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Effects of Transportation Noise Exposure Time on the Subjective Response

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ABSTRACT

A lot of researches have been performed on the subjective response for transportation noise like aircraft, railway and road traffic noise and find their relationship. However it is not easy to make the relationship clear because the subjective responses are appeared depending on the country, society and background. This study tried to examine the effect of exposure time of transportation noise on the subjective response. Road traffic noise is generally produced continuously, while aircraft noise and railway noise are intermittently produced. Therefore, the effect of noise exposure time was analyzed along with comparison the relationship among sources.

INTRODUCTION

In the previous test[1] we examined the effect of combined transport noises to the single noise. The annoyance for three transportation noises was compared and so was for the combined noises. To make balance between noises, the provided noises were edited with 20 sec., which was considered to be the simplest way to compare the subjective response even though the duration is not realistic. The results showed that railway(RW) noise was most annoying and aircraft(AC) noise and road traffic(RT) noise as order. This method was east to compare the relationship between sound sources directly, while there is problem that the test duration was too short to reflect the real situation.

This study aimed to analyse the effects of noise exposure time especially for the transportation noise. Fundamentally RT is produced continuously by time, while RW and AC are produced intermittently when train is passing by and airplane is taking off or landing. This will cause the difference of sound level relatively high for the RT noise but low for the RW and AC. The result will provide more appropriate way of measurement and evaluation to be able to reflect the residents' subjective response.

EXPERIMENTAL DESIGN

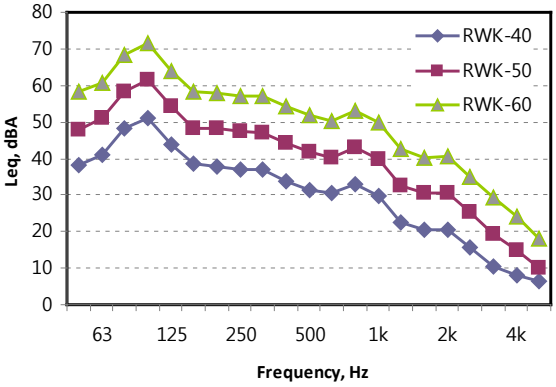
Sound Sources

In this study three kinds of transportation sound were used. Sounds from aircraft, railway and road traffic are considered to be most annoying to residents. While seven sound sources were used in the previous test, this study used only three sources to focus on the examining the effect of noise exposure time. In general the three transportation noises have differenct characteristics of production. RT is continuous fluctuating by time, which has nearly same sound level regardless of exposure time. RW and AC are produced while passing by of train or taking off or landing of airplane. It is therefore different how often it is produced depending on the surrounding situations. And the duration of railway noise is generally shorter than that of aircraft noise. In this study traffic condition of RT and the number of train or airplane are decided reflecting the survey at Gwangju airport and surrounding conditions with express motorway.

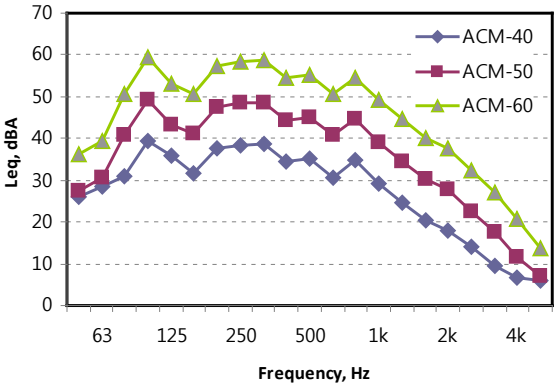
The duration of sound source production is 20 sec, 1 min, 5 min, 10 min, 15 min and 20 min. 20 sec and 1 min each are considered the duration of general railway noise and aircraft noise, respectively. 5 min duration is measurement regulation for road traffic noise in Korea, used for the comparison of relationship with other noises. The exposure time was extended by 5 min step to 20 min. The sound level was provided with three kinds: 40 dBA, 50 dBA and 60 dBA. The Leq(A) for the noises is like in Table 1 and the spectrum like in Figure 1. Where RWK is abbreviation of Korean express train, ACM of military aircraft and RTH of road traffic in the highway.

Table 1. Leq(A) of sound sources

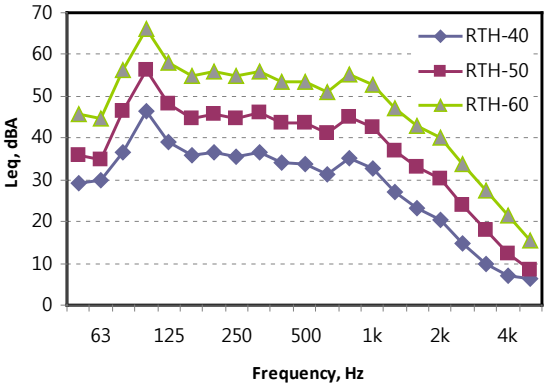
Type	Level Leq, dBA	Noise exposure time					
		20sec	1min	5min	10min	15min	20min
RWK	40	40.4	35.9	30.2	29.2	29.6	29.4
	50	50.3	45.5	38.7	35.9	37.0	35.9
	60	60.1	55.4	48.4	45.4	46.7	45.4
ACM	40	41.3	37.1	33.5	32.7	33.0	32.7
	50	51.2	46.8	42.8	41.6	42.1	41.7
	60	61.6	57.1	53.1	51.9	52.3	51.9
RTH	40	40.5	40.5	40.5	40.5	40.5	40.5
	50	50.2	50.2	50.2	50.2	50.2	50.2
	60	60.3	60.3	60.4	60.4	60.4	60.4



(a) Railway noise



(b) Aircraft noise



(c) Road traffic noise

Figure 1. Spectrum of sound sources

Subjects

All the subjects comprise of undergraduate student of Chonnam National University, with their ages ranging from 20 to 30 years old who has normal hearing. Twelve subjects took part in the test with five male and seven female, and they had break time whenever they want in the middle of test not to make any other variables than noise itself.

Test procedure

The difference depending on the exposure time of noise was intended to analyse through laboratory test in acoustic test room. This room is measured 4.95 m long by 3.85 m wide by 2.7 m high. It is constructed with absorption material on the side wall, bake wall and ceiling, and screen is installed for beam projection. Subjects listened RTH, RWK and ACM sound, in order, and they were asked to rate their response when they see the information on the screen projected by beam projector.

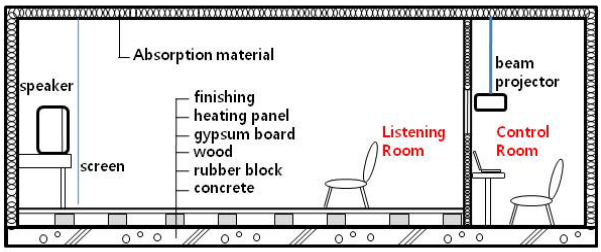
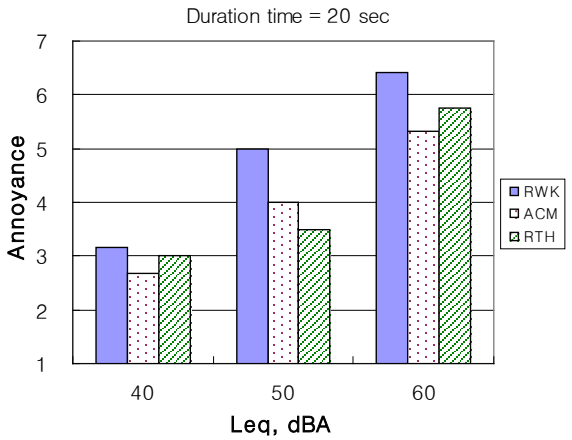


Figure 2. Cross section of acoustic test room

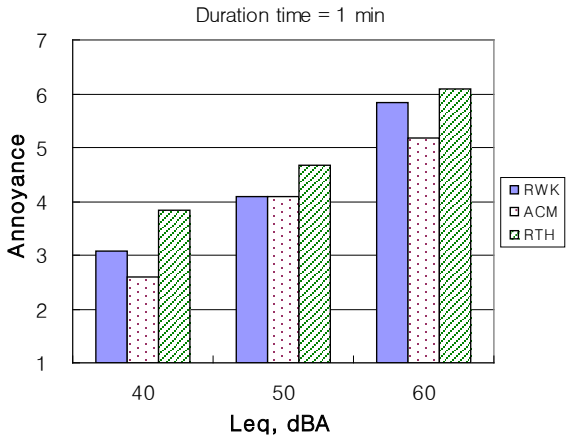
RESULTS AND ANALYSIS

Annoyance by the noise of transportation type

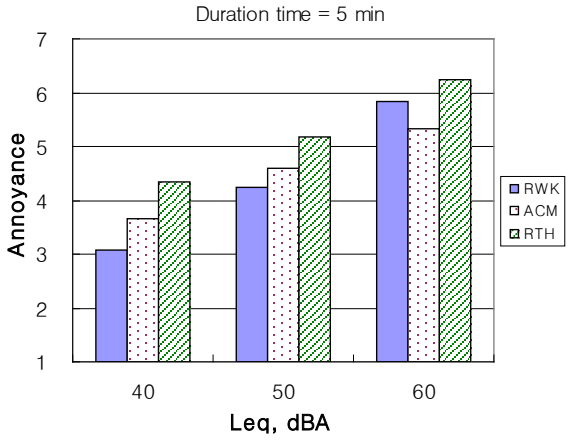
Figure 2 compares the responses by the type of sound source. The subjective response by sound source is showed very differently by the length of duration. The annoyance is increased proportional to the sound level. Like in the previous study[1], for the duration 20 sec railway(RWK) noise is most annoying and road traffin noise(RTH) is more annoying than aircraft noise(ACM). As the exposure time is increased to 1 min and 5 min, the annoyance for the railway noise is decreased comparing with other sound sources. Annoyance for the road traffic noise is appeared to be most annoying for the longer exposure time. This is due to the characteristics of the noise that is produced continuously fluctuating by time, while the other noise is produced intermittently. This results show some differences with those in the previous study that the test was carried out only for noise itself regardless of exposure time that includes background noise.



(a) Exposure time : 20 sec.



(b) Exposure time : 1 min

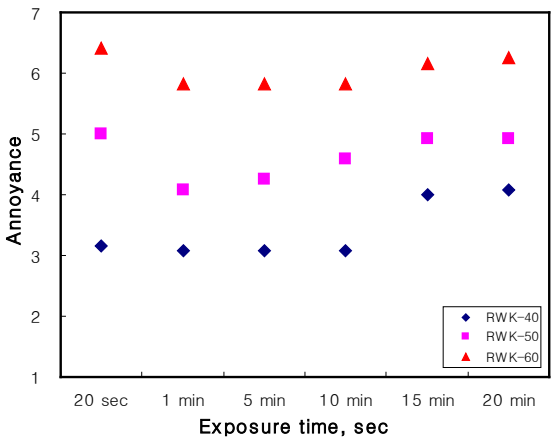


(c) Exposure time : 5 min.

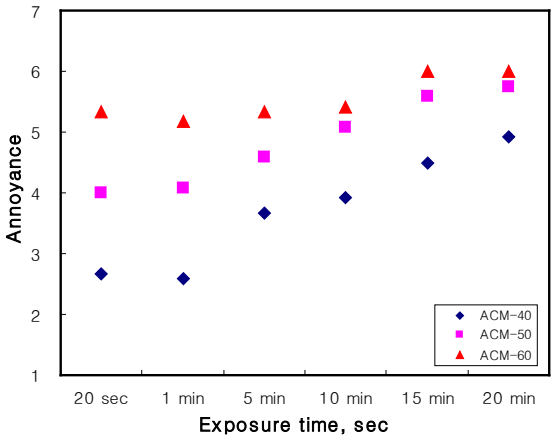
Figure 2. Annoyance by the type of noise

Annyance by the length of sound

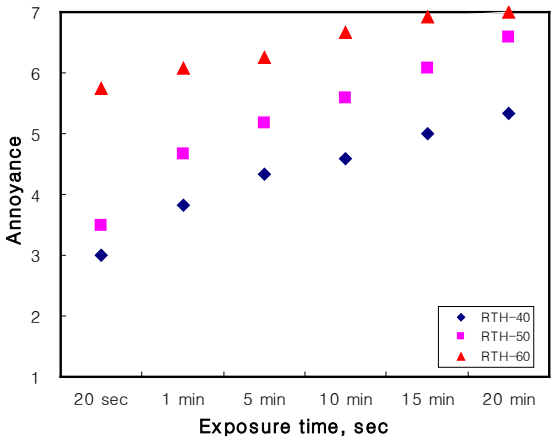
Figure 3 compares the responses by the length of sound source. The subjective response for the railway noise and the aircraft noise is gradually increased as the exposure time is increased even for the low sound level. Railway noise has high annoyance for the 20 sec. exposure time because the duration time of railway noise is about 20sec. The annoyance for 1 min exposure time is a little lowered and then incread again by the increase of sound exposure time. The annoyance for the aircraft noise is almost similar response, high for up to 1 min duration, because the duration time of aircraft noise is about 1 min. Then the annoyance is increase gradually above 1 min exposure time. On the contrary the annoyance for the road traffic noise is continuously increased by the length of exposure time. This result is similar with the annoyance in the existing study that the annoyance was analysed for road traffic noise by exposure time[2].



(a) Railway noise



(b) Aircraft noise



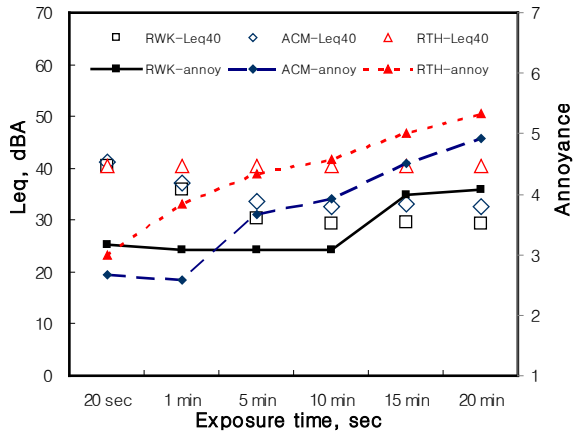
(c) Road traffic noise

Figure 3. Annoyance by the exposure time

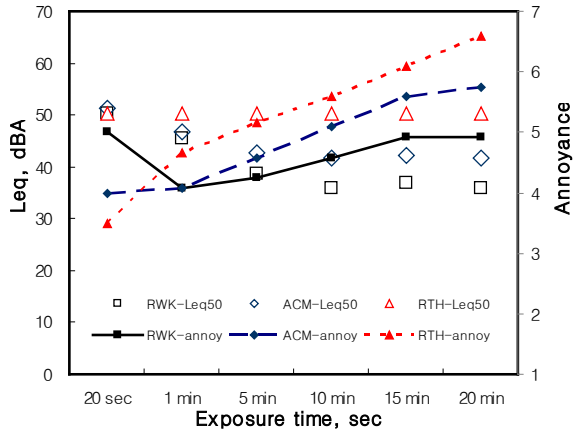
Annyance vs. Sound level

Figure 4 shows the annoyance by exposure time with sound level, Leq(A). The annoyance for low sound level is increased with steeper slope than that for high sound level. This means that, when evaluated using weighting by exposure

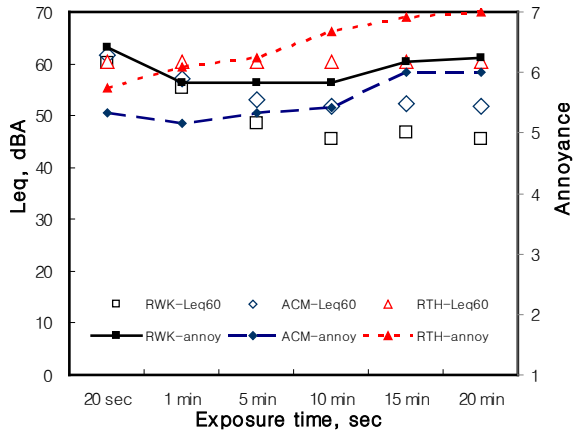
time, the high weighting is needed for low sound level and low weighting for high sound level.



(a) Leq 40 dBA



(b) Leq 50 dBA



(c) Leq 60 dBA

Figure 4. Annoyance by the exposure time with Leq dBA.

CONCLUSIONS

This study evaluated the annoyance for the transportation noise by exposure time. The annoyance for the noise is gradually increased as the exposure time is increased. As the exposure time is extended, the annoyance is increased proportional to the exposure time even though the sound level by exposure time is lowered. In addition the growth of annoyance for low sound level by exposure time is bigger than that for the high sound level. This means that, when evaluated using weighting by exposure time, the high weighting is needed for low sound level and low weighting for high sound level.

ACKNOWLEDGMENTS

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