Annoyance of single and combined machinery noises from construction sites

Sung Chan Lee[1], Jin Yong Jeon[1]

[1] Department of Architectural Engineering, Hanyang University, Seoul 133-791, Korea, sungchan@hanyang.ac.kr, jyjeon@hanyang.ac.kr

ABSTRACT

In this study, annoyance caused by single and combined construction machinery noise is evaluated through the auditory experiments of two groups those are residents and construction engineers. Six construction machinery noises those are pile driver, earth auger, pay loader, breaker, bulldozer and excavator were recorded in several construction sites in Korea, by using the binaural ear microphone. L_{Aeq} was varied from 40 to 90 dBA with an interval of 5dBA for auditory experiment of single construction machinery noise. The annoyance for each construction machineries were increased according to increase noise level. Annoyance for four combined construction noises was evaluated by auditory experiment. L_{Aeq} was varied from 40 to 75 dBA with an interval of 5 dBA. The variations in annoyance scores were not sensitive when background noise levels increased. Based on the results, it can be suggested that the reasonable SN ratios were ranged from 0 to 10 dBA.

INTRODUCTION

The noise from construction site is different from other environmental noise because construction noise appears specific construction period and then disappears when the construction completed whereas other environmental noises such as aircraft, train, factory, traffic noises appear periodically and continuously. Characteristic of construction noise changes due to the construction machineries are changed according to construction stage. However it is difficult to study noise from construction site because it is vary greatly depending on factors such as type of equipment, the specific model, the operation being performed, and the condition of the equipment. The equivalent sound level of construction activity also depends on the fraction of time that the equipment is operated over the time period of construction. The dominant source of noise from most construction is machinery operation and in a cases, such as impact pile driving or breaking, noise generated by the process dominant. For considerations of noise assessment, construction equipment can be considered to operate in two modes stationary and mobile stationary equipment operates in one location for one or more days at a time, with either a fixed power operation such as pump, generators, compressors or a variable noise operation such as pile drivers, breakers. Mobile equipment such as bulldozers, loaders moves around the construction site. Construction activities are characterized by variations in the power expended by equipment, with resulting variation in noise levels with time.

In order to measure the construction noise, several methods have been attempted (Manatakis 2000; Yoshinaga et al. 2006). Assessment of impact of construction noise was studied through simulation programs (Ballesteros et al. 2010; Weixiong 2008). Adverse effect of construction noise has been studied such as pleasantness, physical and emotional effects, perceived behavioural effects, accuracy of task recall (Towers 2001; Ng 2000; Reeb-Whitaker et al. 2000; Fernandez et al. 2009). In this study, annoyances caused by diverse construction noises were evaluated through auditory experiments.

FIELD MEASUREMENT OF CONSTRUCTION NOISES

Six construction machinery noises those are pile driver, earth auger, pay loader, breaker, bulldozer and excavator were selected as shown in Figure 1. Recording was conducted in several construction sites in Korea, by using the binaural ear microphone (B&K type 4100). The distant between source and receiver was 10m.

Figure 1: Selected construction machineries for auditory experiment

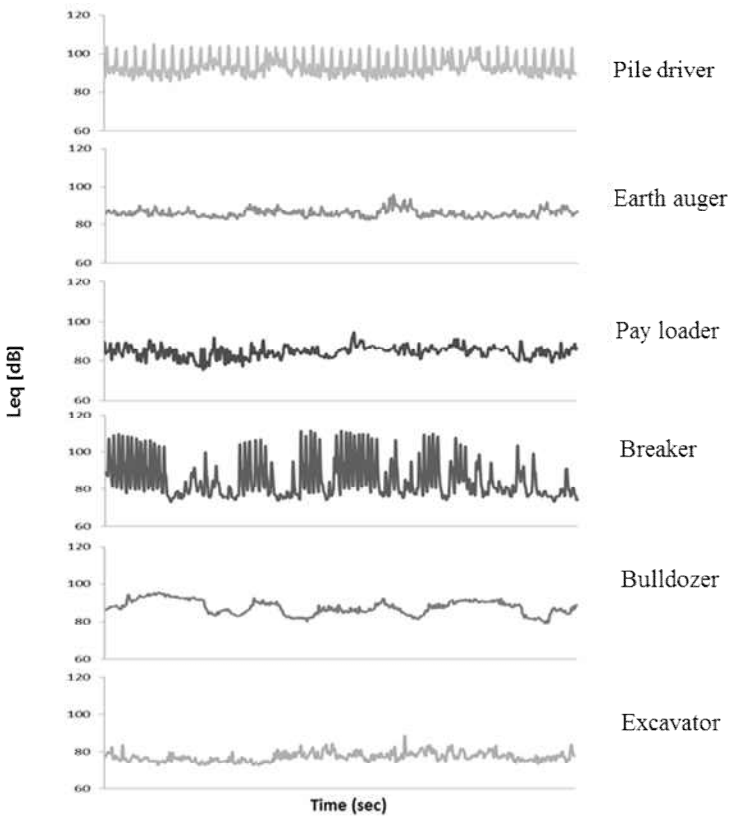

Figure 2: The temporal characteristics of six construction machineries for 1 minute

ANNOYANCE CAUSED BY SINGLE CONSTRUCION NOISE

Auditory experimental conditions

The annoyance of six individual construction noises was evaluated by auditory experiment. L_{Aeq} was varied from 40 to 90 dBA with an interval of 5dBA for each construction machinery so 66 stimuli were randomly presented to subjects. The duration of each stimuli was 10 sec and it takes 11 minutes to present all of stimuli for each subject. The sound levels were adjusted in amplitude without the spectral adjustment to the stimuli, resulting similar spectral characteristics of the stimuli at different levels. Headphone (Sennheiser HD 600) was used to play back and 11-point numerical scale was used to evaluate annoyance of subject. Background noise level of experimental room was 25 dBA.

Auditory subjective evaluation result

The annoyance of six individual noises was evaluated by residents and construction site engineers. Annoyance ratings with 0 as not at all and 10 as extremely for individual noises are plotted in the Figure 3. The annoyance for each construction machineries were increased according to increasing noise level. Statistical analysis was conducted and there is no difference of individual noise annoyance among construction machineries and between residents and engineers.

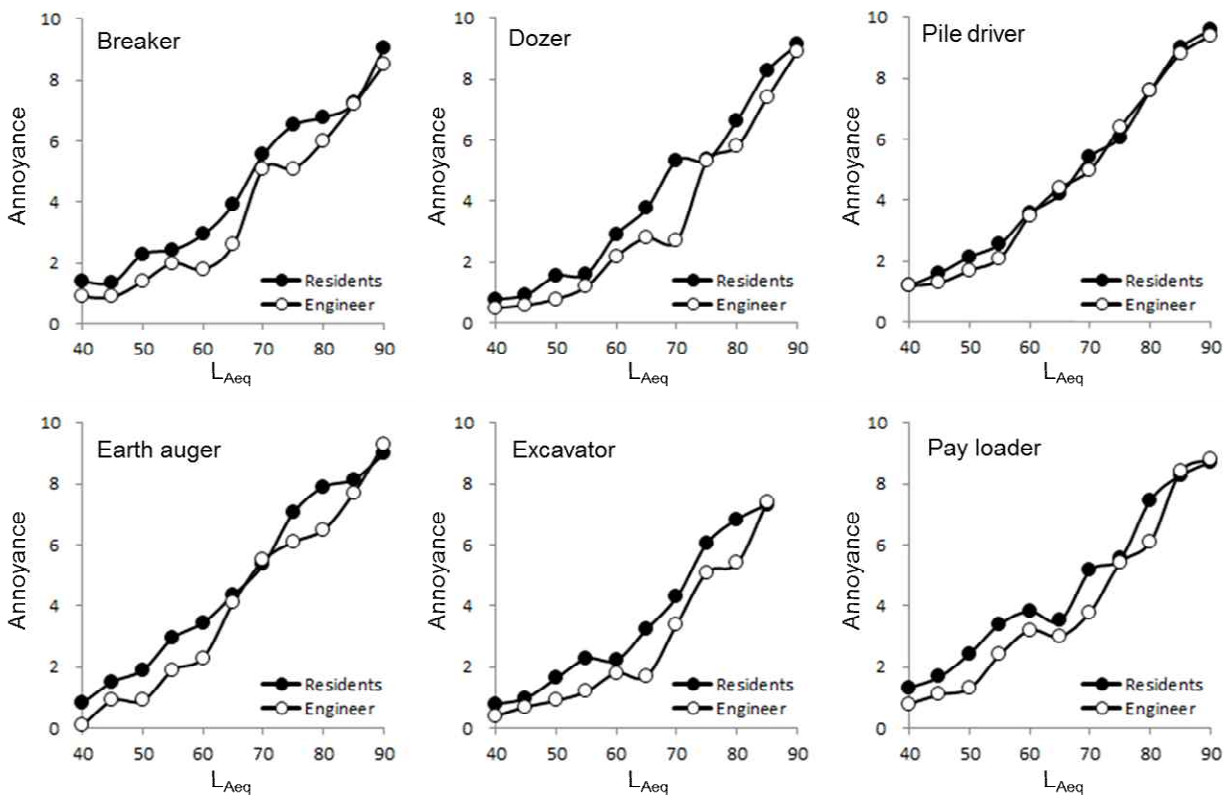

Figure 3: Annoyance caused by single construction machinery noise

ANNOYANCE CAUSED BY COMBINED CONSTRUCION NOISE

Auditory experimental conditions

The construction machineries were classified by construction periods: foundation (breaker, dozer, and excavator) and destruction (pile driver, earth auger, and pay loader). Impulsive noises including breaker and pile driver were combined with the other construction noises such as dozer, pay loader excavator, and earth auger. Annoyance for four combined construction noises was then evaluated by auditory experiment. L_{Aeq} was varied from 40 to 75 dBA with an interval of 5 dBA and the stimuli were randomly presented to the subjects. Other auditory experimental conditions were same as auditory experiment for single construction noise.

Auditory subjective evaluation result

Figure 4 shows the annoyance from four combined construction noises. Similar tendency with regard to annoyance were found in the four cases. Overall, annoyance rating scores decreased as SN ratio increased. However, variations in annoyance scores were not sensitive when background noise levels increased. Based on the results, it can be suggested that the reasonable SN ratios were ranged from 0 to 10 dBA.

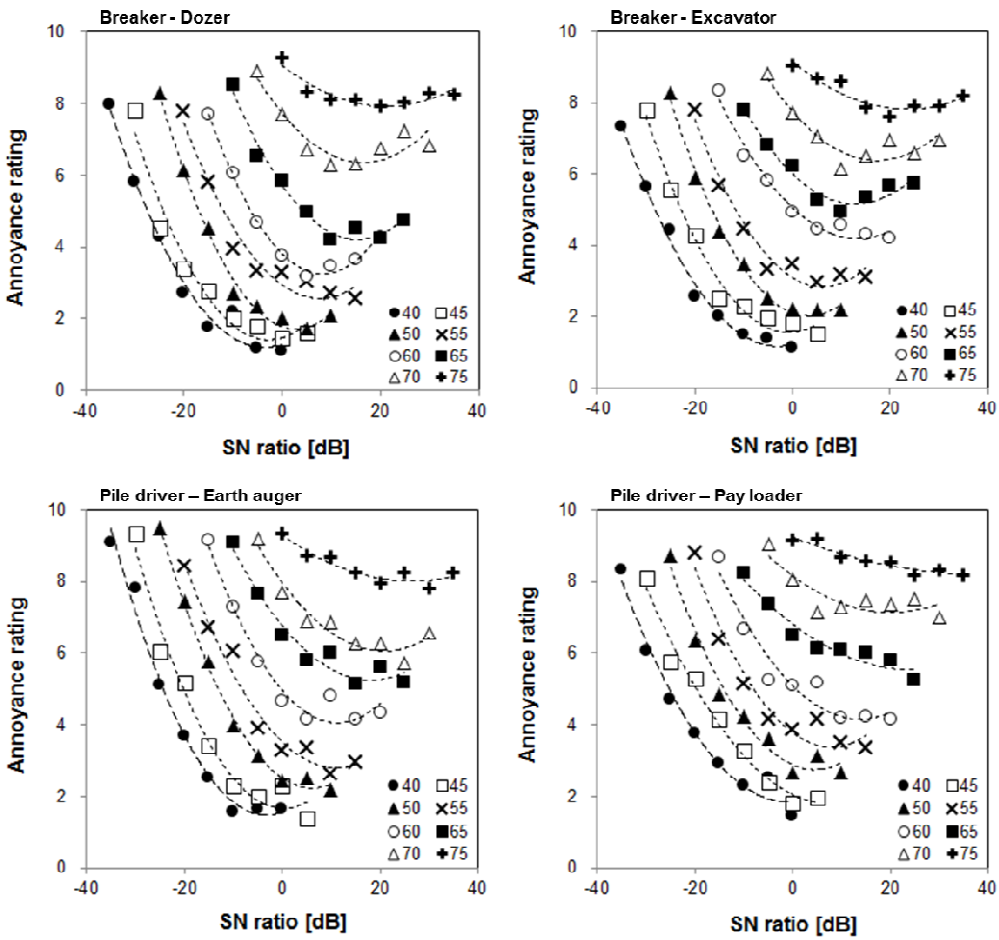

Figure 4: Annoyance caused by combined construction machinery noise

CONCLUSIONS

The auditory experiments were conducted for single construction machinery noise and combined construction machinery noises. The annoyance of six construction machinery noises those are pile driver, earth auger, pay loader, breaker, bulldozer and excavator were evaluated by auditory experiment. The annoyance of single construction machinery noise was increased according to increasing noise level. The annoyance of four combined construction noises was evaluated. The variations in annoyance scores were not sensitive when background noise levels increased. Based on the results, it can be suggested that the reasonable SN ratios were ranged from 0 to 10 dBA. This implies that there exists range of SN ratios for optimum level.

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