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Analysis and control of noise in a textile factory

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Abstract- Increased noise level with the technological advancement becomes a serious problem in the textile industry and it has become a crucial occupational hazard to its workers. Maximum noise level of some textile machines is as high as 95dB and locating many machines inside a single room causes to increase the cumulative noise level by at least 5dB beyond maximum noise level of a machine. So the noise level inside a textile factory is well above the limits specified by NIOSH and it amounts to be hazardous. This article analyzes the quality of noise and its distribution inside the factory. A mathematical model is developed to predict the noise distribution pattern and the model is validated with the noise data gathered following the standard methods. Economically viable noise control panels are designed and carry out a pilot implementation in order to prove the effectiveness of the noise control method experimentally. Further, authors present the potential applications of the proposed design and evaluate its usefulness.

Index Terms- Noise analysis, noise control, noise pattern model, noise measurement

I. INTRODUCTION

With the advent of Technological development, many high speed machines invade the industry with no exception to the textile industry. The machines and devices used in textile factory are highly diverse in its nature and most of them emit high noise levels due to frequent operation of noise generating components such as pneumatic elements and other fast moving mechanical components. The operational speed of textile machines are highly increased and heralded high productivity as well as efficiency. However, parallel to technological and economical progress, ever increasing occupational noise problem reached to an alarming level with the incident of undesirable consequences and adverse health effects to its workers. The maximum noise level of some textile machines has reached 95 decibels. When a number of machines are placed in a room, cumulative noise level is reached to hazardous level where noise control becomes absolutely essential.

Noise is defined as excessive or unwanted sound which potentially results in annoyance and/or hearing loss and it can be from occupational and/or non-occupational sources [Robert et.al]. In other words, noise is a sound disturbance as well as a nuisance which results in health problems and adverse social consequences. Noise effects on human health can be auditory effects such as permanent or temporal hearing loss and non-auditory effects such as communication, concentration and sleep interference, annoyance, loss of working efficiency [AA Abbasi et.al and WE Purcell et.al], and possible hypertension [Parvizpoor, Lees et.al]. The non-auditory effects entails to social issues such as lack of domestic communication as well as the disruption of job performance [EPA]. It may contribute to industrial and road accidents. However, data are insufficient to deterministic endorsement of such specific damage risk criteria as consequences of non-auditory effects. In order to control ever increasing exposure of human beings to high noise levels World Health Organization set standards for noise level [WHO noise exposure limits] and provided guidelines to control noise [Berglund et.al].

Human ear is not sensitive to all frequencies except the frequencies from 20 Hz to 20 kHz. Even within the audible range of frequencies equally loud sound with same sound pressure level perceived by human year differently [ISO 389]. When calculation of a value representing noise level, some frequencies become more important than the other frequencies. The combined effect of noise is calculated with due consideration to its relative contribution of frequency components and their different perception levels considering equal-loudness contours, various weighted schemes are in use to represent noise levels. A-weighted and C-weighted noise levels are frequently in use to measure noise levels.

The adverse effect of the noise is characterized by various descriptive parameters of noise exposure such as noise pressure level, time duration in which that noise level persists. The hearing damage risk criteria states the relationship between such parameters and probability of temporary or permanent hearing loss [MIL-STD-1474C]. In 1972, National Institute of Occupational Safety and Health (NIOSH) published “Criteria for a Recommended Standard–Occupational Exposure to Noise” which provided the basis for a recommended standard to reduce the risk of developing permanent hearing loss as a result of occupational noise exposure. NIOSH recommends that workers should not be exposed to noise at a level that amounts to more than 85 decibels for 8 hours.

Significance of noise control become increasingly important in textile industry as global statistics reveals that the seriousness of the hearing problems of workers in textile industry [MK Talukdar, R Bedi]. In the hierarchical approach of noise reduction techniques ranges from noise elimination by physically removing the hazard, substitution by replacing the hazard, engineering control by isolation from the hazard, administrative control by changing the way that people work to personal protective equipment (reference [11]). The elimination in short time is impractical in Textile industry while development of quieter machines to substitute existing noisy machines may be a long term solution with the advent of sustainable and green

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technology. Engineering control techniques to use of personal protective equipment are identified feasible short term solution approaches to noise problem. The least effective approach-the use of personal protective wear is still heavily used Textile industry in Sri Lanka and it is the high time to move towards more effective engineering control approach.
In this paper, authors attempt to analyze the quality of noise quantitatively and noise distribution pattern inside a textile factory. Theoretical analysis on noise propagation is briefed and underlying theories are reviewed. A mathematical model is developed for the distribution of the noise and the model is validated with the noise date collected from the factory following the standard procedures to collect data. After critical review of available noise reduction techniques quantitatively, economically viable noise control technique was designed. A pilot implementation was carried out in the factory and the effectiveness of the noise control method verified experimentally.

II. MODEL TO ESTIMATE NOISE

A. Noise Propagation

The vibrating elements create pressure differences in the atmosphere and it propagates across the atmosphere as pressure variations transmitted by wave motion [Paul Jenson et.al]. Such pressure variation within audible frequency range heard by the human ear is termed as sound. Sound propagation is characterized by three elements namely sound source which generates soundcharacterized bysound power level, propagation media which attenuate different frequency components by different levels and the receiver what the sound impinges upon that may be a microphone or a person. Sound pressure level at the receiver ends determines the loudness of the sound or noise. Since noise is undesired and unwanted sound, noise propagation also has three key elements and each element can be separately treated to control noise.
The air borne noise is radiated in the environment and in most cases, noise propagation obeys a hemi-spherical model either due to ground in the case where noise source is in close vicinity to the ground or due to ceiling in case of noise source is too close to the ceiling.

B. Measurement of noise

Generally noise waveforms are complex in nature or composed of a frequency spectrumin which each frequency component has different magnitudes. Size or magnitude of the pressure change measured in decibels as the pressure variation range of the human ear is as wide as from 20 μPa to 200Pa. So the quality of the noise is characterized by frequency content and it is essential to carry out a frequency analysis in order to determine the relative contribution of frequency components to the total noise so as to design an effective noise control mechanism.

The combined effect of the different frequencies perceived as noise, can be approximated by various frequency weightings to yield single number rating. The A-weighting is widely in use as it used a family of equal-loudness contours (ISO 1987a) that describe the frequency response of the hearing system. So quantify the hearing sensitivity of human beings the A-weighted decibel or dBA scale is created. The noise level expressed in dBA unit can be directly measured with a sound level meter. The C-weighting network is a nearly flat response except attenuation of extremely high and low frequencies and expressed in the unit of dBC. This weighting scale is used in the selection of hearing protectors. The difference between C-weighted and A-weighted noise levels is an indicative measure of low frequency content when frequency analysis of the noise is not feasible.

With sound level meters, pressure variation in atmosphere can be measured (sound pressure level), but not the power of the source (sound power level). However, the following formula establishes the relationship between sound pressure level (SPL) and sound power level of the source (SWL).

$$\mathrm{SWL} = \mathrm{SPL_x} + 10\log(2\pi x^2) \qquad \text{----(1)}$$

where $\mathrm{SPL_x}$ is the sound pressure level at x meters away from the source and assumed hemi-spherical model in radiation of the noise in the environment. From equation (1), it is possible to deduce that the sound pressure level at a distance of y meters from the source is given by

$$\mathrm{SPL_y} = \mathrm{SPL_x} - 20\log({}^{y}/_{x}) \qquad \text{----(2)}$$

where $\mathrm{SPL_y}$ is the sound pressure level at y meters from the source.

In order to investigate the quality of sound, a noise spectrum is analyzed with special software called “SpectrumView”. “SpectrumView” is an audio spectrum analyzer program that allows the display of audio data captured from the PC's sound card or from a WAVE file in either a spectrum graphical format or in a waterfall display. The data will be displayed in the frequency domain; each data point on the graph will represent a frequency point in the audio spectrum.

C. Noise estimation

The human beings can withstand high noise levels to a shorter duration and with the increase of every five decibel, permissible duration of exposure is halved (5dB exchange rate). The permissible noise exposure limits are defined by OSHA and table 1 depicts the permissible noise exposure.

Table 1: Permissible noiseexposures (Source: OSHA 1910.95)

Duration per day (hrs)	OSHA 1910.95 (US)
8	90
6	92
4	95
3	97
2	100
1 ½	102
1	105
½	110
< ¼	115

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Specific permissible duration of exposure to noise, not given in table 1 can be calculated with the following equation:

$$T = \frac{8}{2^{(L-90)/5}} \quad \text{-----(3)}$$

where T is the permissible duration in hours and L is the measured noise level in dBA. However, action level for noise is defined as 5dBA below noise level specified in OSHA 1910.95 standards.

The total daily noise exposure is composed of noise exposures from different noise sources with different noise levels which is greater than 80dB over different disjoint time periods. The combined effect of the noise sources termed as total noise dose D is given by

$$D = \sum_{i=1}^{N} \frac{C_i}{T_i} \quad \text{----(4)}$$

where C_i is the total duration of exposure at a specified noise level and T_i is the total time of exposure permitted at that level. Since the workers are not permitted to be exposed to an 8hour time weighted average equal to or greater than 90 dBA, the value of D cannot exceed the unit and failure of that amount to exceed the limit value. The equivalent continuous sound level L_{eq} can be calculated as [MIL-STD-1474C]

$$L_{eq} = 85 + \frac{40}{3}\log_{10}\left[D.\frac{8}{Ts}\right] \quad \text{----(5)}$$

where Ts is the total sample time in hours.
Since the decibels are measured using a logarithmic scale based on the sensitivity of the human ear, it cannot be added arithmetically. The sum of sound pressure levels, sound intensity levels, or sound power levels can be calculated with the following formula.

$$CL = 10\log\left[\sum_{i=1}^{n} 10^{L_i/10}\right] \text{----(6)}$$

where L_i is the sound level of i^{th} source in dB and CL is the combined sound level in dB. Since noise is an undesirable form of sound, these equations can be applicable to noise too.

D. Development of model

Pneumatic ejecting valves are identified as major noise sources in the machines of covering plant. Cams and metal bearings are the next dominance sources of noise but compared to the pneumatic ejecting valves, contribution of these sources to the total noise level is assumed to be relatively low to develop a simple model. The pneumatic valve noise without silencers can be estimated by the following equation:

$$L_w = 17\log(M) + 50\log(T) - 15 \text{----(7)}$$

where L_w is the noise power level emitted by the valve in dBA, M is the mass flow rate capacity in t/h, and T is the absolute temperature of the emitting gas. Since the exhaust is equipped with a pneumatic silencer valve with noise reduction capability of 20dBA, the sound power level of pneumatic valve with silencer yields as 96dBA.

The machine bodies act as disturbances to sound propagation, and they can be considered as sound barriers. The insertion loss due to the sound barriers in shadow area are given by

$$IL = \log_{10}\left[\frac{\frac{Q}{4\pi r^2}+\frac{4}{R}}{\frac{Q'}{4\pi r^2}+\frac{4}{R}}\right] \quad \text{----(8)}$$

where IL is the insertion loss, Q is the directivity of the noise source, R is the room constant, r is the shortest distance from the source to distance and Q' is the effective directivity of the source in the direction of shadow zone which is given by

$$Q' = Q\sum_{i=1}^{n}\left[\frac{\lambda}{3\lambda+20di}\right] \text{----(9)}$$

where λ is the wavelength of the noise in meters, and di is the path difference in diffracted path and the direct path between the source and receiver.

In order to calculate noise pressure level at different locations, a 3D-Cartesian coordinate system is defined such that origin of the system lies at the top left corner of the plan in Fig.1, x- axis along the widthwise direction of the machine and y axis is parallel to the lengthwise direction. Z coordinate denotes the height from the ground level. At the grid points of 0.1X0.1 m at 1.5m above the ground level, noise pressure levels are calculated considering the noise generated by pneumatic ejectors only and assuming that the machines are of cuboid shape. In calculation of noise pressure level at each grid point, air attenuation, attenuation due to perforation of energy in the environment by equation (1), and the directivity of sound source are considered for every noise source having line of sight and get the cumulative noise effect of multiple noise sources using equation (6). For each noise source in the shadow area, insertion loss is calculated considering the directivity of the source and the central frequency of each octave band so as to calculate the effective insertion loss of the noise. Insertion loss is deducted from the sound pressure level calculated without the barrier for every noise source and gets the cumulative noise effect at each grid point. Then combine the line of sight incident noise level and diffracted/reflected noise level to obtain the final effective noise level at each grid point. From the final effective noise level calculated at each grid point is used to construct the theoretical noise propagation map.

III. NOISE CONTROL

Noise control can be briefly defined as avoiding unwanted sound reaching the worker's ear drum. Controlling of noise can be broadly categorized into three types of noise treatment, namely source treatment, path treatment and receiver treatment [FA Everest et. al]. Source treatment can be use of exhaust silencers, silencer canopies [Perlikowski]. Path treatment of noise may be either by blocking the air borne sound with barriers which places in between the source and workers' ear drums [MK Talukdar] or by absorbing air borne sound with absorbent surfaces or vibration damping [HS Seddeq]. In case of blocking airborne sound, the object in the sound path must be larger than one wavelength to significantly disturb the sound [DA Beis et.al] and hence this approach is not effective in low frequencies as the panel size needs to be considerably large and it disturbs the very purpose. However, acoustic absorbent approach may be a reasonable solution if the major noise problem lies in the medium frequency range. Vibration isolation techniques such as damping pads to dissipate mechanical vibration and plastic springs to reduce vibration emissions can be used in vibration control [MK Talukdar]. Receiver treatment for noise can be wearing of hearing protecting devices such as ear plugs, noise muffs (circumaural) or attenuating helmets or headsets and this may be the least effective approach as it disturbs the inter personal communication which eventually extends to social problems.

The approaches of noise control can be divided into three main categories namely active noise control, passive noise control and hybrid noise control – combination of active and passive control cancellation [TM Jonsana et.al, MA Milošević et.al]. Active noise control (ANC) is the use of secondary source which generates a sound field of the inverted version of noise signal to cancel the primary sound field generated by the primary noise source. As the noise is time varying in terms of frequency and amplitude in addition to variable sound speed due to temperature and humidity variation ANC becoming a challenging task of adaptive control. Feedback and feed forward models of active noise control were experimented by Peter Gaikwad et. al with an FPGA board and presented the pros and cons of digital electronics in active noise control. Passive Noise Control is preventing sound waves from reaching the eardrum by disturbing, absorbing & isolating the sound wave. For low frequency level, passive noise control systems are much bulky and implementation of such system perturbs the easy working environment. To cover the full frequency spectrum, best approach may be the hybrid approach.

Feasibility of noise control includes the identification of all the noise sources that contribute to the noise level, all noise paths between the noise source and the location of interest, rank ordering of the source/path combinations in terms of their contribution to the overall noise level, development of noise control measures based on the quality of noise and ability to implement according to the dominance of noise until the required noise levels are achieved at the location of interest.

IV. METHODOLOGY

A. Experimental setup

A typical covering plant is selected as the experimental setup for noise control. First draft the machine layout of the factory and identified the most suitable places to take noise readings. The plan of the machine layout is given in Fig.1.

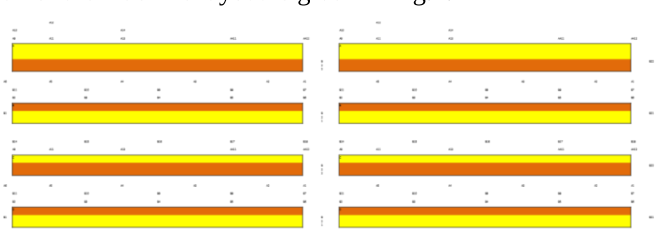


Fig.1: Plan of machine layout

Four number of MULTIPLA P410 machines and four number of SSM, type DP3-C machines are located in the factory. Each MULTIPLA P410 machine has 48 nozzels with 41.5 cm spacing between nozzels at a hieght of 59cm from the ground level. Each SSM, type DP3-C machine has 40 nozzels with inter nozzel space of 44cm at 79cm height from the ground. Each machine has a lenthwise seperation of 223cm between machines and 1.7m seperation in widthwise.

B. Data collection

Since the quality of sound is essential for effective noise treatment, the noise spectrum is measured with "SpectrumView" software running on a portable PC with an external capacity type microphone connected to the PC. Since the noise level is below 171dB level, the capacitive type microphones are ideal as it provides a rather flat response. Prior to use that software, the entire data acquisition system was calibrated by using a tuning fork. Further the sound pressure level measured for each octave band with this data acquisition system is summed up with A-weighting compensation to calculate equivalent dBA reading using the equation (6) and cross verified the calculated value with dBA scale reading of a precise sound pressure meter categorized under type 1 according to IEC 1979 standards in slow response mode. The microphones were kept vertically in taking the measurements and a record of sound is stored in wav format with a sampling rate of 160K samples/s. In order to integrate sound pressure level over one decade, signal is filtered with Bessel type filter with 40KHz cut off frequency and roll off rate of 40dB/octave. 10 bit word size A/D conversion was used conversion of analog signal into digital domain.

C. Method

Calibrated and verified noise data acquisition system was used to record data and subsequent analysis. Most dominant noise problem exist in 0-2500Hz band and it is identified with online spectrum obtained with the "SpectruView" software. In order to identify the most significant noise band, this band is subdivided into 5 bands each having a bandwidth of 500Hz. The noise level at different location in the factory floor is measured at 5 feet above the ground level as it is the plane where the ear of standing average person. With the experimental data gathered, a noise propagation map is plotted in the plan of the factory floor using Civil3D software to indicate noise level variation inside the covering factory.
High noise (>85dB) generating components of the machine is identified with its location and elevation from the ground level. Using the mathematical model developed the sound level at different locations was estimated and thereby constructed a noise propagation map with a code written in Matlab 7.8 version. Based on the quality of sound, an appropriate design of the noise control method is developed and implemented in the factory. Before and after implementation of the noise control design, noise spectrums of the same location were obtained and evaluated the effectiveness of the implemented noise control technique.

C. Design of noise control

Majority of the areas having more than 93dBA or above sound level inside the covering plant and daily shift of workers are 8 hour in duration. Once the daily dose of noise exposure is calculated using equations (3) and (4), the noise dose per day is well above unit value even for 8 hour shift worker and hence the implementation of noise control mechanism is absolutely essential for the occupational health. An analysis of noise exposure reveals that action level of noise exposure level should be 85dBA for 8 hours period which is 5dBA less than the permissible noise exposures specified in OSHA 1910.95 [M Praveen Kumar et.al].

Since the lower frequency is the major component of noise problem, use of acoustic barrier is less effective due to bulkiness. In modern era, bio based materials have been heavily used for sound insulation [Xiaodong Zhu et.al]. So noise control with sound absorbent materials as well as active noise control remains as solutions despite the noise reduction coefficient is higher for high frequencies [CM Harris]. The sound absorbent properties of woven fabrics [Paola Ricciardi et.al] and polyurethane [Tsuyoshi Yamashita et. al] were intensively investigated considering the effect of microscopic internal structures.

In case of control noise in rooms, a reverberant noise control technique was proposed but it has serious limitations especially in high performance control [ACC Warnock]. High performance noise control proposed for museums found in literature with major objective of bringing down the reverberant time to acceptable limits [PO António et.al]. Since the noise in textile industry is of persistent nature with non randomized pattern, such high performance noise control methods have minor role in applicability. Though silencer and acoustic enclosures are potential noise reduction means, it disturbs the easy working environment and full acoustic enclosures are prohibitive in use due to the nature of operation of machines. Use of acoustic ceiling is an ideal solution to control noise inside a textile factory. The acoustic ceiling can be engineered not only to serve as a sound absorber, but also as a resonate type of sound absorber.

Fibre size of material, air flow resistance per unit thickness of material, porosity as well as tortuosity of material, thickness density and compression of material are the factors influencing the factors for sound absorption [HS Seddeq]. For effective sound absorption of a porous absorber, thickness of the material needs to be about one tenth of the wavelength of the incident sound [Michael Coates et.al] and compression of the material could reduce the required effective thickness. Further, denser structure performs better noise absorbent properties for frequencies above than 2000 Hz. Since higher frequencies need to be cut off to reduce the annoyance feeling of the noise, a compressed material becomes a good candidate for the acoustic ceiling material. In the meantime, fire resistance, light weight, impact resistance, and availability in larger blocks easy installation are other important factors under consideration in selection of acoustic material besides noise reduction coefficient. Duraboard could meet all non-acoustic factors with a reasonably higher noise reduction coefficient of 0.31 and with a thickness of 50mm/58mm.

Since the low frequency noise is required to be reduced by greater extent, use of acoustical tile is inevitable. So ¾" thick textured film faced acoustic tiles of 12"X24" size was used to cut off lower frequencies and the remaining space is covered with duraboards in the acoustic ceiling designed. The schematic diagram of the acoustic ceiling is given Fig. 2. The available sizes of acoustic tiles of high noise reduction coefficient (0.75 as per manufacturer's specifications), dimension as well as the separation between machines, economical factors and the results of the many experimental trials determines the design of the acoustic ceiling.

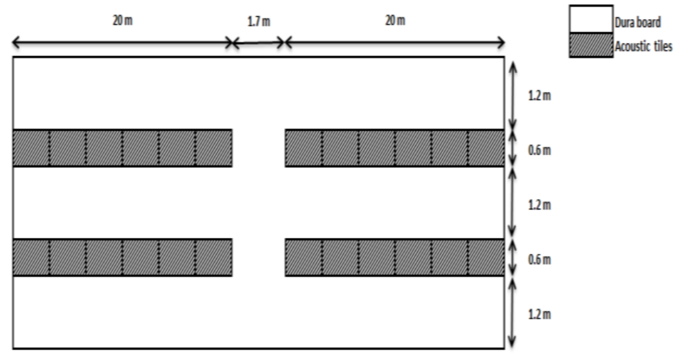


Fig. 2: Schematic diagram of acoustic ceiling

V. RESULTS

Fig. 3 gives the noise spectrum over 0-20kHz and it is rather flat spectrum except in the lower frequency band below 2500Hz. So the most dominant low noise frequency band is subdivided into frequency spectrums having a bandwidth of 500Hz and rates the frequency bands as shown in Fig. 4.

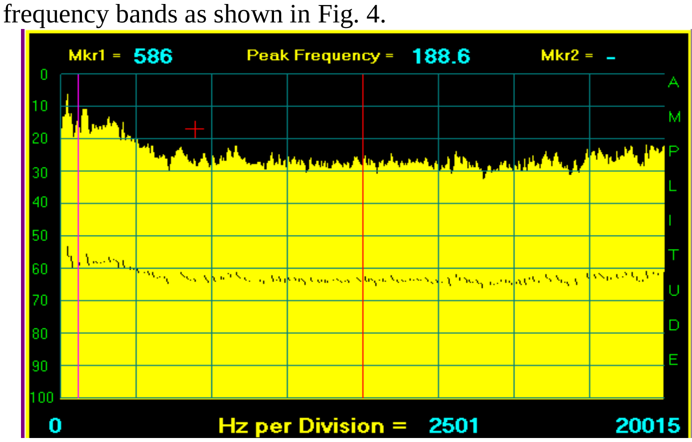


Fig.3: Noise spectrum

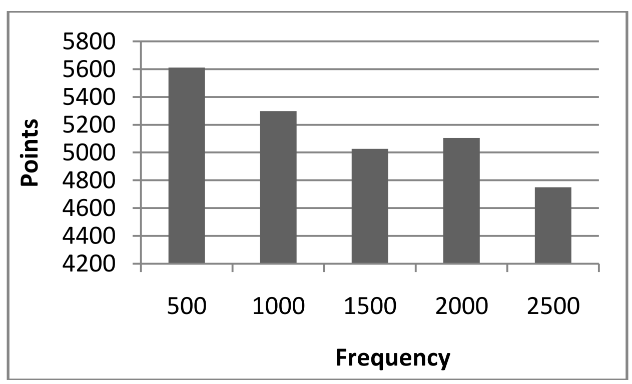


Fig.4: Frequency rating chart below 2500Hz

The noise propagation map in the covering plant is generated with Civil3D software based on the experimental data gathered from sound meter measured in dBA scale and depicted in Fig. 5.

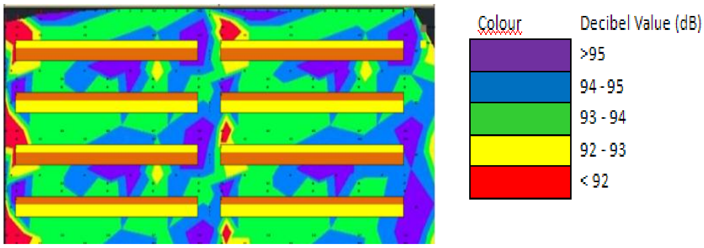


Fig.5: Experimental noise propagation map in covering plant

The theoretical noise propagation map based on the noise estimation model datais given in the Fig. 6 and it has a compatible noise levels with the empirical noise propagation map.

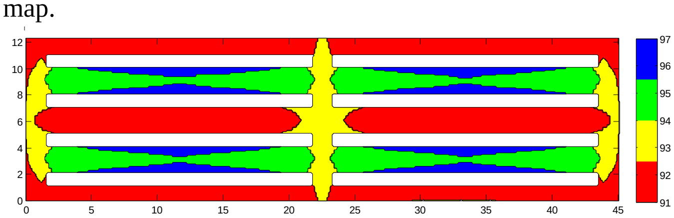
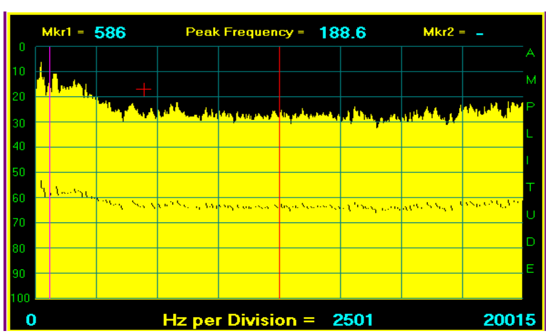
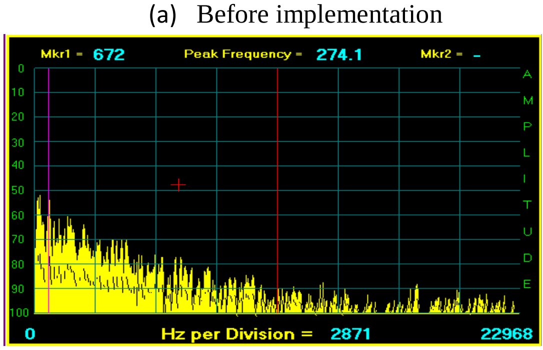


Fig.6: Theoretical noise propagation map

Figure 7 shows the noise spectra inside the covering plant before and after implementation of noise control technique. It is observed that noises over 5kHz are drastically reduced and the noises below 5kHz are not reduced by the same extent due to the implementation of acoustical ceiling as a noise control device. The same phenomenon can be clearly experienced through the frequency sensation of the human ear.



(a) Before implementation



(b) After implementation

Fig.7: Noise spectra before and after implementation of noise control

V. DISCUSSION

When the quality of the noise in ear plane is analyzed, it is quite a flat response except below 2500Hz frequency. Lower frequency band is further analyzed and the frequency rating chart reveals that most dominant noise problem occurs around 500Hz range. The noise level in the octave band having centre frequency 500Hz exceeds 90dBA noise level.

The experimental noise propagation map in covering plant depicts the special pattern of the actual sound field inside the factory. It was noted that at the end of the machine and at the centre of the face to face machines noise levels reached to its peak level. Symmetrical and proximal incidence of noise generated from the pneumatic ejecting valves at the center of machines causes to reach noise level to a maximum value. The refraction of the noise at the end of the machine and direct incidence of noise sources from other machines without the attenuation of machine body triggers to make the noise level quite high at the ends of the machines. However, noise propagation pattern of the theoretical derivation is quite different from the actual noise pattern due to assumptions made in development of the model. Control box locates at the one end of the machine and at this end noise level becomes rather high in rear side of the machine in the empirical noise map. It reveals that other than pneumatic ejectors, other more dominant noise sources are located in the control box and which was not considered in theoretical model. Further, casing of the control box acts as an acoustic barrier to the proximal noise sources of the same machine and thus makes that end of the machine less noisy in experimental noise map.

The sound power level of the pneumatic ejecting valve isabove 120dB in noise power levelbut with silencer valves it was dropped to96dB level. In development of the model, still we assumed that the dominant sources of noise are pneumatic ejectors as compared to the noise levels of cams and gears. Calculations are done assuming that machine is of cuboidal shape and pneumatic ejecting valves are on the front surface of the machine. However, in reality, it is slightly deviated from this assumption as control box is protruded out by many centimeters covering one side from its own noise generating valves. So a slight variation could be noted in theoretically generated sound propagation map or technically spectral pattern of sound field.

Noise estimation model was coded by the Matlab as it provides a convenient way of handling matrices in a multi paradigm numerical computing environment. However, due to higher number of noise sources, the run time of the program exceeded half an hour and avoids consideration the actual shape of the machines with control boxes. However, use of CAD software may be a good option in further analysis of sound propagation pattern considering the actual shape of the machine.

The acoustic ceiling is composed of acoustic tiles (NRC 0.75) which can absorb low frequency content much, is responsible of attenuation of low frequency component of noise. The remaining part is covered with duraboard which has a gradually increasing noise absorbent coefficient for higher frequencies, cuts off the higher frequency components with greater intensity. So it could be noticeable in the noise spectra after implementation of the noise control. Since the acoustic tile covers a smaller area, the noise reduction effect on low frequency is not much intense as for high frequencies.

VI. CONCLUSIONS

The noise level inside a covering plant of a textile factory was experimentally measured and developed a noise propagation pattern. Since the noise level was well above the action level of noise exposure, quality of the noise was analyzed in order to design a noise control system. A mathematical model is developed to predict the noise distribution and the model is validated with the noise data gathered according to the standards. An economically viable acoustic ceiling was designed to control noise and carries out a pilot implementation in order to prove the effectiveness of the recommended noise control method experimentally. Further, a combined use of different sound absorbent material, it was shown that passive noise control approach has greater horizons in noise control without going for hybrid noise control approach.

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