

**AIR & NOISE CONTROL AND ANALYSIS IN CONSTRUCTION  
INDUSTRY**

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**LUCKNOW**

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**CERTIFICATE**

Certified that **Pawan Kumar Bishnoi** (1170470008) has carried out the research work presented in this Project entitled “**Air & Noise and Analysis in Construction Industry**” for the award of **Masters of Technology in Civil Environmental Engineering** from Babu Banarasi Das University, Lucknow under my supervision. The Project embodies results of original work, and studies are carried out by the student himself and the contents of the Project do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

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## **AIR & NOISE CONTROL AND ANALYSIS IN CONSTRUCTION INDUSTRY**

**Pawan Kumar Bishnoi**

### **ABSTRACT**

Major environmental issues related to ongoing construction industry like air emission and Noise pollution have been arisen and impacted on the construction workers and also surroundings. Particulates (dust) are generated from various activities of construction sites excavation, drilling, bulk material transportation, loading and unloading; open-air material storage, concrete and mortar making; cut and fill operations; and movement of equipment and but not limited to. These major activities have significant impacts of existing environment. Dust pollution can cause numerous health issues among construction workers and many studies have dealt with this problem. In addition, safety, comfort and the morale of workers is affected by dust pollution. Dust also creates problems with the neighborhood and is considered to be a nuisance [3]. Many construction procedures, such as drilling and grinding, can produce high level of particulates that can be inhaled into lung, and consequently lead to physical diseases [4,5].

Considering the above situation the present work focuses on the monitoring of the different sources of Particulate matter & Noise generation in different areas using the samplers. Ambient air monitoring was conducted from March 2017 to February 2018 at an averaging period of 24 hour and monthly basis to derive the particulate matter generation behaviour in and around the sites. Seasonal variation on ambient air quality data have been noticed quite markedly. It is found that the monitored particulate matter concentrations thus obtained were not within the prescribed limits of NAAQS 2009. On the basis of these findings suitable mitigation and environmental plans can be devised for the sensitive areas. Ambient Noise have also been affected, the results were analyzed & compared with baseline survey.

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**LIST OF SYMBOLS AND ABBREVIATIONS**

PM	–	Particular Matter
µg/m <sup>3</sup>	–	Microgram per cubic meter
NAAQ	–	National Ambient Air Quality
PM <sub>10</sub>	–	Particles which has the diameter less than 10µm
PM <sub>2.5</sub>	–	Particles which has the diameter less than 2.5µm
LA <sub>eq</sub>	–	Equivalent Noise
PTFE	–	polytetrafluoroethylene
CPCB	–	Central pollution control board

**CHAPTER 1**

**INTRODUCTION**

**1.1 METRO RAIL CONSTRUCTION IN INDIA:**

Now a days, Government has taken steps to improve public transportation system in order to avoid increased traffic demand, vehicles increase on the road, traffic congestion, road accidents and significant environmental pollution. Metro transport system have been introduced in many developing cities like Kolkata, Delhi, Mumbai, Chennai etc and are also being provided in other cities in India. Although this system contributes substantially the reduction of air and noise pollution through the decrease in the number of cars and heavy vehicles circulating in the road network, the works related its construction may pose an extra burden in air and noise quality status and advance impact on public health.

Lucknow is popularly known for its cultural and intellectual traditions as well as its current status as a nucleus of service industry, education & research. With its 2.2 (COI, 2001 Estimates) million inhabitants Lucknow Urban Agglomeration has currently over 3 million population. Being an important cultural and trading centre Lucknow continues to grow and attract large number of people to the city. The rapid growth of the city and the associated urban sprawl has accentuated the demand supply mismatch amidst the constrained transport infrastructure resulting in economic and social externalities.

Regarding the rapid development of cities, underground constructions at urban regions such as metro construction have been largely used for extending the human daily life into underground spaces. Metro rail systems are known as convenient underground transportation solutions amongst citizens [2]. The construction of new metro project or expansion of existing metro systems are being planned in several densely populated and highly polluted cities of the world. The metro systems after construction and commissioning will certainly

reduce the pollution level and add convenience to the public, but such project may grossly aggravate the pollution problem during construction stage, especially in respect of noise and air pollution which are generally at their peak in the city just before such projects are taken up for implementation.

Lucknow is already being experienced with severe air pollution issues for past few years due to vehicular emissions and day by day increasing private vehicles on road, rapid urbanization on the expenditure of greenery and industries surrounding the city. The construction of new metro project or expansion of existing metro systems are being planned in several densely populated and highly polluted cities of the world. The metro systems after construction and commissioning will certainly reduce the pollution level and add convenience to the public, but such project may grossly aggravate the pollution problem during construction stage, especially in respect of noise and air pollution which are generally at their peak in the city just before such projects are taken up for implementation. The metro alignment generally passes through densely populated areas and high vehicular traffic zones; thus the construction activity has to be taken up mostly in the vulnerable areas of the city, which are the most densely populated as well as generally having the highest pollution level. Now-a-days the project implementation period is getting further compressed resulting in more intense activity of construction and much more increase in pollution level in the shorter period of construction. In such situation, large population of city which is already suffering from high pollution level may be further exposed to considerably increased pollution level due to the major construction activity, which may lead to very prolonged adverse effect on the public health in general [21].

The paper deals with all the aspects of air & noise quality for construction of Lucknow metro underground project in Lucknow city highly polluted city. Particulate matter is one of the major threat to environment once it becomes airborne. These airborne particulate matters leads to several severe health problems such as, visible impairment, Pneumoconiosis, allergic reactions etc. Dusts, as per the size of particulates are classified mainly as total

suspended particulates (TSP), Particulate matter of size less than 10 microns (PM10) and Particulate matter of size less than 2.5 microns (PM2.5). These particulate matters are basically measured in microgram per cubic meters. It is necessary to identify the emission sources of different construction activities so that their impacts on the surrounding air quality can be known and depending on its severity proper preventive measures could be devised. It is equally important to know the constituents of these particulate matters in order to find the correct pollutant composition and types of health issues it can create on miners and the people residing in the nearby areas. Particulates (dust) are generated from various activities of construction sites excavation, drilling, bulk material transportation, loading and unloading; open-air material storage, concrete and mortar making; cut and fill operations; and movement of equipment and but not limited to. These major activities have significant impacts on the existing environment. Dust pollution can cause numerous health issues among construction workers and many studies have dealt with this problem. In addition, safety, comfort and the morale of workers is affected by dust pollution. Dust also creates problems with the neighborhood and is considered to be a nuisance [3]. Many construction procedures, such as drilling and grinding, can produce high level of particulates that can be inhaled into lung, and consequently lead to physical diseases [4,5].

The term “dust” refers to the particulate matter generally classified based on its properties such as size, composition, exposure time etc. Normally it is measured in  $\mu\text{g}/\text{m}^3$ .

- **PM10:** These are the particles which has the diameter less than  $10\mu\text{m}$ . They are commonly called as coarse particles coming out of roads, industries as well as particles formed under combustion. 10

- **PM2.5:** The particulate matter which has the size less than  $2.5\mu\text{m}$  is known as PM2.5. These are usually called as fine particles which contains secondary aerosols, combustion particles, re-condensed organic metallic vapours and acid components.

Construction and site activities are mainly responsible for different types of diseases like High Blood pressure (HBP), hypertension (cardio vascular disease, pneumonia, respiratory diseases [16], coughing, asthma [17], cardio vascular [18] diseases, brain strokes, premature

death [19] and type 2 mellitus diabetes. These are the main diseases which contaminated by construction pollutants. In the estimate of global pollution that can be attributed to building and construction activities the pollutions air qualities is affected in cities is 23%, climate change through gases responsible is 50%, drinking water through pollution 40%, landfill pollution occur through construction activities 50%, Ozone depletion pollution through pollution is 50% [19]. Construction activities main pollutant are particulate matter (PM10& PM2.5), NO<sub>x</sub>, SO<sub>x</sub> and volatile organic compounds. In the south east Asia particulate air pollution is mostly responsible for pollution and their related disease. Noise pollution on construction site increases the cases of sleeplessness, eyes irritation, high blood pressure, stress problems also affect the person who has problem of heart stroke due to increase site activities and heavy old vehicle used on site. This is best source of construction pollution [20]. Construction activities could damages the environment, destroy natural vegetation, water bodies, natural sand dunes forests, gardens, parking areas, construction pollution also cause soil compaction substantial increase in the soil level, opened of trenches, damage of plant roots destroying roots, damages of dams are affected by construction pollution [20].

Noise is generally considered to be undesirable sound and sound can be considered undesirable due to amplitude or volume of loudness, category of noise, about the day, or any modality making resonance or obscene. Construction noise contributors include pneumatic equipments, air compressors, machine mounted percussion drills, loaders, trucks and breaking equipments. The main sources of noise at a construction site include construction machines (mainly machines which produce impacts, e.g. devices for breaking concrete), earth-moving machines, pile drivers, pneumatically driven devices and combustion engines. For the purposes of noise studies, these mechanisms must be considered to be point or linear noise sources depending on the level of movement at the construction site. Some types of construction projects are not endangered by increased noise pollution at all, while others are, but only when particular conditions coincide. In the case of certain

construction sites, increased impact can already be expected from the very nature and location of the project.

Noise is responsible for adverse impact on physical and mental health of the people. The other impacts are Physiological effects, Hearing impairment, Communication interference, Sleep disruption. The assessment of impacts of noise sources on surrounding community depends on: Characteristics of noise sources (instantaneous, intermittent or continuous in nature), Time of day at which noise occurs, for example high noise levels at night in residential areas are not acceptable because of sleep disturbance, Location of noise source, with respect to noise sensitive land use, which determines the loudness and period of exposure.

The factors which influence the society and construction are identified. Such main sources of construction worksite noises are: a) Diesel power generators b) Cutting and welding processes c) Heavy machinery like trucks d) Transport of materials e) Demolition f) Maintenance and Repair g) Erection. The noise levels created by construction equipment will vary greatly depending on factors such as, a) The type of equipment b) The specific model c) The operation being performed and d) The condition of the equipment.

The main harmful effects of noise pollution at construction site are, a) Hearing problems b) Health issues c) Sleeping disorders d) Cardiovascular issues. Noise effects on human beings in construction site are classified into two types such as 1. Noise hazards a) Permanent hearing loss b) Neural stress 2. Noise nuisance a) Efficiency b) Mental stress c) Irritability d) Sleep interference e) Habit of talking loudly f) Hearing loss g) Concentration.

## **1.2 OBJECTIVES:**

The particulate matter which proves to be the main source of air pollution in construction areas needed to be assessed. Among various pollutions noise pollution is one of the major contributions of construction industry.

This current work has been planned with the following objectives:

- (a) Collection of the Ambient Air Quality data monitoring data of Lucknow metro construction locations & Comparison with Baseline survey. For the ambient air quality objective, it is necessary to determine the concentration of the substance at the ground level.
- (b) To study the impact of noise pollution at construction site.

### **1.3 ORGANIZATION OF THE THESIS:**

The project “**Air & Noise Control and Analysis in Construction Industry**” focusses on the ambient air & noise quality assessment due to construction activities. Literature review & government guidelines presents the earlier associated work in the field of particulate matter & noise monitoring and analysis. The health impacts are also discussed in this study.

The plan of work can be summarized as listed below:

- Introduction to the work
- Review of Literature Effects on Environment & human health
- Analysis of Ambient Air & Noise Monitoring data
- Discussion and Conclusion
- References

### **1.4 METHODOLOGY:**

The ambient air quality (PM<sub>10</sub>, PM<sub>2.5</sub> etc) were monitored from March 2017 to February 2018 month for Lucknow Metro Underground single station location. Noise Monitoring has been completed by sound level meter. The ambient air monitoring frequency was once in 15 days and noise monitoring frequency was once in every week.

The PM<sub>10</sub> & PM<sub>2.5</sub> data was collected from different locations in the study area. Noise

measurements have been completed by specific sound level meter during day time. Ambient Noise Analysis was conducted at the same location where Ambient Air were analysed. LAeq is known as the equivalent level of noise.

The methodology of ambient air quality & noise assessment was done for the study areain order to evaluate the seasonal trends as well as comparison with baseline data. The data collection has done for an year.

## **1.5 THESIS STRUCTURE**

This research thesis consists of seven chapters, by which the effects of ambient air quality & noise quality due to Lucknow metro construction.

### **1.5.1Introduction**

This chapter presents the precursory background that introduces for the following contents of the research; it recognizes the scope and level of intervention of the research. Moreover, it clearly identifies the problem statements, the research hypothesis, goals and methodology, andsystematicallyitemizedonresearchtheme and context.

The analysis of the study area (Lucknow metro rail stations),and the specified influenced localities (Krishnanagar, IIT Chauraha, Vishwavidayalay and Indranagar) in terms of their physical, geo- political, economic, environmental and other characteristics.

### **1.5.2 Literature Review**

This chapter provides a survey of the existing literature about the subject of the research, it discusses the study behind the existing air quality & noise quality, public health and environment.

### **1.5.3 Methodology**

This chapter describes the methodology of ambient air quality & noise assessment was done for the study area in order to evaluate the seasonal trends as well as comparison with baseline data. The data collection has done for an year.

### **1.5.4 Results and Recommendations**

The closing chapter briefly checks the ability of the research to achieve its goals. It also provides a general policy framework of strategies, for promoting results and a proper analysis of affected air & noise quality in order to mitigate the air & noise quality.

### **1.5.5 Conclusions and Recommendations**

Based on the result, this can help in applying the sustainable development concept and identifying the conditions to improve the environment through a brief discussion for the generalization ideas and recommendations for policymaking towards clean air & noise mechanism.

### **References**

Includes a complete listing of all resources cited in the thesis.

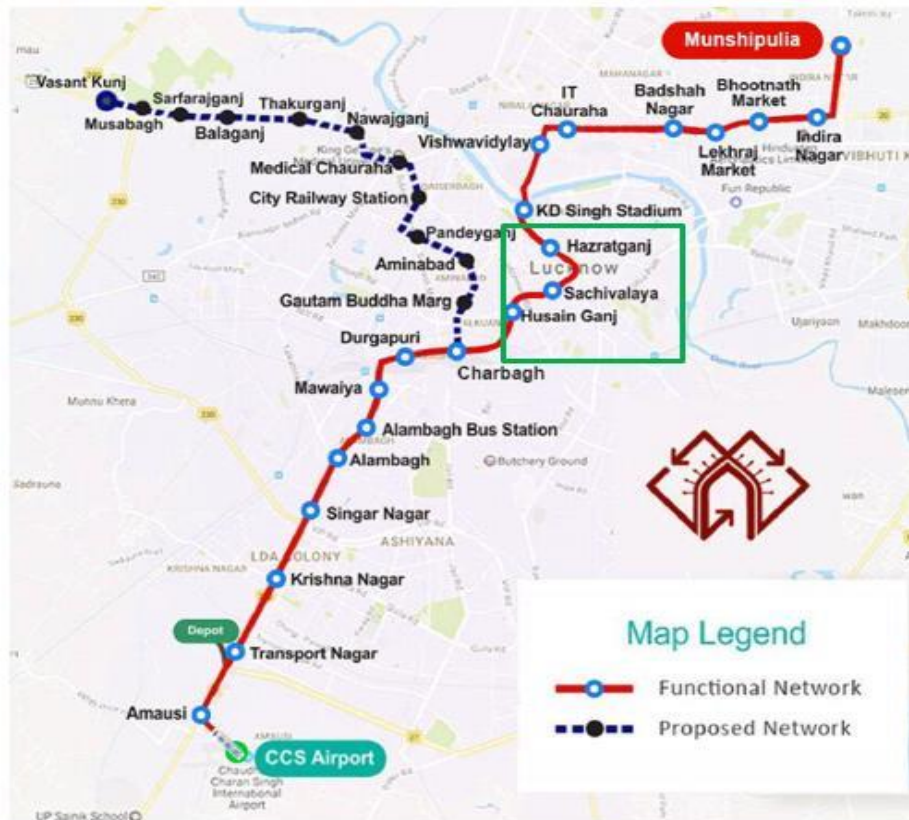
## **1.6 STUDY AREA**

### **1.6.1 LUCKNOW METRO RAIL (PROJECT HIGHLIGHTS)**

Lucknow is popularly known for its cultural and intellectual traditions as well as its current status as a nucleus of service industry, education & research. Lucknow is the capital of Uttar Pradesh & administrative headquarters of Lucknow district & division. With its 2.2 million inhabitants Lucknow Urban Agglomeration has currently over 3 million populations. The master plan has projected a population of about 3.2 million and 4.0 million by years 2011 & 2021 respectively. Being an important cultural and trading

centre Lucknow continues to grow and attract large number of people to the city. The rapid growth of the city and the associated urban sprawl has accentuated the demand supply mismatch amidst the constrained transport infrastructure resulting in economic and social externalities. The need for a well-developed legal mechanism to conserve resources, protect the environment and ensures the health and wellbeing of the people in India was felt. Keeping the pace with international laws, the Ministry of Environment and Forests enacted Environmental Protection Act in 1986. Over the years, the Government of India has framed several policies and promulgated number of Acts, Rules and Notifications aimed at management and protection of the environment. During last three decades an extensive network of environmental legislation has grown and presently it has a fairly complex body of environmental legislation aimed at ensuring that the development

Lucknow Metro, the dream project of the people of Lucknow, is progressing at a very fast pace and has already achieved the distinction of being the fastest Metro project execution that has ever been undertaken in the country. This metro alignment current phase is located in Lucknow on North- South Corridor between Airport (Charan Singh) and Munishipulia. The alignment would serve the area by providing better connectivity to people coming from and going to the rural area between Barabanki and up to Faizabad. The maintenance Depot is also available at transport nagar. This metro corridor is to cater the requirement of the city for a length of about 27.5 Km. The total corridor covers elevated (24 Km) and underground (3.5 Km) respectively and 24 stations.



*Fig. 1.1. Lucknow metro project routes*

Lucknow is already being experienced with severe air pollution issues for past few years due to vehicular emissions and day by day increasing private vehicles on road, rapid urbanization on the expenditure of greenery and industries surrounding the city. The construction of new metro project or expansion of existing metro systems are being planned in several densely populated and highly polluted cities of the world. The metro systems after construction and commissioning will certainly reduce the pollution level and add convenience to the public, but such project may grossly aggravate the pollution problem during construction stage, especially in respect of noise and air pollution which are generally at their peak in the city just before such projects are taken up for implementation. The metro alignment generally passes through densely populated areas and high vehicular traffic zones; thus the construction activity has to be taken up mostly in the vulnerable

areas of the city, which are the most densely populated as well as generally having the highest pollution level. Now-a-days the project implementation period is getting further compressed resulting in more intense activity of construction and much more increase in pollution level in the shorter period of construction. In such situation, large population of city which is already suffering from high pollution level may be further exposed to considerably increased pollution level due to the major construction activity, which may lead to very prolonged adverse affect on the public health in general [21].

### **1.6.2 Meteorology:**

Lucknow has a warm humid subtropical climate with cool, dry winters from December to February and dry hot summers from April to June. The rainy season is from mid- June to mid-September with an average rainfall of 966.24mm, mostly from the south-west monsoon winds. In winter the maximum temperature is around 21 degree Celsius and the minimum is in the 3 to 5 degree Celsius range. Fog is quite common from late December to late January. Summers can be quite hot with temperatures rising to the 40 to 45 degree Celsius range.

### **1.6.3 Rainfall:**

The average number of rainy days is 44. The normal rainfall of Lucknow district is 966.24 mm. The maximum rainfall occurs during the monsoon period i.e. June to September having normal value of 849.78 mm which is 87.9% of the annual rainfall. July is the wettest month having the normal rainfall of 289.56 mm followed by August with normal rainfall of 287.66 mm.

### **1.6.4 Humidity:**

The average relative humidity remains 25% in morning while in the evening it remains 68%. The annual normal potential evapotranspiration of the district is 1519 mm (source: CGWB study report, Lucknow).

**CHAPTER 2**  
**REVIEW OF LITERATURE**

According to a study of 17 cities covered by the National Air Quality Index (NAQI) and released by Greenpeace India on 15th Dec 2015, Lucknow is among the six most highly polluted cities in India. The level of Particulate Matter (PM<sub>2.5</sub>) in the air should be 60 micrograms per cubic metre for the 24-hour standard whereas in Lucknow it was found to be 411 micrograms per cubic metre on an average. Moreover, when the data for this year was compared with the previous years, it showed an increasing trend of air pollution. Central Pollution Control Board officials stated that a high level of Particulate Matter in the air particularly, is of grave concern for the health of the people as well as the environment of Lucknow City.

Despite being a sustainable means of public transportation, Metro rail construction works may often add to local air pollution in commercial and residential areas especially particulate and gaseous pollution in ambient air.

Noise is one of the most important acoustic pollutants in the now-a-days society, as it is present in most of people's activities, consequently, not only the workers of certain sectors, but all the citizens, are exposed to high noise doses. Hence, a set of political actions regarding that topic has been developed with the aim of decreasing the noise pollution in our environment, creating then, more sustainable cities. These policies point out to the control of traffic noise (by road, train or airplanes), and therefore, laws have been set to establish the methods for assessing and controlling the noise. Nevertheless, there are other types of sources that emit high levels of noise and have intrinsic characteristics that make them different from the former and then, they cannot be regulated by the same rules. Among these sources, the activities produced in a construction set are very present in the urban environment and they increase the noise pollution temporarily [10].

**Saurabh Kumar Yadav et al. (March 2012)** analyzed Suspended particulate matter (SPM) and Respirable suspended particulate matter (RSPM) were using Respirable Dust Sampler

(RDS)APM 460 and operated at an average flow rate of 1.0-1.5 m<sup>3</sup> min<sup>-1</sup>. Pre-weighted glass fibers filter paper(GF/A) of whatman and cup were used as per standard methods. The respirable particulate matter(RSPM) was collected on glass fiber filter paper and suspended particulate matter was collected by gravity settling method. Samples were collected continuously for 48 h every week at 8-hourly intervals. SPM and RSPM were measured using gravimetric method.

**Barman, S.C. et al.** paper says that Urban populations are exposed to a high level of fine and ultrafine particles from motor vehicle emissions which affect human health. To assess the hourly variation of fine particle (PM<sub>2.5</sub>) concentration and the influence of temperature and relative humidity (RH) on the ambient air of Lucknow city, monitoring of PM<sub>2.5</sub> along with temperature and RH was carried out at two residential locations, namely Vikas Nagar and Alambagh, during November 2005. The 24 h mean PM<sub>2.5</sub> concentration at Alambagh was 131.74 µg/m<sup>3</sup> and showed an increase of 13.74%, which was significantly higher ( $p < 0.05$ ) than the Vikas Nagar level. The 24 h mean PM<sub>2.5</sub> on weekdays for both locations was found to be 142.74 µg/m<sup>3</sup> (an increase of 66.23%) which was significantly higher ( $p < 0.01$ ) than the weekend value, indicating that vehicular pollution is one of the important sources of PM<sub>2.5</sub>. The mean PM<sub>2.5</sub> at night for all the monitoring days was 157.69 µg/m<sup>3</sup> and was significantly higher ( $p < 0.01$ ) than the daytime concentration (89.87 µg/m<sup>3</sup>). Correlation and multiple regressions showed that the independent variables, i. e., time, temperature, and RH together accounted for 54%, whereas RH alone accounted for 53% of total variations of PM<sub>2.5</sub>, suggesting that RH is the best influencing variable to predict the PM<sub>2.5</sub> concentration in the urban area of Lucknow city. The 24 h mean PM<sub>2.5</sub> for all the monitoring days was found to be higher than the NAAQS recommended by the US-EPA (65 µg/m<sup>3</sup>) and can be considered to be an alarming indicator of adverse health effects for city dwellers.

Assessment of noise quality in Bolpur- Santiniketan areas of India was made by Padhy and Padhi (2005). Noise is a prominent feature of the environment including noise from

transport, industry and neighbors. An important part of noise assessment is the actual measurement of the noise levels. Continuous Leq measurement during day time (0600 – 2100 hr) was carried out in residential, commercial and silence zone location of Bolpur-Santiniketan areas during June-December, 2005. The results show that the noise pollution in the city is wide spread throughout most of its area. The noise in this area is composite in nature. Public participation, education, traffic management and structural designing play a major role in noise management. Gwalior is an important historical city of Madhya Pradesh, India. Rising level of transportation mainly by road vehicles i.e., tempos, rickshaws, four wheelers, two wheelers and heavy vehicles is one of the major source of augmented noise pollution in Gwalior. The ambient noise level was measured by using Sound Level Meter SL- 4010. The highest noise level was recorded at commercial area like railway station and accordingly a maximum of 119.2 dBA at Batmorar and 92.7 dBA at Thathipur followed by residential zone a maximum of 69.8 dBA at Pinto Park and 77.2 dBA at Lascar and silence zone 64 dBA at Madhav dispensary and 65.8 dBA at Jiwaji campus were found.

The noise level values far exceeded the standards set by the CPCB. A cross-sectional study on the basis of questionnaire was carried out the results of which revealed that 100% of the respondents were not wearing ear protective equipments. Noise annoyance, headache, speech interference, etc., have been reported by various shopkeepers. Various mitigation measures have been suggested to keep the noise level within the prescribed standards (Wani and Jaiswal 2010). Singh and Davar (2004) in their paper on Noise pollution - sources, effects and control describe the life of the people. Cross-section surveys of the population in Delhi State points out that main source of noise pollution are loudspeakers and automobiles. However, female population is affected by religious noise a little more than male population. Major effects of noise pollution include interference with communication, sleeplessness, and reduced efficiency. The extreme effects e.g., deafness and mental breakdown neither is ruled out. Generally, a request to reduce or stop the noise is made out by the aggrieved party. However, complaints to the administration and police have also been accepted as a way of solving this menace. Public education appears to be the best

method as suggested by the respondents. However, government and NGOs can play a significant role in this process. Chanhan and Pande (2010) deal with monitoring of noise pollution at different zones of Dehradun, Uttarakhand, India. Exposure to high level of noise may cause severe stress on the auditory and nervous system. Transportation and horn used in vehicles are the major sources of noise pollution in Dehradun City.

The assessment of noise pollution can be made through measurements which, however, are restricted to a limited number of points. The simulation of the sound waves propagation enables the study of a whole region in respect to the expected sound pressure levels as a result from existent sound sources. Of course, in order to perform a meaningful simulation, the environmental properties as well as the characteristics of the sound sources must be modeled. The results obtained may be gathered and presented graphically as in a so called noise map. Actual measurements are used to verify and adjust the simulation to the real situation. Noise mapping techniques together with standards for the calculation of noise propagation are powerful tools to aid urban planners in correctly applying noise abatement measures in an economically feasible way. Nevertheless, the results of such mappings rely on a great amount of data, location and strength of noise sources, ground geometry, location and geometry of buildings, etc. This work also discusses the sensitivity of the obtained simulated noise levels to the quality and precision of the geometric data available. Actual measurements are however, needed only to verify the model Fernando and Pinto (2010).

A study and comparison of the noise dose on workers in a small scale industry in West Bengal, India, was conducted by Sen and Bhattacharjee (2008). This paper refers to a study and effect of noise dose in a small scale manufacturing sheet metal industry situated in West Bengal of India. Different noise related data were taken from individual machine and compared with the different noise related variables with Leq, Lav, LAE and TWA (Time weighted average). Noise induced hearing loss (NIHL), which is creating highly environmental pollution, causes the leading occupational disease. For the development of age related hearing loss, it creates a major contribution. A noise related hearing loss reduction for workers is proposed in this paper. Agbalagba et al (2013) conducted a survey on noise

pollution levels in four selected sawmill factories in Delta State. The physical measurement assessed the noise level of different machines in the factories and the background noise levels were measured at 50 meters away from the factories. A mean level of machine noise pollution (and background noise level) of  $103.77 \pm 4.71$  dBA (78.25 dBA),  $96.55 \pm 1.48$  dBA (72.08 dBA),  $99.02 \pm 3.20$  dBA (72.54 dBA),  $99.97 \pm 3.66$  dBA (79.89 dBA) was recorded in Ozoro, Ughelli, Warri and Sapele, respectively. These recorded values show that the noise levels in the four factories investigated are well above the federal environmental protection agency (FEPA) recommended maximum permissible limits for an industrial environment. This may cause hearing impairment and some psychological effect like susceptibility to mistake, irritation, and sleeping and social discomfort among staff and resident living in close vicinity to these factories. This is further affirmed by the social survey which revealed the level of social discomfort and health menace caused by machines noise from the factories on the workers and those residing close to these factories. Recommendations were therefore made to control, and abate this health threatening pollution effects.

**CHAPTER 3**

**METHODOLOGY OF AMBIENT AIR & NOISE SAMPLING**

The ambient air quality (PM<sub>10</sub>, PM<sub>2.5</sub> etc) were monitored from March 2017 to February 2018 month for Lucknow Metro Underground single station location. The ambient air monitoring frequency was once in 15 days and noise monitoring frequency was once in every week.

Noise Monitoring has been completed by sound level meter. Noise level survey was conducted along the alignment with an objective to establish the baseline noise levels and assess the impacts of total noise expected due to the metro. At random noise level measurement locations were identified for assessment of existing noise level status, keeping in view the land use pattern, residential areas, schools, bus stands, etc., the day levels of noise have been monitored during 6 AM to 10 PM and the night levels during 10 PM to 6 AM.

**3.1 PM<sub>10</sub> SAMPLING:**

In the present work the PM<sub>10</sub> sampling is performed by Respirable dust Sampler  
Principle: Air is drawn through a size-selective inlet and through a 20.3 cm × 25.4 cm filter at a flow rate of about 1132 liter per minute. The particles with aerodynamic diameter less than the cut-point of the inlet are collected by the glass fiber filter paper. The concentration can be determined by the difference in filter weights prior to and after sampling. Concentration of PM<sub>10</sub> in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled by it.

**3.3 PM<sub>2.5</sub> SAMPLING**

Sampler draws the ambient air at the constant volumetric flow rate of 16.7 l pm through the cyclones/impactors. Here the suspended particulate matter of aerodynamic diameter less than 2.5 microns are separated and is collected on a 47 mm PTFE filter. The filter is weighed before and after the sampling, the difference gives the amount of particulate matter concentration (PM2.5) in  $\mu\text{g}/\text{m}^3$  . The flow rate is maintained by volumetric flow controller which is governed by microprocessor. It also averages and stores the ambient temperature, ambient pressure, volumetric flow rate and coefficient of variation of flow rate for the entire sample run time. The procedure of sampling is same as PM10.



**Figure 3.1: Ambient PM10 & PM2.5 sampler**



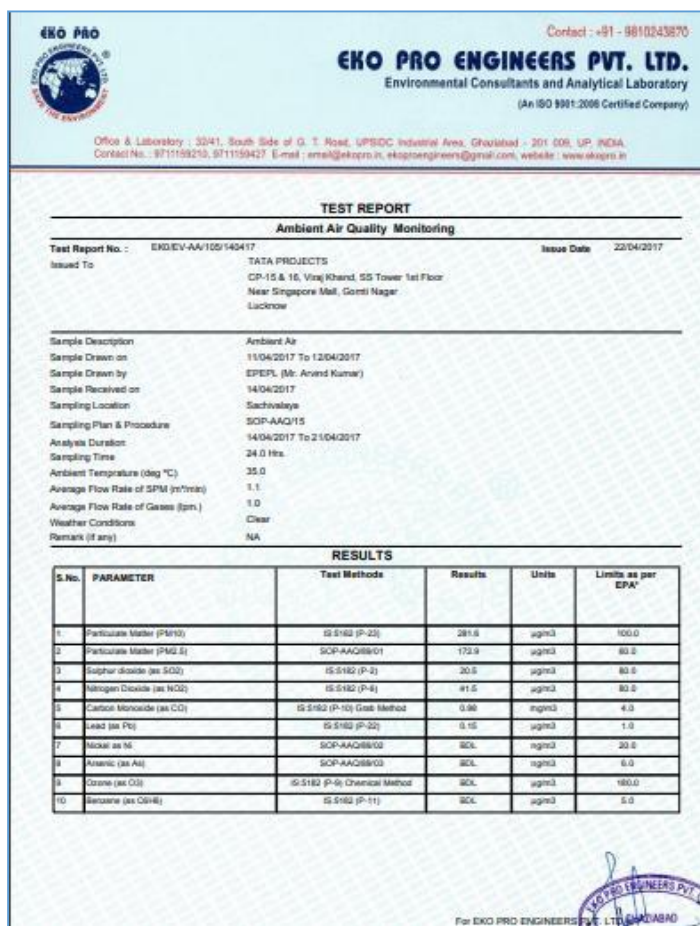
**Figure 3.2: Ambient Noise sampler**

**CHAPTER 4**

**RESULTS & DISCUSSIONS:**

**4.1 AMBIENT AIR QUALITY MONITORING RESULTS:**

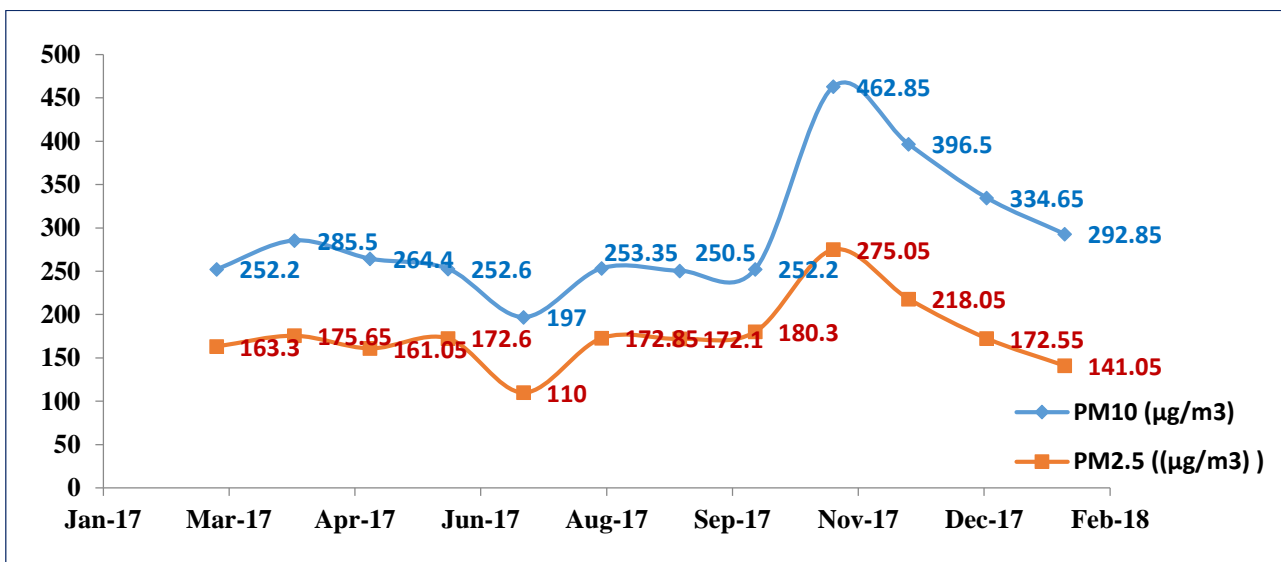
The results of ambient air quality (PM10, PM2.5 etc) were monitored from March 2017 to February 2018 month were analysed with baseline and NAAQ limits. Seasonal variation on the data have also been observed. Sampling stations were taken based on the factors like predominant wind & direction, sensitive receptors, reserve location, topography etc. The frequency of monitoring for ambient air quality was on 24 hourly basis twice in a month. The highest PM10 concentration was recorded at 462.8 µg/m<sup>3</sup> while PM 2.5 was found to 275 µg/m<sup>3</sup> which were not within the norms of NAAQ.



**Fig 4.1: Ambient Air Monitoring results**

Particul ars	Mar- 17	Apr -17	May- 17	Jun- 17	Jul- 17	Aug- 17	Sep- 17	Oct- 17	Nov- 17	Dec- 17	Jan -18	Feb -18
PM10 ( $\mu\text{g}/\text{m}^3$ )	252.2	285. 5	264.4	252. 6	197	253.3	250.5	252.2	462.8	396. 5	334. 6	292. 8
PM2.5 ( $\mu\text{g}/\text{m}^3$ )	163.3	175. 65	161.05	172. 6	110	172.8	172.1	180.3	275.0	218. 05	172. 5	141

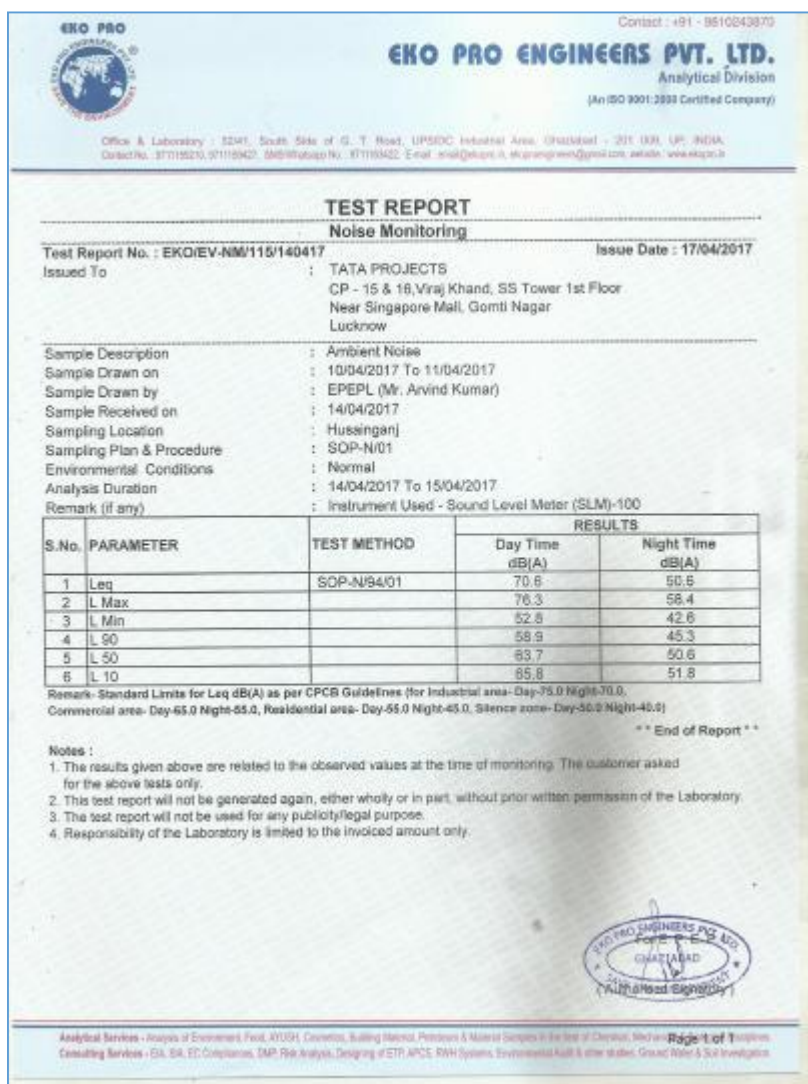
*Table No. 4.1 – PM10 & PM 2.5 Monitoring data*



*Fig No.4.2 – PM10 & PM 2.5 Monitoring graphical data*

#### 4.2 AMBIENT NOISE QUALITY MONITORING RESULTS:

Noise measurements have been completed by specific sound level meter during day time. Ambient Noise Analysis was conducted at the same location where Ambient Air were analysed. LAeq is known as the equivalent level of noise. It expresses the level of irregularly changing noise. It expresses the energy content of variable noise which was in effect at a given time using a value for the level of steady noise which would contain the same quantity of acoustic energy for the same period as the measured noise. The equivalent level of noise is always related to a certain time interval, marked LAeq.



**Fig 4.3: Ambient Noise Monitoring Results**

Lday	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18
LAeq	62.17	65.17	63.6	65.3	62.78	60.23	67.23	65.13	64.17	65.4	63.07	61.55

**Table No. 4.2 – Noise LAeq Monitoring data**

Ambient Air quality baseline was conducted on October 2017 Month. While comparing with baseline value, we have found the monitored results higher than the baseline value. Ambient noise day time found quite satisfactory compared with baseline value.

**Table 3: National ambient air quality standard of central pollution Control board (CPCB, 1994)**

Pollutant	Time Weighted average	Concentration in ambient air			Method of measurement
		Industrial Area	Residential. Rural & other areas,	Sensitive Area	
Sulphur Dioxide (SO <sub>2</sub> )	Annual Average*	80 mg/m <sup>3</sup>	60mg/m <sup>3</sup>	15 µg/m <sup>3</sup>	Improved West and Gacke method
	24 hours **	120 µg/m <sup>3</sup>	80 µg/m <sup>3</sup>	30µg/m <sup>3</sup>	Ultraviolet fluorescence
Oxides of Nitrogen as NO <sub>2</sub>	Annual Average*	80 mg/m <sup>3</sup>	60mg/m <sup>3</sup>	15 µg/m <sup>3</sup>	Jacob & Hochheiser modified ( Na-Arsenite) Method
	24 hours **	120 µg/m <sup>3</sup>	80 µg/m <sup>3</sup>	30µg/m <sup>3</sup>	Gas Phase Chemiluminescence
Suspended Particulate	Annual Average*	360 µg/m <sup>3</sup>	140 µg/m <sup>3</sup>	70 µg/m <sup>3</sup>	(Average flow rate not less than 1.1 m <sup>3</sup> /minute)

*Table 4.3: National ambient air quality standard of central pollution Control board (CPCB, 1994)*

**CHAPTER 5**  
**CONCLUSION:**

This study is to review and analyze of monitoring data with the baseline survey value to make us understand that construction sector has much impact on the environment although, Lucknow, UP like india's other metropolitan cities ambient Air value was exceeding the NAAQ limits. The added value to the air quality by Lucknow Metro construction has an huge impact on public health although Noise was not much major impact since the project area was on the commercial area where background noise was on higher side. Urgent action is required to remediate the pollution problem. The problems associated with air pollution in the concentration of PM10 & PM2.5 was much higher than the permissible limits as per CPCB.

**RECOMMENDATIONS:**

Generation of dust from construction activities is main cause of PM10 and PM2.5 particles. To mitigate air pollution at sites, the sources of construction dust are identified which includes demolition activities, earthwork, on-site storage of materials, on-site manufacture, transportation, and on-site stacking of waste. The adopted measures for the particulate and gaseous mitigation activities in this project are depicted as follows.

- Demolition activity is carried out by mechanical hydraulic equipment. Continuous water spraying during the demolition prevents dust emission to the atmosphere. Green refine mesh safety net was used. Designated places were particularly arranged for stacking demolition waste and are cleaned periodically. In addition, a workman is assigned for water sprinkling the stacked demolition waste several times a day.
- Earthwork - Dust control measure while earthwork is taken at sites. Continuous water sprinkling is done. Again soil loaded on the vehicle for the disposal are compulsorily compacted and covered with tarpaulins to avoid scattering during transportation.

- Storage of materials for concrete production and road restoration work: Materials are stored in the designated place and again tarpaulins covering and water sprinkling on the materials implemented on regular intervals.
- Transportation – Management of vehicle arrival at sites and departure from the sites also recorded. Wheel wash facility to clean dirt attached on the wheels is provided at entry exit gates of each work sites.
- In the concrete production unit, inside and outside roads are paved to prevent the dust flying to the atmosphere.

Noise emitted in this construction site is within the legal limits for the workers and in the case of the environmental noise there is no specific regulations for these activities. Noise is controlled at site in the following methods:

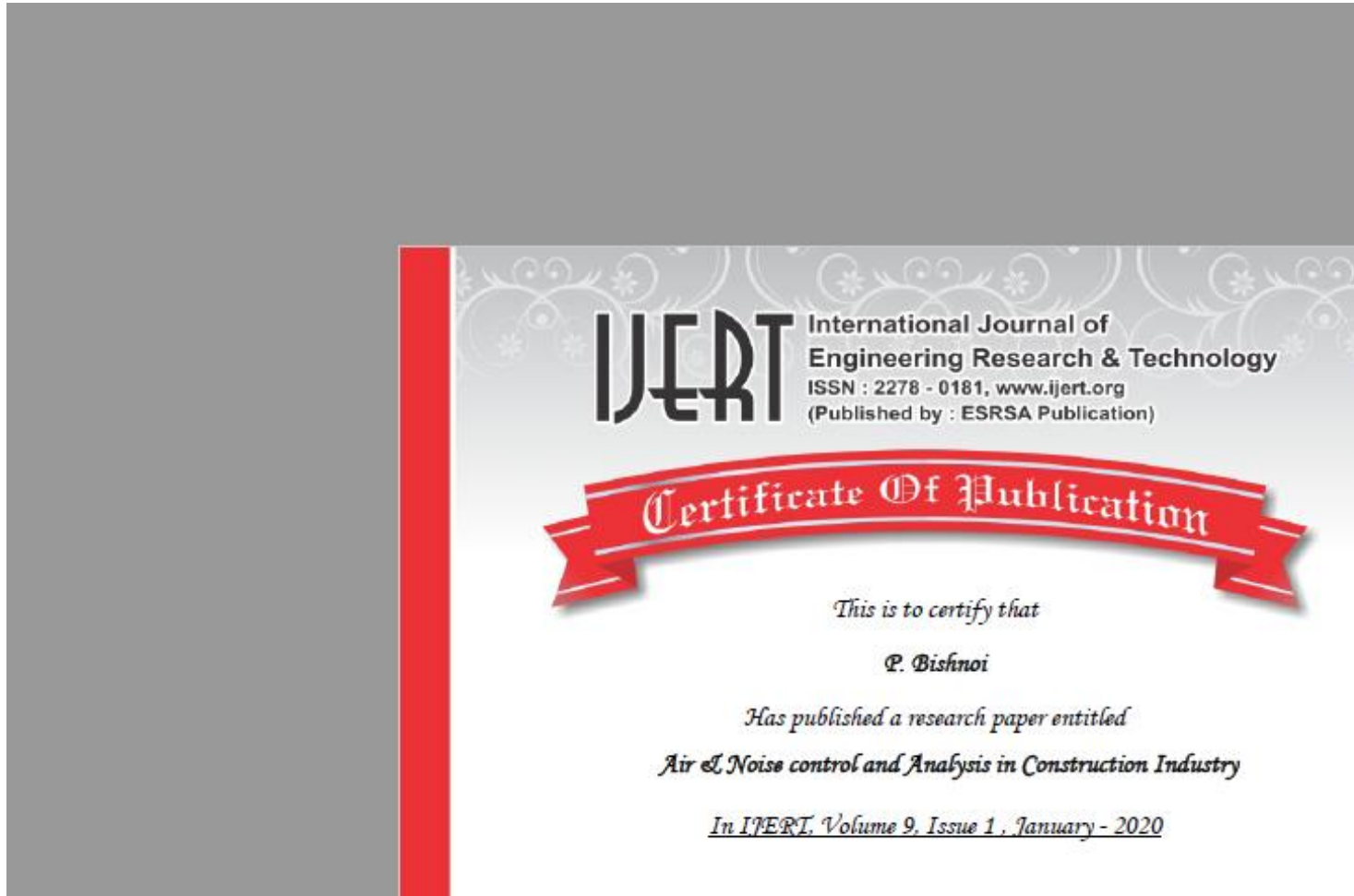
- All the plant and equipment used on the site are properly maintained in good operating condition and are provided effectively sound-reduced by means of silencers, mufflers, acoustic linings or shields, acoustic sheds or screens or other means, to avoid disturbance to any nearby noise sensitive receivers.
- All the noise hazard areas (noise level exceeding 75 dB) are provided with warning signs.
- All the noise hazard works are strictly adhered to the time restrictions.
- All the personnel's working in the noise hazard areas are provided with personal hearing protectors.

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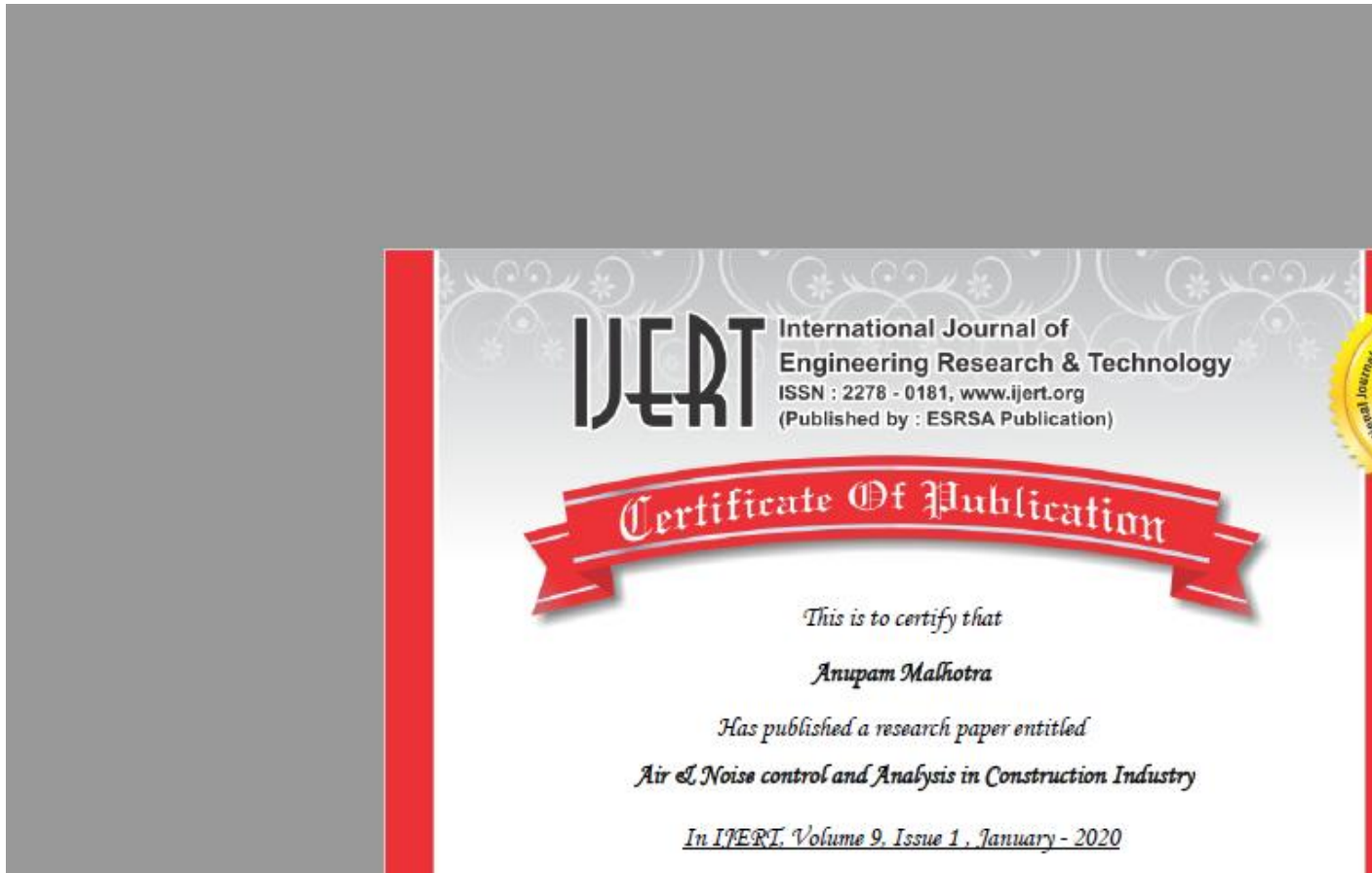
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