DEVELOPMENT OF PASSENGER SAFETY BOARD FOR RAILWAY VEHICLE USE

Hyung-Suk Mun* , Ki-Young Eum*, Dong-Hoe Koo**

ABSTRACT

본 논문은 철도차량의 출입문과 역사의 플랫홈 사이에서 승객의 승하차시에 발생할 수 있는 안전사고를 방지하기 위한 안전발판장치에 관한 것으로서, 특히 출입문의 개폐작동에 따라 연동하여 작동되는 안전발판을 구비하는 것에 의해 별도의 동력과 제어장치를 필요로 하지 않음은 물론, 오작동 없이 정확하게 동작되도록 한 철도차량의 안전발판장치에 관한 것이다.

일반적으로, 지하철 역사의 플랫홈과 철도차량 간에는 열차의 원활한 안전주행을 위해 일정한 간격(이하 "연단간격"이라 함)이 유지된다. 이러한 연단간격은 가능한 한 좁게 형성되도록 구축되는 것이 바람직하나 그러기 위해서는 역사를 직선으로 건설해야 하지만, 통상 지하철은 도심의 인구집중지역의 기존 대로를 따라 노선이 결정되어 공사가 이루어지므로 도시가스배관, 도로주변의 고층대형건물, 기존도로의 형상 및 지하수와 같은 여러 가지 조건에 의해 많은 역사들이 곡선부분을 포함하여 건설될 수밖에 없다.

이 때문에, 철도차량과 플랫홈 간의 연단간격이 크게 벌어지는 구간이 형성되어 짧은 정차시간에 많은 사람들이 승하차하면서 연단간격으로 승객의 발이 빠지는 등의 안전사고가 빈번히 발생하고 있다. 이와 같이, 연단간격이 커짐에 따른 사고발생을 줄이기 위하여 연단간격이 큰 부분에 경고등을 설치하거나 경보음을 발생시키는 방법을 사용하였다. 이러한 경보장치는 차량이 지정된 궤도로 진입하면, 경고등에서 빛을 발산하여 차량과 플랫홈 사이의 공간에 대한 위험성을 승객에게 주의시키면서 경보나 안내방송이 나오게 하고, 차량이 역사를 출발하여 궤도를 지나면 그 작동이 멈추는 장치이다. 그러나, 이러한 경보장치는 위험성을 승객에게 알려 승객 스스로가 위험에 대처하도록 하는 주의정보제공의 기능만을 가지는 장치로서, 바쁜 출퇴근 시간이나 혼잡한 상황에서는 만족할 만한 효과를 기대하기 어려웠고, 특히 위험 대처능력이 떨어지는 어린아이나 노약자에게는 위험성이 그대로 상존하는 문제점이 있었다. 이와 같은 문제점으로 인하여 경전철이 있는 나라에서는 경전철용 차량에 승객이 안전하게 승하차할 수 있도록 계단식 발판을 설치하는 차량용 발판이 제공되어 있으나, 국내 지하철에 적용하기에는 차체 및 역사의 구조상 불가능하였다. 차량의 바닥이 플랫홈과 거의 동일 레벨상에 위치하므로 안전발판이 차량의 바닥과 수평이 되도록 작동되어야 하고, 차량에 있어서도 스테인레스 차량인 경우 사이드 빔(Side beam), 알루미늄 차량인 경우 솔바(Sole bar)에 구멍을 뚫으면 전체적인 차체의 강도 및 구조상의 문제가 발생되기 때문이다.

본 논문에서 이전에 개발된 국내외 안전발판장치를 소개하고 연단간격과, 차량 플랫홈의 높이의 차이에서 발생하는 문제를 함께 해결하는 안전발판장치를 해결책으로 제시하고자 한다.

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ABSTRACT

There are a lot of curved subway stations in Seoul metropolitan area. These must be straightly constructed as many as possible. But some of stations are roundly designed and built in order to avoid pre-existed underground obstacle such as basement of high rise building, underground gas or water pipe line and subway stations from another line.

As shown fig 1, one of the biggest problem occurring curved subway station is considered large gap between platform and vehicle when vehicle completely stop at the station.

The gap potentially is in existence to subway passenger as very dangerous factors in rush hours. If passenger accidentally drop their food or leg between this gap when they get on the train and train leaves station, the passenger will be seriously injured by vehicle.

In this paper, various design and instruments are introduced and best solution for this matter will be presented.

In order to eliminate any possibility of accident happened gap between platform and vehicle, KRRI(Korea Railroad Research Institute) have been developed new safety instrument. These technologies were applied for patent by KRRI. These mechanisms will provide confidence as well as safety to Korean subway passenger

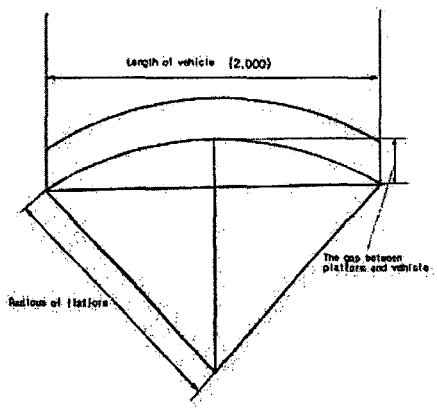

Fig 1 Calculation of maximum gap distance between platform and vehicle in curved station

INTRODUCTION OF NORMAL OPERATION FOR PASSENGER SAFETY BOARD IN SUBWAY STATION

Normal passenger safety board can be operated following steps. Train arrives at the station and safety board is operated to cover the gap between platform and vehicle. Then vehicle door opened.

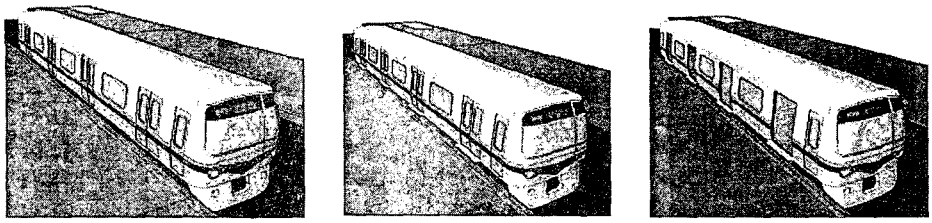

Fig-2 simple operational process of passenger safety board

INTRODUCTION OF TRADITIONAL TECHNOLOGIES TO PROTECT PASSENGER

In fig-3 and 4 automatic steps previously developed from foreign countries are introduced. It is designed to provide step for railway passenger to easily get on the train. This mechanism has been applied conventional train than subway vehicle.

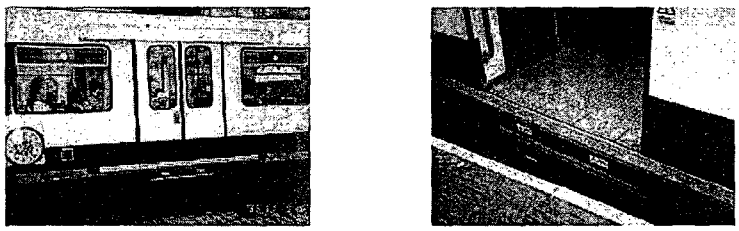

Fig-3 Automatic step for LRT (Light Rail Transit)

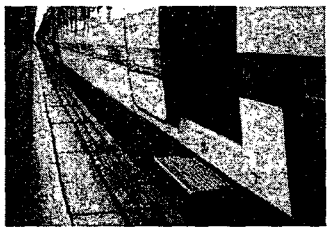

Fig-4 Automatic passenger step for conventional train

INTRODUCTION OF RAMP FOR HANDICAPPED PASSENGER

In Fig-5 ramp for handicapped passenger is also shown. it is designed only for handicapped passenger to provide lamp.

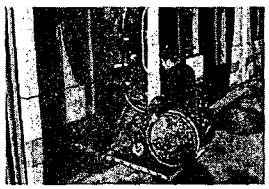

Fig-5 Handicapped passenger ramp for urban transit

INTRODUCTION OF JAPANESE TECHNOLOGY FOR PASSENGER SAFETY (PLATFORM EDGE GAP FILLER)

It is installed along portion of train platform where there are large gaps between the vehicle and platform. But it is hard to apply all the railway station and position of door stop at the station due to the heavy budget to installation as well as very complicate operational process with independent power unit and self-control system.

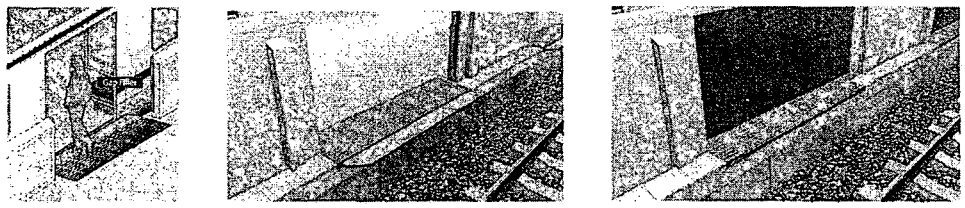

Fig-6 Platform edge gap filler

ALTERING LIGHT

This is very passive passenger protecting solution. But it has been applied in Seoul subway station. It is installed under the platform and front of vehicle door. It provides flashing light to passenger to ask more special attention when they got on or get off train to avoid drop their food or legs into the gab.

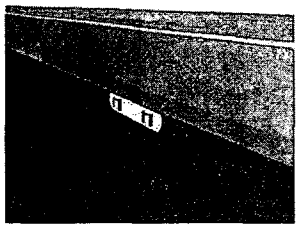

Fig-7 Altering light

SAFETY BOARD OPERATED BY MAGNETIC FORCE

One of Korean amateur inventors designed this mechanism. Main advantage of this design is application of magnetic force to safety board operation.

It is possible to operate without any power source such as electric motor. There are two type magnets installed between vehicle and safety board. Negative(3N) and positive magnet(3S) can be attached vehicle as shown Fig-8. On the contrary, positive magnet(3N) will be jointed safety board side(2). As shown Fig-9 and Fig-10, safety board easily slides forward and backward with roller bearing. When train arrives at the station and stops its programmed position. The safety boars are moved forward to vehicle side and cover the gab between platform and vehicle by

magnetic force. When the train moves to leave station the following installed magnet(3N) next to magnet(3S) will push back safety board(3N). But it still has several difficulties to apply subway station.

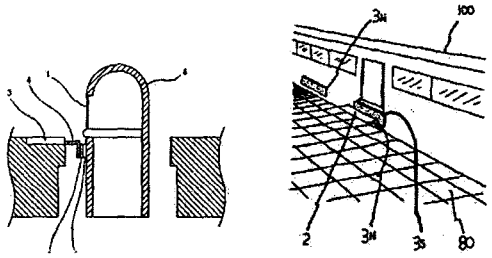

Fig-8 Functioning drawing of safety board operated magnetic force

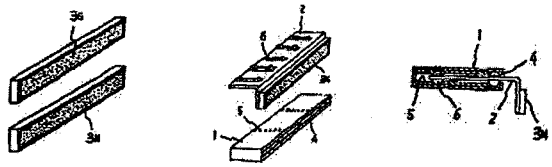

Fig-9 drawings of safety board with roller bearing

SAFETY BOARD OPERATED BY CHAIN MECHANISM

Safety board with chain mechanism is developed by KRRI (Korea Railroad Research Institute). It is installed on vehicle under the sliding door. Hydraulic power is located under the car body. The safety board is unfolded or folded itself to cover gap by vertical motion of hydraulic power.

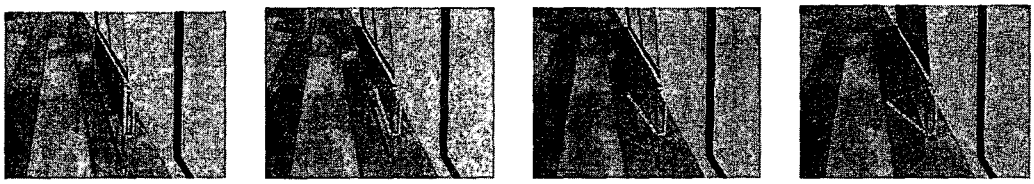

Fig-10 Functioning drawings of safety board operated by chain mechanism

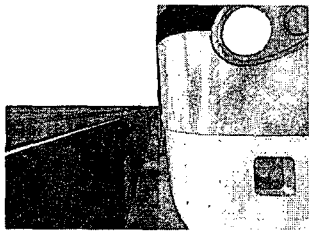

Fig-11 front view of vehicle installed safety board

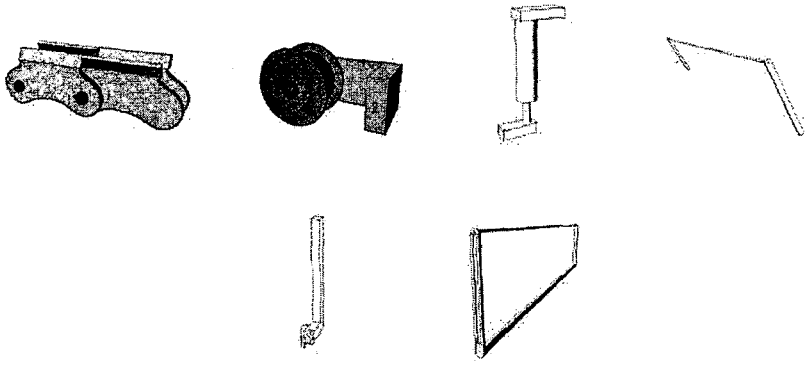

Fig-12 main parts of safety board operated by chain mechanism

SAFETY BOARD OPERATED BY LEAD SCREW

Safety board with lead screw mechanism is also invented by KRRI. Its main advantage is to install under the platform with very small modification. It is operated by lead screw. Each of boards on the platform has different width to cover different the gap. Depend on size of gab, different size of safety board will be applied.

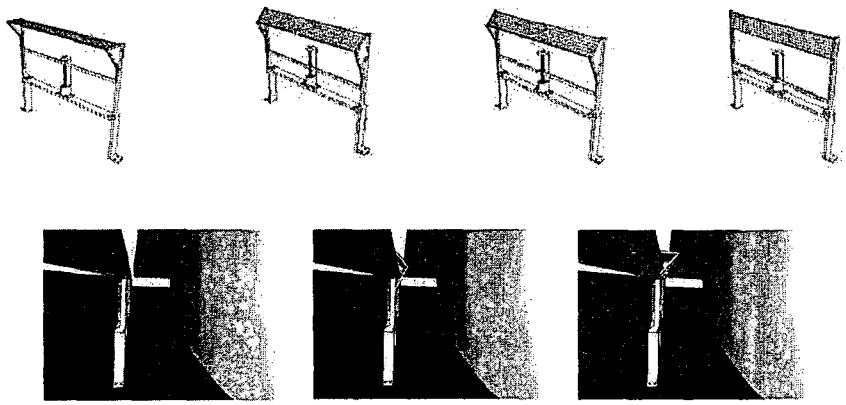

Fig-13 Functioning drawings of safety board operated by lead screw

Main parts of Safety board with Lead screw and its simple operation are introduced in fig-13 & 14

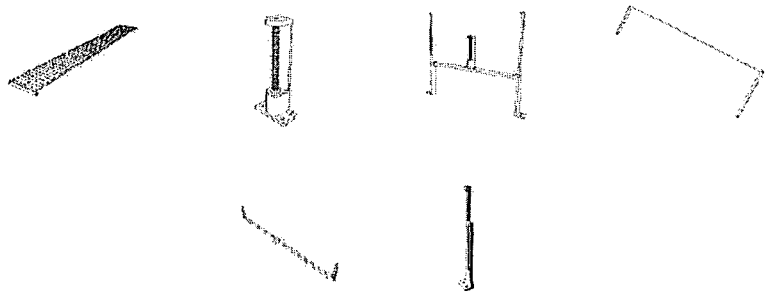

Fig-14 main parts of safety board operated by lead screw

SAFETY BOARD OPERATED WITH SLIDING DOOR FORCE

This invention is considered best solution to cover gap and protect passenger without any independent power unit and control unit up to now. Main power source of this mechanism is supported by sliding door. End of each door is connected to runner block to pull safety board. Sliding door is controlled by train control system. When vehicle arrive at station. The doors will be opened. Then safety board is unfolded and go down to cover the gap. All functioning steps operated with sliding door. It does not need large construction work on platform for installation. It is just installed side of car body then operated with sliding door. It is going to be one-system with sliding door operation. Additional advantage of this safety board is cover not only difference of height between vehicle floor and platform but also gap between vehicle and platform. Depend on service condition of vehicle such as level of wheel abrasion and deflection of secondary spring from heavy from many passengers in rush hour, difference of height between vehicle floor and platform can be occurred. But this mechanism can cover both problems with simple operation.

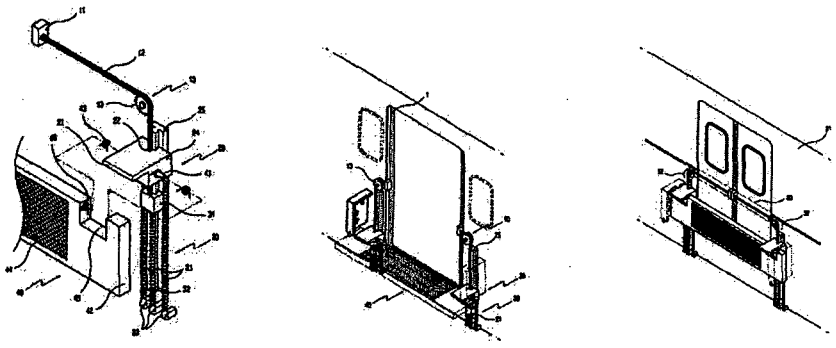

Fig-15 Functioning drawings of safety board operated by sliding door Type_1

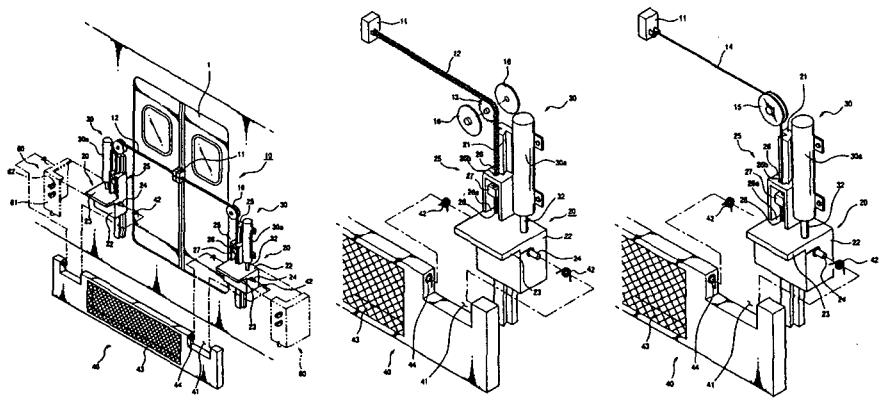

Fig-16 Functioning drawings of safety board operated by sliding door Type_2

CONCLUSION

1. The gap between platform and train in curved station is considered very dangerous factors to subway passenger in rush hour.
2. Foreign technologies to solve this problem are introduced.
3. Safety board designed by Korea amateur inventor is simply introduced. It is operated by magnetic force but there are a lot of problems to apply to practical use.
4. Three mechanisms invented by KRRI are introduced. Safety board with chain mechanism is designed to only install train. Safety board with lead screw mechanism is designed to install under platform. But both mechanisms are required independent power unit and control system.
5. Finally, best solution to cover the gap as well as level difference between platform and vehicle floor in curved subway station is introduced. It has many advantages. It is very easy to install train. And it dose not need additional power unit and control system because it is operated with sliding door force. It is also expected very low cost to set up all trains than any other platform installation mechanism.

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Patent

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[2] KRRI, Safety Board with Lead Screw Patent number 9955320

[3] KRRI, Safety Board with sliding door force Patent number 2003-21760

[4] Nam, K. B. , Safety board for subway train Patent number KR-20-1997-0032160.