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Evaluation of Occupational Environment in Two Textile Plants in Northern India with Specific Reference to Noise

Raman BEDI

Department of Mechanical Engineering, National Institute of Technology, Jalandhar , Punjab, India

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Abstract: Occupational Noise exposure has been linked with a range of negative health effects by various researchers. The resulting injury of occupational hearing loss is also a well recognized and global problem. To protect workers from hearing damage due to noise exposure and other related health effects, a vast store of knowledge has been accumulated till date about its nature, etiology and time course. There is still ignorance, amongst majority of people working in industries in developing and third world countries including India about ill effects of exposure to high values of noise. The study being reported here has been carried out in two textile plants located in Northern Indian state of Punjab. Equivalent sound pressure level L_{eq} has been measured in various sections of these plants with the help of a Class-I type digital sound level meter. The noise spectrum has been evaluated with the help of 1/3 octave filter set. A cross sectional study involving 112 workers exposed to different levels of occupational noise has been conducted. The results of the study establish the fact that noise level in certain sections of the plants i.e Loom Shed, Spinning, Ring Frame, TFO Area is more than the acceptable limit of 90 dBA for 8 h exposure stipulated by OSHA. The noise level in other sections like carding, blow room, combing etc., although is less than 90 dB(A) , but is quite higher than limits used for assessment of noise for community response. Octave band analysis of the noise shows the presence of high sound level in 4,000 Hz frequency range, which can be a major reason for causing occupational hearing loss. The results of the interview questionnaire which included a number of parameters reveal the following; (i) only 29% workers are aware about the effects of noise on health (ii) 28% workers are using ear protectors (iii) the satisfaction with the working environment is related to noise level, as workers exposed to comparatively less noise level report better satisfaction (iv) 70% of the workers reported that high noise level causes speech interference (v) 42% workers report the noise to be annoying. The study thus demonstrates the presence of gross occupational noise exposure in both the plants and the author believes that occupational noise exposure and the related effects in India is a widespread problem.

Key words: Textile industry, Occupational health, Noise exposure

Introduction

General

Development of modern automated machines in Industries has considerably decreased the physical burden of work on workers in addition to increasing the productivity of the industrial enterprises. But one of the most undesirable and unavoidable by-product of these operations and machines is noise pollution. Industrial workers, thus are exposed to these high noise levels because of their occupation. High level noise, not only hinders communication between workers, but, depending upon the level, quality, and exposure duration of noise, it may also result in different type of physical , physiological and psychological effects on the workers.

*To whom correspondence should be addressed.

Noise in textile industries

High noise levels have been traditionally taken for granted in Textile Industries. The noise because of clatter of gears, high speed whine of twisting and spinning machinery and impact noise of looms have long been regarded as necessary evils of the trade. Most of the machinery in use today is more or less unchanged from the design of three decades ago. The only significant difference today is that these machines now run at very high speeds. As might be anticipated, this trend towards greater speeds has resulted in higher noise levels, often exceeding 110 dB(A) in some operations. Despite the fact that spinners and weavers have been found to have significantly greater hearing loss than a controlled unexposed population, little progress has been made in reducing noise in textile industries.

A number of studies have been carried out in last few decades to evaluate the occupational environment in textile industries. Most of the studies have been carried out in developed countries, whereas a large proportion of textile industries over the world are located in developing countries like India.

Ohrstrom *et al*.[1] investigated the subjective noise annoyance among workers in a textile mill and machine factory. The results show that annoyance due to noise exposure is common in both the factories. The authors suggest the use of industrial noise exposure criteria based on annoyance, rather than hearing damage criteria.

Bailey *et al*.[2] presented the noise control measures adopted in textile industries. The authors highlighted the problem of high noise levels in the range of 100 to 110 dB(A) encountered in industries and also stated that very few noise control measures are being adopted in textile industries. Yhdego[3] investigated the occupational noise exposure of workers in textile industries in Tanzania. The results of the investigation indicate gross occupational exposure to noise in these industries where more than 30% of the workers are exposed to noise levels exceeding 90 dB(A).

Bhatt *et al*.[4] has reviewed the various aspects of noise pollution in textile industries in India. Case studies reported in the report suggest the presence of high noise levels of the range of 90 to 106 dB(A) in various sections like ring frame, carding, loom shed etc. Further methods to control noise have been suggested.

Effects of noise

The study of general adverse effects of exposure to occupational noise has been a topic of active research and debate among researchers. Occupational noise exposure, in addition to causing damage to hearing has been found to be associated with a range of indicators of physical health, including cardiac problems[5], sickness related absenteeism[6] and self reported fatigue. Performance related effects of occupational noise have also been studied by a number of researchers. Bedi *et al*.[7] evaluated the hearing loss associated with exposure to impact noise of drop forge hammers. The study reveals that workers in these forging units are exposed to high value of impact noise and NIPTS has been observed in most of the subjects.

Directive for noise control

In order to limit high level occupational noise, maximum permissible occupational noise exposure limit in the range of 85–90 dB(A) L_{eq} for 8 h/d (40 h/wk) has been allowed by the International Standards Organisation (ISO), EEC and other developed countries. United Kingdom, Belgium, Italy, Canada, France and Denmark allow 90 dB(A) L_{eq}. Japan, Sweden, Germany, Norway allow 85 dB(A) L_{eq}. These limits are allowed for halving rates of 3 dB(A) and working schedules of 8 h/d. OSHA (USA) allows 90 dB(A) for 8 h/d with halving rate of 5 dB(A).

In India, model rules under Indian Factories Act—1948 stipulate a limit of 90 dB(A) for 8 h exposure. But due consideration shall be given to the fact that most of the plants in India operate 6 d in a week and total noise exposure per week is therefore 48 h. Most of the workers employed in the industries as skilled or semi skilled workers are illiterate or semi literate, having no information about the noise regulations and adverse effects of noise on their performance and health. The present author has also established the same and other factors like NIHL[7].

Field Study and Data Collection

The study reported here has been carried out at two textile plants located in the northern Indian state of Punjab. Both the plants involved in this study employ approximately 800–1,000 workers. Estimates of noise levels were determined in all the work areas of both the plants using a Cygnet-2031 digital sound level meter. The octave band analysis has been carried out using Cygnet-3013 octave filter set. A cross-sectional study has been conducted involving 112 workers, randomly selected, working in various locations of both the plants. Workers were interviewed personally to study the presence of subjective noise annoyance, and other factors i.e. awareness about effects of noise, use of hearing protection devices etc.

Evaluation of Sound Level, daily exposure and noise spectrum

Measurement of sound level at all the sites has been done by using CYGNET-2031, sound level mater of class-I accuracy. Calibration of the sound level meter has also been done periodically with the help of acoustic calibrator, having calibration traceable to National Physical Laboratories, New Delhi. The measurement of sound pressure has been done to determine A-weighted sound pressure level. Indirect

Table 1. Questionnaire for personal Interview

I	Do You use hearing Protection Devices?		
	1: Yes	2: No.	
II	Does Noise Causes speech Interference?		
	1: Yes	2: No.	
III	Are you aware about effects of excessive noise exposure?		
	1: Yes	2: No.	
IV	Are you annoyed by noise in the working environment?		
	1: Yes	2: No.	
IV-A	Rate the annoyance due to Noise.		
	1: Very annoying	2: Annoying	3: Moderate.
V	Rate the overall satisfaction with working environment.		
	1: Very High	2: High	3: Moderate
	4: Low		
VI	Do you frequently have head ache during the working hours?		
	1: Yes	2: No	

Measurement of daily noise exposure has been done using sampling method[8], in which the indication of sound level meter was read at time interval of 10 seconds over the measurement duration. The equivalent A-weighted sound pressure level L_{Aeq} has been calculated using the equation;

$$L_{Aeq,\,T_{meas}} = 10 \log \left[\frac{1}{n}\sum_{i=1}^{n} \left(10^{0.1LpAi}\right)\right]$$

where L_{pAi} is the A-weighted sound pressure level, in decibels for sample i, n is the total number of samples collected within T_{meas}. The duration of the time intervals may be constant or may vary at random.

Very similar results can be obtained by taking the arithmetic average of number of readings of the sound level meter, as the noise produced in textile industries is steady i.e. the fluctuation is within 5 dB. Octave band analysis has also been carried out to find the noise spectrum.

Personal interviews

All the employees selected for the study were asked various questions regarding the noise in the working environment and their response to each question was recorded. The various questions posed to workers are listed in Table 1.

Results and Discussion

Noise levels

Results of the noise measurement show that overall noise levels and exposure to noise in two textile plants included in this study ranged between 80 and 102 dB(A) L_{eq}. The details of the L_{eq} values of noise to which the workers are exposed in various work areas is shown in Tables 2 and 3.

The daily noise exposure of workers in areas like loom shed, ring frame, TFO etc. exceeds the maximum exposure limit of 90 dB(A), specified by OSHA. The noise exposure in other work areas like blow room, combing etc. is recorded

Table 2. Noise Levels at Site-1

S.No	Work Area	L_{eq}
1	Loom Shed	1. LOOMS(a) = 101.3 dB(A)
		LOOMS(b)= 102.1 dB(A)
		LOOMS(c) = 102.1 dB(A)
2	Spinning	Open End Spinning = 89.962 dB(A)
3	Draw Frame	85.2 dB(A)
4	Carding	86.079 dB(A)
5	Blow Room	80.89 dB(A)
6	Finishing	82.82 dB(A)

Table 3. Noise Levels at Site-2

S.No	Work Area	L_{eq}
1	TFO (Two for One)	100.7 dB(A)
2	Ring Frame- I	100.1 dB(A)
3	Ring Frame- II	99.5 dB(A)
4	Doubling (DRY)	94.7 dB(A)
5	Doubling (WET)	92.4 dB(A)
6	Cheese Winding	92.1 dB(A)
7	Cone Winding	91.7 dB(A)
8	Auto Coner	91.4 dB(A)
9	Carding	89.9 dB(A)
10	Blow Room	84.8 dB(A)
11	Simplex	87.2 dB(A)
12	Combing	84.4 dB(A)

less than 90 dB(A), but is quite higher than limits used for assessment of noise for community response[9]. The direct application of OSHA regulations in Indian plants is also not valid, as most of the plants operate 8 h/d and 6 d/wk i.e. exposure time is 48 h/wk, which is 20% higher than the exposure time per week in USA or European countries.

Spectrum analysis

The octave band analysis of the noise in various work areas shows the presence of high sound level in 4,000 Hz. Figures 1 and 2 show the octave band analysis of sound spectrum in Loom shed and Ring Frame respectively. The high levels of sound present in this frequency region can be a major reason for causing noise induced occupational hearing loss.

Subjective response to noise

The answers to each question on noise environment (i.e. workers reactions) are summarized in Fig. 3. Noise has been reported as a major factor causing speech interference by 70% workers. The awareness amongst the workers, regarding the effects of exposure to high noise levels is minimal, as only 29% workers report to be aware about these

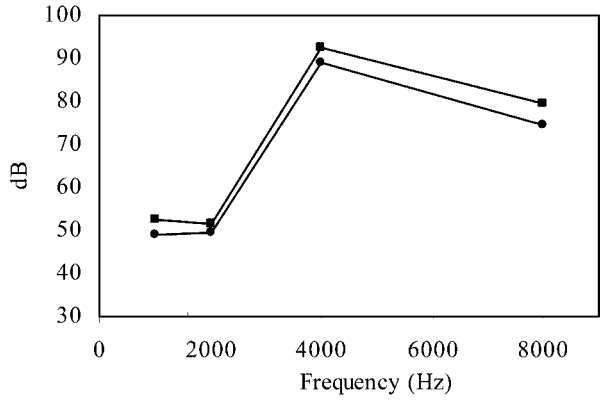

Fig. 1. Results of octave band analysis in Loom shed.

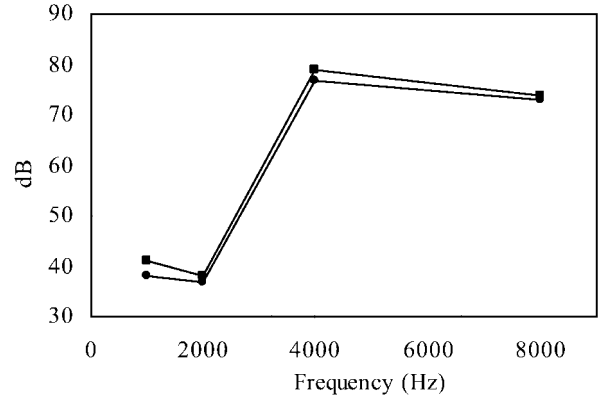

Fig. 2. Results of octave band analysis in Ring frame.

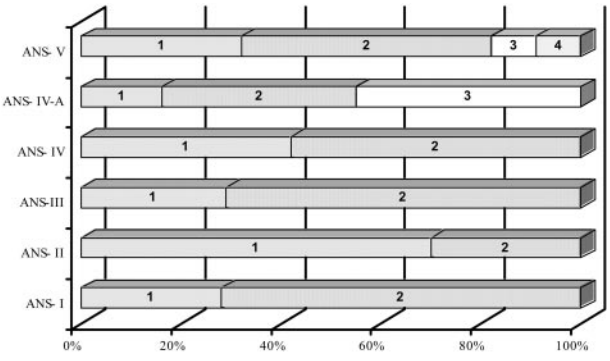

Fig. 3. Response ratio of workers answers for various questions on noise environment.
See Table 1 for Questions (I, II, etc.,) and answers (1, 2, 3 etc.).

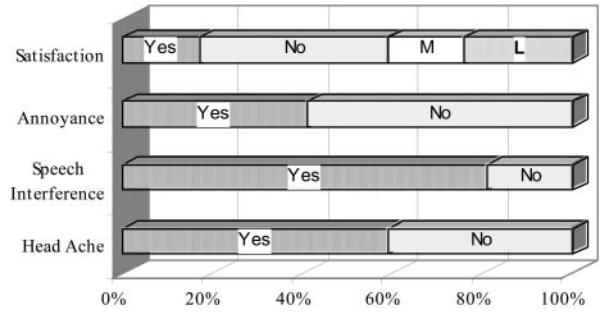

Fig. 4. Response ratio of workers answers for various questions in Loom Shed.

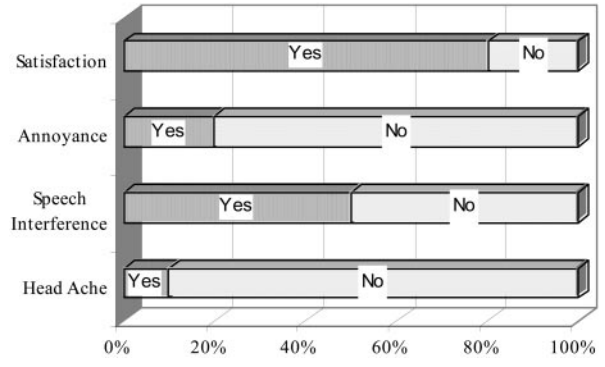

Fig. 5. Response ratio of workers answers for various questions in Blow room.

effects. This factor is very closely related to use of hearing protection devices, which are being used by only 28% workers. The noise is considered an annoyance by 41% workers. The extent of annoyance observed in this study runs counter to many research studies reporting very high annoyance levels[1, 10].

A possible reason which was revealed by further questioning of workers, can be that perceived annoyance caused by noise reduces, as the exposure time to consistently high noise levels increases. The overall satisfaction with the working environment, speech interference, annoyance and head ache during working hours reported by workers is directly related to noise levels in the work area as can be interpreted from Figs. 4 and 5, wherein the response ratio of workers answers to these questions in two work areas, i.e. Loom Shed (L_{eq}=102 dB(A)) & Blow Room (L_{eq}=80 dB(A)) are compared.

Conclusions

The study has clearly demonstrated that the workforce in both the textile plants included in this study are at high risk of developing noise induced hearing loss and other associated ailments due to excessive occupational exposure to noise. There is a need to develop and apply a well defined, comprehensive and enforceable noise regulation. The limit of 90 dB(A) for 8 h/d stipulated by OSHA (also stated by Indian Factories Act- 1947) shall be followed with a caution,

as working hours in most of the plants in India are 8 h/d and six days a week. Total working hours per week in India are about 20% more than those in USA or European countries.

The efforts shall also be made towards reducing the noise generated at the source by modifications in existing technologies. Noise in spinning section can be reduced by providing elastomeric spindle mounts, elastomeric ring holders, proper maintenance lubrication of gears etc. The highest noise levels have been found in loom shed with shuttle looms. Replacement of parts with resilient materials instead of metal can provide reduction in impulse noise of looms. Attempts shall be made to produce complete enclosures around the loom.

There is a need to establish a hearing conversation program in the plants, the components of which shall include noise assessment, increasing awareness among the workers about the adverse effects of noise, use of hearing protection devices and audiometry. Although less practical, wherever possible by application of equal energy principle, the exposure time must be decreased with increase in the L_{eq}.

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