

The progress and controlling Situation of Daegu Subway Fire Disaster

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Abstract

The fire had broken out on February 18th, 2003 at Daegu subway is caused by incendiaries. It might be ended as a typical fire happening but proceeded to the disaster because of the inappropriate system of disaster prevention we had taken, the lack of understanding and specialization we were. Thus we try to find out the whole settlement proceeding of the disaster.

The investigation and analysis of the disaster is following:

- Settlement proceeding and controlling
- Reaction and rescue system of the government and related organizations
- Behaviors of the survivor
- Mechanical system of the subway station

1. Introduction

1.1 Background and the research purpose

Today, various disasters are getting heavy and diversified with changes of global

environment include unusual climate changes. We experienced a series of painful accidents, such as the collapse of Sung-su bridge, Sam-pung department store and the fire of In-cheon bar. And the problem exposed at disasters of Public properties and multiple usage facilities through the disaster of Daegu Subway. Basic situation for a settlement of disaster that cannot have the system, the system for a disaster controlling did not exist. The progress of the settlement shows us

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This work was supported by grant R01-2003-000-11696-0 from the Basic Research Program of the Korea Science & Engineering Foundation

typical chaos of the disaster without the recovery plan to be a spot controlling systematic. This is representative result of the absence of systematic disaster prevention system.

Include Daegu city and most of city government organizations are acknowledging importance and necessity of disaster prevention. They do but the review of a legal requirement as make the local disaster prevention plan and city based plan. And they often to ignore important information of a disaster and are making plan of a disaster prevention system. A systematic operation of disaster prevention system shows us the problems in the case of the past.

Consequently the purpose of research is as follows. We do a disaster of Daegu Subway analysis, a controlling course analysis, and human behavior pattern and facility states for urban safety. We find the problem to consider in the disaster prevention system and fill in Timetable. We compare the affair by the hour and present to the basis data to apply at the management of a hereafter disaster.

1.2 The research method

This research focuses on the disaster of Daegu Subway happened on February 18 and is studied by the data from the field research.

First, we used the date of the situation report of a disaster center, special support group data, administration, province-government and Daegu subway controlling countermeasure headquarter. We fill in Timetable and study the association of many affairs that happened at same time. We arrange a system for settlement time situation around the accident countermeasure headquarter of a center, special support group, province of the government and victim countermeasure committee that is the administration organization of Daegu subway fire

accident. We present samples of controlling disaster that comes into.

Second, this research is based on the field research through the data from city government, volunteer record, and case studies of domestic and abroad

Third, in this research, we analyzed a making up questions, investigation data which execute twice from the survivors, 146 persons among subway coach passenger and the people at the Daegu subway station in fire at February 18, 2003. The making up question items were composed of 60 questions with objectivity questions and subjectivity questions to find out the recognition ability of the disaster for the accident appears, egress types and egress situation.

Forth, for the purposes of this study, the Daegu subway fire was chosen as this is a prime example of fire in an enclosed, underground environment.

The parameters of our research involve analyzing the current refuge facilities, firefighting capabilities currently in place to combat such possibilities additionally, the problems of combating underground fires will be looked at. Also considered are the legal shortcomings of current legislation that hamper effective safety measures.

2. The overview of the Daegu subway fire

The line 1 of the Daegu subway has been opened at May 1998, it was 25.9km of total extension and connected from the Jin-cheon station to the Dae-gok station. The subway train of the line 1 was composed of 6 coaches, control car and power car, and total length is 108m. Train coach 1, 6 are control cars and train coach 2, 3, 4 and 5 are power cars.

There was the fire in the Jung-ang-lo station of the Dae-gu subway line 1 at February 18, 2003. The fire broke out at

coach #1 of No.1079 subway train that was operating from the Jin-cheon station to the An-shim station.

The breaking out time of the fire was about 9:53am and the time of putting out the fire was 1:38pm. The cause of the fire was the commitment of fire with the arson that was used 4 liter of volatile material. After the fire of no.1079 subway train, No.1080 electrical train in the opposite direction was stopped at the Junganglo station and the fire was spread out to No.1080 subway train. In the breaking out time of the fire, the numbers of passengers were supposed to about 640 persons.

The human damage from the fire was total 440 persons that consisted of 192 persons of the dead, 148 persons of injured. The dead persons consisted of 142 persons in subway train, 49 persons from out of subway train, and 1 person from no recognition.

2.1 The fire progress situation

We are as follows if we express in sequence of time about situation occurrence between a NO.1080 train, a NO.1079 train, a subway briefing room, subway station, the fire fighting and police.

(a) 9:52:43, NO.1079 train went the Banuldang station and approached into the Junganglo station. The incendiaries to be on a first passenger coach set fire the just before the train approached at the station.

(b) 9:52:55, Train stops. The moment incendiary set fire after scatter the benzene in passenger coach. passengers began to come down and come down for the door of a NO.1079 train at 9:53 after a 5~6 seconds, incendiary came out to the passenger coach outside with attaching the fire to its body on. The moment the flame was wrapped the NO.1079 train up and passengers began to escape through the door to be opened.

(c) 9:53, the letter "The fire alarm" is found in the CCTV screen and there comes

a fire alarm. But Men on duties ignored not to report at the synthesis commander's room because a fire alarm's failure was frequent.

(d) We had an initial statement at a 9:54:40 fire fighting headquarter situation room. The deployment direction is sentenced at a 9:55:13 at the northern part fire station.

(e) 9:55, Subway situation room report a occurrence of Junganglo station's fire at the driving commission. NO.1079 train is fired at the same time the NO.1080 train started the Dae-gu station at a 9:55:35 and was coming in to the Junganglo station

(f) The smoke was full at an underground third floor at a 9:56:20

(g) A NO.1080 train starts from an opposite direction of Dae-gu station at a 9:56:40 and approach Junganglo station. The safety door shut the underground store at a 9:56:50 by the fire sensor.

(h) 9:58, A NO.1080 train engine driver informed of the emergency situation at the synthesis commander's room. But there were not escape passengers at this time.

(i) The synthesis commander's room and NO.1080 train was mutually stopped the exchange of message at 9:59. The fire shifted opposite side of NO.1080 train from the heat of the NO.1079 train at this time There was a fire at the ceiling and the seat covered with inflammable materials. And the fire spread rapidly.

(j) They requested the traffic control to a 9:59 police. 10:2 spot command posts are established. At the same time a NO.1080 engine driver takes out the Master Controller Key

(k) Passengers escaped through a NO.1 passenger coach and NO.4 passenger coach that opened the door to the manual. But many passengers could not open the door and were imprisoned.

(l) From AM.11 to AM.12 an identity authentication task and the number of a

corpse confirmed by an emergency medical treatment organization. From AM.12 to PM.1 the medical treatment information center requested to convey a little injured person to small hospital.

(m) 13:38 the fire was extinguished and the director of a bureau of fire commanded in the spot at 14:11.

2.2 The damage situation from disaster of Daegu subway

The damage situation from disaster of Daegu subway is as follows. A loss of lives is 192 deceased and 148 wounded. Total is 340. The fixed properties of platform burned about 2,004 square meters of underground 3rd floor and 8,443 square meters of underground 1st, 2nd floor among the area of 10,437 square meters.

The movable properties such as the service facilities, waiting room machinery, tools, 12 passengers coach, communication equipment and platform equipment burned. Total property damage is around 47 billion won. The restoration expenditure is presumed to the 516 billion won as a great economic loss.

3. Overview about fire of Daegu subway

3.1 A fire occurrence overview

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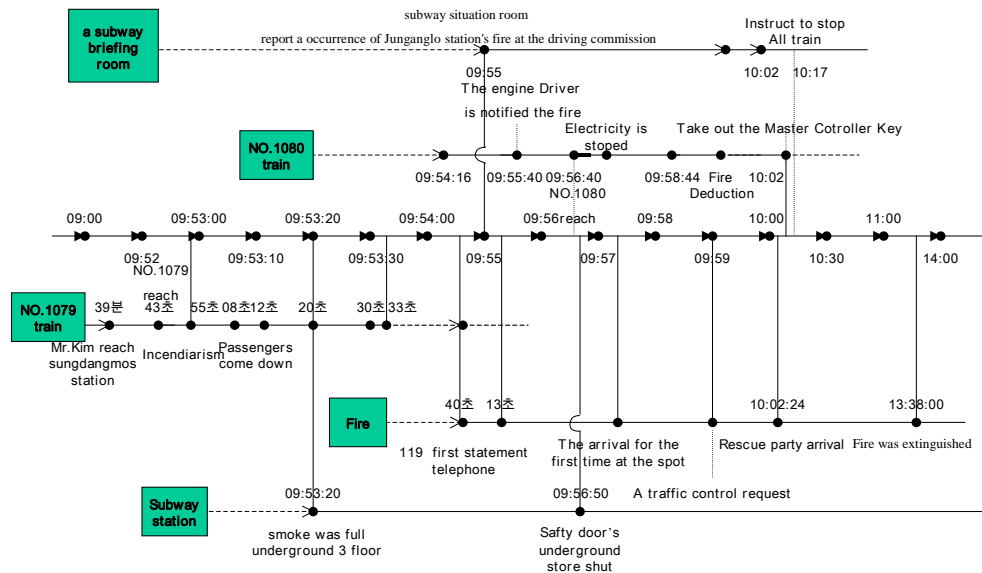


Figure 1. A fire occurrence Timetable

e. A 9:55 subway situation room reports a occurrence of Jungang station's fire at the driving commission. NO.1079 train is fired at the same time The NO.1080 train started the Daegu station at a 9:55:35 and was coming in to the Jungang station.

f. The smoke was full at underground 3rd floor at a 9:56:20

g. A NO.1080 train starts from an opposite direction of Daegu station at a 9:56:40 and marches Jungang station. The safety door shut the underground store at a 9:56:50 by the fire sensor.

h. A 9:58 NO.1080 train engine driver informed of the emergency situation at the synthesis commander's room. But there were not escaping passengers at this time.

i. The synthesis commander's room and NO.1080 train was mutually stopped the exchange of message at 9:59. The fire shifted opposite side of NO.1080 train from the heat of the NO.1079 train at this time. There was a fire at the ceiling and the seat covered with flammable materials. And the fire spread rapidly.

j. They requested the traffic control to a 9:59 police. A 10:02 spot command post is established. At the same time a NO.1080

engine driver takes out the Master Controller Key

k. Passengers escaped through a NO.1 passenger coach and NO.4 passenger coach that opened the door to the manual. But many passengers could not open the door and were imprisoned.

l. From AM.11 to AM.12 an identity authentication task and the number of a corpse confirmed by an emergency medical treatment organization. From AM.12 to PM.1 the medical treatment information center requested to convey a little injured persons to small hospital.

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12 passengers coach, communication equipment and platform equipment burned. Total property damage is around 47 billion won. The restoration expenditure is presumed to the 516 billion won as a great economic loss. (Figure 2).

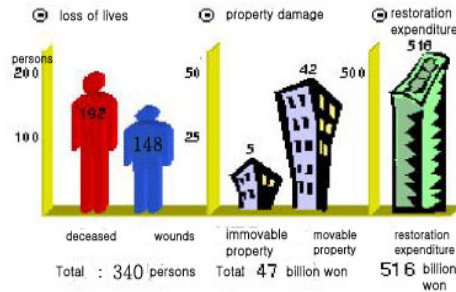


Figure 2. The damage current situation

rescue situation

Total mobilized rescue member was 1046 person. There were 906 persons at the spot which accident happened and 140 persons worked hospital except this. The vehicle is mobilized a total 125. For a rescue 45 and ambulance 42 were mobilized with fire suppression 38 (Table 1).

After Sumunlo firehouse the arrived at spot 9:57, they began to put out a fire at a 10:38. Since they suppress the fire at a 13:38, the rescue party was continuously mobilized with the fire brigade. Kyungnam firefighting headquarter, central 119 rescue party, Kyungbuk firefighting headquarters' as well with the fire station Daegu became

3.3 A fire suppression and human life

Table 1. A firefighting activity situation

The member disposition situation	Total mobilized member(1046persons)		
	Spot which the accident happens	Working hospital except this	
	906persons	140persons	
The vehicle disposition situation	Total mobilized vehicle(125)		
	Fire suppression	Rescue	Ambulance
	38	45	42

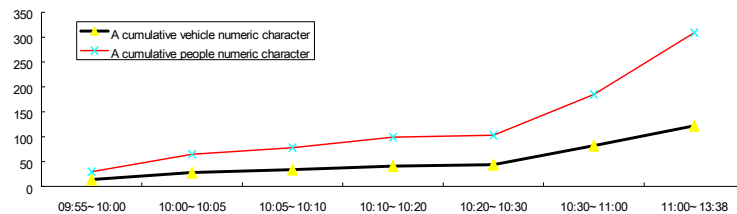


Figure 1. The number of a firefighting member and vehicle cumulative

the commitment at 11:30. The number of fire truck and fire fighter are increasing steadily until it becomes suppression the fire.(Figure 3)

3.4 The system for a disaster of Daegu Subway controlling

It should be followed, if we arrange the system for settlement after the disaster of Daegu Subway in February 18. (Figure 4)

a. Daegu metropolitan rescued the casualties as soon as a subway fire accident happened. They installed the area accident countermeasure headquarter to 107 persons of 9 teams and did the accident controlling. They organized the police investigation headquarter. (Police: 73 person, National science investigation research institute:88 person)

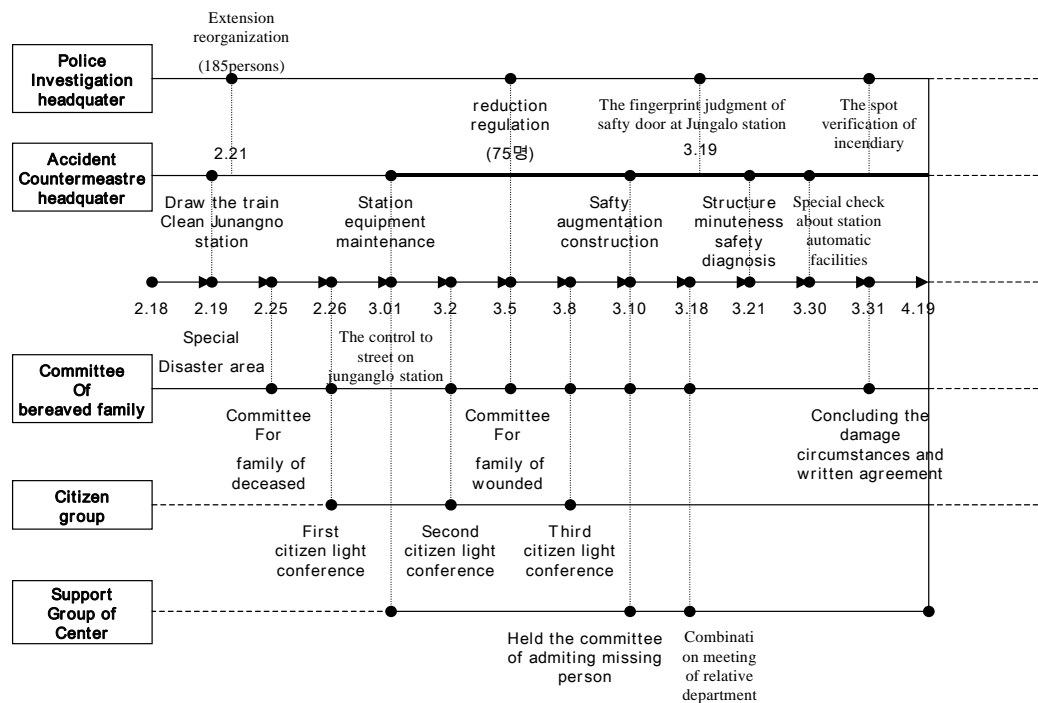


Figure 4. Timetable of every day

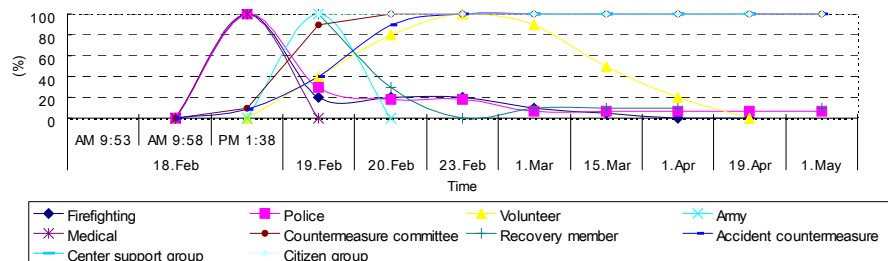


Figure 5. A member mobilization current situation

b. The committee of a missing person's family is consisted on February 18. The government selects Daegu to the special disaster area, and Daegu drew the train and cleaned at Junganglo station on February 19.

c. Support group of Centers' 28 persons were dispatched Daegu on March 1. They held the committee of admitting missing person on March 10. They concluded the damage circumstances and written agreement on March 31. They modified the victim countermeasure committee with the accident countermeasure headquarter to April 19.

d. The citizen group began a citizen light conference with a victim family countermeasure committee on February 25, and requested the accident controlling by the government.

e. The accident countermeasure headquarters considered the subway operation and recovery countermeasure. The station equipment maintenance from March 1, the safety augmentation construction from March 10 and a structure minuteness safety diagnosis from March 21 was recovery.

3.5 Current situation of the member

mobilization

Each group supported by many parties from February 18 (figure 5). The medical treatment, the firefighting and police is the highest point at an evolution complete hour (PM 1:38). The number of recovery member and the army applied to the peak on February 19. The next is the sequence of support groups.

- 1st is The countermeasure committee
- 2nd is The accident countermeasure committee
- 3rd is The citizen group
- 4th is The volunteer
- The support group of government established in on March 1.

3.6 Survey about fire of Daegu subway

Table 2. Plan of survey

Classification	Content
Population	The woman and man (20 olds, lives in Daegu, Currently March 2003)
Investigation period	March 22, 2002.
Sample size	500 persons
Sample extraction method	Population comparison random sampling process
Investigation method	Telephone interview to use the question paper
Sample error	Trust level 95%

Negative assessment is occupying great number (75.0 %) that Daegu is mistaking an incident finish. (Figure 6). The main group to prepare countermeasure and Daegu subway fire controlling counted Center government special support group (44.8%). (Figure 7).

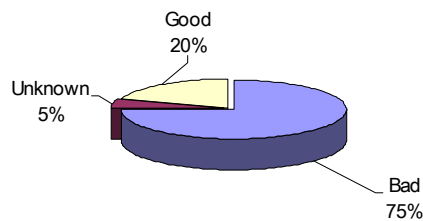


Figure 6. Controlling assessment for disaster of Daegu subway

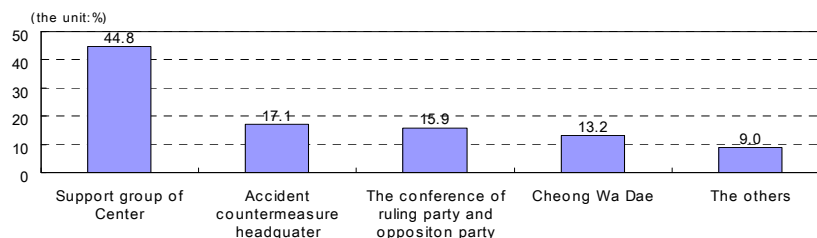


Figure 7. The main group to prepare countermeasure and controlling for disaster of Daegu subway

4. Analysis of egress behavior patterns

4.1 The frequency of usage and the

ability to recognize

We investigated a Junganglo station usage number and a subway usage frequency of the escaper. There was

majority responder, who use the Daegu subway line 1 over one time per a day, over the half replied that they used the subway over two times for the round trip per a day. There was secondly bigger numbers of responder who use over three times per a week. There were included response from subway staffs and the people didn't reply.

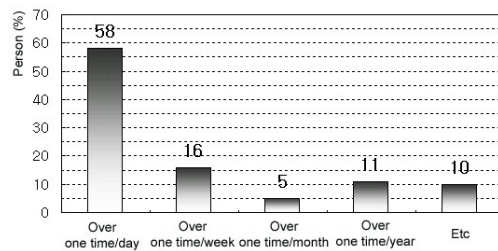


Figure 8. The frequency of usage the Daegu subway

Figure 9 was showing the response of the Jungangro station, which was broken out the fire. There was many of responder, who use the Jungangro station over one time per a day and there was many of responder, who use over two times per a day. There were included response of subway staffs and the people of no reply and the four people who used first time the Jungangro station. There was one person who often used it on vacation and sometimes on school term.

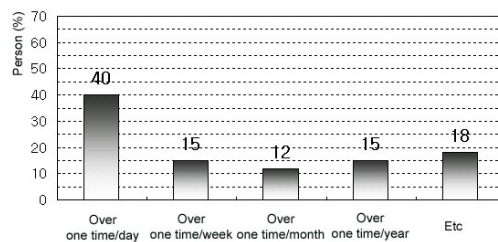


Figure 9. The frequency of usage the Jungangro station

There are the results of the investigation at figure 10 about the ability to recognize of the Jungangro station routes of escaper. There was over 70% of responder who could find out the ground

exit with and without the directional sign. This result was related to the frequency of usage the Daegu subway and the Jungangro station as stated above. There was many of responder who could find out the ground exit without the directional sign. There were included responses, "I can find out the exit if I know the route"(one person), "do not know at all"(four persons), "not reply"(three persons).

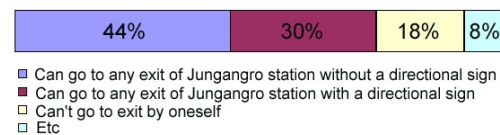


Figure 10. The ability to recognize of the Jungangro station routes

4.2 Behavior type before the egress

There were difference time gaps between fire occurrence of the electric train No.1079 and the electric train no.1080. Figure 11 is showing escaper's behavior after they recognize the fire. There was most many of responder, who responds to "a wait" and "the contact with the outside". And responder who immediately escaped was less than 30%.

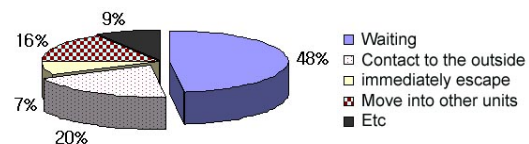


Figure 11. Escaper's behavior after they recognize the fire

There were the factors to decide egress in figure 12. The 41% of responders answered that the factor of decision to egress from the fire is "a smoke". Many passengers of coach 1, 2 of no.1080 subway train, which condition comparatively was better than other coaches, answered that they escaped by the guidance broadcast than any other

responses. Other responses were "subway staff" and "at the sound of 'Do egress'".

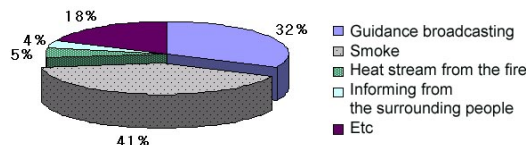


Figure 12. The factor to decide escape

4.3 Egress routes

The data shows that the egress routes are different from the initial standing points of the each occupant. In the case of the NO.1097, the data was collected without identifying each coach because the numbers of responder for the research were very few. The half of replier had no memory while escaping, between the responder. Base on the total responders, the higher ratio of the routes by the numbers of escapers are followed: to the left at the B3 platform, to the right at the B2 ticket gate and to the left at the first floor waiting room.

A figure13 shows that the results of the cases, according to the actual egress routes from the expected egress routes and the case of turning back to the initial location after once trying to the various routes. The 47 people replied they didn't escape the routes what they expected and 17 people replied that they escaped the routes what they expected. The subway staffs were the majority among the 17 people. It means that the escapers had the knowledge of that underground space among the 17 people. The 11 people replied they didn't have any idea for escape route. The most of u-turned people happened at the B2, especially before passing by ticket gate on the B2, and B3 platform that was the most difficult and dangerous for the rescue. The reason for the u-turn was followed; the visual barrier from the smoke, no sense of stair location, missed escapers line, obstructed of the routes.

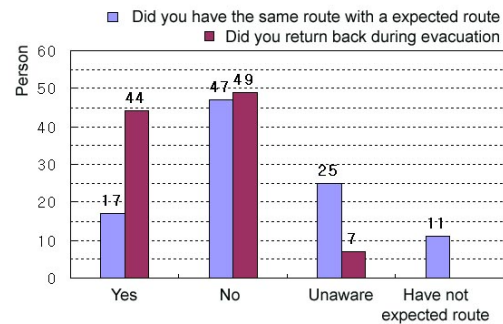


Figure 13. Selection of egress route

4.4 The characteristics of the egress and those applications for the egress

The Junganglo subway station consists of 3 story underground floors. The waiting rooms were located on the first and second underground floor, the platform was located on the third underground floor. It was complicated spaces because the first underground floor was connected to the underground shopping mall.

The figure 14 shows that the degrees of the visual barriers from the smoke and heat from the fire while people escaping through the B3 platform, B2 ticket gate, B1 waiting room and underground shopping mall to the ground floor from the subway fire spot of the train coach. The survivors replied that there were the highest visual barriers at the B3 platform and it was getting reduced at the higher floors. There were also serious visual barriers at the waiting area of the B1. But the actual degree of the visual barrier was almost similar because the survivors couldn't have enough time and clear conscious to identify the degree of visual barrier while escaping from the fire. There is people who had over 5m sight capability were only 2~4% form the escapers of train 1079 because they escaped early stage of fire.

The research shows that there are difficulties to escape from the extremely high temperature enough to melt whole

plastic materials of B1 at the firing routes. But also the degree of heat temperature was similar in terms of human sense even

though the numbers were getting reduced at higher floors for the heat barriers from the data.

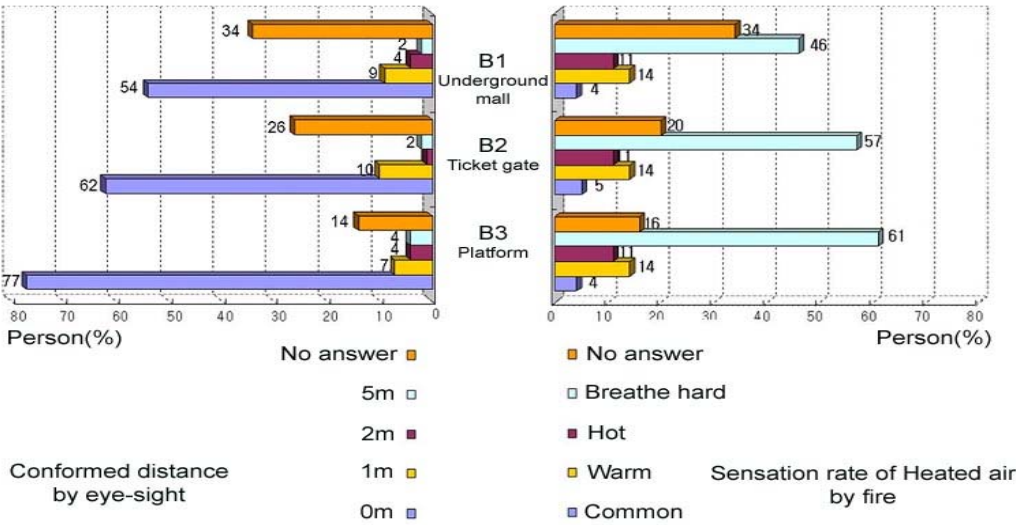


Figure 14. Smoking and heating according to the level difference in the case of escaping

4.5 The method of egress

The research shows that there is the highest number for the method of escape was the case of escaping followed by the wall through the touching and the second ratio was escaping followed by leading people through the holding clothes and part of body. But the research shows that the guide rail and hand rail couldn't enough lead the people to the stairs or egress route because there was no belief for the correct escaping routes and hard to approach to the guide rails like holding peoples' clothes.

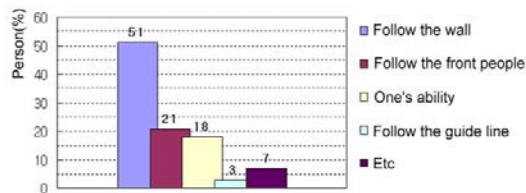


Figure 15. Method about moving forward

4.6 Analysis based on egress devices

There are the higher percentages to help egress was the devices such as inducing light, commercial light boards, flash light as 49%, the knowledge of the subway station was 20% and sounds were 13% among the repliers.

The most barriers to escape were visual obstruction and the next was smoke. The visual barriers and smokes made escapers to loose the sense of direction and these factors gave the escapers difficulties to escape. There

were other minor factors such as stairs, ticket gate, fire shutter, complicated subway spaces, columns and piers, chaos peoples.

The figure 16 shows the factors of barriers on the third platform underground floor that has the longest distance as the egress route. The difficult factors to escape at the third underground floor were the visual barrier and narrow width of platform. There are minor factors such as columns and piers, commercial boards.

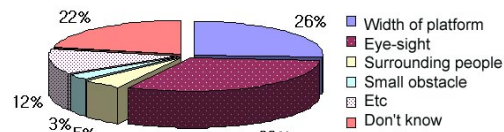


Figure 16. Interference factor of B3

The 48% escapers said that the stairs made them the most obstruction to escape, and the height was the more influence factor to escape than the width of the stair in detail as the figure 17.

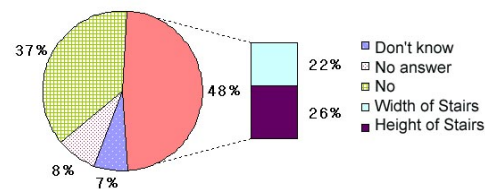


Figure 17. Obstacle at the refuge stairs

4.7 The inducing light

The most of survivors couldn't see the emergency inducing lights after starting to escape from the initial spots and the escapers couldn't get the help from the inducing lights either. It means that the inducing lights couldn't make the role of their own because of smoke obstruction from electricity power off and firing. It should be considered that the location and methods of inducing lights and devices are used by not only visual factor but also audible and tangible.

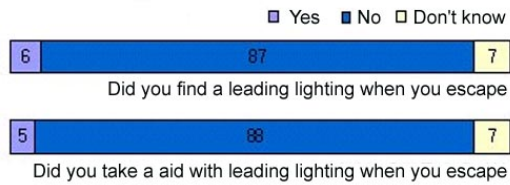


Figure 18. Response of inducing light

5. The facility analysis of Jung-ang subway station

5.1 The facilities current situation and facilities ability of Jung-ang subway station

Table 3. The facilities current situation of Jung-ang subway station

	underground 1st floor	underground 2nd floor	underground 3rd floor	total
service	waiting room	waiting room	station platform	
powder extinguisher	17	15	8	40
indoor extinguishing system	4	3	8	15
sprinkler	383/2	536/2		919/4
CO ₂ extinguishing facilities	12/42	10/24		22/64
automatic detector facilities	89/8	105/7	18/8	212/23
emergency broadcasting facilities	43	50	68	161
emergency alarm	8	7	8	23
exit light	25	26	16	67
emergency light	89	119	43	251
waterworks extinguishing water	1			1
smoke control facilities	96/87	135/107	99/0	330/194
standpipe facilities	4/1(ground)	4	4	12/1(ground)
emergency outlet	8	7	8	23
wireless communications support	○(establishment)	○(establishment)	○(establishment)	○(establishment)

(1) A fire extinguisher

Each two-powder extinguisher for 4.5Kg-ABC levels is furnished in both the front and rear of trains, and each extinguisher is maintained as per the regulations of the F.S.A. However, the box of a fire extinguisher in the train is located so that it is difficult to find and there are no manuals for use.

(2) Indoor fire extinguishing system

According to the Fire Services Act, fire extinguishers are equipped with a 15m hose and a nozzle. And the extinguishers are every 25m along the length of a subway car or platform.

(3) The sprinkler facilities in a platform

Closing sprinkler heads are fitted in regular space stipulated as per regulations. Water for extinguishing is supplied into the section of heads as the valve is opened. When heat and smoke sensors

start to function there is a prepared-operation sprinkler which starts as soon as heat dissolves the head. Not only is the platform excluded by the Fire Services Act, but also there is no preventative measure concerning the possibility of electrocution resulting from contact of water with high voltage cables.

(4) Guidance light

Guidance lights start when fire sensors detect fire, and guidance signs indicate the direction to exit. Guidance lights use two line and three line systems. Three line systems put out lights at normal times; moreover, serious problems arise in that most of the passengers do not have any training regarding safety measures and the three line system is left without any careful management. The capacity of electric power for emergency is conservatively estimated at 20 minutes.

(5) Emergency lights

The Fire Services Act does not specify standards for emergency lights. These lights begin to function just when the whole station loses electrical power. In addition, with a partial power-cut, the emergency lights function can be effected so that passengers may meet difficulties to make sure of their safety. Generally, in the F.S.A , it says that guidance light should play its role during effective operation time of 20 minutes with

luminous intensity-more than one lux. These emergency lights should be positioned in areas such as passageways, stairways, and the lobby, and other pathways to help passengers escape from danger.

(6) Smoke control facility

In the station platform area, there are exhaust ports and air curtains to protect passengers from the wind tunnel effect of passing trains. This are changes into an exhaust port. At the lobby level, exhaust and import facilities ventilate air through the ceiling; however, in a fire, the import facility gets blocked and only the exhaust port plays it's role in exhausting air.

(7) Emergency evacuation pathways

Urban subway stations do not have any direct evacuation stairway because it is exempted from building laws and codes. In this respect, emergency pathways are necessary. It will be required to evacuate the elderly or the handicapped or the injured in the event of disaster. We also suggest an emergency pathway for fire fighters for fire suppression, life-saving and carrying of the injured or infirm.

(8) Fire Sensor System

Heat and smoke sensors established at both the platform and station level detect fire and consists of a system to minimize

the occurrences of false alarms. There are no automatic fire watching systems in trains so the control panel shows fire warnings by being activated by a fire sensor which is installed between the station office and the fireproof room when sensors in the platform and station start to function.

Table 4. Machine facilities control system of the Daegu subway

control location	district to concern	function	object equipment
station platform (29)	station platform (1)	driving control	station platform
			-air conditioning facilities -air cooling facilities - flue-gas facilities
		situation and alarm monitor	main
			-ventilating room air blower
part station (2)	1 part station (14 station platform) 2 part station (15 station platform)	situation and alarm monitor	station platform and main
			-rotation machine activate and failure -environment situation (temperature, humidity, dust) -water level of the water tank -fire observation -smoke observation
		situation and alarm monitor	main
			-rotation machine activate and failure -environment situation -water level of the water tank -fire observation -smoke observation
commander's room (1)	station platform (29) main (whole section)	driving control	station platform
			-air conditioning facilities -air cooling facilities - flue-gas facilities
		situation and alarm monitor	main
			-ventilating room air blower
commander's room (1)	station platform (29) main (whole section)	situation and alarm monitor	station platform and main
			-rotation machine activate and failure -environment situation -water level of the water tank -fire observation -smoke observation
		situation and alarm monitor	main
			-rotation machine activate and failure -environment situation -water level of the water tank -fire observation -smoke observation

It is essential that passengers take training in operating fire extinguishers; additionally, there should be distinct marks and signs for the location of extinguishers and their manuals to properly operate them.



Figure 19. 20kg powder extinguisher and utility explanation



Figure 20. 3.3kg powder extinguisher and utility explanation

5.2 The problem according to the facilities ability from the Jung-ang station fire, and the improvement solution

(1) The fire extinguisher can spray its chemical powder for about 18 seconds so that it takes effect of early fire extinguishing. However, it may take more time for ordinary people to use a fire extinguisher because they have no formal training in its proper use.

(2) Despite the indication of interior fire hydrants, it is hard for citizens to locate them in an emergency or due to a fire and thick smoke. Based on careful inspection of the Daegu subway fire, there was no evidence of their use at the time of the fire. To resolve this problem, luminous marks and indicators must be used to guide citizens to these facilities in the event of smoke and fire.



Figure 22. Indoor fire plug box



Figure 23. Visual alarm device



Figure 24. Water curtain facilities

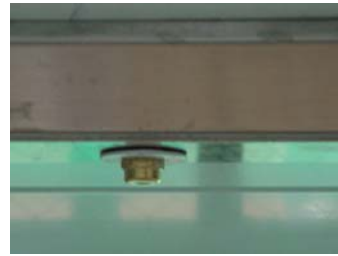


Figure 25. Water curtain facilities head

(3) When considering installment of sprinklers in the station, it is ineffective that sprinklers occupy the station platform where there is a low probability of fire or conflagration. Considering this fact sprinklers should be considered the facility which prevent secondary electrocution upon contact with high voltage cables. Furthermore, it is possible that the water curtain is formatted to release several heads, but in this case, it spends too much time on releasing automatic heads themselves.

Therefore, the water curtain facilities should be concentrated at the stairwell connecting the basement to the ground level. This would result in reducing the possibility of poisonous gas, thus allowing passengers to be evacuated.

(4) In the event of fire and thick smoke, luminous intensity of guidance lights could become impaired. Expansion of heat coming from the fire may impair the guidance lights wiring which could cause them not to function in a timely fashion. If a conflagration ensues and evacuees cannot see the guidance lights in an underground area like a basement or at the platform level, it would take a lot of time to find the exit due to the long line of evacuees. In short, luminous intensity and time under the existing provisions do not assist in proper evacuation in the event of a fire.



Figure 26. Fire escape inductive light



Figure 27. Direction inductive light

(5) The indoor fire extinguishing system and sprinkler, basin system facilities, spend on average 20 minutes before running out of the water source. Connection of the basin system facilities to the water supply facility can maintain a water supply in the event of power failure.

(6) An oil film-supply facility plays role of a discharge pipe at the platform, but in case of a large amount of thick smoke generated by conflagration, the source of smoke may move up to the lobby level through the stairway. The smoke will remain thick because of the lack of smoke exhaustion. To be more specific, with this natural discharge of smoke by buoyancy, evacuees meet problems of escaping the situation due to thick smoke at both the stairway and lobby levels.

(7) In a subway fire, evacuees are exposed to more dangers than in a normal environment. This is due to the movement of evacuees moving in the same direction as the smoke. To protect evacuees, direct stairways such as emergency pathways should be built to exterior safe areas away from the platform.



Figure 28. Luminescence inductive board of the stairs



Figure 28. Direction luminescence board of the pillar

(8) The watch system of central station often generates abnormal warning of fire so that at the time of fire, officers of station tend to depend on reports of passengers; therefore a locomotive man cannot treat an emergency situation in time. Regarding the control panel installed from the station office, dealing

with emergencies is delayed by the alarm bell and panel-light not indicating a fire in a timely fashion.

6. The conclusion

Since a subway is an integrated system of hardware and software without better cooperation between systems the potential for loss of life and property is real.

First, if it presents a conclusion from system for settlement, we try independent related agencies to order mutual association Timetable in this research. We arranged each hour situation that gives a disaster settlement the influence currently.

When we setup a satisfied disaster prevention system, we can apply to the basis data of the action subject of the hour and refuge plan time, etc.

Also we put management whole

responsibility instrument of the disaster system for the settlement not for a management instrument of disaster that is the transient like headquarters for the accident countermeasure.

Second, if it presents a conclusion from the characteristics of the volunteer activities and those managing system for restoring disaster, first of all, officers who control the volunteering service must take the effect situation of the disaster condition, and then they can have an ability to manage volunteers and volunteering team for volunteering activity that is needed on the restoring process, setting

volunteers in the right place, donated things and etc.

This research expects to provide basic data for the effective management system of the volunteering service, appropriated contribution time for each of various volunteering services, and those activates

Third, it presents a conclusion from in Human Behavior Pattern and Application of the Designing for Escape Routes at Daegu subway fire.

Even though the ground floor is the main exit as the refuge space, the underground plaza could be used as a refuges area and it should be considered on the characteristic of the underground space. The expert staff of the emergency should be on duty against any case of firing at underground space. We should consider the facts of the escape route intersects, smoke stream, refuge, activity direction of the fire fighting at the same time.

Lastly, in examining the Daegu subway fire this study concludes that the current building codes, laws and the Fire Services Act needs to overhaul to combat underground fires.

This study suggests a fundamental review of said legislation. Moreover, training for the fire brigades and other groups involved in combating underground fires must take place to effectively train them for future

emergencies. Finally, we conclude safety assessment and simulation of underground fires must be considered when designing and constructing subways. A fundamental review of our Fire Prevention Systems is also recommended from the design of a subway to its construction. Thus, establishing the basic requirements of prevention, control and restoration of a subway system.

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