IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

NOISE ASSESSMENT IN AN AUTOMOTIVE INDUSTRY THROUGH NOISE MAPPING

Mr. J. PRAKASH, M.E.,[1] G. GOWTHAMAN[2]., Mrs. A.ELAVARASI, M.E.,[3]
[1,3] Assistant Professor, Department of Mechanical Engineering, Knowledge Institute of Technology, Kakapalayam, Salem,-637504, Tami Nadu.
[2] PG Scholar, Department of Industrial Safety Engineering, Knowledge Institute of Technology, Kakapalayam, Salem,-637504, Tamil Nadu.

Abstract— Noise pollution has been rising as a critical issue in recent days particularly for the working individuals in the industries. Noise pollution is unwanted sound, it needs to be controlled to make the workplace comfortable. This chapter analyses noise mathematically and the effects of multiple sources are examined. Two noises of exactly the same level can have a combined noise level that is 3 dB higher than the individual values. The greater the difference between the two individual noise sources, the lower is the combined noise level. Different people react differently to the same type of noise. A noise level up to 90 dB does not have any appreciable effect. Exposure in excess of 115 dB is not permitted with unprotected ears as it runs the risk of hearing impairment. The average noise level of various equipment used inside the washery generally ranges from 85 to 110 dB. Various control measures for the abatement of noise pollution have been studied. The hierarchy of control for a reduction of hearing loss to personnel is illustrated. This study has been conducted to find out the effects of machinery and man induced noise within the industry. Reduction pattern of noise level can easily be visualized and evaluated by using noise maps. This type of study could support decision makers during adaptation of suitable remedial measures.

I. INTRODUCTION

The noise mapping concept is popular in the world as it is the graphical representation of the sound level distribution of a given region for a certain defined period. Mapping can be made about individual noise sources, i.e., machineries, material handling, vehicles, overhead cranes etc. However, all the sources can be combined into one map to give an overall picture of the noise distribution. In an automotive industry, where noise does not vary significantly with height due to absence of obstacles, a 2D representation may still suffice. Noise exposure is the primary cause of preventable hearing loss. Noise exposure at work is responsible for an estimated 16% of disabling hearing loss in adults worldwide. Left untreated; hearing loss can lead to communication difficulty, social isolation, stress, and fatigue. Workers with hearing loss face challenges to their personal safety, show higher rates of absenteeism, may be at increased risk (probability) of work-related injuries, and are more likely to be underemployed or unemployed. In addition to hearing loss, high levels of noise are associated with tinnitus, hyperacusis, cardiovascular disease, annoyance, performance decrements, and sleep disturbance. Simply put, noise exposure and its effects can have a substantial negative impact on quality of life.

II. PROBLEM IDENTIFICATION

In Refractory industry, the mechanisms of noise generation depend on the particularly noise operations and the finishing equipment's like vertical block saw machine, vertical rotating surface grinding machine, bridge grinding machine, polishing machine and drilling machine. Exposure to high levels of noise can cause permanent hearing loss. Neither surgery nor a hearing aid can help correct this type of hearing loss. Short term exposure to loud noise can also cause a temporary change in hearing (your ears may feel stuffed up) or a ringing in your ears (tinnitus). These short-term problems may go away within a few minutes or hours after leaving the noise. However, repeated exposures to loud noise can lead to permanent tinnitus and/or hearing loss. Loud noise can create physical and psychological stress, reduce productivity, interfere with communication and concentration, and contribute to workplace accidents and injuries by making it difficult to hear warning signals. The effects of noise induced hearing loss can be profound, limiting your ability to hear high frequency sounds, understand speech, and seriously impairing your ability to communicate.

III. Related Study

M.K. Saha, S.J. Ahmed, A.H. Sheikh and M.G. Mostafa have published on "Occupational hazard of brick kiln worker at high intensity noisy environment". Evaluation of noise pollution load and its mitigation is a big challenge towards a sustainable environmental. The present study is an attempt to assess the noise pollution load of the study area and address the impacts of the noisy environment in brick kiln areas. An extensive noise level monitoring study was conducted at 12 pre-identified brick kiln cluster. The recorded data were interpreted and compared with the prescribed standard of Ministry of Environment, Forest and Climate Change to evaluate the ambient noise quality status around the study area. A structured questionnaire was prepared to collect noise related compliance from a brick kiln worker. The noise sources were identified and their levels at different brick kiln cluster during peak working hours between 09:30 AM – 04:30 PM were measured. The study results showed that the noise level in most of the brick kilns areas exceeded the acceptable level 75 dB in on-site sampling. However, brick kiln workers were not well aware of such types of occupational hazard and noise related compliance issue.

Christa L. Themann, and Elizabeth A. Masterson have published a journal on "Occupational noise exposure: A review of its effects, epidemiology, and impact recommendations for reducing its burden". Exposure to hazardous noise is one of the most common occupational risks, both in the U.S. and worldwide. Repeated overexposure to noise at or above 85 dBA can cause permanent hearing loss, tinnitus, and difficulty understanding speech in noise. It is also associated with cardiovascular disease, depression, balance problems, and lower income. About 22 million U.S. workers are currently exposed to hazardous occupational noise. Approximately 33% of working-age adults with a history of occupational noise exposure have audiometric evidence of noise-induced hearing damage, and 16% of noise-exposed workers have material hearing impairment. While the Mining, Construction, and Manufacturing sectors typically have the highest prevalence of noise exposure and hearing loss, there are noise-exposed workers in every sector and every sector has workers with hearing loss. Noise-induced hearing loss is preventable. Increased understanding of the biological processes underlying noise damage may lead to protective pharmacologic or genetic therapies. For now, an integrated public health approach that (1) emphasizes noise control over reliance on hearing protection, (2) illustrates the full impact of hearing loss on quality of life, and (3) challenges the cultural acceptance of loud noise can substantially reduce the impact of noise on worker health.

Jian Cheng, Yu Yang, Niaoqing Hu, Zhe Cheng, Junsheng Cheng have published a journal on "A noise reduction method based on adaptive weighted symplectic geometry decomposition and its application in early gear fault diagnosis". When the gear appears early fault, it will be accompanied by strong background noise, and the fault information is weak. Therefore, the result of noise reduction often determines whether the early gear fault can be accurately diagnosed. However, there are many defects in the existing methods of noise reduction. Wavelet decomposition (WT) requires setting parameters manually, and it is not adaptive. The ensemble empirical mode decomposition (EEMD) still has mode aliasing and endpoint effects. The singular spectrum analysis (SSA) and symplectic geometry mode decomposition (SGMD) select the useful components by energy size, which will delete the components with more fault information but less energy. Therefore, an adaptive weighted symplectic geometry decomposition (AWSGD) method is proposed for noise reduction in this paper. On the one hand, AWSGD is adaptive without setting parameters manually. On the other hand, AWSGD defines cycle kurtosis (CK) and periodic impact intensity (PII). CK is used to characterize the strength of periodic impact in the component, and PII is used to measure the fault information amount of the component. It can avoid the defect of the traditional noise reduction method by energy size. The noise reduction results of emulational and experimental signals show that AWSGD has excellent performance in noise reduction.

Janusz Wyrwal, Marek Pawelczyk, Ling Liu, Zhushi Rao have published a journel on “Double-panel active noise reducing casing with noise source enclosed inside – Modelling and simulation study”. The main purpose of the article is to provide a theoretical study of a double-panel active casing by developing a mathematical model for such a dynamical system. The aim of the active casing is to reduce device noise generated to the acoustic environment by controlling vibration of wall panels of the device casing. The article concerns mathematical modelling and simulation of an active casing comprising six double–panel walls mounted to a rigid frame. The casing is considered as a complex coupled vibro-acoustic system, where the wall panels are excited by the acoustic fields inside the casing and by actuators bonded to the wall panels and used for active control. The acoustic field inside the casing is, in turn, produced by the noise originating from the device itself, and the secondary sound generated by all vibrating walls panels. In the first part of the paper a theoretical analysis is performed to derive mathematical model for the system under consideration. The Kirchhoff-Love equations are used to describe walls panels dynamics and the acoustic wave equations are applied to describe acoustic fields in appropriate media. The mathematical model represented as a system of coupled partial differential equations, subject to appropriate boundary conditions, is derived. The fluid–structure interactions of vibroacoustic and acoustic-vibration character, are also incorporated into the model. The model describes also imperfect fastening of the walls panels edges to the rigid frame. All assumptions applied to derive the model are chosen to relate the model to the realities of the utility. In the second part of the paper in order to prove the correctness of the derived model and give a better physical insight into the system, simulations are performed by means of a general-purpose simulation software COMSOL Multi physics. Responses to noise generated by a primary source of noise located in the interior of the active casing are investigated there. Simulations conditions are chosen in such a way to demonstrate the model behaves properly in the context of all incorporated vibro-acoustic interactions that can be observed in a real system.

Xingsong Wang, Oluseyi Adewale Orelaja, Dauda Sh. Ibrahim, Stephen Mbam Ogbonna have published on “Evaluation of noise risk level and its consequences on technical operators of tobacco processing equipment in a cigarette producing company in Nigeria”. This paper evaluates the noise risk level and its consequences on technical operators of tobacco processing equipment in Nigerian cigarette industries. The noise generated by dif- ferent equipment used in primary, secondary and utility production departments in three different tobacco companies in Nigeria were evaluated and analysed. It is discovered that the highest noise mean of about 106.02 dB is generated from the utility departments due to non-stop usage of 3.2 Kilowatts (kVA) generators as the company depends on electrical generator for the machines operation. The overall mean of noise measured from the three companies (101.89 dB, 98.63 dB, and 96.15 dB) showed that all technical operators were subjected to intense noise which is well above the standard of National and International limit of 85 dB. This research proved that high decibel of noise has severe impact on health and performance of the technical operators who spend an average of 12 h daily on the production floor. In addition, the noise effects negative effects on the overall production efficiencies of all the companies were evaluated. Analysis of the result outcome showed that all the companies were operating at efficiencies of less than 55%. In a quest to implement standard control measures to minimize the effect of noise to a limit set by Occupational Safety and Health Administration. It is therefore recommended that engineering controls in areas of equipment aging inspection, routine maintenance, proper implementation of administrative measures and workplace etiquette to serve as the everlasting solution to the noise problem bedeviling operators in tobacco producing companies.

Honghui Wang, Sibo Wang, Xiang Wang, Tong Liu and Yuhang Wang have published a journal on “RDTS noise reduction: A fast method study based on signal waveform type”. In order to reduce the measurement error of Raman-based distributed temperature sensor (RDTS) caused by random noise, we have proposed an effective noise reduction method, which can reduce the time consumption of data processing due to the low time complexity of the method. We classified the signal as five models based on the waveform types, thus to filter the raw data according to the waveform types. Then, we established an experimental device to test the effects of different signal noise reduction methods, including maximum deviation (MD), root mean square error (RMSE), smoothness, and time consumption. Experimental results show that it can efficiently suppress random noise and reduce temperature measurement errors in RDTS compared with direct demodulation of the raw data, and significantly improve the curve smoothness compared with D-SVD and WT-Soft. The time consumption test based on three different devices shows that the time consumption of the proposed method is approximately 10% of the D-SVD method, and about 30% of the WT-Soft method. It proves that this method is an effective and fast noise reduction method in RDTS systems.

Hongli Ji, Xiaodong Wang, Jinhao Qiu, Li Cheng, Yipeng Wu,Chao Zhang have published a journal on “Noise reduction inside a cavity coupled to a flexible plate with embedded 2-D acoustic black holes”. Acoustic black hole (ABH) structures have been exploited to manipulate the flexural wave propagation with results showing a great potential for structural vibration damping enhancement and suppression of free-field acoustic noise radiation.

Murphy E, Faulkner JP, Douglas O. Current state-of-the-art and new directions in strategic environmental noise mapping. Curr Pollut Rep. 2020;6:54–64. This paper evaluates Environmental noise mapping has the potential to act as a powerful resource for policymakers as a decision support tool for the mitigation of the negative effects of environmental noise pollution and its impact on public health. The aim of this paper is to review current state-of-the-art developments in how the strategic noise mapping (SNM) process has progressed at the EU level since the introduction of the Environmental Noise Directive (END) in 2002. Reviewing such developments is important because of the relevance of SNM to public health. In this regard, the development of a new standardized noise calculation method (i.e. CNOSSOS-EU) is also considered, as well as the future potential for noise mapping and the impact of technology on the development of noise pollution assessment.

Alsina-Pages RM, Vilella M, Pons M, Garcia Almazan R. Mapping the sound environment of Andorra and Escaldes-Engordany by means of a 3D city model platform. In the new paradigm of the smart cities world, public opinion is one of the most important issues in the new conception of urban space and its corresponding regulations. The data collection in terms of environmental noise cannot only be related to the value of the equivalent noise level $LAeq$ of the places of interest. According to WHO reports, the different types of noise (traffic, anthropomorphic, industrial, and others) have different effects on citizens; the focus of this study is to use the identification of noise sources and their single impacts on background urban noise to develop a visualization tool that can represent all this information in real time. This work used a 3D model platform to visualize the acoustic measurements recorded at three strategic positions over the country by means of a sound map. This was a pilot project in terms of noise source identification. The visualization method presented in this work supports the understanding of the data collected and helps the space-time interpretation of the events. In the study of soundscape, it is essential not only to have the information of the events that have occurred, but also to have the relations established between them and their location. The platform visualizes the measured noise and differentiates four types of noise, the equivalent acoustic level measured and the salience of the event with respect to background noise by means of the calculation of SNR (Signal-to-Noise), providing better data both in terms of quantity and quality and allowing policy-makers to make better-informed decisions on how to minimize the impact of environmental noise on people.

Bozkurt TS, Demirkale SY. The field study and numerical simulation of industrial noise mapping. J Build Eng.The acoustic environment is known to have a physiological as well as psychological impact on human health and also have a great importance in the establishment of comfort conditions. Accordingly, a healthy environment and better quality of life depend on environmental noise control. There are numerous research about traffic, airport and railway noise mapping studies with related to the subject in the literature. However, there are some other factors affect the outcomes of the noise mapping studies such as how the industrial buildings is used. Although this factor effects significantly the industrial noise mapping studies, there is no sufficient number of research studies refers this topic. In fact, the research studies about the noise level of industrial units and their interaction between its surrounding areas play a key role on the industrial noise mapping. It is a well-known fact that there are too many parameters effect the noise mapping results in the real world applications. On the contrary, in the local areas such as an industrial estate, some parameters can be more effective on the noise level and may need a special attention in order to obtain noise mapping results accurately. This study deals with the issue of industrial noise mapping process as part of ensuring environmental noise control and demonstrates that there is a strong relation between the noise level of an industrial estate and the usage of the industrial buildings. In order to achieve this purpose, numerical analysis and some field researches were carried out in the study. In this scope, the sound levels of industrial noise sources were determined and – on the basis of the prevailing sound propagation conditions – a noise map was established for the region. For the industrial noise map, the limit values published in the Turkish Environmental Noise Regulation were used, and the number of people affected by excessive noise levels determined. Noise barriers were designed and their impact on reducing excessive noise in populated areas to acceptable limit values were evaluated. It is concluded that the industrial noise mapping research systematically carried out in order to show the role of the sensitivity analysis related to the different opening of the doors of the industrial buildings.

Seong JC, Park TH, Ko JH, Chang SI, Kim M, Holt JB, et al. Modeling of road traffic noise and estimated human exposure in Fulton County, Georgia, USA. In this paper Environmental noise is a major source of public complaints. Noise in the community causes physical and socio-economic effects and has been shown to be related to adverse health impacts. Noise, however, has not been actively researched in the United States compared with the European Union countries in recent years. In this research, we aimed at modeling road traffic noise and analyzing human exposure in Fulton County, Georgia, United States. We modeled road traffic noise levels using the United States Department of Transportation Federal Highway Administration Traffic Noise Model implemented in Sound. After analyzing noise levels with raster, vector and façade maps, we estimated human exposure to high noise levels. Accurate digital elevation models and building heights were derived from Light Detection And Ranging survey datasets and building footprint boundaries. Traffic datasets were collected from the Georgia Department of Transportation and the Atlanta Regional Commission. Noise level simulation was performed with 62 computers in a distributed computing environment. Finally, the noise-exposed population was calculated using geographic information system techniques. Results show that 48% of the total county population [N = 870,166 residents] is potentially exposed to 55 dB(A) or higher noise levels during daytime. About 9% of the population is potentially exposed to 67 dB(A) or higher noises. At nighttime, 32% of the population is expected to be exposed to noise levels higher than 50 dB(A). This research shows that large-scale traffic noise estimation is possible with the help of various organizations. We believe that this research is a significant stepping stone for analyzing community health associated with noise exposures in the United States.

Morillas JMB, González DM, Escobar VG, Gozalo GR, Vílchez-Gómez R. A proposal for producing calculated noise mapping defining the sound power levels of roads by street stratification. Environ Pollut. In this paper The European Noise Directive proposes using strategic noise maps as tools to assess populations affected by environmental noise. It recommends using computational methods instead of in situ measurements when possible. A sound source's emission power is an important factor in the calculation of noise indicators. For traffic noise, this parameter is usually defined based on vehicle flow considering an emission spectrum that depends on the type of vehicle and its speed. This study analysed the possibility of using the categorisation method to propose an alternative method of defining a sound source's emission power to develop noise maps. This was accomplished using previously published values of the emission power per unit length. Another method is also proposed that estimates traffic flows. To verify their estimation capacity, the results of both methods were compared with the values obtained from in situ measurements. The results demonstrated similar uncertainties in both methods and were in the range of expected average uncertainties compared to the results obtained by calculating a noise map with the measured experimental values. In particular, for the differences between calculations and measurements, in absolute values, the mean uncertainties were approximately 2 dBA in estimating different long-term noise indicators.

IV. TOOLS

A sound level meter (also known as a sound pressure level (SPL) meter) is used for sound measurements. It is usually a handheld device with a microphone. The ideal microphone for sound level meters is the condenser microphone, which combines accuracy and reliability.[1] A microphone's diaphragm responds to changes in air pressure caused by sound waves. That is why the instrument is sometimes referred to as a sound pressure level (SPL) meter. This movement of the diaphragm, i.e. sound pressure (unit pascal, Pa), is converted into an electrical signal (unit volt, V). When describing sound in terms of sound pressure, a logarithmic transformation is commonly used, and instead the sound pressure level is expressed in decibels (dB), with 0 dB SPL being equal to 20 micropascals. A microphone can be distinguished by the voltage value produced when a known, constant root mean square sound pressure is applied. This is called microphone sensitivity. The instrument must be aware of the sensitivity of the microphone being used. Using this information, the instrument accurately converts the electrical signal to sound pressure and displays the resulting sound pressure level (unit decibel, dB).

Labels used to describe sound and noise level values are defined in the IEC Standard 61672-1:2013. the first letter is always an L. This stands for Level, as in the sound pressure level measured through a microphone or the electronic signal level measured at the output from an audio component, such as a mixing desk. Measurement results depend on the frequency weighting (how the sound level meter responds to different sound frequencies), and time weighting (how the sound level meter reacts to changes in sound pressure with time) applied.

Sound level label examples

Description	Label
Level A-weighted equivalent	LAeq
Level A-weighted fast maximum	LAFmax
Level C-weighted slow minimum	LCSmin
Level Z-weighted impulse maximum	LZImax

V. METHODOLOGY

The goal of the industrial hygienist is to keep workers, their families, and the community healthy and safe. They play a vital part in ensuring that federal, state, and local laws and regulations are followed in the work environment.

Typical roles of the industrial hygienist include the following:

- Anticipate, identify, and recognize workplace hazards (or health hazard identification).
- Investigate and examine the workplace for current risks, emerging, and developing risks.
- Analyze the risks stemming from the identified workplace hazards.
- Evaluate risks to achieve As Low As Reasonably Practical (ALARP) risk levels.
- Make recommendations on improving the health and safety of workers and the surrounding community (apply appropriate risk treatment).
- Monitor and review the proposed control measures to improve productivity, sustainability, and product stewardship.
- Align industrial hygiene programs with operational, financial, and strategic objectives of the organization.
- Develop a business case for industrial hygiene interventions and improvements.
- Communicate the value of industrial hygiene risk assessment and risks treatment in terms of financial and non-financial benefits.
- Work together with upper level managers (C-Suite) to fully integrate industrial hygiene programs into an Enterprise Risk

Management (ERM) system.

Sl No	work shop - SEG	of Perso	LAeq,T dBA	LAeq,T dBA	LAeq,T dBA	LEX,8h dBA	LEX,8h dBA (AVE	Lex with HPE	Uncertainty of sampling (<3.5)
1	Pattern Shop	[illegible]	86.6	84.9	85.7	88.2	85.7	72.2	1.2
2	Mould Shop	[illegible]	86.3	84.8	84.7	87.4	85.3	76.8	1.3
3	Mould Assembly	[illegible]	82.5	84.5	83.5	86.1	[illegible]	75.0	1.6
4	RN Flasking	[illegible]	86.5	87.6	85.7	88.3	86.6	78.1	1.5
5	RT Flasking	[illegible]	86.4	84	84.3	89.5	[illegible]	76.4	2.4
6	Pour Basin setting	[illegible]	82.5	81.5	82.7	85.6	[illegible]	73.7	1.9
7	Furnace Operation	[illegible]	88.9	91.3	89.4	94.5	89.9	[illegible]	2.3
8	Plugging / Grog Topping	[illegible]	84.7	86.6	88.6	90.1	86.0	77.5	1.8
9	RT Deflasking	[illegible]	83.8	85.3	83.9	87.8	[illegible]	75.5	2.1
10	RN Deflasking	[illegible]	86.5	84.7	85.2	89.0	85.5	77.0	1.4
11	RT Wet Blasting	[illegible]	83.7	85.7	84.2	88.4	[illegible]	79.0	1.70
12	RN Wet Blasting	[illegible]	83.7	86.4	84.5	90.1	[illegible]	76.4	2.7
13	VRSG	[illegible]	82.6	81.3	81.1	[illegible]	81.7	73.2	1.2
14	VBS	[illegible]	82.5	81.2	84.2	88.4	[illegible]	79.9	3.1
15	Polishing / Drilling	[illegible]	81.7	84.4	84.4	88.3	[illegible]	[illegible]	3.3
16	EG / BG / DEGM	[illegible]	80.8	83.7	82.9	88.2	[illegible]	79.7	3.1
17	Assembly & Packing	60	83.1	85.7	83.4	88.8	[illegible]	[illegible]	2.8
18	Loading / Unloading	8	85.4	85.8	83	90.8	84.7	[illegible]	3.1
19	Jargal Graphite	[illegible]	86.3	85.7	84.3	87.7	85.4	79.2	1.6
20	Mould Assembly & Coating	[illegible]	85.2	85.6	86.4	88.7	85.7	[illegible]	0.8
21	Jargal Furnace	[illegible]	85.2	84.8	84.4	87.7	[illegible]	79.2	0.5
22	Hot Stripping / Alumina Topping	[illegible]	83.3	82.6	85.4	89.4	[illegible]	[illegible]	2.9
23	Jargal Deflasking	[illegible]	86.8	87.3	87.5	90.1	87.2	[illegible]	0.4
24	Jargal Grit Blasting	[illegible]	87.8	88	88.8	91.2	88.2	[illegible]	0.6
25	A25 batching	[illegible]	83.8	82.7	84.1	86.3	[illegible]	78.4	1.0
26	Jargal Batching	[illegible]	86.5	88.2	87.1	90.9	87.3	[illegible]	1.3
27	A25 FL Operations	[illegible]	85.3	86.1	84.5	88.7	85.3	[illegible]	1.1
28	Jargal FL operations	[illegible]	90.1	88.9	89.3	92.6	89.4	[illegible]	0.8
29	Mechanical	[illegible]	86.9	85.8	84.3	90.7	85.7	[illegible]	2.4
30	Electrical	[illegible]	83.5	81.6	81.9	86.4	[illegible]	77.0	1.5
32	Technical Lab	16	76.8	78.7	77.8	[illegible]	77.8	73.1	1.5
33	EC	6	82.2	82.6	83.8	86.6	[illegible]	78.1	1.3

VI. Types of Industrial Noise

1. General Noise

- The distinction between noise and intelligible sound is purely subjective. A sound judged intelligible by one person may well be just a noise to his neighbor. As for instance, conversation between two persons may appear as disturbing noise to a third person who requires privacy or who may be engaged in a serious meditative work.
- Noise is not always a nuisance. For instance, in an office building beside a busy street a background humming noise is present which submerges many of the occasional disturbing sounds which in the absence of the above noise will appear too prominent and disturbing to the occupants.

2. Indoor Noise

- Noises in industrial buildings are mainly of indoor origin. These are caused by the machinery in operation and the work processes involved.

3. Continuous and Impulsive Noise

- Sound may be continuous, when the source is constantly vibrating, or as with many industrial noises, it may be impulsive in character, the source being set in vibration only for a short time. For instance, sound from a drop forge hammer belongs to the latter category.
- Here the high intensity pressure waves die away fast although the peak levels attained are very high.

4. Intermittent noise

- Intermittent noise is a noise level that increases and decreases rapidly. This might be caused by a train passing by, factory equipment that operates in cycles, or aircraft flying above workplace.

5. Low Frequency noise

- Low frequency noise makes up part of the fabric of our daily soundscape. Whether it's the low background hum of a nearby power station or the roaring of large diesel engines, we're exposed to low frequency noise constantly.
- It also happens to be the hardest type of noise to reduce at source, so it can easily spread for miles around.

REFERENCES

1. Jian Cheng, Yu Yang, Niaoqing Hu, Zhe Cheng, Junsheng Cheng.; Mechanical Systems and Signal Processing 149 (2021) 107351, "A noise reduction method based on adaptive weighted symplectic geometry decomposition and its application in early gear fault diagnosis".

2. Janusz Wyrwal, Marek Pawelczyk, Ling Liu, Zhushi Rao; 152 (2021) 107371, "Double-panel active noise reducing casing with noise source enclosed inside – Modelling and simulation study".

3. Xingsong Wang, Oluseyi Adewale Orelaja , Dauda Sh. Ibrahim , Stephen Mbam Ogbonna; Scientific African 8 (2020) e00344, " Evaluation of noise risk level and its consequences on technical operators of tobacco processing equipment in a cigarette producing company in Nigeria".

4. Yu Luan, Olivier Doutres, Hugues Nélisse , Franck Sgard; Applied Acoustics 176 (2021) 107856, "Experimental study of earplug noise reduction of a double hearing protector on an acoustic test fixture.

5. Eun Soo Kim , Youngjin Lee, Chan Rok Park; Optik - International Journal for Light and Electron Optics 247 (2021) 167909, "Feasibility of MMWF noise reduction algorithm in brain SPECT images according to various reconstruction methods: A phantom study".

6. Qingli Guo, Jing Ye, Yiran Chen , Yu Hu , Yazhu Lan , Guohe Zhang , Xiaowei Li , Neurocomputing 401 (2020) 160–172, " INOR—An Intelligent noise reduction method to defend against adversarial audio examples".

7. Heow Pueh Lee , Kian Meng Lim, Sanjay Kumar; Applied Acoustics 183 (2021) 108340, "Noise assessment of elevated rapid transit railway lines and acoustic performance comparison of different noise barriers for mitigation of elevated railway tracks noise".

8. Hongli Ji, Xiaodong Wang, Jinhao Qiu, Li Cheng, Yipeng Wu,Chao Zhang; Journal of Sound and Vibration 455 (2019) 324e338, "Noise reduction inside a cavity coupled to a flexible plate with embedded 2-D acoustic black holes.

9. Murphy E, Faulkner JP, Douglas O. Current state-of-the-art and new directions in strategic environmental noise mapping. Curr Pollut Rep. 2020;6:54–64.

10. Alsina-Pagès RM, Vilella M, Pons M, Garcia Almazan R. Mapping the sound environment of Andorra and Escaldes-Engordany by means of a 3D city model platform. Urban Sci. 2019;3:89.

11. Bozkurt TS, Demirkale SY. The field study and numerical simulation of industrial noise mapping. J Build Eng. January 2017;9:60–75.

12. Seong JC, Park TH, Ko JH, Chang SI, Kim M, Holt JB, et al. Modeling of road traffic noise and estimated human exposure in Fulton County, Georgia, USA. Environ Int. 2011;37(8):1336–41.

13. Morillas JMB, González DM, Escobar VG, Gozalo GR, Vílchez-Gómez R. A proposal for producing calculated noise mapping defining the sound power levels of roads by street stratification. Environ Pollut. 2021;270:116080