A

Project Report

On

ANALYSIS OF TRAFFIC NOISE

Submitted by

SATYAJIT SAHOO

(ROLL NO-110CE0054)

In partial fulfillment of the requirements for the degree in

Bachelor of Technology

In

Civil Engineering

Under the guidance of

Dr. Ujjal Chattaraj

Department of Civil Engineering

National Institute of Technology Rourkela.

CERTIFICATE

It is certified that the work contained in the thesis entitled "*Analysis of Traffic Noise*" submitted by Mr. Satyajit Sahoo, has been carried out under my supervision and this work has not been submitted elsewhere for a degree.

_____

Date: 10.05.2014

(Ujjal Chattaraj, Ph.D.)
Assistant Professor
Department of Civil Engineering
NIT Rourkela

ABSTRACT

Environmental noise is an undesirable byproduct of industrialization and urbanization. Although it is not noticeable, this unwanted or excessive sound makes a significant damage to human beings and has a hazardous impact on our environment. The noise sources we interact daily, perhaps the most fast-growing and difficult to avoid noise source is the noise emanating from transportation. Highway traffic noise is the major contributor of transportation noise. To measure the impact of noise, nowadays mostly used tool is drawing contour over a map. The objective of this work is (a) to draw the noise profile of Rourkela on different hours of the day (morning, noon & evening) and (b) to perform t-test that determines whether there is a statistically significant difference between the means of equivalent sound pressure level of morning, noon and evening.

Most of the sound pressure level at different site was within permissible limit. The noise level during evening time was more than morning and noon. This is because of high volume of traffic is experienced in the evening.

KEYWORDS: Noise, Sound Level meter, Hypothesis, Student's t-test

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

My heart pulsates with the thrill for tendering gratitude to those persons who helped me in completion of the project. First and foremost, I express my sincere gratitude and indebtedness to Dr. Ujjal Chattaraj, for allowing me to carry on the present topic "Analysis of Traffic Noise" and later on for their inspiring guidance, constructive criticism and valuable suggestions throughout this project work. I am very much thankful to him for his able guidance and pain taking effort in improving my understanding of this project.

I would also like to give a special thanks to our Institute- NIT Rourkela and the Department of Civil Engineering for providing all the necessary facilities during the course of the project. An assemblage of this nature could never have been attempted without reference to and inspiration from the works of others whose details are mentioned in reference section. I acknowledge my indebtedness to all of them.

At the last, my sincere thanks to all my friends who have patiently extended all sorts of help for accomplishing this assignment.

SATYAJIT SAHOO

LIST OF FIGURES

LIST OF TABLES

CHAPTER - 1

INTRODUCTION

1.1 BACKGROUND

Sound is the vibration in the air that reach our ear. Where noise is unwanted or excessive sound.In developing country like INDIA experience several environmental problems. These environmental problems include air, water, and noise pollution. Out of three, noise pollution is one of a major concern for people residing in urban areas.The factor contrbuting high noise levels are increase in population and increase in the traffic volume. Traffic noise emerges as a new headache for people residing near highways.

1.2 IMPORTANCE OF STUDY

Rourkela is a city located in the northwestern border of the Odisha. It is one of largest city of Odisha and situated 340 km north of Bhubaneswar. One of the largest steel plant of Steel Authority of India Limited (SAIL) is situated here. One National Highway (NH-23) is passing through Rourkela which runs from Chas to Banarpal junction with NH-42 via Ranchi, Rourkela, and Talcher. State Highway No – 10 which runs from Rourkela to Sambalpur is another good road used in a large way particularly after its renovation and up gradation in 1995. From civic point of view the Steel City consists of two parts i.e. Steel Township and Civil Township. While the ring road constructed by Rourkela Steel Plant Authority which has surrounded the Steel Township the other part of the ring road is Civil Township. The Steel Township roads are also maintained by the RSP authority. A large volume of traffic is experienced by the city because of its importance and road network. So this will give rise to a high traffic noise, which need to be take care of.

1.3 OBJECTIVE

The main objectives of the present study have been presented as follows.

- To quantify the levels of noise pollution in Rourkela.
- To compare the result with WHO standards for noise specification.
- To draw the noise profile of different places of Rourkela at various hours of the day.
- To perform t-test that determines whether there is a statistically significant difference between means of sound pressure level during morning, noon, evening.

1.4 STUDY FRAMEWORK

In any case, this study finds out the level of noise pollution and, also, talks about the effect of traffic noise on the inhabitants of Rourkela region. Later writing about noise pollution will be inspected.

Chapter 1: Introduction is pointed at briefing the spectator about the setting of the study. Furthermore this part gives an issue proclamation and records the objectives to be accomplished all around the study.

Chapter 2: Literature Review gives a short demonstration about noise/environmental noise pollution. It additionally incorporates past and current writing with respect to noise pollution.

Chapter 3: Present study: Noise pollution in Rourkela is highlighted/ researched. Likewise recognized are the measuring techniques that were utilized throughout the noise review that was directed in Rourkela.

Chapter 4: Hypothesis testing on measured sound level during morning time, noon time and evening time was carried out to compare between their means.

CHAPTER - 2
LITERATURE REVIEW

2.1 INTRODUCTION

This part furnishes the spectator with a concise prologue to environmental noise and noise pollution. The reason for activity noise are taken a gander at, and in addition the effect noise has on people.

2.2 ENVIORNMENTAL NOISE

Noise is characterized as unwanted sound. Encompassing noise or environmental noise is unwanted or unsafe open air sounds made by human exercises, including noise emitted through method for transport (e.g. street traffic, air traffic) and noise from locales of modern action.

Environmental noise pollution is a danger to the wellbeing and prosperity-of human- kind. It is more serious and far reaching than at any other time, and it will keep on increasing in size and seriousness by virtue of present societal patterns to be specific populace development what's more urbanization. Its seriousness will escalate, in connection with the increment in the utilization of dynamically all the more capable, changed, and exceedingly portable wellsprings of noise. Noise levels will likewise keep on ring with supported development in highway, rail, and air traffic, the major wellsprings of environmental noise.

Environmental noise population is not a totally new sensation, yet rather an issue that has become slowly with time. Despite the fact that environmental noise is fundamentally an urban issue, the noise of machines that humankind demands building is progressively bringing noise population to the few staying wild asylums on the planet. Environmental noise population may not represent the danger of quick annihilation that atomic war does, yet one ought to manage as a top priority that the impacts are the same and almost as enduring.

Escape from human-impelled sound is uniquely more troublesome today than a century prior, furthermore inside an alternate half-century it may be everything except unthinkable. One may well ask how human-kind touched base at the current situation. A few causative elements might appear to be capable. Maybe most paramount has been the predictable resignation to engineering and the perpetually-expanding development of high-thickness improvements, the reason being that for every last improvement:

1) There is an increment in the amount of vehicles.

2) Noise, dissimilar to air and water pollution, can't be outwardly decided and takes off no unmistakable record of its vicinity.

3) Noise is innately a specialized issue which the standard national has extraordinary trouble in understanding. While humankind does not comprehend the complex make-up of noise pollution, it is by the by evident that noise is a type of pollution that is requests therapeutic activity by government.

2.3 NOISE POLLUTION

The words that are continually heard in the media and scholastic rounds are "climate change and global warming". These words are connected with studies focused around carbon dioxide discharges and over the top high temperature. As per man made considering, for the most part,

people don't accept that the noise sways upon the earth. They accept that honestly normal air poisons have more compelling results for the planet rather than noise.

2.4 CAUSES of TRAFFIC NOISE

Noise comes from many sources: one of significant source is from transportation. Noise comes from three sources (a) the friction between vehicle tyres and road (b) the engine and (exhaust).

The level of highway traffic noise depends on:

(a) Speed of the traffic

(b)Traffic volume

2.5 EFFECTS of NOISE ON HUMAN BEINGS

Physical effects of noise

Noise of a high intensity volume will cause either temporary or permanent damage to our hearing. The science behind these injuries are well understood.

High volume of sound will give rise to noise-induced hearing deficits that can be experienced in various situations. Considering the significant variations in human ear sensitivity to noisy environment, it could cause hearing impairment, and this hazardous nature of noisy

Environment is termed as “damage risk”. The risk is considered negligible when the equivalent sound level is less than 75dB for an exposure period of 8 hours.

Physiological Effects

Noise may cause temporary stress reactions (increasing the heart rate and blood pressure), and produce negative effects on our coordination system and respiratory systems. Noise can cause persistent increase in blood pressure after a long term exposure to noise. A few studies were made on general population comparing the physiological behavior of those living in noisy street to those living in Quiet Street. The result show that an increase in blood pressure in those people living in noisy street.

2.6 OTHER LITERATURES COVERED

- Lucknow,INDIA : 2006

The name of this study is Profile of noise pollution in Lucknow city and its impact on environment.

This research was done by G.C. Kisku, Kailash Sharma, M.M. Kidwai, S. C. Barman, A.H. Khan, Ramesh Singh, Divya Mishra and S.K. Bhargava to make a noise modelling study of Lucknow during day and night time .This research is based on relating the traffic flow to the noise produced by different vehicles.

- Verginia : 2007

Highway Noise Reduction Experiment, was done by Virginia Transportation Research Council (VTRC), in conjunction with The Virginia Transportation Tech Institute. The specific objective were to quantify the reduction in noise emanating from the state's interstate highways attribute to various types of evergreen trees commonly found in Virginia, and to measure the reduction in road noise achievable from the use of quiet pavement. There was a minimal noise reduction that could be attributed to the coniferous trees. The quiet pavement section tested had a noise level higher than that of intermediate pavement, but less than that of standard asphalt pavement and concrete pavement.

- STUDY OF NOISE POLLUTION DURING HAJJ SEASON 1427 H

This study was done by Abdulaziz Al-Zahrani ,Hazim Al-Hazimi ,Rami Menkabo ,Meshal Al-Malki ,Muhammed Al-Mutairi ,Mutaz Qutob at Sha'aban 1428 H August 2007 D. Main objective of this research was to evaluate the noise level in holy cities Mina valley and Arafat area during hajj season in 1427 H. The measured sound pressure level at different places were compared with world health organization standard.

- Lisbon Airport: 2012

This research was done by Pablo Gauna Medrano, to generate noise contour from measured data at Lisborn airport. The noise contours were calculated from flight reports and data from the Aircraft manufacturers. The measures were taken on typical hour basis, depends on type of aircraft and part of the day. The calculus of the noise contours was based on the noise levels

produced by each plane in each point of a grid so as to sum all the values and interpolate the contours.

- Springfield, Illinois: 2011

This research was done by Illinois Department of Transportation Division of Highways Bureau of Design and Environment to prepare a Highway Traffic Noise Assessment manual. This manual describes the technique and procedure to analyze and report the impacts of traffic noise, describes to provide noise barriers and abatements in order to mitigate noise, and describes the feasibility of noise barriers.

CHAPTER - 3

PROJECT METHODOLOGY

This chapter explains how the noise assessment in Rourkela was conducted.

Illustrations of the instruments used during noise readings and the specific measuring points are also provided.

3.1 MEASURING INSTRUMENT

Sound level meter NL-42:

Noise measurements were performed using an integrated Average Sound Level Meter NL-42 which are designed for sound level measurements according to the IEC standard. It support diffuse sound field measurements and also meets standard requirements when the supplied windscreen is mounted.

Specifications

NL-42 IEC 61672-1:2002 Class

Main processing (Main channel)

Instantaneous sound pressure level- Lp

Equivalent continuous sound pressure level Leq

Sound exposure level – L_E

Maximum sound pressure level – L_{max}

Minimum sound pressure level – L_{min}

Figure-3.1 : NL-42 IEC 61672-1:2002 Class

3.2 STUDY AREA

Rourkela is located at 84.54E longitude and 22.12N latitude in Sundergarh district of Odisha at an elevation of about 219 meters above mean sea level. The area of Rourkela is 200 square kilometers approximately. Red and laterite soils are found here which are quite rich in minerals. The area near Rourkela is rich in iron-ore hence a steel plant is situated in Rourkela. Rourkela is situated in a hilly region. Being in a state, which has depended on Road Transport for decades.

Rourkela has a good connectivity to the other towns on the State with an average frequency through Road. Rourkela city is connected with National Highways NH-23 and SH-10 to the towns and cities of Odisha.

The following location are marked where ,the noise are to be observed.

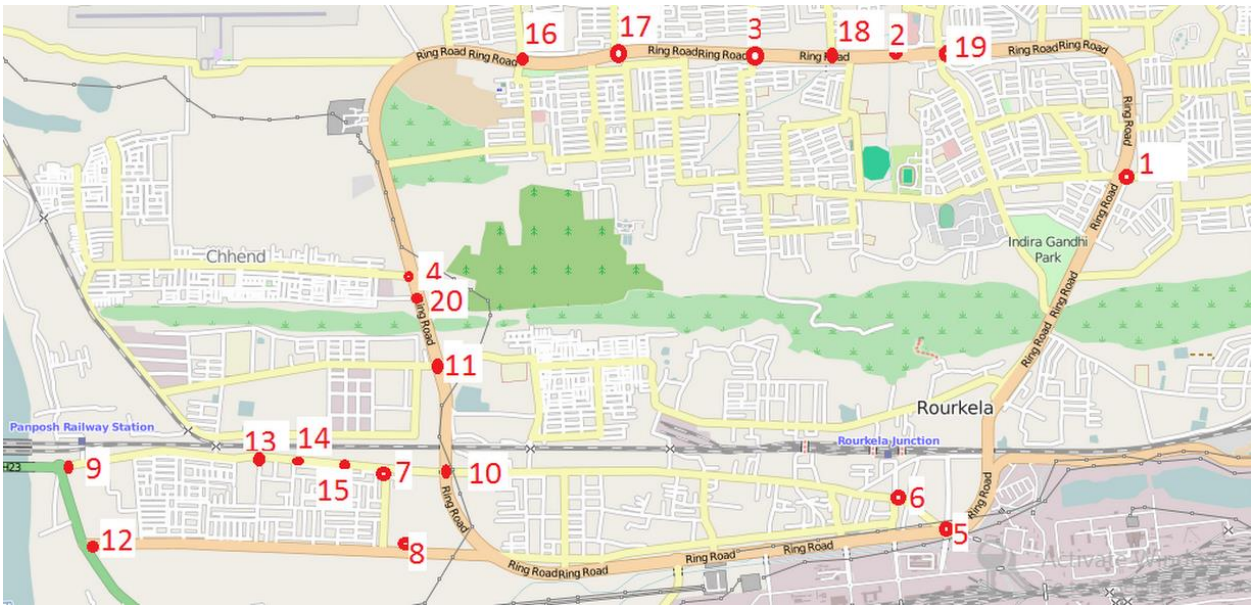

Figure 3.2: Locations of Sites [16]

Table-3.1:Name of the locations as per fig-3.2.

Seriel no	Place	Seriel no	place
1	Sector-2	11	Basanti Chowk
2	Ambagan	12	Hockey Chowk
3	Sector-17	13	Panposh-2
4	Chhend	14	Panposh-3
5	Bisra Chowk	15	Suruchi Bazar
6	Railway Station	16	Ring Road (DPS)
7	STI Chowk	17	Sector-15
8	Hanuman Vatika	18	Ispat market fountaion
9	Panposh Chowk	19	Ring Road (near ispat gopabandhu library)
10	Udit Nagar	20	Chhend petrol pump

LOCATION: Location were chosen such that a maximum traffic flow can be expected. Such locations are (a) near railway station, (b) near Rourkela Steel Plant (RSP), (c) crossing of roads.

3.3 DATA CLLECTION

(1) The noise at the specified location are noted for a duration of fifteen minutes minutes.

(2) In the specified locations sound level was taken either at the separator or on bank of the road.

(3) The sound pressure level at a specified location was noted for 3 times during tha day (e.g morning, noon, evening).

(4) Frequency type C is chosen in the sound level meter.

The following measurement were carried out:

C-weighted peak sound level - LCpeak

C-weighted equivalent continuous sound level -LCeq

C-weighted minimum sound level- LCmin

CHAPTER - 4
RESULTS AND OBSERVATIONS

4.1 DATA COLLECTED

SERIAL NO	LOCATION	SOUND LEVEL METER READING(in dB)		
		MORING	NOON	EVENING
1	Sector-2	78.8	75	80.2
2	Ambagan	79.9	76	81.2
3	Sector-17	78.2	75.7	81
4	Chhend	79.3	77.8	82
5	Bisra Chowk	79.2	77.7	84
6	Railway Station	78.9	77	85
7	STI Chowk	78.6	75.8	81.2
8	Hanuman Vatika	79.8	78.2	84.1
9	Panposh Chowk	80	82.3	84.9
10	Udit Nagar	79.3	79	83
11	Basanti Chowk	78.7	79	83
12	Hockey Chowk	80	79	84.7
13	Panposh-2	79.4	78.8	80.9
14	Panposh-3	78.8	77.6	81
15	Suruchi Bazar	78.7	80	81
16	Ring Road (DPS)	77.6	75	79.3
17	Sector-15	78	75	79.3
18	Ispat market fountaion	79.3	78.1	82
19	Ring Road (near ispat gopabandhu library)	78.3	76	79.8
20	Chhend petrol pump	79.9	79	83

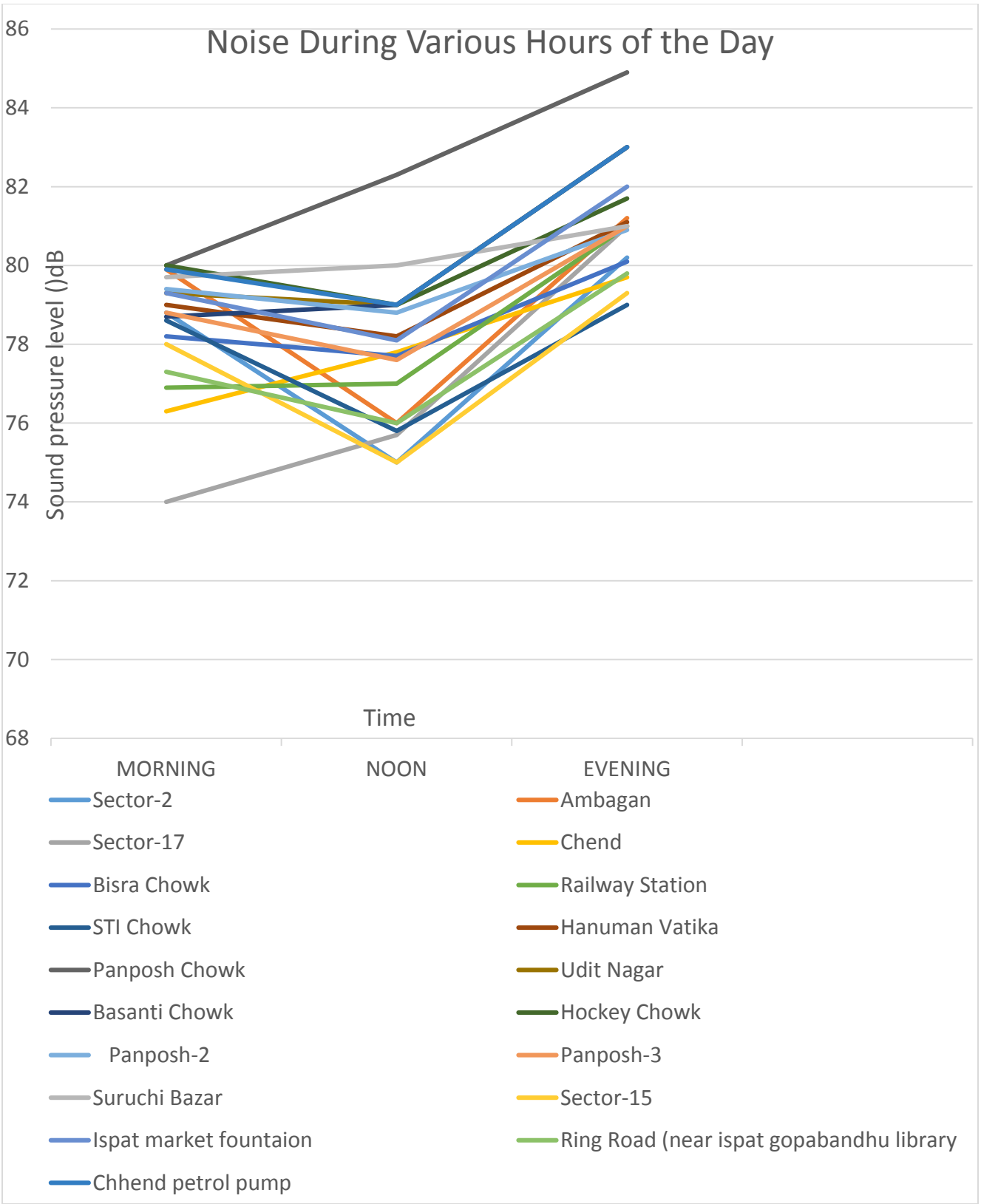

Figure 4.1: Noise during Various Hours of the Day

4.2 COMPARISION WITH STANDARD NOISE VALUE

In the morning hours the maximum equivalent sound level of noise is Lceq =80dB, is less than Leq = 85 dB so that, this area is suitable for human hearing as the recommended noise value by WHO 1999.

In the noon hours the maximum equivalent sound level of noise is Lceq =77.8dB, is less than Leq = 85 dB so that, this area is suitable for human hearing.

But, in the evening time the maximum equivalent sound level Lceq =85dB.This area is not suitable for human hearing.

4.3 NOISE PROFILE OVER ROURKELA

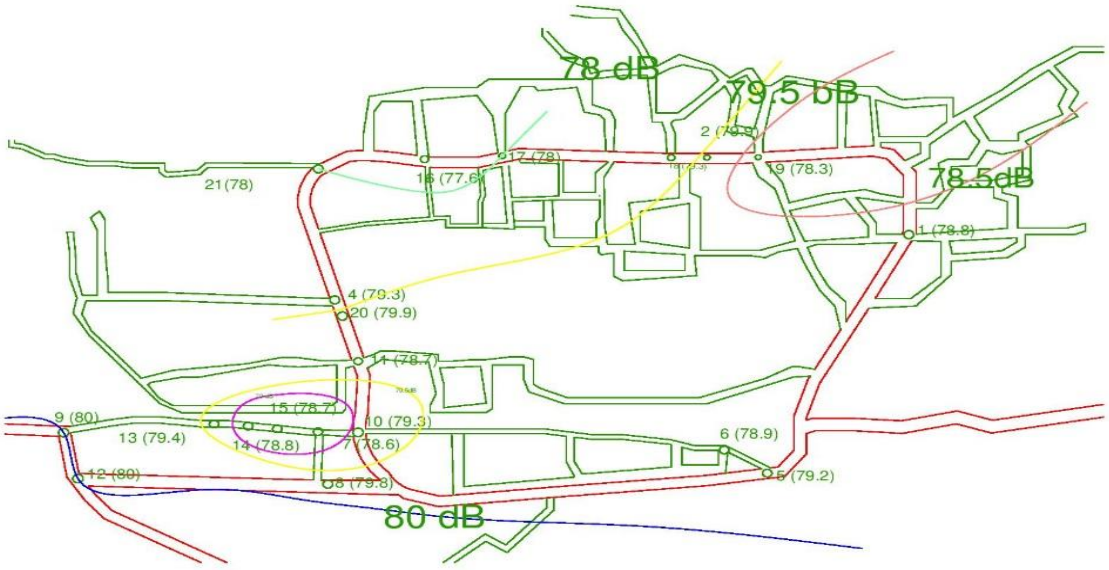

Figure 4.2: Noise profile during morning

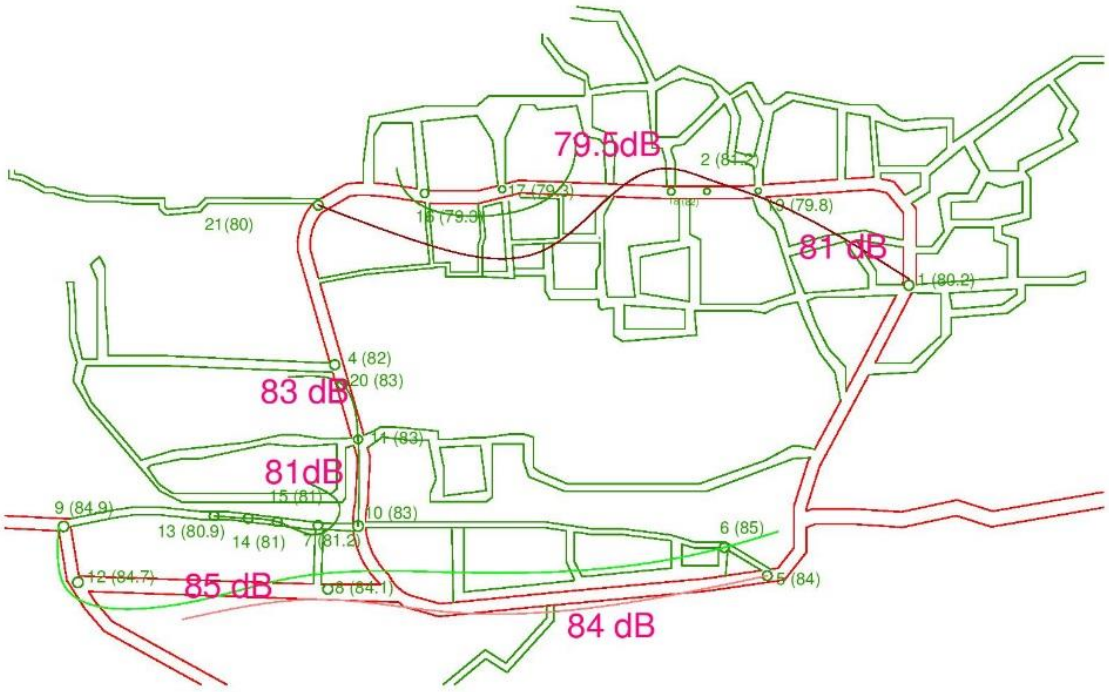

Figure 4.3: Noise profile during evening

CHAPTER - 5

HYPOTHESIS TESTING

A **statistical hypothesis** is an assumption about a population parameter. This assumption may or may not be true. **Hypothesis testing** refers to the formal procedures used by statisticians to accept or reject statistical hypotheses.

Hypothesis testing can be done in 2 approach:

The probability value (p-value) approach

The Critical Value Approach

5.1 The probability value (p-value) approach

The probability value (p-value) of a statistical hypothesis test is the probability of getting a value of the test statistic as extreme as or more extreme than that observed by chance alone, if the null hypothesis H0, is true. It is the probability of wrongly rejecting the null hypothesis if it is in fact true. It is equal to the significance level of the test for which we would only just reject the null hypothesis. The p-value is compared with the actual significance level of our test and, if it is smaller, the result is significant. That is, if the null hypothesis were to be rejected at the 5% signficance level, this would be reported as "$p < 0.05$". Small p-values suggest that the null hypothesis is unlikely to be true. The smaller it is, the more convincing is the rejection of the null hypothesis. It indicates the strength of evidence for say, rejecting the null hypothesis H0, rather than simply concluding "Reject H0' or "Do not reject H0".

5.2 Student's t-test

We use this test for comparing the means of two samples (or treatments), even if they have different numbers of replicates. In simple terms, the t-test compares the actual difference between two means in relation to the variation in the data (expressed as the standard deviation of the difference between the means).

PROCEDURE

1. We need to construct a null hypothesis - an expectation - which the experiment was designed to test.
2. List the data for sample 1
3. List the data for sample 2
4. Record the number (n) of replicates for each sample (the number of replicates for sample 1 being termed n1 and the number for sample 2 being termed n2).
5. Calculate mean of each sample
6. Calculate s^2 for each sample; call these s_1^2 and s_2^2
7. Calculate the variance of the difference between the two means (sd2) as
8. Follows

$$\sigma_d^2 = \frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}$$

9. Calculate sd (the square root of sd2)
10. Calculate the t value as follows:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sigma_d}$$

11. Enter the t-table at (n1 + n2 -2) degrees of freedom; choose the level of significance required (normally p = 0.05) and read the tabulated t value.
12. If the calculated t value exceeds the tabulated value we say that the means are significantly different at that level of probability.
13. A significant difference at p = 0.05 means that if the null hypothesis were correct (i.e. the samples or treatments do not differ) then we would expect to get a t value as great as this on less than 5% of occasions. So we can be reasonably confident that the samples/treatments do differ from one another, but we still have nearly a 5% chance of being wrong in reaching this conclusion.

    Now compare your calculated t value with tabulated values for higher levels of significance (e.g. p = 0.01). These levels tell us the probability of our conclusion being correct. For example, if our calculated t value exceeds the tabulated value for p = 0.01, then there is a 99% chance of the means being significantly different (and a 99.9% chance if the calculated t value exceeds the tabulated value for p = 0.001). By convention, we say that a difference between means at the 95% level is "significant", a difference at 99% level is "highly significant" and a difference at 99.9% level is "very highly significant".

5.3 COMPARISION BETWEEN NOISE DURING MORNING AND NOOON

H_0 : Noise level in morning=Noise level in noon

H1 : H1:Noise level in morning>Noise level in noon

Table 5.1: t-Test of morning and noon noise level\

	Morning	*Noon*
Mean	78.98571	77.57143
Variance	0.512286	3.537143
Observations	21	21
Hypothesized Mean Difference	0	
df	26	
t Stat	3.220697	
P(T<=t) one-tail	0.001711	
t Critical one-tail	1.705618	
P(T<=t) two-tail	0.003422	
t Critical two-tail	2.055529	

p-value < significance level, we have to reject the null hypothesis. Hence noise during morning is more than noise during noon.

5.4 COMPARING THE NOISE LEVEL DURING MORNING AND EVENING

H_0: Noise level in morning=Noise level in evening

H_1: Noise level in evening>Noise level in morning

Table 5.2 : t-Test between morning and evening noise level

	Morning	*Evening*
Mean	78.98571	81.93333
Variance	0.512286	3.408333
Observations	21	21
Hypothesized Mean Difference	0	
df	26	
t Stat	-6.82187	
P(T<=t) one-tail	1.53E-07	
t Critical one-tail	1.705618	
P(T<=t) two-tail	3.06E-07	
t Critical two-tail	2.055529	

p-value < significance level, we have to reject the null hypothesis. Hence noise during evening is more than noise during morning.

5.5 Comparing between noise level during noon and evening

H_0 : noise level during noon = noise level during evening.

H1:Noise level in evening>Noise level in noon

Table 5.3 : t-Test between noon and evening noise level

	Noon	
Mean	77.57143	81.93333
Variance	3.537143	3.408333
Observations	21	21
Hypothesized Mean Difference	0	
df	40	
t Stat	-7.58464	
P(T<=t) one-tail	1.46E-09	
t Critical one-tail	1.683851	
P(T<=t) two-tail	2.91E-09	
t Critical two-tail	2.021075	

p-value < significance level, we have to reject the null hypothesis. Hence noise during evening is more than noise during noon.

5.6 ANALYSIS OF VARIANCE

Analysis of variance (**ANOVA**) is a collection of statistical method used to analyze the differences between group means and their associated procedures (such as "variation" among and between groups). ANOVA provides a statistical tests of whether or not the means of several groups are equal, and therefore generalizes the t-test to more than two groups ANOVAs are useful in comparing (testing) three or more means (groups or variables) for statistical significance.

$$F = \frac{\text{variance between treatments}}{\text{variance within treatments}}$$

$$F = \frac{MS_{\text{Treatments}}}{MS_{\text{Error}}} = \frac{SS_{\text{Treatments}}/(I-1)}{SS_{\text{Error}}/(n_T - I)}$$

MS is the mean square, I= no of groups, n_T= no of observation.

$$F = \frac{(\text{sum of variance within groups})^2 / (\text{degree of freedom within groups})}{\text{Total (variance)}^2 / (\text{total degree of freedom})}$$

F) $_{\text{Critical}}$ is obtained from the table for the corresponding degree of freedoms

If F) $_{\text{calculated}}$ > F) $_{\text{critical}}$ then the groups are significantly similar.

But if F) $_{\text{calculated}}$ < F) critical then are significantly different.

Table 5.4: Summery of the noise level during the day

Groups	*Count*	*Sum*	*Average*	*Variance*
Morning	21	1658.7	78.98571	0.512286
Noon	21	1629	77.57143	3.537143
Evening	21	1720.6	81.93333	3.408333

Table 5.5: Analysis of Variance

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	208.0041	2	104.0021	41.83644	4.2E-12	3.150411
Within Groups	149.1552	60	2.485921			
Total	357.1594	62				

As $F_{critical} < F$, Hence all the observation of the 3 times are not significantly similar.

6. CONCLUSION

1. Most of the sound pressure level at different site was within permissible limit.

2. Near railway system and Panposh Chowk the measured sound pressure level is same as the permissible limit (85 dB), so special provision should be taken for attenuation of noise.

3. The noise level during evening time was more than morning and noon. This is because of high volume of traffic is experienced in the evening.

4. From t-Test hypothetical analysis it was found that, the means of noise level of morning and noon are significantly different or similarly the noise level in evening is significantly more than morning and noon time.

5. From ANOVA it was clear that all sound pressure level during different hours of the day significantly different from each other.

REFERENCES

1. World Health Organization (WHO), WWW.WHO.INF .
2. Ayman N. Al-Dakhlallah, 2005
3. Ahmed Shhatah,2003
4. Ising H, Babisch Wand Kruppa B 1998. Acute and chronic noise stress as cardiovascular risk factors .Federal Environmental Agency, Berlin, Germany.
5. Abdulaziz Al-Zahrani , Hazim Al-Hazimi (2007). Study of Noise pollution During HAJJ season 1427 H
6. V. Krishna Murthy, Ahmad Kamruzzaman Majumder, Sanjay Nath Khanal(2007) Assessment of Traffic Noise Pollution in BANEPA,A Semi Urban Town of NEPAL.
7. R.D. Moela, 2010 . The Impact of Traffic Noise Pollution on The Population of STRUBENSVALLEY in ROODEPOORT
8. Pablo Gauna Medrano, 2012, Noise contour calculation from measured data Runway 03/21 Lisbon Airport
9. Airport Authority Hong Kong,2012, Expansion of Hong Kong International Airport into aThree-Runway System
10. Mark Lea Drummond, 1996, A Survey of Aircraft Noise and Aircraft Certification Based on noise levels
11. Illinois Department of Transportation Division of highways Bureau of Design and Environment, 2011, Highway Traffic Noise Assessment Manual

12. G.C. Kisku, Kailash Sharma, M.M. Kidwai, S. C. Barman, A.H. Khan, Ramesh Singh, Divya Mishra and S.K. Bhargava, 2006, Profile of noise pollution in Lucknow city and its impact on environment
13. Virginia Transportation Research Council (VTRC) 2007, Highway Noise Reduction Experiment
14. U.S Department of Transportation, Federal Highway Administration,2011, Highway Traffic Noise:Analysis and Abatement Guidance
15. http://archive.bio.ed.ac.uk/jdeacon/statistics/tress4a.html
16. https://www.google.com/maps/preview