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# Ensuring Construction Equipment Workers Safety based on Noise Dosimeter Study

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***ABSTRACT***

*Noise is defined as any loud, discordant, or disagreeable sound, international health and safety regulation provides permissible noise exposure limit, it should not exceed 85 dBA. Any noise >85 dBA can cause hearing loss. Focus of this study was to determine the noise exposure and prevalence of hearing noise among the workers in stone crusher and sawmill industry. The noise dosimeter SC310 was used to obtain noise levels and noise dose in different zones of stone crusher and sawmill. The audiological effects such as poor speech discrimination, hear loss, and giddiness, and non-audiological effects such as headache, migraine, anxiety, and high blood pressure depression. were observed among the workers during interview session and the authors have also observed that the workers were having poor hearing capability in responding to the question asked. A total of 13 workers in stone crusher and sawmill were evaluated. The results show that workers were exposed to noise 89.1-104.5 dBA and noise dose 300.4-7570.8% dBA in stone crusher and in sawmill workers were exposed to noise 87.4-93.25 dBA and noise dose 130-515.6%. None of the workers used hearing protective devices such as earplug, earmuff, and ear foam plug. These exposed workers were suggested to have an annual audiometric tests to determine degree of hear loss, hearing sensitivity, and severity of hearing loss as early as possible.*

***Key words:*** *Noise exposure, Noise dose, Noise effects, Hearing protection devices, Audiometric test, Stone crusher, Sawmill.*

## 1. INTRODUCTION

The construction industry such has stone crusher and sawmill normally generates high sound level and high noise dose and put the workers at an overexposed risk. The noise from those industries ranges from 85 to 120 dBA. The labor code of India has suggested to limit the working hours for 8 h, but the workers are working beyond 8 h, they may have high noise dose and time-weighted average (TWA). Tables 1 and 2 give the Occupational Safety and Health Administration (OSHA) and National Institute of Occupational Safety and Health (NIOSH) specification tells those equivalent unprotected noise exposures that produce a 100% noise dose [1]. If the workers are crossing those limits, the hearing protection devices should be preferred. The most of the worker lose their hearing ability after years of working in that industry. Not only the high noise level and high noise dose are responsible to cause hearing loss, but also there are other parameters such have type of noise (continuous noise, impact), intensity of noise, duration of exposure, source distance, and workers age which determine the degree and extent of hearing loss. The continuous exposure of high noise level and high noise dose is also associated with other health effects such has increased in diastolic blood pressure and cardiovascular disease risk [2-4]. In developing country like India, there is a huge demand for aggregate and timber. In these Industries, the workers are exposed to more than 85 dbA for a period of 8-12 h. In country like India, there is a lack of awareness among the workers in industry. The company owners are not taking initiative to provide earplug, earmuff, and workshop are not conducted regarding hazardous noise exposure; hence, the study was carried on stone crusher site and sawmill area to access the occupational noise exposure among the workers and conducting the interview session.

## 2. INSTRUMENTATION

The SC310 shown in Figure 1 is a class one integrating sound level meter (SLM) conforming to EN 60804 and EN 61672, it is a perfect instrument to carry out measurement with the worker present or not. The SC310 also compiles with the American standards ANSI S1.4 and ANSI S1.43. The SC310 measures simultaneously the equivalent level with frequency

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**Table 1:** OSHA specification [1].

| Level (dBA) | Duration | Dose % |
|---|---|---|
| 90 | 8 | 100 |
| 95 | 4 | 100 |
| 100 | 2 | 100 |
| 105 | 1 | 100 |
| 110 | 30 min | 100 |
| 115 | 15 min | 100 |

OSHA=Occupational Safety and Health Administration

**Table 2:** NIOSH specification [5].

| Level (dBA) | Duration | Dose % |
|---|---|---|
| 85 | 8 h | 100 |
| 88 | 4 h | 100 |
| 91 | 2 h | 100 |
| 94 | 1 h | 100 |
| 97 | 30 min | 100 |
| 100 | 15 min | 100 |

NIOSH=National Institute of Occupational Safety and Health


**Figure 1:** Noise dosimeter and kit.

weighting A, daily noise exposure level (LEX, 8 h), and noise dose referred to a programmable criterion level ($L_C$) and also the peak level with frequency weighting ($L_{peak}$). The SC310 enables the measurement to be carried out during a time shorter than the exposition time; it also shows all the parameters projected to the expected exposure time (programmable projection time $t_p$). Moreover, it is helpful to design and run a reduction program and to choose suitable hearing protectors. The communication software was provided with the SC310 (capture studio).

## 3. METHODOLOGY

One of the stone crusher and sawmills has been selected near Srirangapatna, Mandya District to measure occupational noise exposure among workers. An official permission is taken from the corresponding authority to carry out the measurements. The initial survey was conducted to identify the place of work where the noise is beyond the limit. It is advisable to check the instrument before starting the measurements. Select the sound pressure level with fast weighting LAF; the calibrator CB006 was introduced into the microphone, it generates a tone of 94 dB at 1 kHz. Check the value in the SC310 using SLM mode so that it should show 94 dB in the big screen. Prior adjustments have to be done before beginning a measurement. The following parameters should be set $L_c$ criterion level=85 dB, $t_p$ projected time=8 h, and integration time (T)=01 s. The whole stone crusher and sawmill area was differentiated into different zones such as red zone where the noise level was more than 100 dBA, orange zone where the noise level range was 95-100 dBA, yellow zone where the sound level range was 90-95 dBA, and blue zone where the sound level was 85-90 dBA. CESVA capture studio software is used to obtain the digital format and data acquired by the SC310. After the measurement of noise exposure and sound pressure level, the interview sessions with the workers in stone crusher and sawmill were conducted. This study was focused on workers who are exposed to high noise level in stone crusher and sawmill area. A total of 8 workers in stone crusher and 5 workers in sawmill were working. The measurements were taken in different zones for 4 h, and it was projected over 8 h. All workers were male and full-time contract basis. Most of the workers were working throughout the week. They will start the work at 6:00 am to 6:00 pm in stone crusher the working hours was around 10-12 h. The sawmill workers will start the work at 9 am and finish work at 6 pm, the working hours around 8-10 h.

## 4. RESULTS AND DISCUSSIONS

Tables 1 and 2 are the OSHA and NIOSH specification for permissible noise dosage corresponding to TWA and exposure time. Tables 3 and 4 summarize the results of occupational noise exposure of workers in stone crusher and sawmill which includes noise Dose for 4 h and it is projected for 8 h, TWA for 4 h, projected TWA for 8 h, and $L_{peak}$ values are obtained. The worker in the stone crusher was exposed to noise dose of 150.2-3785.4% for 4 h and 300.4-7570.8% for 8 h, corresponding range for TWA for 4 h is 87.6-103.2 dBA and 89.1-104.5 dBA for 8 h, which exceeds the permissible limit of OSHA and NIOSH specification. Coming to the workers in sawmill were exposed to noise dose of 65.12-257.81% for 4 h and 130-515.6% for 8 h and corresponding TWA range for 4 h. 86.2-92.37 dBA and TWA for 8 h 87.4-93.25 dBA, which exceeds the permissible limit of OSHA and NIOSH. The TWA of the workers which fall below the criterion level (85 dBA) is considered as safe working environment. Figure 2 shows the sound profile as found in the worksite indicating the position of

the workers. From the Figure 2, it is clear that the workers are exposed to higher noise dose.

## 5. INTERVIEW FEEDBACK EVALUATION

Based on the interview feedback, all workers do not undergo any audiometric test. The owner has not supervised all the workers during working period. Table 5 summarizes the other information obtained during the interview sessions with 13 workers in stone crusher and sawmill. The demographic information of the workers shows the working experience is from 7 months to 25 years and age of workers is from 22 to 52 years. The workers were not wearing any hearing protection devices such as earplugs and earmuffs. In the term of awareness and perception of noise exposure, all the workers were not aware of noisy working environment and health problem due to noisy environment. All the workers reported that they have health problems which include daily headache, migraine, frequent fever, high blood pressure, cardiovascular problem, and poor speech discrimination. The owner had not taken the initiative to provide a workshop on noise hazard and provision of hearing protection devices. Similar feedback analysis has been made in the earlier studies as well [6].

## 6. DISCUSSION AND CONCLUSION

In this study, noise dosimeter is used to monitor the construction workers safety and to understand the seriousness of the noise exposure. Dosimeters measure all essential parameters for workplace noise regulations such as daily exposures and peak levels. To use the experimental data very effectively and to serve a purpose, this data must be easily accessible and be presented in a format that is comprehensible to all those concerned. Use of modern software will give the dosimeter user; the ability to store data in a format that accounts for who was being measured, when these measurements were taken, and at what worksite. The latest software can output data into reports automatically including the average and peak time history; in addition to all other required data for noise regulations.

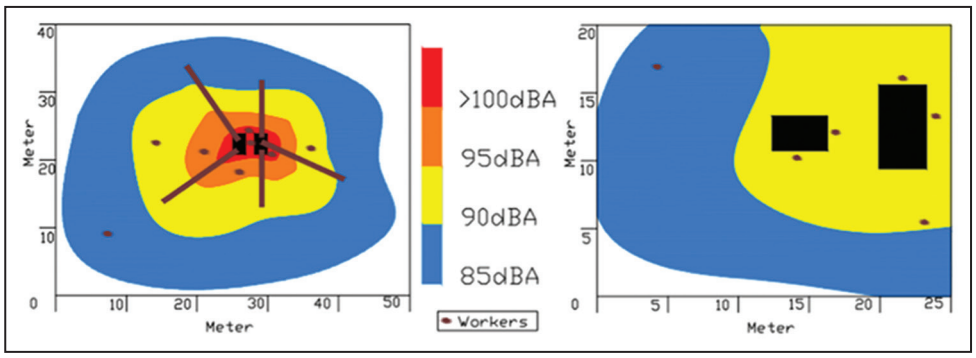


**Figure 2:** Sound profile of stone crusher and sawmill.

**Table 3:** Summary of occupational noise exposure among the workers in stone crusher.

| Worker location | No of workers | Noise dose, % for 4 h | TWA for 4 h in dBA | Projected noise dose, % for 8 h | Projected TWA for 8 h | $L_{peak}$ dBA |
|---|---|---|---|---|---|---|
| Red zone >100 | 3 | 3785.4 | 103.2 | 7570.8 | 104.5 | 126.3 |
| Orange zone 95-100 | 2 | 650.50 | 96.2 | 1300 | 97.8 | 116 |
| Yellow zone 90-95 | 2 | 220.81 | 92.3 | 441.76 | 93.4 | 105 |
| Blue zone 85-90 | 1 | 150.2 | 87.6 | 300.4 | 89.1 | 96 |

TWA=Time weighted average

**Table 4:** Summary of occupational noise exposure among the workers in sawmill.

| Worker location | No of workers | Noise dose, % for 4 h | TWA for 4 h in dBA | Projected noise dose,% for 8 h | Projected TWA for 8 h | $L_{peak}$ dBA |
|---|---|---|---|---|---|---|
| Red zone >100 | - | - | - | - | - | - |
| Orange zone 95-100 | - | - | - | - | - | - |
| Yellow zone 90-95 | 4 | 257.81 | 92.37 | 515.6 | 93.25 | 118.23 |
| Blue zone 85-90 | 1 | 65.12 | 86.2 | 130 | 87.4 | 94.17 |

TWA=Time weighted average

**Table 5:** Summary of interview feedbacks among stone crusher and sawmill workers.

| Location | Worker | Age | Working experience | Noise working environment | Health problem | Provision of earplug and muffs | Workshop on noise hazard |
|---|---|---|---|---|---|---|---|
| Stone crusher | W1 | 22 | 7 months | Yes | Yes[1][2] | No | No |
| | W2 | 30 | 7 years | Yes | Yes[2] | No | No |
| | W3 | 34 | 3 years | Yes | Yes[1] | No | No |
| | W4 | 28 | 4 years | Yes | Yes[1] | No | No |
| | W5 | 32 | 6 years | Yes | Yes[1][3] | No | No |
| | W6 | 32 | 4 years | Yes | Yes[1][2] | No | No |
| | W7 | 42 | 10 years | Yes | Yes[2] | No | No |
| | W8 | 44 | 15 years | Yes | Yes[1][2][3] | No | No |
| Sawmill | W9 | 34 | 5 years | Yes | Yes[1] | No | No |
| | W10 | 30 | 7 years | Yes | Yes[1] | No | No |
| | W11 | 43 | 8 years | Yes | Yes[1] | No | No |
| | W12 | 48 | 18 years | Yes | Yes[1][2] | No | No |
| | W13 | 52 | 25 years | Yes | Yes[1][2][3] | No | No |

[1]=Head ache, [2]=High blood pressure, [3]=Migraine, W=Worker

Noise dosimeters are crucial in noise study and monitoring in all construction environments, with its highly mobile workers and varying noise exposure. Noise dosimeters provide valuable information using logged time history data that show exactly when and where specific noise exposure took place (Figure 2). These details allow the implementation of proper controls to prevent hearing damage, which is the true end goal of any noise survey. In the present study, it is found that the workers are exposed to noise which is more than that specified by the regulating authority and worker are prone to health hazard. In India, workers at all construction sites should be properly educated in this direction to control the sound hazard and to ensure proper occupational safely. Figure 3 shows the comparison of noise exposure among the workers in different zones of stone crusher and saw mill with the criterion level 85 dB (A). TWA for 4 hours and 8 hours in any zone of stone crusher and saw mill which fall below the criterion level 85 dB (A) is considered as safe working environment.

The workers in stone crusher and sawmill were exposed to the excessive noise level, and dose within for 4 h, and they may have a high dose and level within 8 h of working period. The results were obtained from the sample of the workers. This study revealed that most of the workers are exposed to high noise level during the working period. Although there are earplugs and earmuff, these are not so effective in reducing noise level. It is the duty of the owner to have annual audiometric test, and to maintain the records. Through audiometric test, hearing loss, severity of hearing loss, frequency specific information, and hearing management of workers can be addressed. The government of India should bring strict rules and regulations for the safety of the workers and they should also take initiative to check whether these rules and regulations are implemented and followed.

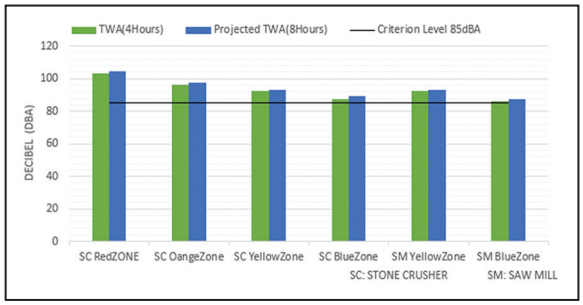


**Figure 3:** Represents the comparison of noise exposure in different zones with the criterion level 85 dBA.

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****Bibliographical Sketch***

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