Noise Reduction: A Review

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Abstract—*This paper is a first in the series of publishing papers in our research of Passive noise reduction using EPS beads in Concrete. In this paper a review of the previous research on noise reduction by many scientists is presented and discussed. Benefits of noise reduction are briefly presented here also and some valid points are presented here to explain how the cost is related to noise. In conclusion our research background on EPS Beads in concrete is also precisely explained.*

Keywords— Noise, Textile Factory, EPS.

I. INTRODUCTION

Noise is a common phenomenon that we encounter in our day to day lives. We are surrounded by various kinds of sounds in the atmosphere. Noise may range from low whisper to loud roaring of thunder. Complete silence cannot be achieved even in the silence zones. More over with the advancement in technology and rapid urbanization, noise levels in our environment are going constantly up. Noise has become one of the major sources of pollution in modern times. It is the major cause of concern in developing as well as developed countries. The ever increasing noise pollution is making environment more and more unpleasant to live. The constant beeping of horns, blaring of loud speakers, music being played on the TV sets has become part and parcel of urban life. This ever increasing noise has ill effects on human, animal and plant life. Its ill effects range from insomnia to cardio vascular diseases. It is responsible for high levels of stress in humans in urban as well as rural areas. Recent researches have also shown the negative effects of noise on plant growth. Legislations have been passed in many countries to reduce this form of pollution. Various studies have been carried out to study the ill effects of noise on humans and plants and various methods and techniques have been tested for tested for noise reduction purposes.

II. NUISANCE OF NOISE

Noise pollution interferes with the normal human activities at both domestic as well as non-domestic locations like schools and colleges, industrial areas and work places, homes, hospitals, railway stations and crossings, traffic conveyances, pedestrian zones, marketplaces etc.

ZulkepliHj et al observed that increase in commercial traffic and other activities around the schools leads to increase in noise pollution in school environment and negatively effects teacher's and pupil's performance. The observed noise ranges for the case study of schools were found to be 56-77 dB, 53-72 dB and 42-59 dB against the allowable range that is 35-45 dB.

T.S.S. Jayawardana et al while analyzing the noise in a textile factory saw that some of the textile factory equipped with heavy machinery produces a noise level up to 95 dB, while the national institute of occupational safety and health (NIOSH) recommend that the intensity and time to which workers must be exposed are 85 dB and 8 hours respectively. Developed mathematical node and spectrum view software were used in his study.

Dr. T. S Thanadamoorthi et al while exploring the sources, effects of noise at locations like railway stations, pedestrian locations and construction sites observed that the noise levels at all the locations exceeded the prescribed limits. With pedestrian locations having noise 60-110 dB and railway crossing having 45-110 dB range of noise levels. The exposure time for machinery is limited to 5 minutes as per CPCB but results exceed 5 minutes.

Sanale P. A during the study on the sources of noises determined typical noise levels of various sources with noise level ranging in between 95-104 dB for Gensets, 80 dB for printing press, 96 dB for trains, 90-100 dB for trucks, 90-105 dB for car horns. When humans remain exposed to such high levels of noise for prolonged period of time it results in serious health hazards to them few of them are deafness, nervous breakdown, mental disorder, heart trouble, high blood pressure, dizziness etc.

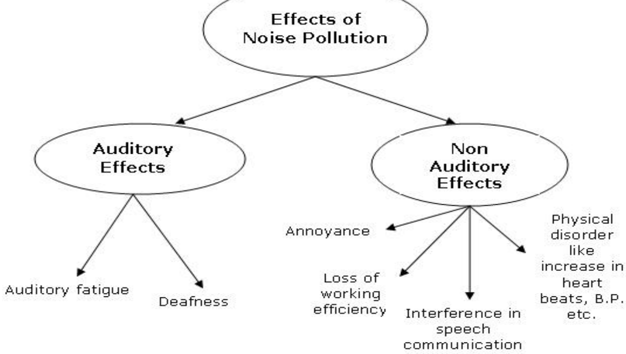

Fig.1: Showing effects of noise on humans

III. NOISE REDUCTION TECHNIQUES

In the recent past the society's haste to pursue progress through relentless development and the short sighted approach involved has resulted in what we counter in the present era; Noise, pollution, congestion and the serious erosion of the quality of living. The main focus in this study is on noise. The word noise is derived from the Latin word nausea. Noise means wrong sound in the wrong place at the wrong time. Noise pollution may be defined as unwanted sound which gets dumped into the atmosphere without regarding to the ill effects it may have. Noise is measured by several complex systems, but the best known unit of measurement is the decibel (dB). The sources of noise pollution include those of transportation, commercial and industrial, social events, household sources etc...The noise pollution has many adverse effects not only on humans but also on animals and plants. The WHO has given seven categories of adverse health effects of noise on humans; hearing impairment, interference with spoken communication, sleep disturbances, cardio-vascular disturbances, disturbance in mental health, impaired task performance and negative social behavior. Various researches and case studies have been done in this regard and the conclusions drawn are as under:

Various noise reduction techniques ranging from active to passive have been used for the purpose of reduction of noise. Synthetic and natural materials have been used as absorbers for the purpose of noise reduction. These absorbers may either be categorized as panel absorbers or porous absorbers. The noise reduction techniques may range from traditional to innovative.

Arno PRONK et al in their work have presented water as a sound insulation material. Use of 200mm thick water layer with a membrane can be effective in reducing the noise as much as 100mm concrete wall. Water being cheap can be better alternative to synthetic sound absorbers.

Francesco Asdrubalitested the methods of controlling the noise by the use of green and sustainable materials. By the term sustainable materials we mean the materials whose development meets the needs for present without compromising the ability of future generation to meet their own needs. Sound absorbing and sound insulation are the two factors which dictate the acoustics of built spaces and are measured in form of absorption coefficient , noise reduction coefficient and sound transmission coefficient .These are dependent on fibre properties ,porosity , tortuosity, air flow resistance ,surface impedance, volume, density, placement and position of a material being used for such purpose . Sound is effectively absorbed by increasing the thickness of a material. Low density materials absorb low frequency sounds ,while mid and high frequency sounds are absorbed by high density materials .Various sustainable materials used for noise reduction purposes are cellulose, expanded clay, cork panels, wool wood, hemp, rock wool, flax, glass wool, expanded polystyrene, polyurethane etc. These materials also show good thermal insulation properties, are often light and they are not harmful for human health.

Z.Azkorra etal studied passive noise control by using vertical greenery systems also called green walls or living walls for buildings. It was observed that the introduction of the green wall specimen into the reverberation room implies a reduction in the reverberation time, highlighting and quantifying the sound absorption capacity of this construction system. The green wall showed a similar or better acoustic absorption coefficient than other common building materials, and its effects on low frequencies were of particular interest because its observed properties were better than those of some current sound absorbent materials at low frequencies. The calculated value of weighted sound absorption coefficient was α=0.40. However despite paving way for sustainable urbanisation, numbers of studies concerning the acoustic insulation contribution of green walls to buildings are very less.

Ancuta-ElenaTiucaet al conducted an experimental study on acoustic properties improvement of Polyurethane foam by incorporating various percentages of textile waste. The polyurethane was prepared by mixing polyol and isocyanate at a ratio of 1:1.5 at room temperature. The composite materials were prepared with percentages of RPF (Rigid Polyurethane Foam) ranging from 50%-100%. The absorption coefficient of the composite material was measured using an impedance tube and it was observed that the composite materials obtained had better sound absorption properties compared to rigid polyurethane foam. It has been observed that the noise reduction coefficient (NRC) of the composite material with 40% textile waste doubles to that of rigid (pure) polyurethane foam. The material is also eco-friendly, cost efficient and can be used for both indoor and outdoor environment.

Elisa Morettia et al explored the acoustic and thermal properties of innovative basalt fiber insulating panels. The acoustic performance of this material has been evaluated from cylindrical samples with diameters 29mm and 100mm, different thicknesses and densities in terms of absorption coefficient at normal incidence. The panels turned to have high values of absorption coefficient. The basalt fiber insulation panels can be an effective solution when compared to rock wool and glass wool panels as these can be used with thicknesses of even less than 3cm.

Moreover the panels also possess good thermal insulating properties and are 100% recyclable.

Jan Sikora and Jadwiga Turkieuizeperformed experiments to find out absorption coefficients of granular materials. Tests were carried out on granular materials of various thickness (10, 20,30,40 and 50) and hence it was possible to determine the influence of layer thickness on sound absorbing characteristics. It was observed that irrespective of structure and bulk volume the increase of layer thickness results in increased average sound absorption coefficient. Also the shape of sound absorption characteristics depends on structure of granular material, irrespective of its type. More ever these absorbers can be classified as narrow band and wide band absorbers on the basis of the frequency band , in which the greatest sound absorption is observed.

E. Tholkappiyan et al explored the use of banana fibre-reinforced paper pulp bio-composites and suggested a mathematical model in order to predict the NRC with respect to some parameters. The predicted NRC value was 0.55 and that found experimentally came to be 0.53, this showed a good agreement at an accuracy of 96.36%. It's also found that minimum and maximum NRC can be achieved at 1.5-3.5cm fibre cut length with 2-6cm thickness at $0.20V_f$ (volume fraction) respectively. Throughout frequency range of 250-4000Hz bio-composites of bulk density about $154kg/m^3$ gave maximum NRC. The optimum fibre length was 2.5-3.5cm with $0.20V_f$ at thickness of 6cm for superior acoustic performance. Banana fibre-reinforced paper pulp composite is found to be a good noise barrier and also possessed a good bending strength of $0.685N/mm^2$ when used as reinforcement.

MesfinGetahumBalachew etalwhile analysing the acoustics of a hall with arrangements like partition walls made of glass wool, laminate of both sides with wooden panels observed that there is a drop in SPL of order 30-35 dB and thus has an advantage of creating acoustically divisible spaces where in one can conduct two activities simultaneously, without any disturbance to each other but these partition walls are uneconomical.

Francesco and GuilioPispola investigated on the measurement of sound absorption coefficient of novel sustainable fibrous materials. The fibrous materials have the properties of noise mitigation and building acoustic correction. They also carried out the optimization of reverberation room characteristics in order to quantify the sound absorption properties and to make a comparison with traditional fibrous sound absorbers according to ISO 354 standard. They observed a remarkable influence on the measured absorption coefficients by installing different numbers of diffusers both in terms of mean value and of standard deviations; suspended gypsum-board plane diffusers were employed, even in combination with wall diffusers placed at the lower room corners. They observed the dependence of final data on the climatic conditions of the room; it was noticed that when temperature and relative humidity gets closer to the limits prescribed by the ISO 354 standard (15^0C and 30%), the correction for air absorption can strongly influence results mainly at higher frequencies.

Hodda S Seddaq studied the effect of physical properties of materials like fiber type, fiber size, material thickness, density, airflow resistance and porosity on the absorption behaviour. He also studied the effect of surface impedance, placement/position of sound absorptive and compression on sound absorption behaviour of materials. He also tested experimentally the sound absorption of different fibrous materials. From his study he concluded that higher airflow resistance always gives better sound absorption values but for airflow resistance higher than 1000 the sound absorption have less values because of difficulty movements of sound wave through materials. The creation of air gap 5mm, 10mm behind the absorptive material increase the sound absorption coefficient values in mid and higher frequencies. From his experiments he concluded that fiber surface area and fiber size have strong influence on the sound absorption properties. Higher surface area and lower fiber size increases sound absorption. Films such as PVC attachment increase sound absorption at lower and mid frequencies at the expense of higher frequencies.

From the above survey it clearly appears that there are many natural as well as artificial materials present that have potential of being used to mitigate the noise levels. But a lot more needs to be done with regard of using these materials under varied circumstances.

IV. BENEFITS OF NOISE REDUCTION

Mark Lijesen et alperfomed analysis of noise reduction at Amsterdam airport using the results of influence of aircraft noise, expressed in Noise depreciation Index(NDI) which reflects the average percentage decrease in property value due to an increase in noise by 1db(A). He proposed two methods Contingent Valuation method (CVM) and the hedonic price method (HPM). With the CVM, respondents are asked how much they are willing to pay for a reduction of noise around their place of residence. Since respondents explicitly state their preference, this method can be classified as a stated preference method. The use of stated preference methods allows researchers to value items, even if they are not consumed, but some disadvantages arise as well, for instance:

- Stating a preference has no real effect in terms of budget, allowing respondents to answer strategically. Careful design may limit the possibilities for strategic answers, but the problem that respondents don't actually pay for their choices remains.
- Answers in a survey often depend on the context of the questions.
- Respondents may be inexperienced in valuating the item at hand, making it difficult to value it correctly.
- Respondent may have changing preferences.

The HPM compares prices of residences in areas with differing levels of noise nuisance. After correcting for other factors that influence house prices, the effect of noise on house prices may be computed, yielding a valuation for noise nuisance. HPM is a revealed preference method, as the valuation is based on actual behavior. This makes the outcomes very realistic, although some disadvantages apply as well:

- HPM cannot measure valuations if they are not related to actual use.
- This method requires a large amount of data.
- The use of the HPM requires two somewhat unrealistic assumptions:
- Consumers are fully informed.
- Transaction costs are zero.

V. CONCLUSION

There are various techniques that can be employed for the purpose of noise reduction. Various materials can be used as noise absorbers for reducing noise levels. These absorbers may either be used in porous form or panel form. The absorbers used may be either synthetic or natural. It is necessary to develop sustainable material to be used for noise reduction purposes. Various innovative methods like water membrane and green wall should be encouraged as they do not have any harmful on environment. Our ongoing research on producing a green concrete by using EPS beads as a waste material in concrete. EPS insulation can return up to 200 times the amount of energy required to produce it, and reduce emissions by up to 100 times the volume produced during the manufacturing process. Our current research is about performing experiments and investigations to check how much is the potential of noise absorption of EPS beads in concrete. Expanded polystyrene is made from expandable polystyrene, which is a rigid cellular plastic containing an expansion agent. The properties of EPS beads are shock absorption, thermal insulation, light weight, low water absorption, low thermal conductivity, ageing resistance. EPS is a good example of efficient use of natural resources because it is 98% air. When such a material will be used in concrete probably the concrete will exhibit some properties of EPS beads as well. Our ongoing research is about checking the influence of noise reduction when EPS beads are used in concrete. This paper is a first in the series of papers for the investigation of EPS beads in concrete.

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