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Full Length Research Paper

Noise level analysis of a bulldozer used in constructing a forest road in Mediterranean region of Turkey

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Heavy machinery utilized in forest operations, as one of the working environments with intensive noise disturbance, result detrimental effects on the workers' health. Particularly, high level noise generated from the road construction machines causes physiologic and psychological health problems on the operators. Among these problems, one of the most important occupational problems is hearing impairment or permanent hearing loss. In this study, the average and peak noise levels generated by a CAT D7G model bulldozer during two working stages (that is, unloaded running stage and road construction stage) of a road construction activity were measured from the operator cabin. The results indicated that the average noise levels for unloaded running stage and road construction stage were 73.87 and 84.11 dBA, respectively. The peak noise levels were measured as 95.90 and 113.40 dBA for unloaded running stage and road construction stage, respectively. Thus, it was found that the mean values of the average noise levels in both working stages were less than the warning limit of 85 dBA. The results also indicated that all of the peak noise levels were over the hazard limit of 90 dBA for both stages.

Key words: Ergonomics, noise, worker' safety, work machines.

INTRODUCTION

Heavy machineries have been intensively used not only in construction industries but also forestry activities especially in forest road construction. The operators of the heavy machines face some detrimental effects such as noise and vibration, depending on the work type, roughness of the work, and features of the machine (Neitzel and Yost, 2001). The high level noise caused by heavy machines is one of the most important effects on the human health (Piccolo et al., 2005; Doygun and Gurun, 2008; Erdogan and Yazgan, 2009).

A study carried out by Neitzel and Yost (2002) on forest workers in USA revealed that 46% of the workers were exposed to extremely high levels of noise. Heavy machines such as bulldozer, excavator, grader, and loader are commonly used in forest road construction and maintenance activities. The operators who operate these machines spend most of the working hours under high level noise. Depending on the level and duration of noise effect, the physiologic and psychological health problems can be observed on the employees, who work in an environment with high level of noise for long period of time (Durgut and Celen, 2004; Ozer et al., 2009). The previous studies and observations indicated that the most common physiologic health problems are hearing impairment, high blood pressure, heart diseases, and breathing problems, while the psychological problems may include uneasiness and nervousness (Quis, 2001; Serin and Akay, 2008). These health problems also result in reduction in labor productivity and motivation of the workers depending on the level and duration of noise (İlgürel and Sözen, 2005; Serin and Tutus, 2008).

The noise level of the heavy machines vary depending on many factors such as structural feature of the machine, location of the noise source, noise reflecting surfaces, operation technique, roughness of the work, and maintenance of the machine. The studies conducted on examining the effects of noise level on human health reported that the workers, who are exposed to average noise level of 85 dBA for 8 h, experience significant hearing impairment problems from a lifetime of exposure (Lutman, 2000). The noise level of 80 dBA and less may not result in significant problems on human health and its effect can be prevented by using personal hearing

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Table 1. The maximum noise limits for various construction machines.

Noise sources	Maximum limits(dBA)
Rock hammer	125
Bulldozer (100-450 kw)	120
Grader	120
Loader	115
Jackhammer	115
Crawler-shovel (40-60 kw)	110
Road roller (2-75 kw)	110
Excavator (45-80 kw)	105
Damper (1.2-2.5 ton)	100

Table 2. The maximum daily exposure times of the workers for various noise levels.

Noise levels(dBA)	Daily exposure times(h)
90	4
95	2
100	1
105	0.500
110	0.250
115	0.125

protections such as earplugs or earmuffs (Güvercin and Aybek, 2003).

According to the International Labor Organization (ILO), 85 dBA is set as the warning limit, while 90 dBA and above is set as the hazard limit with material risk. It was also reported that the noise level of 85 to 115 dBA may result in physiologic and psychological health problems. The workers exposed to noise level of 115 dBA or higher can suffer from permanent hearing loss problems. According to the previous studies, the hearing loss also varies depending on the age of the workers (McBride et al., 2003). Sabancı et al. (1985) reported that the hearing loss speed on tractor drivers was 17.36 dBA higher at younger ages.

The noise level to which the operators of the heavy machines are exposed should not exceed warning limit of 85 dBA; however, the noise level generally exceeds this limit in construction areas. Based on “Noise Control Regulations” in Turkey, the maximum noise limits for various construction machines were listed in Table 1 (Anonymous, 1986). According to this Table, the noise level of bulldozers used in road construction activities can not exceed 120 dBA. In order to protect the hearing of workers who are exposed to high level of noise, daily working hours of the workers should be determined based on noise level. Table 2 indicates the maximum daily exposure times of the workers for various noise levels (Güvercin and Aybek, 2003).

MATERIALS AND METHODS

In this study, the noise level of a CAT D7G model bulldozer was analyzed during a forest road construction activity in the city of Kahramanmaraş, in Mediterranean region of Turkey (Figure 1). The road was constructed on a karst topography shaped by the layers of soluble bedrocks such as limestone or dolomite. The technical specifications of CAT D7G are presented in Table 3. The width, height, and length of the operator cabin are 1.42, 1.50 and 1.15, respectively. In the study area, the average slope and elevation were measured as 42% and 1320 m, respectively.

To analyze the noise level which to the bulldozer operator is exposed, the level of noise generated by the bulldozer was measured from the operator cabin for two working stages including unloaded running stage and road construction stage. DELTAOHM HD 2010 model sound meter was used to measure the average and peak noise levels for 3 min long with 1 s intervals. At the time of the study, there was not any noise source around the study area other than the bulldozer.

Before starting the measurements, the sound meter was calibrated based on 110 dB(A) generated by the bulldozer. When measuring the noise level in the operator cabin, the sound meter was placed in a location which was as close to the ears of the operator as possible. Finally, the noise measurements were recorded and then analyzed by using ANOVA method in SPSS statistical program.

RESULTS AND DISCUSSION

The average road gradient for the road section was measured as about 10%. The plan view of the road section was generated based on the UTM coordinates, which was obtained by using a hand GPS along the roadway during the field studies (Figure 2).

The general statistics for the average and peak noise levels measured during the working stages (that is, unloaded running stage and road construction stage) were listed in Table 4. The average noise levels measured during the working stages indicated that there was a significant difference between the noise levels recorded in unloaded running stage and in road construction stage ($p < 0.005$).

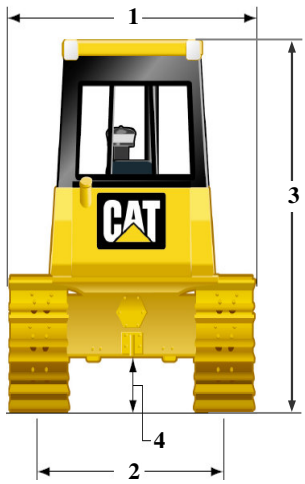
The average noise levels were measured as 73.87 and 84.11 dBA for unloaded running stage and road construction stage, respectively. The maximum average noise level (89.50 dBA) was measured during the road construction stage. This value was 11.7 dBA higher than the maximum noise level measured during the unloaded running stage. However, the minimum noise levels measured during unloaded running stage (73.10 dBA) and road construction stage (74.10 dBA) were found to be very close.

The results indicated that the noise levels measured during the unloaded running stage were less than 80 dBA. The negative effects of up to 80 dBA noise level on human health can be prevented by simple precautions (Güvercin and Aybek, 2003). However, the mean value of

Figure 1. CAT D7G model bulldozer.

Table 3. The technical specifications of CAT D7G.

Specifications	Values
Weight	20580 kg
Width (1)	2.56 m
Track gauge (2)	1.98 m
Height (3)	3.29 m
Ground clearance (4)	0.35 m
Length	4.20 m
Shoe Width	0.56 m
Flywheel power	150 kW (202 hp)
Speed: 1.0 forward	3.9 km/h
2.0 Forward	6.4 km/h
3.0 Forward	9.9 km/h
1.0 Reverse	4.5 km/h
2.0 Reverse	7.8 km/h
3.0 Reverse	12.7 km/h



the average noise levels in road construction stage was very close to the warning limit of 85 dBA, which can result in significant hearing loss problems from a lifetime of exposure (Lutman, 2000).

The statistical analysis indicated that the difference between the peak noise levels recorded in unloaded running stage and in road construction stage was also statistically significant ($p < 0.005$). The average values of peak noise levels measured for unloaded running stage and road construction stage were as 95.90 and 113.40 dBA, respectively. The maximum peak noise level was measured during the road construction stage as 129.20 dBA, which was 19.8 dBA higher than that of measured during the unloaded running stage. The minimum noise level measured during road construction stage was also slightly higher (4.3 dBA) than the noise level measured during unloaded running stage. The results also indicated that all of the peak noise levels were over the hazard limit

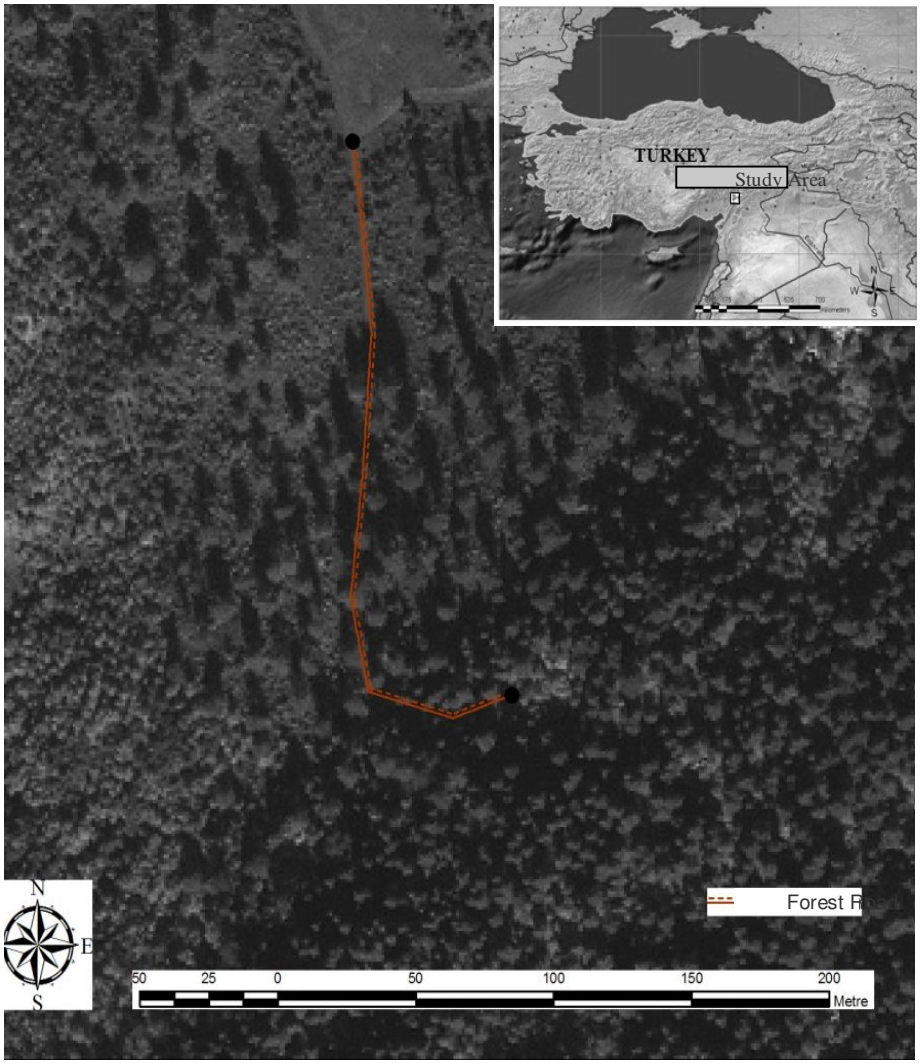


Figure 2. Plan view of the road section on air photo of the study area.

Table 4. The general statistics for the noise levels (dBA) measured during the work stages.

Noise levels	Working stages	Mean	Std. Dev.	Std. error	% 95 Conf. Intr.		Min.	Max.
					Lower	Upper		
Average values	Unloaded running	73.87	1.27	0.23	73.40	74.33	73.10	77.80
	Road construction	84.11	2.86	0.22	83.67	84.54	74.10	89.50
Peak values	Unloaded running	95.90	3.43	0.62	94.64	97.16	93.90	109.40
	Road construction	113.40	4.11	0.32	112.77	114.03	98.20	129.20

of 90 dBA for both stages. If the noise level exceeds the hazard limit, the hearing of exposed workers should be protected by reducing exposure time or reducing the level of noise reaching their ears (Lutman, 2000). Besides, the peak noise levels measured during the road construction stage reached up to 129.20 dBA, which may results in permanent hearing loss problems, if exposure time exceeds 1/8 h/day (Güvercin and Aybek, 2003).

CONCLUSIONS AND RECOMMENDATIONS

The average and peak noise levels generated by a CAT D7G model bulldozer were measured during two working stages (that is, unloaded running stage and road construction stage) of a road construction activity. The results from the noise level analysis indicated that the mean values of the average noise levels for both working

stage were less than the warning limit of 85 dBA. However, the average values of peak noise levels were over the hazard limit of 90 dBA for both stages. The interviews and observation during the field studies indicated that the bulldozer operator suffers from hearing loss problems. It was also found that the operators, who are exposed to high level of noise for long exposure time, experience psychological problems such as uneasiness and nervousness. These problems result in reduction in labor productivity with respect to the level and duration of noise. Some of the precautions should be taken in the noise source to reduce the level of noise and safety measures must be taken to protect the operators from the negative effects of excessive noise. The precautions that should be taken against the bulldozer as the noise source in this study include:

1. The pieces that generate high level of noises due to vibration should be isolated from the main body of the bulldozer
2. The pieces that affect the level of the noise (radiator fan) should be replaced on a regular basis
3. To reduce the noise generated by the engine, engine hood should be isolated accordingly
4. Appropriate maintenance methods should be applied on the machine by following a specified timetable.

The safety measures must be taken to protect the operators include:

1. The operators should be informed about the potential risks of the high level noises on human health
2. The daily working hours of the operators should be determined based on noise level and appropriate resting times should be arranged
3. The operators should use their earplugs properly
4. Hearing check of the operators must be made periodically and health records should be kept regularly.

REFERENCES

Anonymous (1986). Noise Control Regulations. Official Gazette: 11.12.1986- 19308, p. 17.

Doygun H, Gurun DK (2008). Analysing and Mapping Spatial and Temporal Dynamics of Urban Traffic Noise Pollution: A Case Study in Kahramanmaraş, Turkey. Environ. Monit Assess., 142: 65-72

Durgut MR, Celen H (2004). Noise levels of agricultural machineries. Pakistan J. Biol. Sci., (7): 895-901

Erdogan E, Yazgan ME (2009). Landscaping in reducing traffic noise problem in cities: Ankara case. Afr. J. Agric. Res., 4(10): 1015-1022

Güvercin Ö, Aybek A (2003). Noise Problem in Stone Pulverizing and Sieving Plants. KSU J. Sci. Eng., 6(2): 101-107

İlgürel N, Sözen MŞ (2005). Objective and Subjective Examinations Related to the Noise Factor in Noisy Plants and Analyses of the Noise Regulation. YTU, Faculty of Architecture. Electr. J. 1(1): 9-17

Lutman ME (2000). What is the risk of noise-induced hearing loss at 80, 853 90 dB(A) and above? Occup. Med., 50(4): 274-275

McBride DI, Firth HM, Herbison GP (2003). Noise exposure and hearing loss in agriculture: A survey of farmers and farm workers in the southland region of New Zealand. J. Occup. Environ. Med., (45): 1281-1288.

Neitzel R, Yost M (2001). Task-based Assessment of Occupational Vibration and Noise Exposures in Forestry Workers. The International Mountain Logging and 11th Pacific Northwest Skyline Symposium, 10-12 December, Seattle, Washington, USA, pp. 21-27.

Ozer S, Yilmaz H, Yesil M, Yesil P (2009). Evaluation of noise pollution caused by vehicles in the city of Tokat. Turkey. Sci. Res. Essay, 4(11): 1205-1212.

Piccolo A, Plutino D, Cannistraro G (2005). Evaluation and analysis of the environmental noise of Messina, Italy. Appl. Acoust., 66(4): 447-465.

Quis D (2001). Annoyance from road traffic noise: A review. J. Environ. Psychol., 21: 101-120.

Sabanci A, Özgüven F, Özşahinoğlu C, Özsoy F (1985). Noise analysis on agricultural tractors and its effects to hearing ability. VIII. Joint Ergonomics Symposium. 9-12 September Silsoe, U.K, pp. 20-30.

Serin H, Akay AE (2008). The Analyses of Noise Level During Tree Bucking Operation. XIV. National Congress of Ergonomics. 30 October-1 November. Trabzon, Turkey, pp. 412-416.

Serin H, Tutus A (2008). The Noise and Light Level Analysis in Paper Mills. XIV. National Congress of Ergonomics. 30 October-1 November. Trabzon, Turkey, pp. 204-210.