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Development of a noise insulating cover for selected sewing machine used in garments section

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Abstract

A research was undertaken to explore sound levels in garments industries and their effects on the workers' health and hearing, to test sound absorption capacity of different materials and to propose a design of a sound insulating sewing machine casing. Three industries were visited and workers' health effects due to long time sound exposure were understood by questionnaire interview. Sound proofing efficacies of ply, Styrofoam, foam sheet and shine board were assessed, which were expressed by noise reduction coefficient (NRC). The NRC of the materials were respectively 0.06, 0.03, 0.05 and 0.03 in a single casing, 0.08, 0.04, 0.06 and 0.04 in a single casing with inclined partitions on inner wall and 0.11, 0.09, 0.11 and 0.06 for double casing with partitions of the same material and aggregates of foam particles between the walls of the casings. NRC of the ceramic material of Brothers Company sewing machine was found to be 0.09, a lesser value than the ply-foam combination. Button sewing machine was found to emit higher sound through the opening provided for easy circulation of thread tension lever. A casing for this opening was designed for full insulation system and providing safe and healthy working environment for garments workers.

Keywords: Garments industry, garments workers, health effect, noise reduction coefficient, button sewing machine, full insulation system.

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1. Introduction

Noise is unwanted sound judged to be unpleasant, loud or disruptive to hearing. It is indistinguishable from sound. The difference arises when the brain receives and perceives a sound (Wikipedia 2018). Loud sound is harmful even for a brief time. These sounds can damage sensitive structures in the inner ear and cause hearing loss. The risk to hearing from noise exposure depends on how loud it is and how long one is exposed to it. Exposure to elevated levels of sound have different effects within a given population as follows (Kumar *et al.*, 2004).

- Noise-induced hearing loss (NIHL): NIHL is hearing impairment resulting from exposure to loud sound. Constant exposure to loud levels of noise can easily result in loss of hearing.
- Health Issues: Excessive noise pollution in working areas such as offices, construction sites, bars and even in homes can influence psychological health. Studies (Rinkesh 2009) showed that the occurrence of aggressive behavior, disturbance of sleep, constant stress, fatigue and hypertension could be linked to excessive noise levels. These in turn could cause more severe and chronic health issues later in life.
- Sleeping Disorders: Loud noise can certainly hamper sleeping pattern and may lead to irritation and uncomfortable situations.
- Cardiovascular Issues: Blood pressure levels, cardio-vascular disease and stress related heart problems are on the rise. Studies suggested that (Rinkesh 2009) high intensity noise caused high blood pressure and increased heart beat rate as it disrupted the normal blood flow.
- Communication problem**:** High decibel noise can put trouble and may not allow two people to communicate freely.
- Effect on wildlife: Wildlife faces far more problems than humans because of sound pollution, since they are more dependent on sound.

Table 1
Health effect of higher sound level

High dB Level	Effect
65 ± 5	Creates annoyance, psychological effects only.
80 ± 10	Permanent hearing loss by long year exposure.
105 ± 15	Irreparable damage to auditory organ by long year exposure.
130 ± 10	Causes pain.
150 ± 5	Instantaneous loss of hearing.

Table 2
Allowable maximum exposure time for higher dB of sound

dB	Maximum exposure time per 24 hours
85	8 hours
88	4 hours
91	2 hours
94	1 hours
97	30 minutes
100	15 minutes
103	7.5 minutes
106	3.75 minutes
109	112 seconds
112	56 seconds
115	28 seconds
118	14 seconds
121	7 seconds
124	3 seconds
127	1 seconds
130-140	Less than 1 seconds
140	No exposure

Generally, though sound is said to be elevated, polluted or considered as noise when it passes 80 dB, it may also cause hearing impairment by long time exposure to even lower level of sound. Table 1 (Otto *et al*.,2010) shows the effect of higher dB level of sound in hearing and health.

Hearing impairment not only depends upon the level of sound (dB) alone but also upon the exposure time to a specific level of sound. Table 2 shows “3 dB exchange rate”, which means that for every 3 dB above 85 dB, the maximum exposure time is cut in half (Sarinne 2010).

Gazipur is one of the noisiest areas of Bangladesh due to the presence of many different established industries. The lion parts of them are garments factories. From the above knowledge, it was presumed that, workers of different sections of garments factories in Gazipur might have been greatly affected by the sound emitted from industrial sewing machine. So, a preliminary survey was done to verify the above presumption. A confirmatory result was found of the negative effect of sound pollution in different health statuses of the workers. To address the above problem, the present work was undertaken with a view to fulfill the following objectives.

- To enumerate sound emission levels in different sections of garments industries;
- To assess their probable effects on the workers’ health and hearing;
- To select a best insulating material among several, based on their sound absorbing capacities;
- To propose a design of a casing for sewing machine to ensure a complete sound insulation system.

2. Methodology

A prevalence study was done among the garments workers of RAWA Fashion and Euro Nitt, Vogra Bypass, Chandona Chaurasta, Gazipur and Fortuna Apparel Limited, Tongi, Gazipur. Thirty workers of both sexes of each garments were interviewed by face to face questioning before theirentrance in the industries. From the survey, a statistics was prepared showing the percentage of people affected by noise. During visiting the industries’ sectors, name and function of different sectors in industries, numbers of workers in each sector, type of machines used by the workers and sound emission level of sewing machines were noted. The types of sewing machine used by the workers in industry are shown in table 3.

Table 3
Types of sewing machine used commercially in garments industry

Section name	Machine type
Sewing section	Lock stitch machine
	Interlock machine
	Over lock machine
	Button hole machine
	Button sewing machine
	Pasting sewing machine
	Pant pocket sewing

The sound emitted from different machines and exposure time of workers there, were compared to the standard values for health maintenance of the workers. High sound emitting machine were marked for further research. Four materials, namely ply, foam sheet, shine board and Styrofoam of 0.2" thickness were collected for making casing and partition for testing their sound absorption capacity. The materials were categorized based on best proofing capacity by analyzing Noise Reduction Coefficient (NRC). NRC (Noise Reduction Coefficient) = reduced sound / original sound.

where, reduced sound = original sound – insulated sound.

Full reflection of sound was represented by the value NRC = 0 and full absorption of sound, by NRC = 1.Cases (Figure 1) were made having dimension of 9" × 9" × 4.5" with each of the casing materials. Sound of 92 dB level was downloaded in a Samsung J7 mobile set which was then placed in each case. The cases were then closed By FEVICOL SH, synthetic resin adhesive (Pidilite Speciality Chemicals BD Pvt. Ltd., Munshiganj, Bangladesh), with a view to insulate properly. The insulated sound was then measured from outside by sound level meter as the first test. For the second test, partitions (Figure 2) of the same material of 3.8" × 1" × 0.2" dimension was fixed to the inner walls of each case with 1(H):3(V) inclination at a rate of 1.4" centre to centre distance and emitted sound levels were measured.

Next tests of measuring sound level was done by fixing some pieces (Figure 3) of either Styrofoam (third test) or foam (forth test) of 0.5" × 0.5" × 0.2" size, scattered on the remaining open surface after fixing the partitions. Finally, last two tests were executed by placing a smaller case inside the above prepared cases (Figure 4) keeping an air gap of 1.0" between them. According to the above description, for each casing material, 6 tests were made. Thus, the total number of tests became 24.

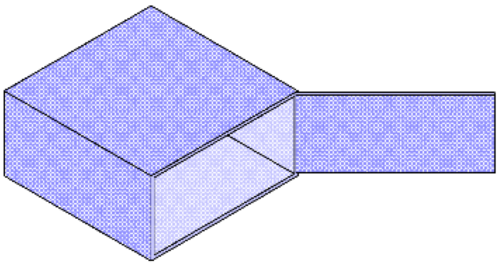

Fig. 1. 9" × 9" × 4.5"casing.

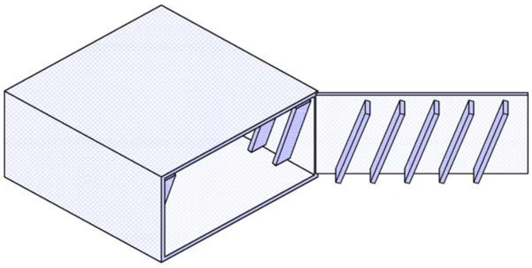

Fig. 2. 3.8" × 1" × 0.2" partition @ 1.4" c/c distance on inner surface.

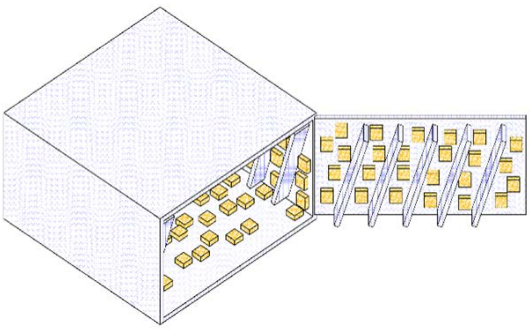

Fig. 3. Scattered piece of 0.5" × 0.5" × 0.2" size on inner free surface.

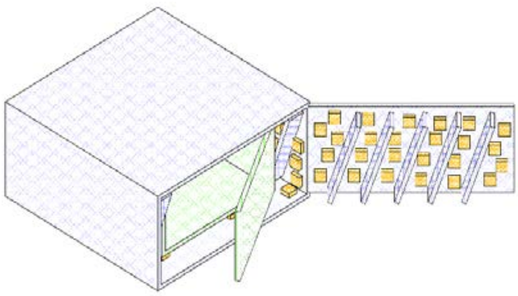

Fig. 4. Double casing; a smaller case.

To design an appropriate sound proofing case, the NRC of existing sewing machine casing material made by ceramics was measured during the operation of the sewing machine. This value was compared with NRC of tested materials to choose the appropriate material for case designing. With reference to the test results, a sound proofing case made by the appropriate material/s was suggested to be designed to minimize the high level sound emission of the selected sewing machine.

3. Result

From the questionnaire interview, the following information was found about the timings of the labors.

- Entry time: 8:00 am
- Exit time: 7:00 pm
- Lunch break: 01 hour
- Exposure time to sound (regular): 10 hours
- Exposure time to sound (over time): 4 hours

The information explored through the questionnaire interview of the garments workers are summarized in Table 4. It was found that 25% of the workers were male and 75% female. Workers worked for less than 4 years showed more interest for work and complained nothing about any pressure of sound of machine, while workers who experienced more than 4 years were reported to be tired of hearing the sound of sewing machine. Workers involved for long time in garments, reported that, they would get annoyed whenever supervisor would point out any defect of their work. It was also observed that, those who worked more than 4 years in the sound exposure, they experienced dry cough at night after returning from work. They even had either tinnitus in ear or inertia of sound. Headache was observed in case of most of the workers. Sound levels found in different working sections are shown in Table 5.

Table 4
Comparative results of different topics of male and female workers found from questionnaire interview

TOPIC			Male	Female
Worker			25%	75%
	Age limit	15 – 35 years	45%	60%
		35 – 60 years	55%	40%
Over time worker			65%	40%
Health effect on workers experienced	0 - 4 years		Nil	Nil
	>4 years		Observed	Observed
Results of workers working for more than 4 years				
Pressure on hearing during running of machine			40%	80%
Feeling relax when machine was turned off			100%	100%
Bad tempered during and after returning from work			80%	100%
Tinnitus in ear			70%	80%
Inertia of sound			Nil	Nil
Dry cough/mild pain in throat (usually after returning from work)			66%	70%
Headache			80%	80%

Sounds were found to fluctuate within 10 dB level. Thus first 5 dB is added with the minimum level and next 5 dB is shown as ± 5.

It was observed that the workers, during their long 10 hours of working, did not have any precautionary measure to save themselves from high level of sound like 80-90dB.Again, ear plug has many disadvantages and negative health effects as described below (Livestrong 2017):

- Ear pain
- Sound distortion
- A stuffing feeling

– Persistent itching
– An unpleasant odor
– Ringing in the ears
– Discharge of oozing substance
– Persistent cough

Lubricated button sewing machine of 2700 rpm speed, under program No.3, was analyzed for covered and uncovered condition. In uncovered condition, the emitted sound of button sewing machine was measured to be 92 ± 1 dB and by existing covered condition, 84 ± 1 dB. Thus, the NRC of the existing ceramic casing was found to be in average 0.09. It was observed that, sound of top shaft and thread tension lever were emitted to ones ear through the 1/4" wide, 4.5" long opening on casing (Figure 5) provided for thread tension lever circulation.

Table 5
Sound level of different sector of garments industry

Sector name	Machine type	Sound level
Sewing Sector	Lock stitch machine	75± 5
	Interlock machine	76±5
	Over lock machine	74± 5
	Button hole machine	77 ±5
	Button sewing machine	85 ±5
	Pasting sewing machine	75 ± 5
	Pant pocket sewing	74 ± 5

Fig. 5. Opening on sewing machine cover.

The sound absorption capacities of the four kinds of materials *viz.*, ply, foam sheet, shine board and Styrofoam are shown in Table 6. Styrofoam and shine board separately could insulate only 3 dB sound, average NRC being 0.03. Foam sheet alone could insulate 5 dB sound and ply, 6 dB. By adding partitions in case of all materials, sound insulation capacity increased 1 dB more. Ply and foam sheet in combination with foam, made 10 dB sound insulation, showing average NRC 0.11.

Table 6.
Sound absorption capacities of different materials

Trail no.	Casing material	Casing		Partition material	Filler material	Original sound (db)	Insulated sound (db)	Absorbed sound (db)	NRC
		Single	Double						
1	Styrofoam	√		-	-	92	89	3	0.03
2		√		Styrofoam	-	92	88	4	0.04
3		√		Styrofoam	Styrofoam	92	87	5	0.05
4			√	Styrofoam	Styrofoam	92	86	6	0.06
5		√		Styrofoam	Foam	92	85	7	0.08
6			√	Styrofoam	Foam	92	84	8	0.09
7	Foam sheet	√		-	-	92	87	5	0.05
8		√		Foam sheet	-	92	86	6	0.06
9		√		Foam sheet	Styrofoam	92	85	7	0.08
10			√	Foam sheet	Styrofoam	92	83	9	0.10
11		√		Foam sheet	Foam	92	84	8	0.09
12			√	Foam sheet	Foam	92	82	10	0.11
13	Ply	√		-	-	92	86	6	0.06
14		√		Ply	-	92	85	7	0.076
15		√		Ply	Styrofoam	92	84	8	0.09
16			√	Ply	Styrofoam	92	83	9	0.10
17		√		Ply	Foam	92	83	9	0.10
18			√	Ply	Foam	92	82	10	0.11
19	Shine board	√		-	-	92	89	3	0.03
20		√		Shine board	-	92	88.5	3.5	0.04
21		√		Shine board	Styrofoam	92	87.5	4.5	0.05
22			√	Shine board	Styrofoam	92	86	6	0.06
23		√		Shine board	Foam	92	87	5	0.05
24			√	Shine board	Foam	92	86	6	0.06

4. Discussion

This work reported that, workers experienced more than 4 years suffered from dry cough at night after returning from work, which might be due to loud sound. Boateng and Amedofu (2005) reported that, due to loud sound, hair cells of inner ear might bend to the point of breaking. As they would not be replaceable, they would be unable to maintain equity in pressure of acoustic tube. These inequities would cause dry cough. Headache was observed in case of most of the workers which might also be a consequence of exposure to sound for more than allowable time(Kumar *et al.*, 2004). Inside the industry, workers handling sewing machines other than button sewing machines, exposed to a sound level of 60 dB to < 80 dB. The workers engaged in button hole machine and button sewing machine worked in a sound field of 80 dB to 90 dB. From Table 2, it was understood that, one would not be exposed more than 8 hours for sound level above 85 dB. So, it was comprehended that, workers handling button hole machine and button sewing machine were in risk level.

While analyzing the button sewing machine, the 1/4" wide and 4.5" long opening on casing was observed which allowed sound to reach ones ear. It was planned that, if this opening could be sealed or covered properly, sound emission might be reduced to a considerable limit. From the result of material testing, it was found that, ply and foam sheet in combination with foam, made 10 dB sound insulation, showing average NRC 0.11, which was the highest insulation. Hence, it was inferred that, foam might be guessed to be the best supporting material for sound insulation and ply, as casing material. As described in results, the average NRC of existing ceramic cover of button sewing machine was 0.09 and average NRC of ply, together with foam, was found to be 0.11. Thus, it was evident that ply-foam combination would be the best sound insulator at least amongst the materials tested.

An extra covering was thus designed (Figure 6) for the opening on the front surface of button sewing machine, provided for thread tension lever circulation, with ply-foam combination. It may reduce the emitted sound to 81 dB and permit workers to work whole day long without causing any health and hearing hazard.

Fig. 6. Additional external covering.

5. Conclusion

High level of sound emitted from sewing machine in garments factories used to causes noise induced hearing loss, high temper etc. of workers, which were planned to minimize by designing a sound insulation covering by appropriate insulating substance/s. Ceramic casing of button sewing machine was found to be not sufficient to insulate sound. Cases by ply, foam, Styrofoam, shine board or foam sheet were prepared separately which were re-combined with bars, aggregated units and inner cases to test their sound absorption capacities. Case made such by ply-foam combination was found to be the best insulator among tested materials. An extra sound proofing case might preferably be prepared by ply-foam combination to provide on the opening for thread tension lever circulation that may reduce sound level to 81 dB and allow workers to work in safe environment with no time limitation.

6. Recommendation

It was recommended that further research works addressing at least the following three points might be conducted to model the design of the external covering. First to test the thermal effect due to covering the opening, by running the machine with cover for a full working day. Second to assess the benefit-cost ratio of the provision of cover to make it feasible for commercial marketing, by making a comparison between medical expenses for hearing loss treatment of workers and manufacturing cost of casing and to find out more feasible material for the cover combining the insulation capacity of ply-foam combined material and strength of ceramic material.

References

Boateng, C.A. & Amedofu, G.K., 2005. Industrial noise pollution and its effects on the hearing capabilities of workers: A study from saw mills, printing presses and corn mills. African Journal of Health Sciences, 11(1), pp.55–60. Available at: http://www.ajol.info/index.php/ajhs/article/view/30778%0Ahttps://www.ajol.info/index.php/ajhs/article/view/30778.

Kumar, B., Oberoi, S. V & Goenka, A., 2004. A Brief Review of the Legislative Aspects of Noise Pollution. Workshop on Environmental Pollution: Perspectives and Practices, (Nrma 1991), pp.53–65.

Livestrong, 2017. Dangers of Wearing Ear Plugs _ LIVESTRONG. Available at: file:///D:/Research/Thesis/papers/Dangers of Wearing Ear Plugs _ LIVESTRONG.COM.html [Accessed April 3, 2018].

Otto H Koenigsberger, O. H., Ingersoll, T. G., M., 2010. Manual of Topical Housing and Building 34th ed., Hyderabad, India : Universities Press, 2010. Available at: http://www.worldcat.org/title/manual-of-tropical-housing-and-building-climatic design/oclc/703782329?referer=di&ht=edition.

Rinkesh, 2009. Causes and Effects of Noise Pollution - Conserve Energy Future. Available at: http://www.conserve-energy-future.com/causes-and-effects-of-noise-pollution.php.

Sarinne, F., 2010. Noise help. Available at: http://www.noisehelp.com/noise-dose.html [Accessed on March 7, 2018].

Wikipedia, 2018. Wikipedia. Available at: https://en.wikipedia.org [Accessed on March 3, 2018].