NOISE MAPPING OF RAILWAY TRAFFIC NOISE AT KALUPUR RAILWAY STATION, AHMEDABAD

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Abstract: In today's modern world, due to urbanization and industrialization, there has been increment in noise pollution. Noise pollution has often been neglected compared to other forms of pollution i.e. water pollution, air pollution. Noise pollution creates harmful health effects on human being and other living organism. It is necessary to estimate the exposure of noise due to any source and thus carry out the risk assessment study. This study includes the determination of noise level present at various locations at the kalupur railway station, Ahmedabad using noise modeling software. Because of the high intensity of noise produced by the train, it can cause discomfort in surrounding area of kalupur railway station and to the staff working at kalupur railway station or in the close proximity of kalupur railway station. As kalupur railway station being one of the busiest railway stations of Gujarat and having passenger train frequency of 303 trains per week, it is necessary to study and carry out critical assessment of noise pollution present at kalupur railway station, Ahmedabad.

IndexTerms: **Noise Pollution, Noise Mapping, Kalupur Railway Station, Noise measurement.**

I. INTRODUCTION

Noise word is derived from the Latin word "Nausea" which means sickness or any similar sensation of disgust, annoyance or discomfort.

Noise is defined as an unwanted sound that can cause discomfort and stress among living organisms especially in urban areas. Noise has been classified as a pollutant from 1970s by USEPA because of its detrimental effects on our quality of life and our acoustic comfort.

Noise pollution is defined as the sound in the environment that are caused by humans or human activities or natural activity that threaten the health and welfare of humans, animals, plant or other living organism of the ecosystem.

Environmental noise possesses direct influence on human, animals, plants and other living organism presents in the environment. Because of adverse effect of Noise Pollution on human and other living organisms of the environment, Environmental noise has been classified as top stressors in terms of environmental burden of diseases.

Ahmedabad is declared as the only heritage city of Gujarat by the UNESCO in 2017. Ahmedabad is connected with railways, roadway and airways, But railway is the most common of them. There are several railway stations in Ahmedabad e.g. Kalupur railway Station, Maninagar railway station, Sabarmati railway Station, etc. Among them Kalupur Railway Station is the main station and is connected with all zone of Indian Railways. Kalupur Railway Station has a frequency of 303 passenger trains per week. In addition to passenger trains there are freight trains too passing through Kalupur railway station and contributing in overall noise pollution. On an average 4-5 trains pass through Kalupur railway station within an hour, hence continuous noise is produced throughout the day. In addition to this primary noise, secondary noises like passenger movement, vendors, announcement, coolies, advertisements, etc. contribute in the overall noise levels at the platform.

Indian Railway is ranked as the fourth largest railway network in the world. It was established in 1853 and it covers 119,630 kilometres of total railway track. Railway transport is economical feasible compared to other means of the transport. Due to this both passenger and freight transport is increasing day-by-day. When there is high train volume and high train speed, it will create a problem for surrounding areas. Long term exposure of noise pollution can create harmful effects both physiological and psychological, on the staff working at railway station or the people residing in the nearby residential area.

Because of tremendous emission source of noise pollution in India, regulation authority have set the noise level criteria and divided areas into four zone as Industrial zone, Commercial zone, Residential zone and Silent zone (The Noise Pollution (Regulation and Control) Rules, 2000).

Table 1:- Ambient Air Quality Standards in respect of Noise

Area Code	Category of Area/Zone	Limits in dB(A) Leq	
		Day Time*	Night Time#
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silent Zone$	50	40

Source: The Noise Pollution (Regulation and Control) Rules, 2000

Day time*: 6:00 am to 10:00 pm

Night time#: 10:00 pm to 6:00 am

Silent Zone$: It is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority.

1.1Noise Modeling

As per EPA 2009, Model is defined as a simplification of reality that is constructed to gain insights into selected attributes of physical, biological economical or social system. It expresses the relationship between different variables of system in mathematical form.

Noise modeling is the mathematical prediction of Noise level of a particular area, based on measured inputs. Noise Mapping is a graphical representation of the sound level distribution existing in a given region, for a defined period.

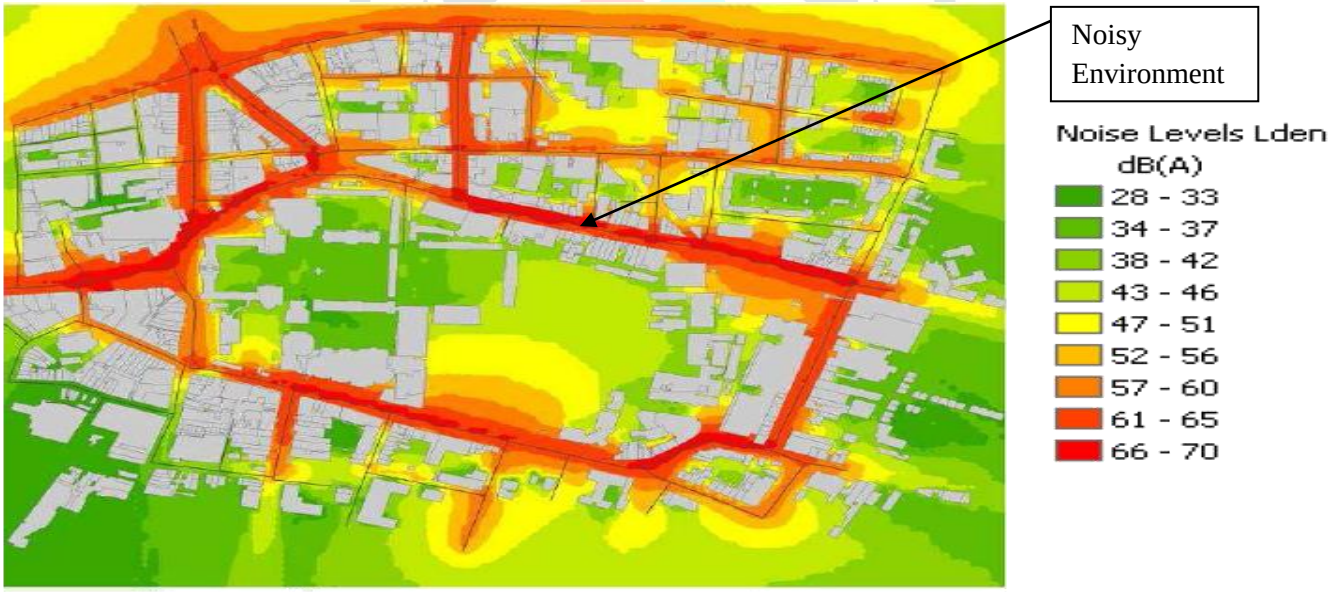

Fig. 1:- Pictorial representation of Noise Map

Sometimes, the noise levels may be shown by contour lines which show the boundaries between different noise levels in that area.

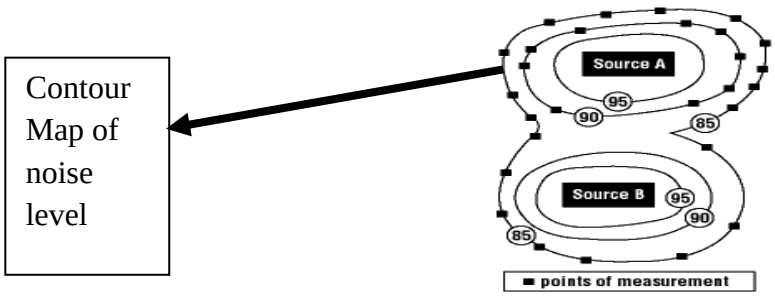

Fig. 2:- Noise Mapping as Contour Maps

1.2Exposure Assessment Techniques

In this section brief overview of various noise pollution exposure assessment techniques and models used to determine exposure is provided. Exposure assessment techniques are divided into three groups: (1) Deterministic Modeling, (2) Stochastic/Statistic Modeling including land use regression model and (3) Measurement/Sampling.

1.2.1 Deterministic Modeling

This type of modeling involves the relationship between variables mathematically on the basis of knowledge of physical, chemical and biological characteristics governing this relationship. It also involves parameters like urban built, land cover, meteorology etc; which are static and dynamic parameter which are used to reflect the actual atmospheric environment.

Models of this category are so widespread and accessible that majority of identified study used deterministic modeling approach for noise exposure assessment. For the assessment of noise exposure most widely used models are SoundPLAN, CadnaA and TRANEX.

SoundPLAN is a commercial software available offering high end simulation models for both air pollution assessment and noise pollution assessment. For the calculation of traffic noise, European modeling methods such as French (NMPB2008), German (RLS90) and several Nordic methods are implemented in SoundPLAN.

Computer Aided Noise Abatement (CadnaA) is generally used for road traffic noise assessment. For the assessment of noise multiple standards like German (RLS-90), French (NMBP-Routes-08), Austin (RVS 04.02.11), Swiss (SonRoad), Nordic RTN-96 etc. are available with CadnaA.

Open source software are getting popular day-by-day because of their easy availability and easy operation. TRANEX is the open source software available for noise assessment calculation. CNOSSOS-EU is other open source software available which includes assessment of road, railway, aircraft and industrial noise.

1.2.2 Stochastic/Static Modeling

This type of modeling includes relationship between effects and cause of noise pollution which is statistically derived. Best example of this type of modeling is LUR (Land Use Regression) models. LUR models predicts through statistical regression through land use patterns, their activity and type of pollutants and their levels. GIS plays a vital role in this type of modeling for the development of predictors and in the result estimation.

1.2.3Measurement/Sampling

This type of modeling is done by microphones which are calibrated as per ISO Standards. This measuring technique involves higher cost compared to other two modeling techniques. Though this type of modeling technique provides direct assessment of personal exposure to the pollution levels and their health impacts in the study related to epidemiology.

II. MATERIALS AND METHODS

Fig. 3: Satellite view of Kalupur Railway station, Ahmedabad

In this present study Deterministic Modeling approach for noise exposure assessment has been selected. SoundPLAN Essential 4.1 software was used for the preparation of noise maps and to assess the noise exposure at Kalupur railway station, Ahmedabad.

Noise levels were measure at various platforms of Kalupur Railway station, Ahmedabad when train arrives or departs from the platform.

Three sound level meter with model number SL-4033SD which is a class 1 type sound level meter were used to measure the sound emitted by the train when arrival or departure.

Simultaneous measurements were taken at distance of 2m, 4m and 5m. All measurements were taken over a period of week during day time and night time. The frequencies of measurement were set such 30 readings were taken in one minute (2 second interval). Each Measurement was taken for continuous 10 minutes time period.

Meteorological parameters like temperature, humidity and atmospheric pressure were also measured as the requirement in software input.

Other input data required are type of track, type of train, number of trains passing during day time and night time, average mean speed of train, % of vehicles with active brake gear, ground elevation and ground factor.

Noise emission at frequency of 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz are required as input data. Noise emissions were recorded at frequency of 1 kHz and other frequency were calculated based on the sound level meter SL-4033SD manual.

SoundPLAN Essential 4.1 software use RMR-2002 method for the calculation of noise emission. Measurements taken at Kalupur railway station are showed below in table.

Table 2: Equivalent noise level when train arrives/departs from platform in day time

Frequency (Hz)	LE bs (dB) 0 m	LE as (dB) 0.5 m	LE 2m (dB)	LE 4m (dB)	LE 5m (dB)
63	68.2	78.8	68.8	66.8	59.8
125	78.3	88.9	78.9	76.9	69.9
250	85.8	96.4	86.4	84.4	77.4
500	91.2	101.8	91.8	89.8	82.8
1000	94.4	105	95	93	89
2000	95.6	106.2	96.2	94.2	90.2
4000	95.4	106	96	94	90
8000	93.3	103.9	93.9	91.9	87.9

Table 3: Equivalent noise level when train arrives/departs from platform in night time

Frequency (Hz)	LE bs (dB) 0 m	LE as (dB) 0.5 m	LE 2m (dB)	LE 4m (dB)	LE 5m (dB)
63	69.8	81.8	70.8	69.8	64.8
125	79.9	91.9	80.9	79.9	74.9
250	87.4	98.7	88.4	87.4	82.4
500	82.8	104.1	93.8	92.8	87.8
1000	96	107.3	97	96	91
2000	97.2	108.5	98.2	97.2	92.2
4000	97	108.3	98	97	92
8000	94.9	106.2	95.5	94.9	89.

Table 4: Meteorological data collection

Day	Temperature (°C)	Humidity (%)	Atmospheric Pressure (hPa)
1	23.6	45	1008
2	26.4	54	1009
3	22.3	53	1007.65
4	22.8	47	1008.5
5	19.6	84	1008
6	18.5	82	1007.4
7	21.4	74	1004.9

III. RESULTS

Noise maps generated in soundPLAN Essential 4.1 software are based on RMR-2002 calculation method which is used to calculate railway noise emission. Results of the software are shown below.

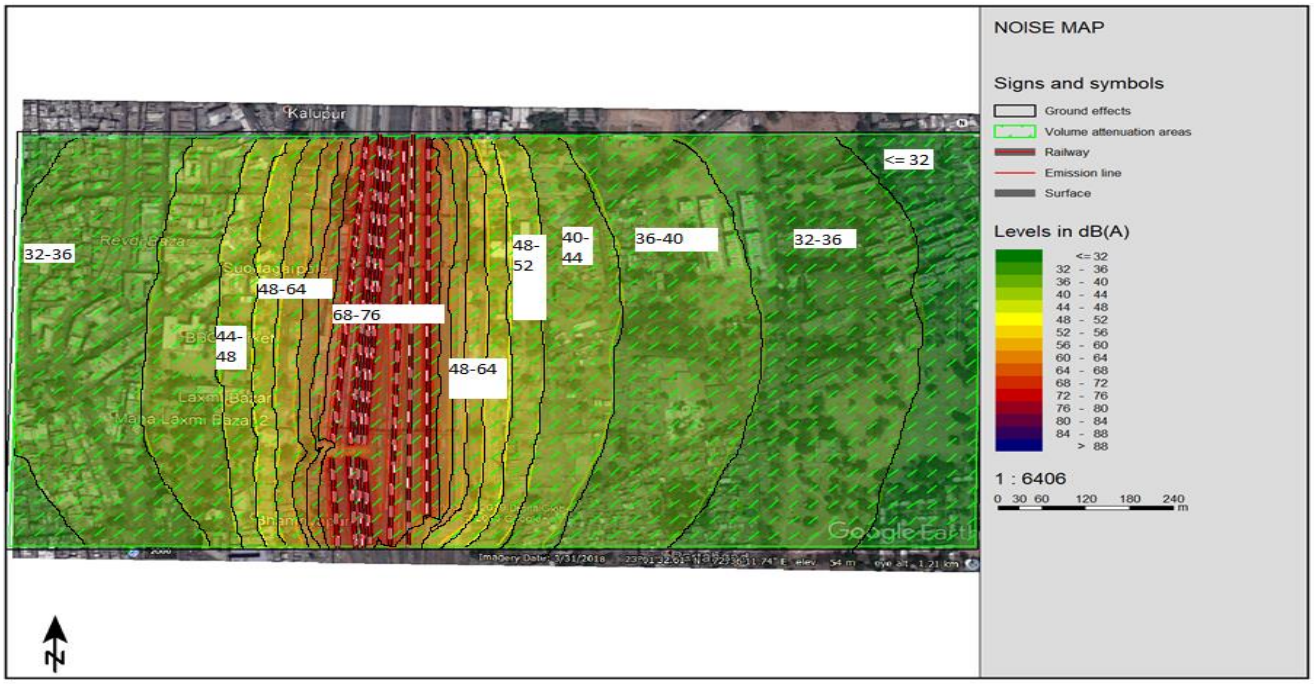

Fig. 4: Noise map of Kalupur Railway Station due to train movement, during day time

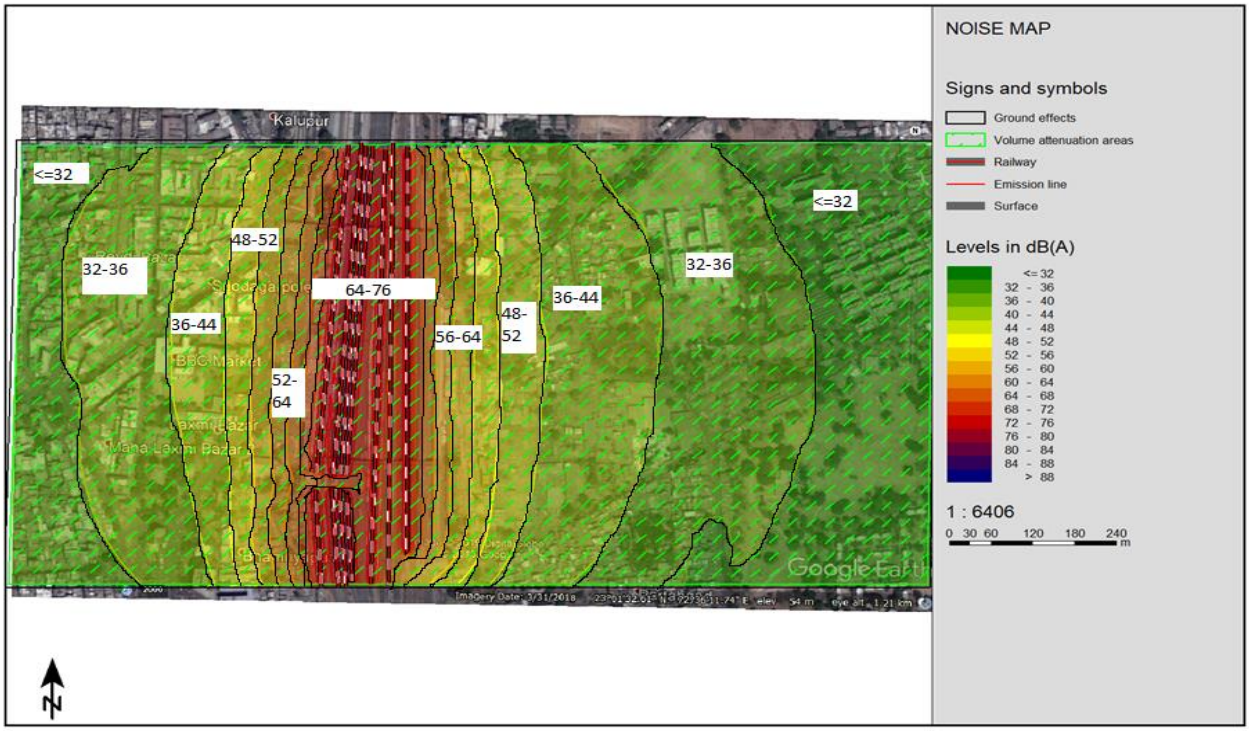

Fig. 5: Noise map of Kalupur Railway Station due to train movement, during night time

IV. CONCLUSION

The present study assessed that when the train arrives or departs from the platform there is an increment in noise level present at railway station. This increment in noise level can cause detrimental health effects on the staff working at railway station or to the people living nearby railway station. The noise levels at Kalupur railway station are higher than prescribed standards for noise levels in commercial area as per NOISE POLLUTION (REGULATION AND CONTROLL) RULES, 2000 during day time and night time. As per the noise map generated, noise propagation is more during night time compared to day time. Hence, higher noise level can be observed near Kalupur railway station during night time compared to day time. This will cause disturbance in hearing, communication, understanding the announcement, etc. This noise level will cause physiological effects like hearing loss permanent or temporary) or psychological effects like irritation sleep disturbance, insomnia, etc. to the staff and people living nearby station.

V. MITIGATION MEASURES

High amount of vegetation, surrounding railway station will help in dampening the noise level. Construction of noise barriers will also reduce the noise level. Personnel Protective Equipments (PPEs) like ear plugs, ear muffs, etc. can be useful for the workers so that their exposure to the noise pollution can be minimised. Interference in understanding the announcement can be mitigated by replacing speakers with the display boards in English, Hindi and Regional language. With improved technology, Indian Railway can take steps towards advancement of trains so that noise produced by them can be reduced.

VI. REFERENCES

1. Bouzir TAK, Zemmouri N 2017, Effect of Urban Morphology on road noise distribution. Energy Procedia, 119: 376–385.
2. Bunn F, Zannin PHT 2016, Assessment of railway noise in urban setting. Applied acoustic, 104 :16-23.
3. Dzambas T., Lakusic S., Dragcevic V. 2018, Traffic noise analysis in railway station zone. Applied Acoustic, 137: 27-32
4. Gan WQ., Mclean K., Brauer M., Chiarello SA., Davies HW. 2012, Modeling population exposure to community noise and air pollution in a large metropolitan area. Environmental Research, 116: 11-16
5. Hunashal RB., Patil Y.B. 2012, Assessment of noise pollution indices in the city of Kolhapur, India. Procedia- Social and Behavioural Sciences, 37: 448-457
6. Ivanov NI., Boiko IS., Shashurin A.E. 2017, The problem of high speed railway noise prediction and reduction. Procedia Engineering, 189: 539-546
7. Kanakasabai V, Senthikumar G, Chandrasekar E 2005, Study of noise levels in Railway Station. Journal of Scientific & Industrial Research, December, 64: 957-959.
8. Khan J, Ketzel M, Kakosimos K, Sorensen M, Jensene SS 2018, Road traffic air and noise pollution Exposure assessment – A review of tools and techniques. Science of the Total Environment, 634: 661–676.
9. King EA, Murphy E 2016, Environmental Noise – 'Forgotten' or 'Ignored' Pollutant. Applied Acoustics, 112: 211–215.
10. Martin MA., Tarrero AI., Machimberrena M., Gonzalez J., De Garibay VG. 2011, A methodology to study noise annoyance and to perform action plans follow up using as input an existing survey and noise map: Application to the city of Malaga (Spain). Applied Acoustic, 72: 495-504
11. Orchi B, Suman N, Debamalya B, Effect of noise on people Residing near Railway Tracks and Working in Railway Station. Ergonomics for rural development, 182-188.
12. Paozalyte I, Grubliauskas R, Vaitiekunas P 2011, Research of railway noise pollution at the living area of railway station in Klaipeda city and designing of noise barrier. The 8th International Conference, Vilnius, Lithuania, 1 ISBN 978-9955-28-826-8, 3 ISBN 978-9955-28-827-5.
13. Prasad HGV, Shariff MS, Prajwal K., Kurki SR, Shobih M., Analysis of Railway Traffic Noise in Mysuru City. International Journal of Scientific Engineering and Technology, 6 (7): 228-230.
14. Prof. Lakusic S., Prof. Drgcevic V., Ahac M., Ahac S. 2011, Determination of noise levels in railway station zones. Gradevinar, 63:521-528
15. Quartieri J., Troisi A., Guarnaccia C., Lenza TLL, D'Agostino P., D'Ambrosio S., Iannone G., Analysis of Noise Emissions by Trains in Proximity of a Railway Station. 10th WSEAS International Conference on Acoustic & Music Theory & Applications, ISSN 1790-5095.
16. Srivastava S. 2012, Effect of noise pollution and its solution through Eco-Friendly control devices in North-East India. Procedia Engineering, 38:172-176
17. Stansfeld SA., Shipley M. 2015, Noise sensitivity and future risk of illness and mortality. Science of Total Environment, 520: 114-119
18. Tiwari AV., Kadu PA., Mishra AR. 2013, Study of noise pollution due to railway and vehicular traffic at level crossing and its remedial measures. Americal Journal of Engineering Research, 2: 16-19

19. Tumaviþo A, Laurinaviþius A, Jagniatinskis A, Vaitkus A 2016, Environmental noise mitigation measures for Lithuanian railway network. Transportation Research Procedia, 14: 2704 – 2713.
20. Zanin PHT., Bunn F. 2014, Noise annoyance through railway traffic- a case study. Journal of Environmental Health Science & Engineering, 12:14
21. The Noise Pollution (Regulation and Control) Rules, 2000 published in the Gazette of India, vide S.O. 123(E), dated 14.2.2000 and subsequently amended vide S.O. 1046(E), dated 22.11.2000, S.O. 1088(E), dated 11.10.2002, S.O. 1569 (E), dated 19.09.2006 and S.O. 50 (E) dated 11.01.2010 under the Environment (Protection) Act, 1986.