

Temporal Assessment of Noise Pollution in Major Intersection of Ahmedabad City of Gujarat

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Abstract—

Background: Automobile industry has changed human life making it faster and comfortable. We cannot think modern life without vehicles. However, problems associated with these automobiles are many; one of them is ‘Noise pollution’. Expanding urbanization has posed serious concern of noise pollution globally. In India, this is aggravated on account of demography, indiscipline and inadequate road infrastructures due to limited resources. Recently, it is established that the noise affect human health adversely. Hence, with projected level of urbanization, it is apprehended that noise pollution may be one of the serious concern to the urban planners. Accurate and thorough analysis of this problem is therefore necessary for in depth perception of sources of noise generation and their specific contribution to the combined level of noise

Methods: Traffic volume, noise levels, vehicular speed were measured on commercial, residential and industrial area of Ahmedabad city.

Results: Ahmedabad is a fast growing city of Western India, facing acute traffic problems and as such, noise pollution is also associated. The primary measurements were carried out at selected intersections in commercial, residential and industrial areas installing noise meters, cameras with manual monitoring. Noise levels were measured during identified peak times in different seasons, using SLM 109, Larson Davis system 824 noise meters. Further, parameters were categorized for different types of vehicles, speed, and traffic volume. Prima facie it is found that the traffic noise level is higher than permissible limits fixed by GPCB and CPCB. In all of the selected intersection of residential, commercial and industrial, the noise level is found to be 82 to 110 dB which is higher than the permissible limits of 45, 55 and 75 dB prescribed for residential, commercial and industrial areas. It is observed that noise level is proportional to the traffic volume. Heavy vehicles and auto rickshaw create more noise than other type of vehicles. In case of commercial zones, three wheelers, i.e. auto rickshaws followed by two wheelers contributes the noise the most; whereas, in the industrial zone, heavy vehicle’s noise contribution seems to be more.

Speed of vehicles is also identified as a major factor for noise. Analysis on different types of two wheelers, four wheelers and types of fuels shows that noise level is almost directly proportional to the speed. Optimum speed derived for different types of vehicles would prove advantageous in both the ways, i.e. increasing fuel efficiency and reducing noise.

Noise level is also found to be increasing with the distance of vehicle from the intersection, i.e. noise is found increasing as the vehicle speed increases from the intersection. With increase of speed from stop line at the intersection, noise level enhanced by 5 to 8 dB by distance of 250 m. Factors responsible for this noise are found to be engines, gears, tyre condition, and age of the vehicles, road type and condition.

Keywords--Urbanization, characterization, demography, indiscipline.

Introduction:

Pollution of the air, water, hazardous waste, and noise has always been a global concern, affecting human health and the environment. Intensity of pollution in the environment is ever increasing, posing a serious issue to the quality of ambience. Pollution control is a difficult task. Noise pollution has been identified as a growing societal problem of urbanization. Road traffic, air transport, railways, industrial

activities, construction activity etc contribute to noise pollution. Amongst the sources of noise pollution, road traffic is the major one and the most harmful which is responsible for approximately 66% of all noise pollution contributors in a city. Engines noise, tires friction, and horns contribute to the noise produced by road traffic. Noise is widely considered as an environmental concern that affects human health and well-being. Environmental problems are worldwide covering developing and developed countries. Compared to various forms of pollution, noise pollution may be less evident but this issue is increasing with time. "Noise pollution is the third most dangerous sort of pollution in metropolitan cities, behind air and water pollution [3]. In past decades, noise problem has increased manifold, both in severity and extent. Thickly populated cities and towns, with motorized transport, diversified activities and amenities add to the pollution of atmosphere with their sustained noise. Noise pollution generally expressed as a sound and its adverse effect on human health. Drastic raise in population led to industrial development, mass transport, community activities etc- which adds to the noise pollution. Basically, noise is associated with technology and doubles every decade along with industrial growth. Noise is increasing in with geometrical progression with increasing urbanization and growth of technology [2]. Population of India is 1.21 billion [1]. Increasing urbanization is due to the employment opportunities, better infrastructure, education and amusement etc [3 & 4]. Indian cities face a lot of noise problem mainly due to transport, ill planning and traffic congestion compared to most of the cities in North America and Europe [101]. In India, Ahmedabad is one of the fastest-growing cities in the country. The population of Ahmedabad has increased by 25% from 5,816,519 in 2001 census to 7,214,225 in the 2011 census [2]. Being economical capital of Gujarat state, industrialization, educational and health establishments, cloth markets etc, population has been fast increasing. With this urbanization and population growth, infrastructural growth; easy access to livelihood resulted in an increase usage of vehicles. Vehicles play a significant role in urban area as a source of noise emission approximately 55% of total urban noise [3, &5].

Present Status And Focus On Traffic Noise Pollution:

Limited research towards traffic noise pollution research has been carried out in India as compared to developed countries. Traffic noise is one of the most significant sources of pollution in metropolitan city [86 and 89]. Since 1990s with abnormal increase in vehicle ownership, road traffic noise has emerged as a major problem in developing countries. With the increase in numbers of two wheelers, three wheelers and cars i.e. light and heavy vehicles have contributed to noise pollution. Irrational use of breaks, inconsistent driving pattern, impassionate honking, road quality, random parking etc lead to traffic congestion during peak hours and from this it is evident that traffic congestion and urban city go hand in hand. Poor maintenance of vehicles and roads, irregular speed, traffic volume, stop and go traffic pattern creates more noise, compared to smooth flow and contribute to increase traffic noise pollution. This traffic noise propagation may also be varying due to meteorological (weather) conditions. The total number of automobiles in India increased abnormally from 0.3 million on March 31, 1951 to 230 million on March 31, 2016. Now, private vehicles contribute significantly to the total vehicle population [3]. Traffic noise pollution deprives property values and affects adversely the quality of life of the people living in the proximity of urban corridors. Due to the lack of funds and unavailability of land, many important roads and highways are located in residential and commercial areas.

Objectives Of Research Work:

1. Selecting category wise specific intersections of Industrial, commercial and Residential zones of Ahmedabad city to study the existing status of noise levels.
2. To analyse variation of equivalent noise levels with respect to the distance from an intersection. (Speed verses distance).
3. Analysis of noise by ANNOVA considering various dependent variables and examining the effects of noise parameters.

Material And Methodology:

The methodology of the present study is elaborated in following section.

Study Area:

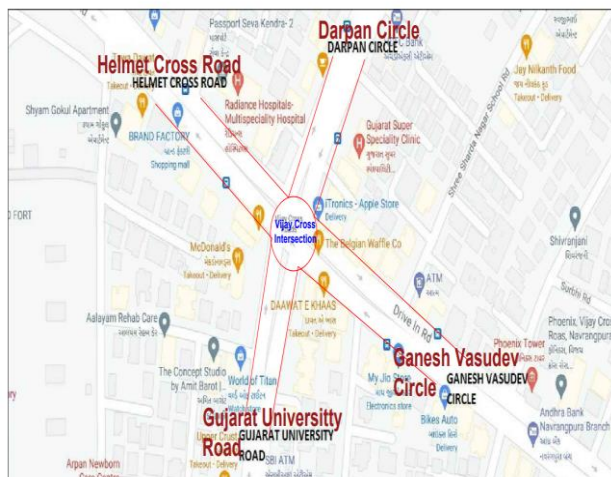
The river Sabarmati divides Ahmedabad into two sections: Eastern and Western. Based on socio-economical ground, there is wide difference in average economic status, living standard and educational background. These two sections have many peculiarities and obviously, there is a difference in the range of vehicles, road network, speeds, directions, and durations, resulting in heterogeneous traffic. Ahmedabad is an economic and industrial capital of Gujarat. With a rapid pace of expansion, higher income, demographic inflation is quite high, and as a result, vehicular growth is very high and expected to skyrocket.

Ahmedabad Urban Development Authority (AUDA) is responsible for land use planning within its jurisdiction. Total area covered under this is 1294.65 sq. km [6]. Nearly 44% is built up area, commercial area 1%, water bodies' cover about 5%, and industries cover 16% area.

To assess the noise level, some representative intersections in Ahmedabad city were identified which faces usually acute traffic congestion. These selected intersections were based on classified zones viz. residential, commercial and industrial. Namely, the intersection are Vijay Cross Road (Commercial), Nava Vadaj (Residential), Naroda road (Industrial), Map showing the locations is as under:

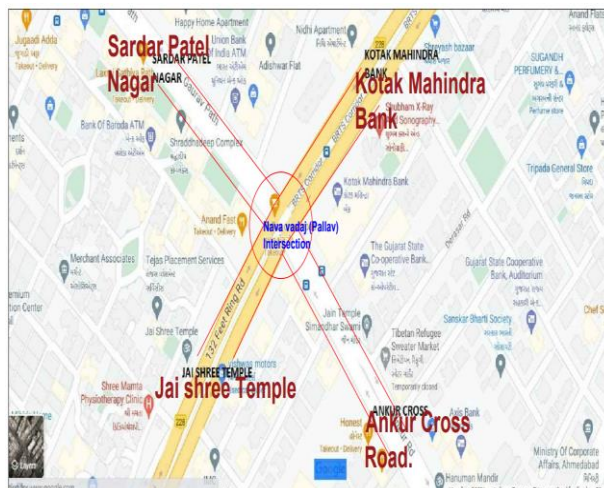
Vijay Cross Road (Commercial) intersection:

This intersection is located in the Western part of Ahmedabad. The latitude is 23.0436° N and Longitude is 72.5503° E. The population in this area is 119788 (Census 2011) and size of area is 4.9 sq.km. This intersection is located on the roads crossing of Gujarat University and that of Drive-in, mainly there are many educational and commercial establishment located in the area around. This is relatively a well developed area having good road connectivity.



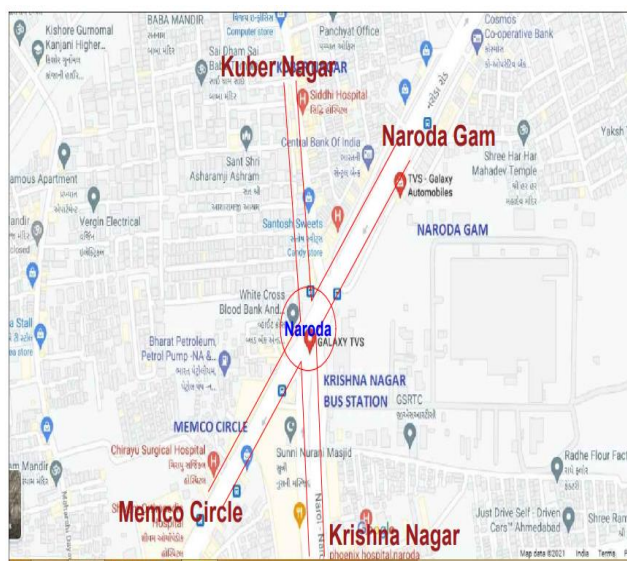
Nava Vadaj intersection (Residential):

This intersection is located in the Western part of Ahmedabad. The latitude is 23.0676° N and Longitude is 72.5611° E. The population in this area is 119798 (Census 2011) and size of area is 3.2 sq.km. This intersection is located on the roads to Ranip and RTO circle. This is one of the most congested intersections. This is relatively a well developed area having good road connectivity, having malls, metro rail, bus stations and logistic services are located here.



Naroda: (Industrial)

This intersection is located in the Eastern part of Ahmedabad. The latitude is 23.0685° N and Longitude is 72.6535° E. The population in this area is 124887 (Census 2011) and size of area is 3.1 sq.km. This intersection is located on the Sardar Patel Ring Road. This is one of the most congested intersections. This is an industrial area wherein industrial establishments and logistic services are located. Traffic is comprised of considerable heavy vehicles.



Data collection:

This chapter deals with data collection work on selected seven intersections of Ahmedabad city. As stated earlier, out of these seven intersections, three are located in commercial zones (Memnagar, Helmet circle and Vijay Crossing), two of them are located in residential zones (Nava Vadaj and Juna Vadaj) and rest two are located in the industrial area (Naroda Road and Narol). The entire survey under this study on noise assessment is primarily based on the guidelines of Indian Road Congress [IRC]. Observations and measurement of primary data on noise were taken at all these intersections, during morning as well as evening peak hours and afternoon non peak hours. Allied data on road geometry, building heights, road surfaces, meteorology etc were collected prior to the commencement of survey, whereas data on traffic volume, speed, honking data etc were simultaneously collected during noise data collection.

Observations on traffic parameters and measurement of noise were carried out in the months of December 2018 to January 2019 and again during the months of April 2019 to May 2019 on all working days

i.e. Monday to Friday. Noise measurements were carried out using instruments like SLM 109, Larson Davis System 824, which were calibrated prior to take up the actual measurement. Noise measurement was divided in to three slots, morning 9 am to 12 pm, noon 1 pm to 4 pm and evening 5pm to 8pm. Sound level meter was mounted 1.5 m above ground level and set with fast response mode with frequency weighting A network and data logging of 1 sec time interval. This was fixed at the edge of all selected road intersections. Noise measurement was continuously recorded for peak and nonpeak hours stated above. Guidelines of IRC suggest the classification of vehicles based on axles, weight, length etc. However, in the city traffic, generally three types of vehicles are majority. Hence, vehicles were classified as Heavy vehicles (Truck and Bus), medium vehicles classified as 4 wheelers (Car), 3 wheelers (Auto rickshaw), light vehicles 2 wheelers (Motorcycle, scooter) etc as usual. The traffic volume studies were conducted to determine the number, movements, and classification of vehicles at the selected intersection for the sampling period. Traffic volume was recorded manually as well as using video camera. A group of four people were assigned for each approach of intersection for counting the number of vehicles passing the point of measurement. Simultaneously, each person was assigned counting horn honk event of different classified vehicles. Speed was also observed using hand held radar gun. Road temperature was also measured using infra red meter. The average weighted (L_{eq}) noise produced by the vehicles travelling the road of Ahmedabad was determined at all the seven intersections as stated earlier. After data collection, data processing consists of traffic count, vehicle speed, no of honking event etc. Noise levels (L_{eq}) and noise indices (L_{10} , L_{50} , L_{90}) stored in automatic sound level meter automatically generates a complete data sheet of all necessary noise data. Data on traffic volume count were manually transferred to excel sheet.

Results And Discussions:

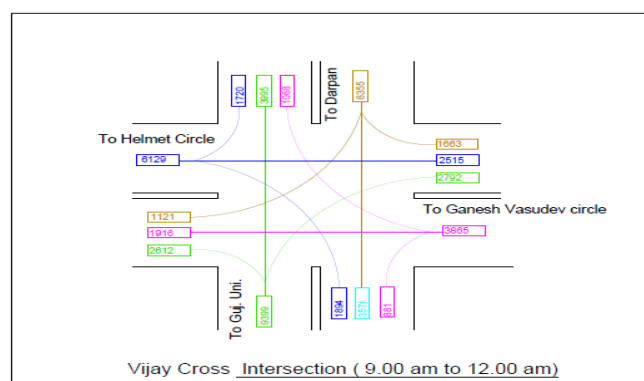
1) Traffic volume and noise measurement of all selected intersection location:

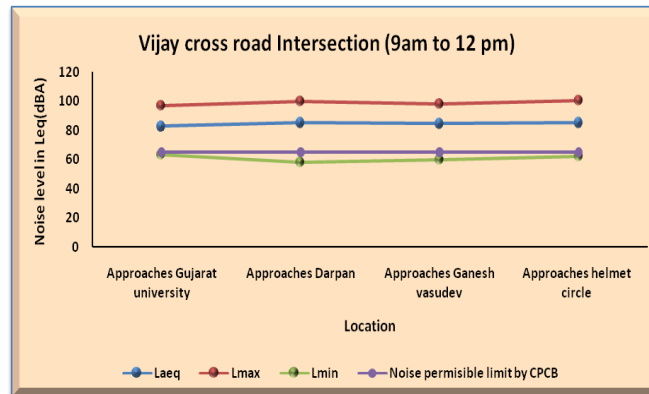
Traffic volume survey provides the basic data for the traffic noise assessment. Therefore, the traffic volume survey and measurement of sound i.e. L_{eq} were conducted simultaneously. The data were collected during the working days of Monday to Friday. The compiled presentation of the same is as under.

- (i) Conflict diagram
- (ii) Graphics of L_{eq} , L_{max} and L_{min} .

Displaying Conflict Diagram and corresponding Noise parameters of different approaches of selected intersections during morning 9.00 am to 12.00 pm.

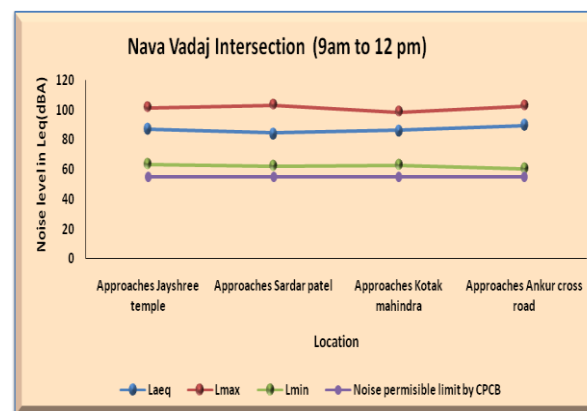
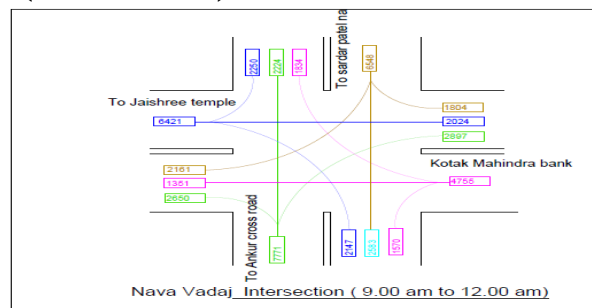
1) Vijay Cross road intersection (Commercial area):





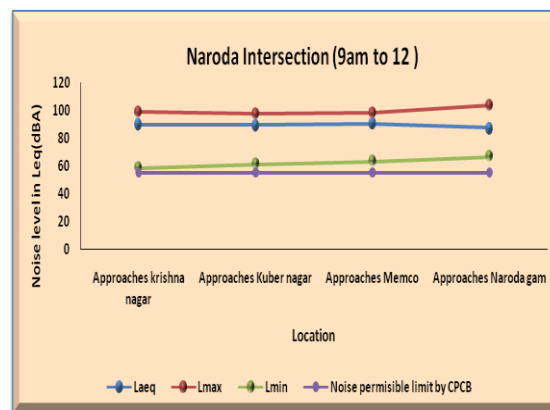
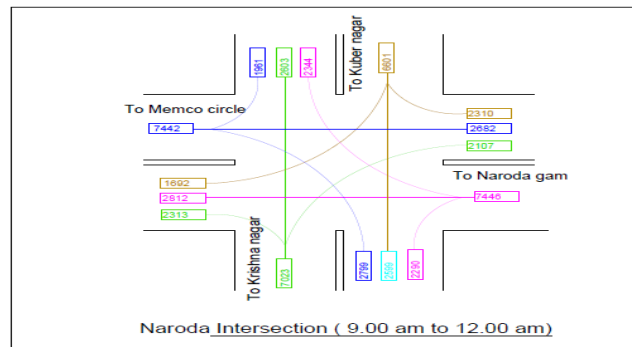
Above data depicts the average noise pollution indices Leq of this intersection during the working day. It clearly shows that in Vijay cross road intersection towards Gujarat university Leq observed 83dB (A), towards Darpan Leq observed 85.4 dB (A), towards Ganesh Vasudev Leq observed 84.7dB (A) and towards Helmet circle observed 85.4dB (A). At all approaches of Vijay cross road intersection, the Leq is higher than permissible limit of 65 dB for commercial area as per CPCB ambient noise standard. Hence, it is a point of concern for the people residing in this vicinity

2) Nava Vadaj intersection (Residential area)



Above data depicts the average noise pollution indices Leq of this intersection during the working day. It clearly shows that in Nava Vadaj intersection towards Jayshree temple observed 87.2dB (A), towards Sardar patel Leq observed 84.5dB (A), towards Kotak Mahindra Leq observed 86.3dB (A) and towards Ankur cross road observed 89.5 dB (A). At all approaches of Nava Vadaj intersection, the Leq are higher than permissible limit of 55 dB for Residential area as per CPCB ambient noise standard. Hence, it is a point of concern for the people residing in this vicinity.

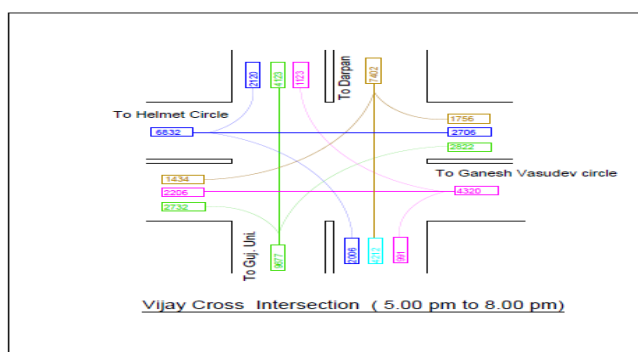
3) Naroda road intersection (Industrial area) :

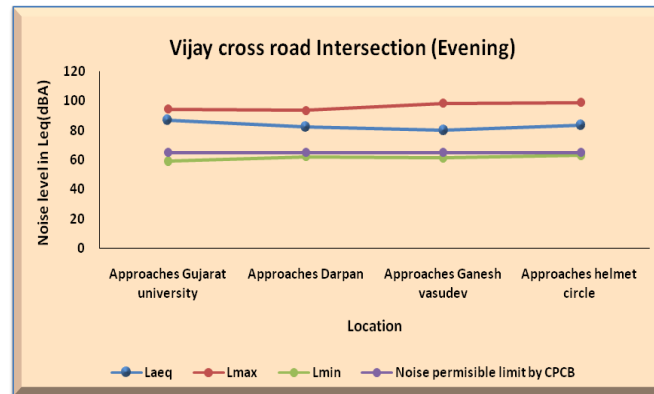


Above data depicts the average noise pollution indices Leq of this intersection during the working day. It clearly shows that in Naroda road intersection towards Krishna nagar observed 94.3dB (A), towards Kuber nagar towards observed 96.1dB (A), Memco Leq observed 93.2dB (A), towards Naroda Gam Leq observed 98.2dB (A). At all approaches of Naroda road intersection, the Leq are higher than permissible limit of 75 dB for Industrial area as per CPCB ambient noise standard. Hence, it is a point of concern for the people residing in this vicinity.

Displaying Conflict Diagram and corresponding Noise parameters of different approaches of selected intersections during morning 5.00 pm to 8 pm.

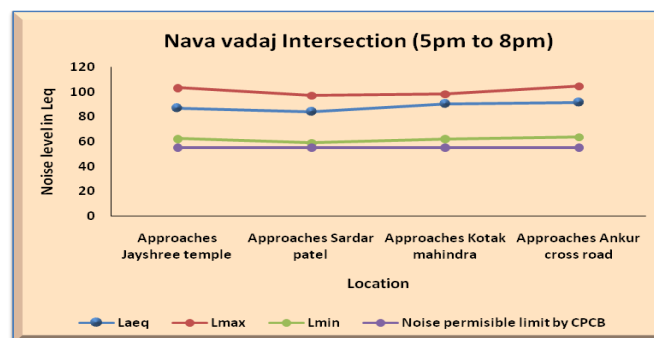
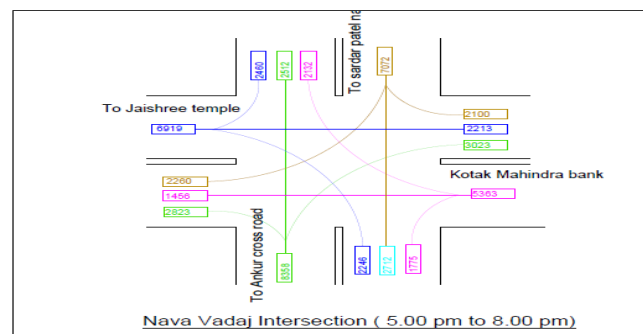
1) Vijay cross intersection (Commercial area) :





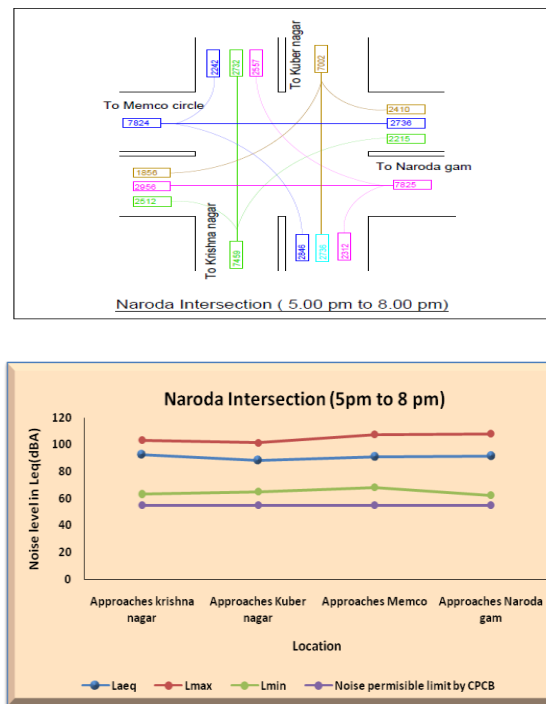
Above data in depicts the average noise pollution indices Leq of this intersection during the working day. It clearly shows that in Vijay cross road intersection towards Gujarat university Leq observed 86.6dB (A), towards Darpan Leq observed 82.4 dB (A), towards Ganesh Vasudev Leq observed 80.1dB (A) and towards Helmet circle observed 83.4dB (A). At all approaches of Vijay cross road intersection, the Leq is higher than permissible limit of 65dB for commercial area as per CPCB ambient noise standard. Hence, it is a point of concern for the people residing in this vicinity

2) Nava Vadaj intersection (Residential area) :



Above data in depicts the average noise pollution indices Leq of this intersection during the working day. It clearly shows that in Nava Vadaj intersection towards Jayshree temple observed 86.5dB (A), towards Sardar patel Leq observed 83.7dB (A), towards Kotak Mahindra Leq observed 89.8dB (A) and towards Ankur cross road observed 91.1dB (A). At all approaches of Nava Vadaj intersection, the Leq are higher than permissible limit of 55dB for Residential area as per CPCB ambient noise standard. Hence, it is a point of concern for the people residing in this vicinity.

3) Naroda road intersection (Industrial area) :



Above data depicts the average noise pollution indices Leq of this intersection during the working day. It clearly shows that in Naroda road intersection towards Krishna nagar observed 97.5dB (A), towards Kuber nagar towards observed 99.dB (A), Memco Leq observed 98.2dB (A), towards Naroda gam Leq observed 97.7dB (A). At all approaches of Naroda road intersection, the Leq are higher than permissible limit of 75 dB for Industrial area as per CPCB ambient noise standard. Hence, it is a point of concern for the people residing in this vicinity.

2) Observing Noise Variation With Respect To Speed And Distance From Intersection:

At the intersection, traffic is controlled and regulated with signals. Therefore, after getting green signal, vehicles start and gain speed. As they move further, due to increase in speed, noise level increases because of increased rpm of the engine. Under this back drop, noise level observations at the approaches of highest traffic volume were taken separately with respect to the distance from the intersection. This has been carried out during 9:00 to 12:00 hours in the morning with the five minute interval during a working day of the week. To measure noise level, SLM 109 noise meter was set at a distance 0 m and at 250 m from the intersection. Noise level variation with respect to the distance is presented in the following graphs showing noise level at zero distance i.e. stops line at the intersection and at 250 m from the intersection, where, vehicles almost resume their normal speed. Set of observation is taken for all the intersections. The same are compiled and represented at Fig

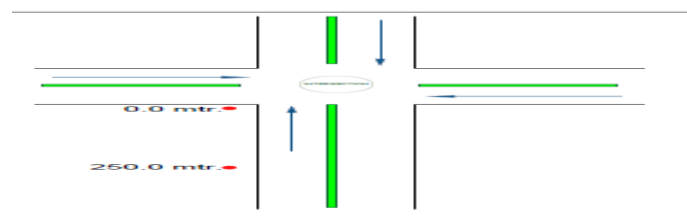
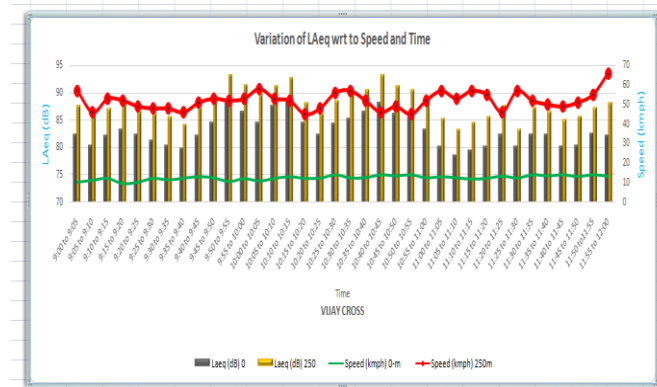


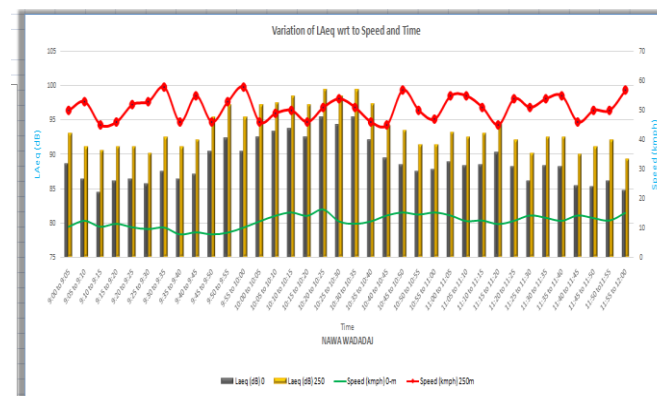
Fig 7.36 Schematic layout showing location of noise and speed measurement

1) Vijay cross road intersection (Commercial area):



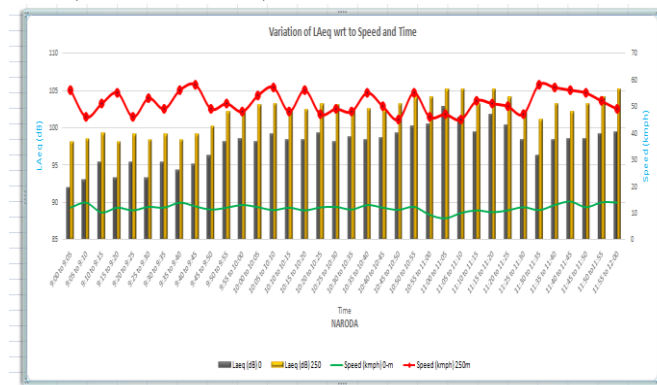
With the setting of noise level measurement instrument SLM 109 stated as above, i.e. at 0 and at 250 m from the intersection, noise level was measured. At Vijay cross road intersection, the observed equivalent noise levels Leq found to be higher by 3 to 7 dB at a 250 m distance compared to that observed at 0 m. Beyond the distance of 250 m, the speed of vehicle almost reach a constant value. This happens at starting vehicles runs at low gear with less engine rpm. But thereafter assumes speed and it runs at top gear having more engine rpm. Obviously, the noise level, which is proportional to the engine rpm, increases proportionally with speed. As such, speed of the vehicle is also one of the major factors contributing to the inoise.

2) Nava Vadaj intersection (Residential area):



With the setting of noise level measurement instrument SLM 109 stated as above, i.e. at 0 and at 250 m from the intersection, noise level was measured. At Nava Vadaj intersection, the observed equivalent noise levels Leq found to be higher by 3 to 6 dB at a 250 m distance compared to that observed at 0 m. Beyond the distance of 250 m, the speed of vehicle almost reach a constant value. This happens at starting vehicles runs at low gear with less engine rpm. But thereafter assumes speed and it runs at top gear having more engine rpm. Obviously, the noise level, which is proportional to the engine rpm, increases proportionally with speed. As such, speed of the vehicle is also one of the major factors contributing to the inoise.

3) Naroda road intersection (Residential area):



With the setting of noise level measurement instrument SLM 109 stated as above, i.e. at 0 and at 250 m from the intersection, noise level was measured. At Naroda intersection, the observed equivalent noise levels Leq found to be higher by 3 to 6 dB at a 250 m distance compared to that observed at 0 m. Beyond the distance of 250 m, the speed of vehicle almost reach a constant value. This happens at starting vehicles runs at low gear with less engine rpm. But thereafter assumes speed and it runs at top gear having more engine rpm. Obviously, the noise level, which is proportional to the engine rpm, increases proportionally with speed. As such, speed of the vehicle is also one of the major factors contributing to the noise.

3) Analysing Effect Of Vehicular Type And Speed On Noise Using Variance:

To examine the effect of vehicle type and their speed on the traffic noise, variance analysis of observed data has been carried out as under:

Table 7.1: Analysis of variance for vehicular speed and vehicular type on traffic noise

Variance Analysis for type of vehicles and speed on traffic noise					
Parameters	Degree of freedom	Sum of squares	Mean square	F	P
Vehicle type	3	152.9	51.5	22.2	0.001
Vehicular speed	3	32.2	9.2	3.8	0.023
Error	9	24	2.5		
Total	15	207.1			

For this analysis, three types of vehicles considered i.e. light, medium and heavy. For these types of vehicles, speed varied in the range of 40-50 kmph for light vehicles, then 50-60 kmph for medium vehicles and 30-40 kmph for heavy vehicles. It is observed that for all the types of vehicles; noise level varies linearly with speed. It is observed that autos and heavy vehicles have dominating effect of traffic noise related to light vehicles. Two-way ANOVA software is used to examine the impact of vehicle type and its speed on traffic noise and results have been displayed in the table no 7.1 above. As can be seen, p value is less than 0.1% for vehicular type, which shows that type of vehicle has significant impact on traffic noise level (i.e. CI -95%). As can be seen that p value is less than 0.05 for speed of the vehicle on noise level, (i.e. CI -95). It signifies that type of vehicle is more governing factor for noise level impact than the vehicle speed.

Conclusions:

In depth exercise to assess the noise level and its dependency is carried out at the selected intersections of Ahmedabad city. Extensive data based on observations and measurements were collected and

thereafter, analysis has been carried out to correlate noise level with respect to major contributing factors. Based on these studies important outcome those have been drawn are as under:

- 1) It is primarily gathered that noise level exceeds permissible limits prescribed by GPCB and CPCB at all the selected locations. It is predicted that population of Ahmedabad will increase from 8 million at present to 10 million by 2031. With this pace of demographical growth, number of vehicles will also increase geometrically and may pose a serious concern to citizen health.
- 2) Traffic volume is one of the prime factors contributing noise level. As has been observed, the noise level is proportional to the traffic volume. The variation of different type of vehicles in traffic volume has also significant impact on the noise level as observed at different intersections. Noise level above 90 dB has been observed in the industrial area of Narol and Naroda, where there is large number of heavy vehicles. As against, in the residential and commercial areas with lesser heavy vehicles have earmarked noise level of 80 dB.
- 3) Speed of vehicles, which varies with respect to the distance from the intersection, has remarkable effect on the noise level. It is found that the noise level is directly proportional to the speed, which increases with distance from the intersection; speed almost doubles in a distance of 250m with addition of Leq of 5 to 8 dB.

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