transportation services in metro cities are crowded and many of the users feel uncomfortable due to low standards and maintenance. On the other hand, local and metro trains are loaded beyond the maximum capacity, Mumbai local trains are one of the major examples for the congestion problems in metropolitan areas. Metro trains are only permitted to the major four metro cities and for the remaining cities, it is still in planning condition. To develop a new transportation system, one need to demolish some of the major landmarks in existing cities which are not appropriate, as they are the symbols for the historic and cultural heritage of ancient India. So, planners need to keep in view that the new transportation system should not disturb the existing infrastructure and it should be installed within the existing conditions.

MOVING WALKWAY

Majority of moving walkways uses either a belt or a chain of metal pallets as a moving platform. The moving platform is selected based on the operator's choice. They are also classified based on their angle of inclination as horizontal moving walkways or inclined moving walkways. Another classification involves the position of drive systems like a head driven system or tail driven system. Since the existing moving walkways use a high capacity motor drive. Belt type moving walkways excels inefficient ways when compared with metal pallet walkways by means of smooth, noiseless operation along with compactness and stability.[2][6] Whereas a metal pallet system is slightly noisier and requires more recirculating space underneath the walkway surface. On the other and the metal pallet system is more rigid and tough and can withstand extreme loading capacities.

As walkways are derived from industrial conveyors during the initial days moving walkways are only made up of rubber belt moving surface which tends to be economical. Reduction gearbox with helical gears is widely accepted for all kinds of moving walkway applications as it consumes less power during start-up when compared with normal gear drives.

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Figure 1. (a) Belt type moving walkway in Delhi Airport, (b) Pallet type moving walkway at Toronto Airport (Figure (a) courtesy of Somnath Mahendra, Figure (b) courtesy of ThyssenKrupp Elevator AG) [1]

With helical gear drives existing walkway designers are able to achieve a highly varied reduction ratio by which they can obtain the rated operation speed for the system. With the help of on-board computers which are typically microprocessors that are specialized in moving walkway applications walkways are comprising a variety of features for users. [5] The on-board computer monitors and control the whole drive system, electronics such as led indicators, announcements for users. All these assisting features for users are mandatory for any moving walkway as per moving walkway standards given by European association (EU). Every manufacturer needs to maintain the required standards prescribed by corresponding authority.

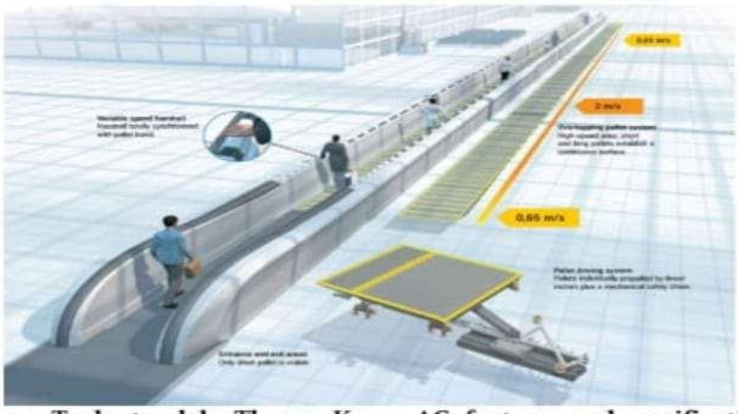

Figure 2. Turbo track by ThyssenKrupp AG, features and specifications (courtesy of ThyssenKrupp Elevator AG)

With the development of the variable speed moving walkways, it is possible to attain the average speed of typical city buses so that they can be applied as a potential transportation system [10]. All the major manufacturers are developing their walkway systems with this new technology. There are also a large number of escalator and elevator company. It is capable of attaining a maximum operating speed of 17kmph which is the highest speed achieved by any moving walkway. Figure2 illustrates the Turbo track features and specifications. It uses a series of linear motors connected with pallets which tend to move on guided rails throughout the moving platform [11] [12].

At the accelerating zone, pallets come closer and at the high-speed section, they move farther allowing for increasing speed. The same operation repeats at the decelerating zone or exit section, this is a pure instance of a linear motor and links application.

PROPOSED MOVING WALKWAY

In this aspect with the dimensions developed with the existing walkway, a CAD Model has developed in CATIA V5 R20 which shows all the components as shown in figure 3 where it is developed with reference from XY, YZ, and ZX axis simultaneously. Individual parts have been developed separately and assembled in assembly module which shows a fine model

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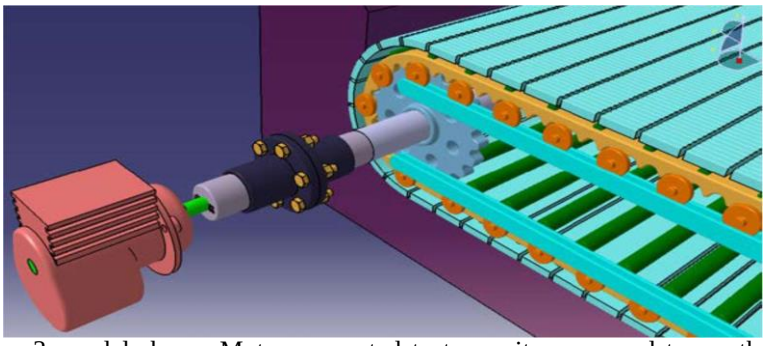
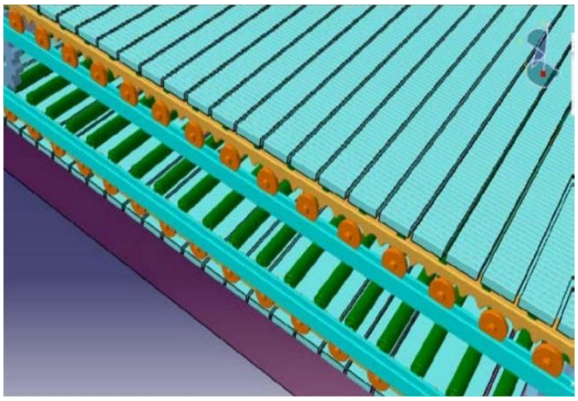


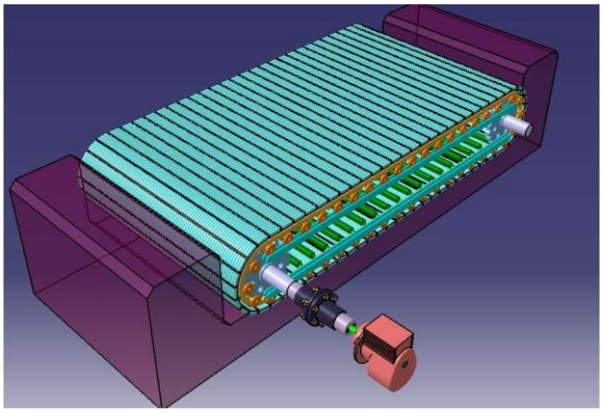
Figure 3. model shown Motor connected to transmit power and to run the pallets

Predominantly as discussed from the figure3 it is observed that a motor has been designed in such a way that it is connected to shaft followed by couplings and a chain-link mechanism have to adjust to run up the show positively. The perimeter of the motor wheel is attached with the track connected by a group of rollers as determined.

Each individual pallet is connected to track which are connected to rollers as it started to move forward direction chain support will attain to load in the positive direction and move in forwarding direction initially it is at deaccelerating zone, once the travellers got inked to the system it leads to accelerating zone or high-speed zone. Later when the passengers need to step down the system is switched to deaccelerating zone again [15]. Figure 4 shows the path of the plane how the passengers are moving from one place to another.

The proposed system is fixed in the underground where only the pallet paths are on the surface means that the control part of the system is done in the background as shown in figure 5 and it describes that the overall view of the accelerating moving walkway. One end is connected with motor and another end is connected with a supported shaft where the power transmission takes place from one end to another end.





DRIVE SYSTEM

Majority of the existing moving walkways uses either a single drive head driven system or a single drive tail driven system. A typical moving walkway uses a high capacity AC induction motor.Theoretically, the peak efficiency of an induction motor occurs at 90% load and significantly drops at 25% to 30% of motor load. On continuous operation, a single drive system is very often prone to a huge amount of heat dissipation which results in the decrease of system efficiency.There are different types of electric drives existing, among them the induction motor proved its reliability and easy maintenance. It has a wide scope in industrial and domestic applications [3][4]. A typical induction motor is an AC powered machine and also called an asynchronous machine as it cannot operate at synchronous speed due to slip. It consists of either a slotted rotor or a caged rotor, among caged Squirrel cage is the wide accepting design. Working principle of induction motor is on supplying of power the stator slots get short-circuited inducing an EMF into the rotor which results in the rotation. Slip of an induction motor depends on the number of poles in the stator, so if a motor has low slip then it can be neglected and can say that the motor is operating at synchronous speed and because of that the induction motor is also called as AC synchronous machine.

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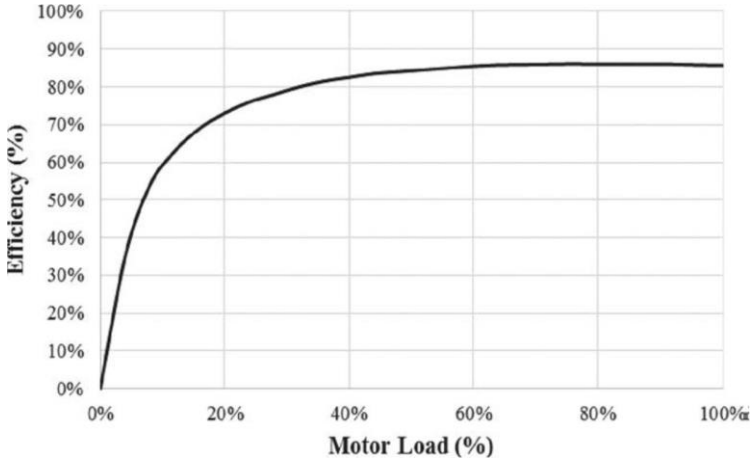
The main reason behind the usage of a multidrive system with a group of low capacity motors instead of a single drive system with high capacity motor is the efficiency curve of the induction motor. By the curve (fig 6) one can observe that the maximum efficiency of the motor is observed at 80% of motor load. A high capacity system needs to be operated at the rated load which is not always possible for a moving walkway and if not operated at rated load the efficiency of the motor decreases. To overcome this situation instead of a high capacity drive group of low capacity motors can be operated at rated loading condition very easily which ultimately maximises the efficiency of the system



CONTROL SYSTEM

Control system plays a significant role in any moving walkway system. A typical single drive moving walkway system. A typical single drive moving walkway system simply operated by a VVVF drive (variable voltage and variable frequency drive) and the whole control operations are monitored by a specially designed microprocessor [8]. As the system uses multiple drives there is a need for the robust control system and highly sophisticated algorithms for power consumption by each motor. All the motor drives are operated with vector control drives; they are also capable of monitoring individual motors power consumption so that they work efficiently under all conditions. To produce constant speed under all loading conditions PID control strategy is used and the gain value is responsible for operating the drive to produce required torque with respect to required speed [9]. There is a provision for different control techniques to use in this application and in our future work we will deal with them. During start-up the whole system requires more power until the drives attain synchronous speed, for this soft starting technique is used otherwise the whole drives may get damaged.

The PWM inverter, soft starter, vector controller for a drive each one of them is controlled by using a specialized microprocessor. The same control strategy is used for controlling all of these. The system also has hibernated function which can operate the system at minimum speed when the system detects no passenger flow continuously for a period of 5 minutes in order to save electricity. It mainly depends on tread way width which is officially the width of the moving walkway, the speed with which it needs to be operated. As all these values are known the theoretical capacity of the moving walkway will be calculated as the following[1] C_t The proposed walkway width is 1m, so K value is 2. By these parameters, the theoretical capacity of the proposed moving walkway

is 13500 p/h/d. Theoretical capacities are way higher than practical capacities since it mainly depends on the Tredway of the moving walkway at its entrance. Practically there is no constant flow of passengers with respect to time as during peak hours the loading is more and during normal times it may be less than the normal capacity. According to this, users may not be loaded as we estimated like 5 persons per 1 m= V * 3600 * (K / 0.4) [1] Where V is nominal speed (m/s) K is a factor related to a nominal width of Tread way, Z K value is taken as 2^{2} which is way higher and may not be happened in practical situations. Sometimes passengers may tend to walk instead of standing on the moving platform which results in non-uniform loading over the moving walkway that affects the efficiency of the system. To observe the behaviour, structural rigidity and drive performance of the system software models are developed with and simulated.

CONCLUSION

The proposed multidrive moving walkway system is analysed for both structural rigidity and drive performance characteristics using the required parameters. Both the analysis has shown the optimum result. To decrease congestion in cities this, type of continuous transportation system need to be installed because of its eco- friendly, noiseless and pollution-less operation. It also integrates with all existing modes of transport. A network of this multi-drive moving walkways will have the potential to be a new public transportation system in metropolitan commutes.

Differently-abled people can travel with ease through this new continuous transportation system. Our further work includes the development of a prototype for this multidrive moving walkway in-order to understand the real-time application of the system. To analyse the real behaviour of the drive characteristics like overheating, the lifetime of the drive and its components under constant loading a prototype of the multidrive moving walkway that resembles the real system is to be developed. As all the simulated results are promising as a possible working system, developing a working prototype can pave a way for further enhancement of this new- age public transportation system.

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