Fifth International Conference on Construction in the 21st Century (CITC-V)
"Collaboration and Integration in Engineering, Management and Technology"
May 20-22, 2009, Istanbul, Turkey

Noise Exposure of Construction Workers

Gülin Birlik
Department of Engineering Sciences, Middle East Technical University, Ankara, Turkey
birlik@metu.edu.tr

Abstract
Publication and acceptance of standards or directives relevant with the monitoring of noise in a construction site seems still not sufficient for the hearing and health conservation of the workers. It is now well known that the lower and upper noise action levels have to be respectively 80 dBA and 85 dBA. What is still not well established is the use of hearing protection devices, HPD, and the keeping of health follow-up records. In order to display the current conditions, two construction sites, namely an in-city construction site of a contractor and a state construction site are chosen. The working habits of the workers are observed and L_{Aeq} values are measured at the ear level of the operators. The L_{Aeq} values corresponding to the operator of the front loader (tracked excavator) was 93 dBA (79.5 dBA). The workers near to the excavator were exposed to a noise level of 75.6 dBA. None of the workers had worn HPD. The noise spectra are observed to contain Low Frequency Noise, LFN.

Keywords
Construction site, Noise exposure, Certificates, Health surveillance, Occupational health and safety

1. Introduction

Hazard identification and associated risk assessment is the fundamental subset of the construction safety management set. One of the main health hazards on the construction site is noise. In a recent survey (ASCC NHEWS survey, 2008) done by Australian Safety and Compensation Council (ASCC) it is found that 53% of the 655 construction workers are exposed to loud noise. Loud noise was defined as "noise so loud that people would have to raise their voice in order to be heard when speak to people who are one arm's length away from them". According to a suggestion mentioned in the paper written by Neitzel *et al*., (2009) the level of loud noise can be thought to be greater than 90 dBA. Workers in an 85-90 dBA environment are expected to shout for communication (May, 2000).The recognition of noise as a risk factor at the workplace brought forward some regulations, standards and even law relevant with it. Turkish Labor Law (No: 4857, Publication date: 22.5.2003) and associated directives and regulations try to organize healthy and safe workplaces for the workers. Occupational Health in Construction industry in particular is dealt first by a general directive on Occupational Health and Safety (No: 25311, publication date: 9.12.2003), OHSD, and then by sector specific, Health and Safety in Construction, directive, HSCD, (No: 25325, publication date: 23.12.2003).

In this study first an overview of the regulations and recommended standards relevant with occupational health and safety in construction industry will be presented. Then results of a pilot study done to assess the construction noise exposure levels pertaining to heavy equipment operators and Hearing Level, HL, data based on audiometric testing will be displayed.

2. Regulations Directives and Standards

It is a common knowledge that construction sites need a special Occupational Health and Safety (OHS) management system. The first step taken by the industry happens to be either to seek for an OHSAS 18001 and or (ISO 9001; ISO 14001) certificate. Figure1 displays the number of certified member firms of The Turkish Employers Association of Construction Industries, INTES, (INTES, (2008)). INTES is a member of Turkish Confederation of Employer Associations (TISK) who is in turn member of Business Europe.

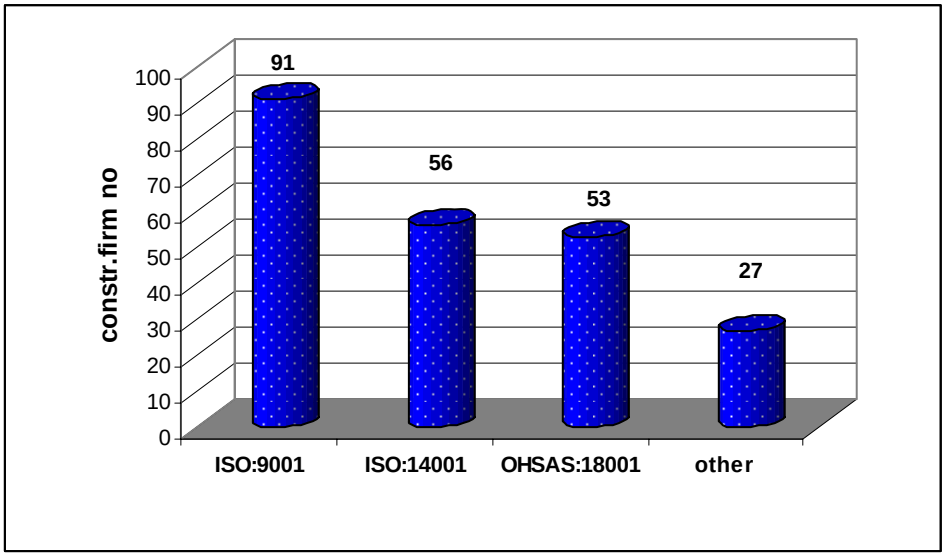

Figure 1: Construction Firms Having OHS Certification

It has to be noted that the firms having OHSAS: 18001 certification also have ISO: 9001 and ISO: 14001 certification. The associated Turkish standards are TS 18001, TS 18002, TS EN ISO 9001 and TS EN ISO 14001.

In 2003 Ministry of Labor and Social Security had published a general directive OHSD relevant with Occupational Health and Safety (OHS) at work. Article 6 of this directive held employers responsible for taking preventive measures, whenever necessary, for securing the health and safety of the workers. They have to know the risks relevant with their sector (they can refer to the risk list of the Ministry of Labor and Social Security), they have to prevent these risks or have to assess them and prepare a conservation program. They are also responsible of providing necessary information to the workers on health and safety precautions relevant with their tasks. Besides they have to train them before the start of their jobs and have to update their knowledge whenever there is a change in the equipment used and whenever a new technology is adopted. Employers are held responsible also for the job specific health surveillance of the workers (Section 4 of OHSD). Health surveillance is required to be done regularly during the job. Pre job health report will have to be submitted by the worker.

Health and Safety in Construction directive, HSCD, requires the preparation of a health and safety plan before the initiation of the construction. Article 6 of attachment 4 of HSCD deals with the special risks encountered in construction. According to article 6.1 employers will have to prevent hazardous noise exposure of the workers. The exposure limits are given in Turkish directive on the minimum health and safety requirements for the workers exposed to noise (No: 25325, publication date: 23.12.2003).

A comparison of the criterion level and the level required for the initiation of Hearing Conservation Program (HCP) with regard to various regulations is displayed in Table 1.

Table 1: Comparison of Regulations with Regard to Noise Levels

Government or Administering Agency	Criterion Level (dBA)	Requirement for HCP (≥ ….dBA)
Australian	85	85
EU	85	85
Japanese	85	85
NIOSH	85	85
OSHA	90	85
Turkish	85	85

In addition to ISO 9612:1997 the Turkish standards listed in Table 2 are followed while determining the occupational noise exposure of workers and the protection performance of hearing protection devices.

Table 2: Standards for OHS

Standard Name	Turkish Standard No (publication year)	Equivalent ISO No (publication year)
Determination of occupational noise exposure and estimation on noise induced hearing impairment	TS 2607 ISO 1999 (2005)	ISO 1999 (1990)
Guide to the measurement of airborne acoustical Noise and evaluation of its effects on man	TS 2673 (1977)	-
Hearing protectors Part 2:Estimation of effective A-weighted sound pressure levels when hearing Protectors are worn	TS EN ISO 4869-2 (1997)	ISO 4869-2 (1995)

3. Pilot Study

3.1 Noise Exposure of Workers

Two in-city highway construction (i.e., the industry sector estimated to have the highest percentages of overexposed workers, (Suter, 2002)) sites are chosen for the assessment of noise exposure of construction workers. One of the construction sites was a private site (Site 1) and the other a state site (Site 2). The construction firm had acquired ISO 9001; ISO 14001 and OHSAS 18001 certificates respectively in years 2004 and 2006.The research performed until now have shown that among the construction workers, operators of heavy equipment are the ones who are mostly affected by the construction noise. In this study therefore worker group of operators of heavy equipment, namely tracked excavator (working in site 1) and front loaders (working in site 2) are chosen in order to display the current state of task based noise exposure. Figures 2 and 3 display the variation of noise level (i.e., 1/3 octave band values) with respect to frequency, f. During the measurements (done by sound level meter) the guide lines suggested in TS 2607 ISO 1999 are followed. The number of measurements was respectively 6 and 9 for the loader and the excavator. Noise levels, NL, are measured at the level of the left ear of the operator. Even though A-weighted noise spectra are given in Figures 2 and 3, L-weighted measurements were also done. The operator of the excavator works generally four hours in the morning and five hours in the evening. It was also observed that besides lunch break there were ~ 70 minutes waiting periods during which the operator did not leave his place. The noise levels corresponding to this compulsory break period (i.e., the period during which operator waits for the return of the trucks) were also measured at the level of the left ear of the operator.

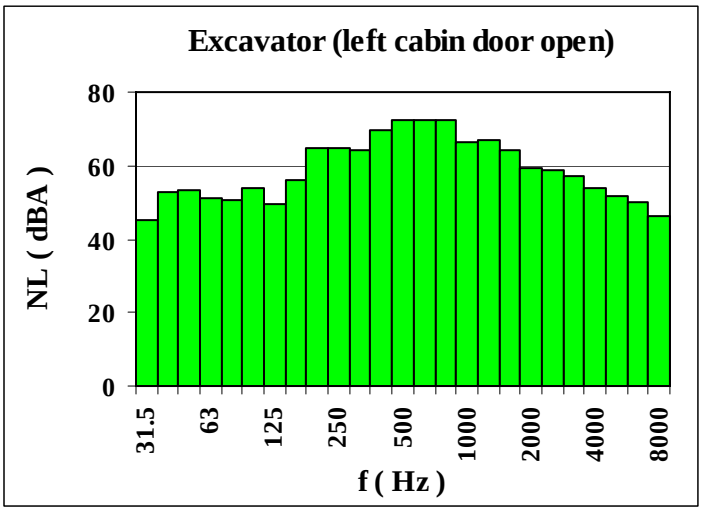

Figure 2: Noise Spectra of the Operator of the Excavator (Site 1)

In case of excavator there was a difference of ~ 2 dBA between the noise level exposures of the right and left ear of the operator. During the waiting period mentioned above the operator was exposed to a noise level of (L_{eq} =) 66.1 dBA.

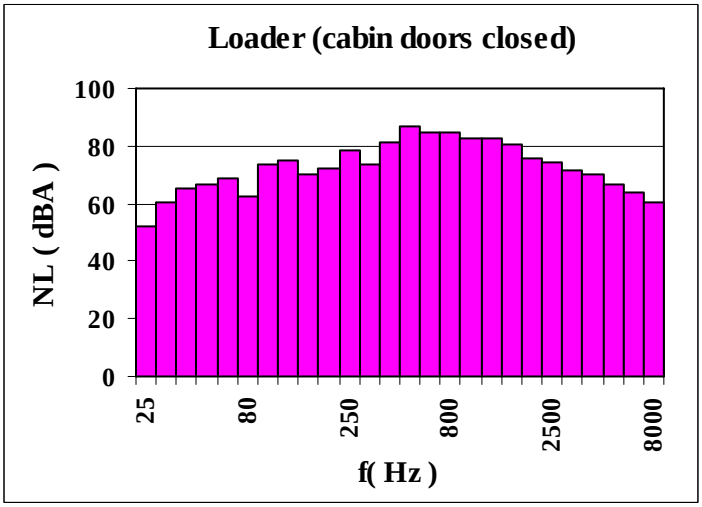

Figure 3: Noise Spectra of the Operator of the Loader (Site 2)

In case of loader whether the cabin doors are open or closed is found to be of not much importance to the operator. The noise level measurements at the operator's ear level, for cabin doors closed or open, have exhibited a difference of 1 dBA.

The sound level parameters relevant with the measurements are given in Table 3. Here $L_{AEP,d}$ indicates the personal exposure level of the operator for an exposed period of, d, hours and $L_{Ceq} - L_{Aeq}$ can be thought as a measure of low-frequency spectral content. Sound level parameters in Table 3 indicate that in case of the excavator operator the lower action value is reached. Whereas in case of the loader operator the exposure limit, 87 dBA, is exceeded.

Table 3: Discrete Noise Parameters

	Excavator (site 1) (model : 1996)	Loader (Site 2) (model : 1975)
Measurement time (min.)	2	3
L_{eq}	79.5 dBA (90.6 dBC)	93 dBA (104.2 dBC)
$L_{AEP,d}$	80 dBA (d = 9 hrs)	91.7 dBA (d = 6 hrs)
LF_{max}	95.7 dBA (103.7 dBC)	106.9 dBA (112.3 dBC)
LF_{max} / L_{eq}	1.20	1.15
$L_{Ceq} - L_{Aeq}$	11.10	11.20

It has to be noted that a worker who is working in the vicinity (~ 2 m) of the excavator(Figure 4) is exposed to a noise level ,NL, which is 3.9 dBA lower compared to the NL of the operator of the excavator during his work.

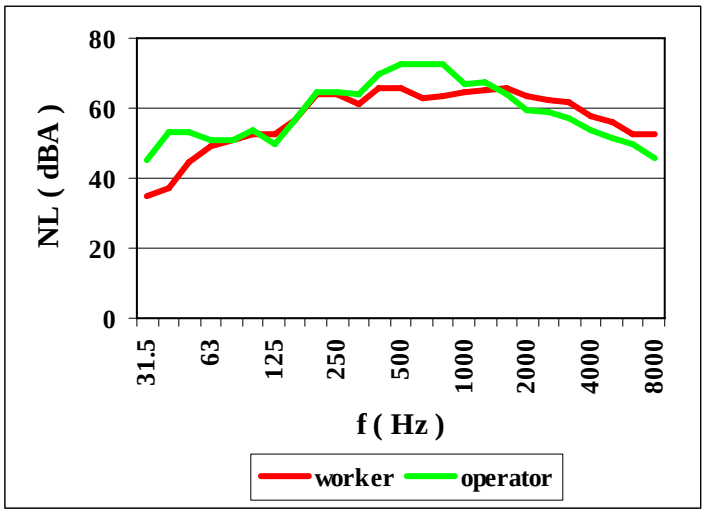

Figure 4: Comparison of the Noise Exposure of a Worker and an Operator (L_{eq} (worker) = 75.6 dBA, L_{eq} (operator) = 7 9.5 dBA)

3.2 Hearing Levels of Workers

As can be seen in Figure 1, out of 227 member firms of INTES, 23 % of the firms have ISO 9001, ISO14001 and OHSAS18001 certificates. Safety assessment surveys are still unavailable both in state sites and in private sites. Construction however is considered within the 5th group of risky work groups in the list (publication year: 2005) of Ministry of Labor and Social Security. In other words there has to be a doctor in the work place and the doctor has to work at least five working days per month. It has to be noted that if the number of workers do not exceed 50 the employer will feel free of not hiring a doctor.

Initiation of Hearing Conservation Program, HCP, in Turkey is suggested when 85dBA limit is exceeded. As can be seen in Table 1 there is a global agreement on this value. Among the construction sites considered in this study annual audiometric testing is done only in the state site (Site 2). Workers of site1 had been tested in 2005. Figure 5 shows the results of this test. Out of 43 workers only seven were reported as having slight difficulty in hearing. Workers of neither Site1 nor site2 wear hearing protectors.

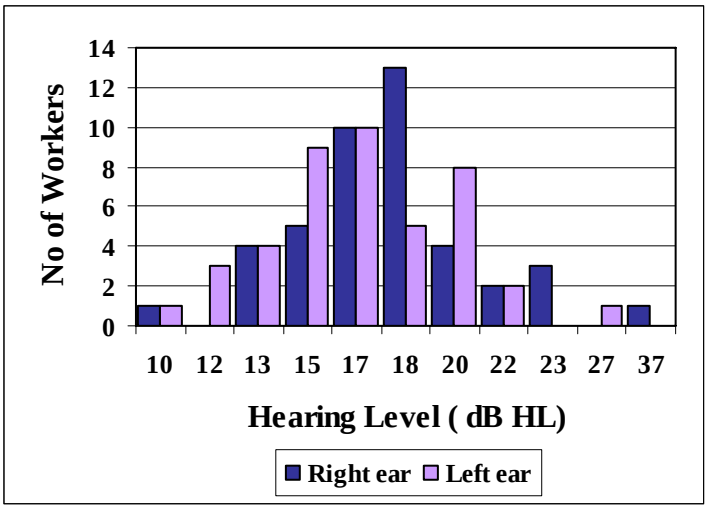

Figure 5: Hearing Thresholds by Ear (Site 2)

4. Concluding Remarks

According to the statistics (July 2008) of Turkish Statistical Institute (TUIK) the number of workers in construction industry is 769 923. Operators of Site 1 of this pilot study work between 8-12 a.m. and 13-16.30 p.m. but 9hrs /day is found to be a common practice. Operators of Site 2 work continuously (without break) at least one hour or at most six hours a day. They do not receive training relevant with occupational health and safety. Even though $L_{Ceq} - L_{Aeq}$ values are lower than 15 dB, both of the operators can be considered as exposed to a considerable amount of LFN. Even though noise is recognized as hazardous in the directives there is still no task based data about the noise exposure of the construction workers and also no regular health surveillance record. Noise management plan in construction sites is not widespread. Based on this pilot study it can be said that irrespective of the size of the construction site there is a need for (i) a comprehensive noise exposure survey (ii) a regular audio testing of the workers in construction sites. The much needed information seems to be obtainable much more easily in the sites having more than 50 workers compared to the small firms where there is no obligation for the presence of a health and safety personnel.

5. References

ASCC. (2008). NHEWS Survey: 2008 Results. Online at http: //www .ascc .gov.au.

INTES (2008). Information on firms having OHS certification is obtained from the General Secretary of INTES. INTES at http: //www.intes.org.tr

ISO 9612. (1997). Guidelines for the measurement and assessment of exposure to noise in a working environment.

May, J.J. (2000). "Occupational hearing loss". *American Journal of Industrial Medicine*, Vol.37, pp.112-120.

Neitzel, R., Daniell, W., Sheppard, L., Davies, H., and Seixas N. (2009). "Comparison of perceived and quantitative measures of occupational noise exposure". *The Annals of Occupational Hygiene,* Vol. 53, pp. 41-54.

Suter, A.H. (2002). "Construction noise: Exposure, effects and the potential for remediation; a review and analysis". *AIHA Journal*, Vol. 63, pp. 768-789.

TS 18001. (2008). Occupational health and safety management systems-Requirements, 2 nd ed.

TS 18002. (2004). Occupational health and safety management systems - Guidelines for the implementation of OHSAS 18001.

TS EN ISO 9001. (2008). Quality management systems-Requirements.

TS EN ISO 14001. (2005). Environmental management systems- Requirements with guidance for use.