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SIGNAL TO NOISE RATIO OF THE SIGNAL SOUND AND ANNOUNCEMENT IN SUBWAY STATION

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This study conducted survey and acoustical analysis for the signal sound and announcement in subway station. The results of survey showed that 82 % of participants are dissatisfied with the signal sound and announcement. Acoustical characteristic and signal to noise ratio (S/N) of the signal sound and announcement were also analysed after measuring the signal sound, announcement, train arriving noise and background noise in concourses and platforms of four subway stations. In the concourse, S/N between announcement of escalator and background noise (BGN) ranged from -1.3 to 8.3 dB. In the platform S/N between sound signal for train arriving and BGN ranged from 4.9~13.8 dB, and S/N between announcement and noise of train arriving ranged from -14.4~1.4 dB. It was also found that S/N of the signal sound and announcement in separate platform was 2 dB higher than in island platform. S/N of the signal sound and announcement in platform with screen door was about 7 dB higher than platform without screen door.
Keywords: signal to noise ratio, signal sound, announcement, subway station

1. Introduction

Percentage of elderly person over 65 years among the population in Korea will be exceeded 15% in 2018, which mean that Korea becomes in ‘aged society’. Thus a lot of studies on improvement of living and public spaces for elderly person’s life are being conducted. However, only a preliminary investigations [1] on signal sound and announcement in public space such as subway station was done for elderly person with hearing loss in Korea. In addition, there is little study on signal to noise ratio (S/N) for announcement and signal sound which is important factor for information recognition. In other countries, acoustical qualities including speech intelligibility were investigated for subway station [2-4]. In addition, a lot of studies on acceptable speech level and speech intelligibility in public spaces were also carried out [5-9] for elderly person especially [10-11]. Sato *et al.* [11] suggested that speech to noise ratio should be over 10 dB for 75 % correct of single word recognition of elderly person with 40 dB hearing loss.

In this study, signal to noise ratios for signal sound and announcement were investigated from acoustical measurement in four subway stations. The results was discussed and compared with the previous study results [11]. A survey on signal sound and announcement was also conducted. In addition, influence of building element in subway station such as platform type and screed door on signal to noise ratio was also investigated.

2. Survey

Fifty elderly persons participated the survey on signal sound and announcement in the subway station. The questionnaire consisted of several questions including ‘signal sound and announcement is comfortable? If not, what is uncomfortable?, and why is it uncomfortable?’ As shown in Table 1, results showed that 82 % of respondents felt uncomfortable in signal sound and announcement. Uncomfortable items were announcement (60%), signal sound (43 %) and inducement sound (34%). Reasons why they felt uncomfortable are because of ‘noisy train sound (62 %)’, ‘too reverberant space (34 %)’, ‘people conversation (22 %)’, and ‘unsuitable reinforced system (6 %)’.

Table 1. Questions and responses of survey on signal sound and announcement

Questions	Response
Comfortable or Uncomfortable	1. Comfortable (18 %) 2. Uncomfortable (82 %)
What is uncomfortable? (multiple responses)	1. Announcement (60 %) 2. Signal sound (42 %) 3. Inducement sound (34 %)
Why is it uncomfortable? (multiple responses)	1. Train sound is noisy (62 %) 2. Too reverberant (34 %) 3. People conversation (22 %) 4. Unsuitable reinforced system (6 %)

3. Measurement

3.1 Selection of subway station

Room acoustical properties of subway station depend on volume, finishing material, ceiling type, plan type, platform type and screen and so on. In this study, four subway stations considering the variation of screen door, platform type and ceiling type were selected for the measurement of S/N ratio as shown in Table 2.

Table 2. Architectural properties of subway stations

Station	Above/Under ground	Screen door	Platform type	Ceiling type
W	Under	None	Separated	Flat
M	Under	Close	Island	Flat
Y	Under	Close	Separated	Flat
P	Above	Close but open in upper parts	Separated	Inverted triangle (partially open)

3.2 Methods

Announcement, sound signal and background noise were measured in concourse and platform of subway station. Announcement and sound signal were measured during duration from started and finished, and background noise was also measured for 10 seconds. Figure 1 shows the measurement of announcement, signal sound, train noise and background noise in concourse and platform. In the concourse, signal sound of escalator and background noise were measured at 1 m from escalator. In the case of platform, signal sound and announcement for train arriving as ‘signal’, and train arriving noise and background noise as ‘noise’ were measured the positions below sound speakers near to positions, which are installed at 50 m in both directions from the center position of platform.

Figure 1. Acoustical measurement in concourse (left) and platform (right)

3.3 Results

3.3.1 SPL in octave band

Figure 2 shows the sound pressure level in octave band which measured in platform of W-subway station when train was arriving. First, overall *SPL* of train arriving noise was 82.4 dBA and highest, and overall *SPL* of the others were 73.1, 68.0 and 59.3 dBA for announcement, sound signal and background noise (BGN), respectively. Background noise and train noise showed flat spectral property and sound in 250 Hz band was highest for the sound signal of train arriving. The announcement for train arriving had the high sound pressure level in bands from 500 to 2k Hz. It was also shown that sound signal for train arriving has high *SPL* in all octave band than background noise. On the other hand, *SPL* of announcement for train arriving was very lower in low frequency range below 1k Hz band than train arriving noise

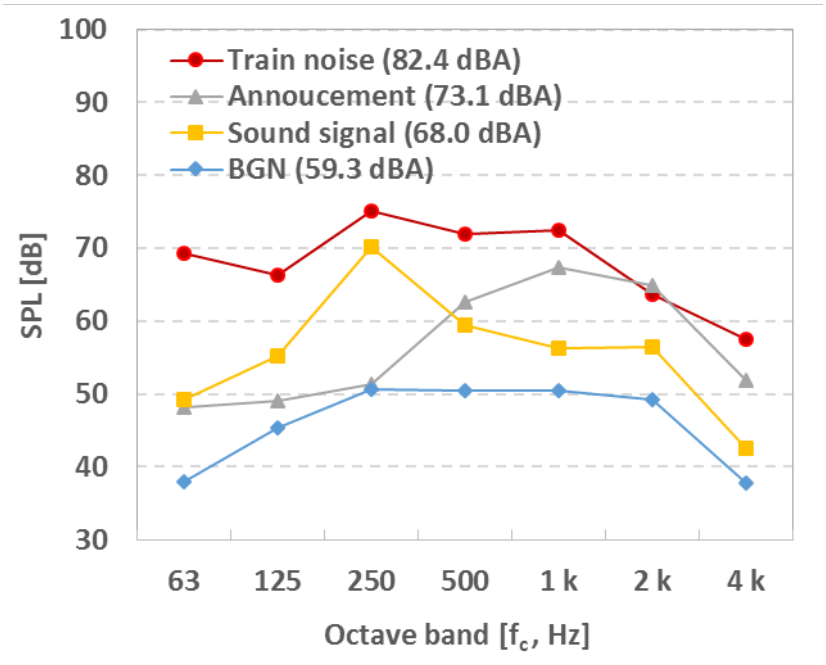

Figure 2. Sound pressure levels in octave band measured in the platform of a subway station (W-station) when train was arriving

3.3.2 Signal to noise ratio (S/N)

Table 3 shows the S/N ratio in concourse and platform of each subway station. In the concourse, S/N ratio ranged from -1.3~8.3 dB, and S/N ratio of P-station was very low because of low *SPL* of announcement from speaker. In the case of platform, S/N ratio between signal sound for train arriving and background noise ranged from 4.9~13.8 dB, and S/N ratio between announcement for train arriving and train arriving noise ranged from -14.4~1.4 dB. S/N ratio in platform of P-station was also very low due to the fact that *SPL* of train arriving noise was low because of partially opened ceiling in the center of railway.

Sato et al. [11] investigated the relation between S/N ratio and percent correction of single word recognition for eldery person. The study showed that eldery person with hearing loss of 40 dBHL had 70 % correction of single word recognition in the condition of S/N ratio of 10 dB. In this study, S/N ratio between signal sound or announcement and noise were lower than 10 dB in the most subway stations. In particular, S/N ratio between announcement for train arriving and train arriving noise was very low.

Table 3. S/N ratio in concourse and platform of each subway station [dB]

Station		M	Y	P	W
Concourse (Announcement/BGN)		4.9	6.2	-1.3	8.3
Platform	Signal sound/BGN	5.9	6.4	4.9	13.8
	Announcement/Train noise	-6.6	-4.6	1.5	-14.4

3.3.3 S/N ratio for each architectural properties

Table 4 shows S/N ratio for each platform type and screen door existence of subway station. As shown in Table 4, S/N ratio in separated platform was 2 dB higher than that of island platform. This result is due to the higher *SPL* of train arriving noise in island platform. It was also shown that S/N ratio in station with screen door was about 7 dB higher than that in station without screen door. This indicates that screen door is useful to reduce *SPL* of train arriving noise and to enhance S/N ratio.

Table 4. S/N ratio for each architectural properties [dB]

Platform type		Screen door existence	
Island (M-station)	Separated (Y-station)	Yes (Y-station)	No (W-station)
-6.6	-4.6	-4.6	-11.9

4. Summary

This study investigated the S/N ratio between signal sound or announcement and noise in subway station through filed measurement and analysis. Results showed that the S/N ratios were lower than 10 dB, which is suitable value for word recognition of eldery person in the most stations. The S/N ratio in separated platform was 2 dB higher than that of island platform. In addition, the S/N ratio in platform with screen door was about 7 dB higher than that in platform without screen door.

In order to secure the acceptable S/N ratio for word recognition of eldery person in public spaces such as subway station, more investigations regarding volume level and acoustical quality of reinforced system and S/N ratio in each frequency band including noise reduction design of indoor space should be conducted in the future.

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