SUSHANT UNIVERSITY ORGANIZED INTERNATIONAL CONFERENCE ON
"ADVANCES IN MULTIDISCIPLINARY RESEARCH AND INNVOATION" ICAMRI-2023
ON 28-29TH OCTOBER 2023
INTERNATIONAL ADVANCE JOURNAL OF ENGINEERING, SCIENCE AND MANAGEMENT (IAJESM)
July-December 2023, Submitted in October 2023, iajesm2014@gmail.com, ISSN -2393-8048
Multidisciplinary Indexed/Peer Reviewed Journal. SJIF Impact Factor 2023 =6.753

Comprehensive Assessment of Traffic-Induced Noise Pollution at Urban Signalized and Rotary Intersections: A Case Study of Agartala City, India

Manish Pal, Professor, Department of Civil Engineering, National Institute of Technology, Agartala, Tripura – 799046, India

Abstract

Urban traffic noise has become a serious environmental challenge due to rapid motorization, unplanned urban expansion, and inefficient traffic control systems. Intersections are recognized as critical noise-generating locations because of frequent stopping, acceleration, and horn usage. This study presents a comprehensive assessment of traffic-related noise pollution at selected signalized and rotary intersections in Agartala city, India. Noise measurements were carried out at five major signal-controlled intersections and three rotary intersections during daytime and nighttime periods. A calibrated sound level meter conforming to international standards was used to record equivalent noise levels over a 14-hour observation period. The results reveal that signalized intersections exhibit significantly higher noise levels due to prolonged vehicle idling and indiscriminate horn usage. The average noise levels at signalized intersections were observed to be 84.13 dB(A) during daytime and 76.93 dB(A) during nighttime, exceeding permissible Indian ambient noise standards. In contrast, rotary intersections recorded comparatively lower noise levels of 64.4 dB(A) during daytime and 55 dB(A) during nighttime. The comparative analysis indicates that rotary intersections reduce noise exposure by approximately 25% during daytime and 30% during nighttime. The study highlights the effectiveness of rotary intersections in mitigating urban traffic noise and recommends their adoption as a sustainable traffic management solution.

Keywords: Traffic noise, Signalized intersection, Rotary intersection, Urban environment, Noise pollution

1. Introduction

Transportation infrastructure plays a vital role in supporting economic growth, social connectivity, and urban development. However, the rapid increase in vehicular population without corresponding improvements in traffic management has resulted in severe environmental problems, particularly in urban areas. Among various environmental pollutants, noise pollution is often underestimated despite its significant impact on human health and well-being.

Traffic noise is primarily generated due to engine operation, tire–road interaction, braking, acceleration, and the use of vehicle horns. Intersections amplify these effects because vehicles frequently stop, idle, and restart. Signalized intersections, especially those operated manually, are more prone to congestion, leading to higher noise emissions. Drivers often respond to delays by excessive horn usage, further increasing ambient noise levels.

Agartala, the capital city of Tripura, represents a typical medium-sized Indian city experiencing rapid urbanization. The city has a mix of signalized and rotary intersections, many of which are located in commercial and residential zones. Traffic control at several signalized intersections depends on manual signaling by traffic police, resulting in irregular flow and prolonged waiting times.

Rotary intersections are designed to promote continuous vehicular movement, thereby reducing stoppage time and unnecessary acceleration. This operational characteristic suggests a potential reduction in noise levels. The present study aims to evaluate traffic noise characteristics at both types of intersections and to examine whether rotary intersections offer a viable solution for controlling urban noise pollution.

Transportation networks are essential for economic growth and urban development; however, their expansion often brings unintended environmental consequences. Among these, traffic-related noise pollution has become one of the most persistent problems in urban areas.

Continuous exposure to high noise levels adversely affects human health, causing stress, sleep disturbances, reduced work efficiency, and hearing impairment.

Agartala, the capital city of Tripura, has experienced a rapid rise in motorized traffic over the past few decades. The city's road network includes both signal-controlled and rotary intersections, many of which operate beyond their intended capacity. At signalized intersections, traffic movement is regulated manually by traffic personnel, resulting in long queues, extended waiting times, and excessive horn use by impatient drivers. These conditions significantly elevate ambient noise levels.

Rotary intersections, by design, allow continuous vehicle movement with minimal stopping. This operational advantage suggests a possible reduction in traffic noise levels. The present study aims to quantitatively compare noise levels at signalized and rotary intersections in Agartala city and assess their compliance with national ambient noise standards.

2. Objectives and Scope of the Study

The primary objective of this research is to evaluate and compare traffic-induced noise levels at signalized and rotary intersections in Agartala city. Specific objectives include:

- Measurement of ambient noise levels at selected intersections during daytime and nighttime periods
- Comparison of observed noise levels with Indian ambient noise standards
- Analysis of the influence of traffic control type on noise generation
- Assessment of driver behavior, such as idling and horn usage, at intersections
- Evaluation of the effectiveness of rotary intersections in reducing traffic noise

The scope of the study is limited to major urban intersections where traffic volume is high and human exposure to noise is significant. Five signalized intersections and three rotary intersections were selected to represent different traffic conditions and land-use characteristics. The study focuses on equivalent continuous noise levels expressed in dB(A), which are widely used for environmental noise assessment.

This research does not include long-term seasonal variation or indoor noise exposure. However, it provides a reliable representation of typical urban traffic noise conditions and offers valuable insights for urban planners, traffic engineers, and policymakers.

3. Description of Study Area

Agartala city is located in the northeastern region of India and serves as the administrative, commercial, and cultural center of Tripura. The city has experienced rapid growth in vehicle ownership over the past two decades due to increased income levels and limited availability of public transport alternatives. As a result, traffic congestion has become a routine problem, particularly at major intersections.

The selected signalized intersections—IGM Chowmuhani, Paradise Chowmuhani, Fire Brigade Chowmuhani, Math Chowmuhani, and North Gate Chowmuhani—are located in densely populated commercial zones. These intersections experience heavy traffic flow throughout the day and frequent congestion during peak hours.

The rotary intersections—Battala Rotary, Post Office Chowmuhani Rotary, and Circuit House Rotary—are strategically located at important road junctions. Although traffic volume at these rotaries is comparable to or even higher than that at signalized intersections, traffic movement remains relatively smooth due to the absence of traffic signals.

The surrounding land use at most study locations includes commercial establishments, educational institutions, hospitals, and residential buildings, making noise exposure a significant concern for the local population.

Noise measurements were carried out at eight major intersections in Agartala city. Five signalized intersections—IGM Chowmuhani, Paradise Chowmuhani, Fire Brigade Chowmuhani, Math Chowmuhani, and North Gate Chowmuhani—were selected due to their high traffic volumes and commercial importance. Additionally, three rotary intersections—

Battala Rotary, Post Office Chowmuhani Rotary, and Circuit House Rotary—were chosen for comparison.

Traffic volume surveys were conducted simultaneously to understand vehicle flow characteristics at each location. Noise data were collected continuously for a period of 14 hours per day, from 6:00 AM to 10:00 PM, covering both peak and non-peak traffic conditions.

A calibrated sound level meter conforming to IEC 61672 Type II standards was used for noise measurement. The instrument was mounted on a tripod at a height of approximately 1.5 m above ground level and placed 3.0 m away from the edge of the carriageway. The microphone was oriented toward the traffic stream to ensure accurate capture of vehicular noise.

4. Methodology and Data Collection

Noise measurements were conducted using a precision sound level meter conforming to IEC 61672 Type II standards. The instrument was calibrated before and after each measurement session to ensure accuracy. The sound level meter was mounted on a tripod at a height of 2.0 m above ground level and placed 3.5 m from the pavement edge.

Noise monitoring was carried out for 15 hours per day, from 6:00 AM to 11:00 PM, covering both peak and off-peak traffic conditions. Measurements were recorded using A-weighting and slow response mode to capture fluctuating traffic noise.

Simultaneously, traffic volume surveys were conducted manually to record the number and types of vehicles passing through each intersection. Observations related to driver behavior, such as engine idling and horn usage, were also noted.

Equivalent continuous noise levels were computed from the recorded data to represent average exposure during daytime and nighttime periods.

Noise Measurement Principles and Standards :

Sound intensity is commonly expressed in decibels (dB), a logarithmic unit representing sound pressure levels. For environmental noise studies, A-weighted decibel levels [dB(A)] are used, as they closely represent the sensitivity of the human ear.

In India, ambient noise standards specify permissible noise limits based on land-use categories such as residential, commercial, industrial, and silence zones. Prolonged exposure to noise levels exceeding these limits can result in adverse physiological and psychological effects.

In this study, noise levels were recorded using both fast and slow response settings to capture variations in traffic flow. Equivalent continuous noise levels were computed to represent average exposure at each intersection during daytime and nighttime periods.

5. Noise Standards and Health Implications

Noise levels are measured in decibels, a logarithmic unit representing sound pressure levels. Prolonged exposure to high noise levels can result in hearing loss, cardiovascular stress, sleep disturbances, reduced concentration, and psychological discomfort.

According to Indian ambient noise standards, permissible noise limits for commercial areas are 66 dB(A) during daytime and 56 dB(A) during nighttime. Noise levels exceeding these limits pose serious health risks, particularly in densely populated urban areas.

In this study, observed noise levels at signalized intersections were found to exceed these limits by a significant margin, indicating a high level of environmental stress. Rotary intersections, on the other hand, generally complied with permissible standards.

6. Results of Noise Levels at different Intersections:

The analysis of noise data reveals that all five signalized intersections recorded noise levels above permissible limits. The average daytime noise level was 84.13 dB(A), while nighttime levels averaged 76.93 dB(A).

A bar chart showing average daytime and nighttime noise levels at each signalized intersection.

X-axis: Intersection name

Y-axis: Noise level (dB(A))

North Gate Chowmuhani recorded the highest noise levels, with peak values exceeding 108

INTERNATIONAL ADVANCE JOURNAL OF ENGINEERING, SCIENCE AND MANAGEMENT (IAJESM)
July-December 2023, Submitted in October 2023, iajesm2014@gmail.com, ISSN -2393-8048
Multidisciplinary Indexed/Peer Reviewed Journal. SJIF Impact Factor 2023 =6.753

dB(A). Field observations indicated excessive horn usage and prolonged vehicle idling as primary contributors.

Noise levels at rotary intersections were significantly lower than those at signalized intersections. Average daytime and nighttime noise levels were recorded as 63.4 dB(A) and 54 dB(A), respectively.

A comparative bar chart showing noise levels at rotary intersections during daytime and nighttime.

Despite handling high traffic volumes, rotary intersections maintained lower noise levels due to smoother traffic flow and reduced stoppage.

7. Traffic Noise Assessment at Urban Intersections – Agartala City

This document presents graphical representation of traffic noise levels measured at signalized and rotary intersections in Agartala city. The charts are prepared based on field data collected during daytime and nighttime.

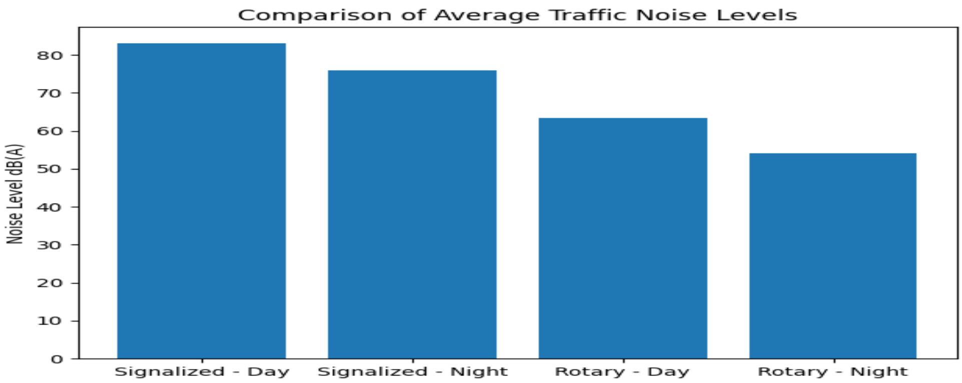

Figure 1 Comparison Between Signalized and Rotary Intersections

This figure 1 clearly demonstrates the **overall noise reduction** achieved by rotary intersections—

- **24.73% reduction during daytime**
- **29.88% reduction during nighttime**

A direct comparison between signalized and rotary intersections highlights the effectiveness of rotary intersections in reducing noise pollution.

A percentage reduction graph showing noise reduction at rotary intersections relative to signalized intersections for daytime and nighttime.

Noise reduction was observed to be approximately 24.73% during daytime and 29.88% during nighttime. This reduction can be attributed to continuous vehicle movement and reduced driver frustration

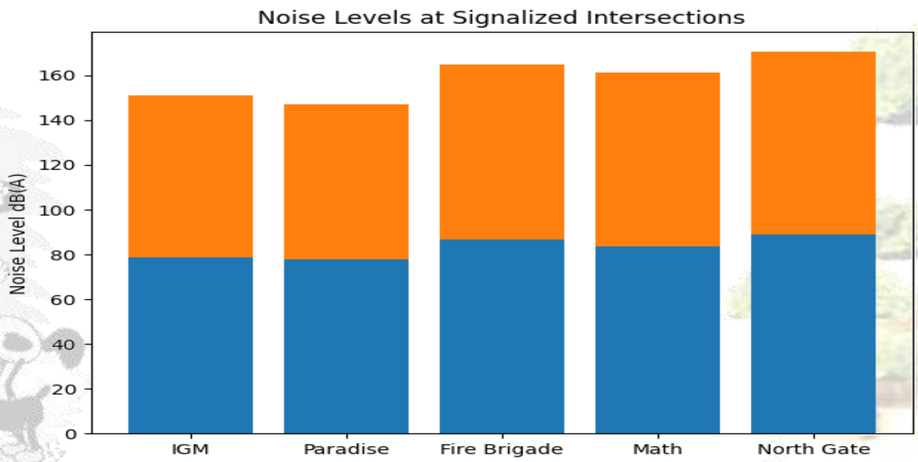

Figure 2: Average Noise Levels at Signalized Intersections

Figure 2 shows a bar chart representing the **average daytime and nighttime noise levels** at the five selected signalized intersections in Agartala city—IGM Chowmuhani, Paradise Chowmuhani, Fire Brigade Chowmuhani, Math Chowmuhani, and North Gate Chowmuhani.
Figure 2 illustrates the variation in average noise levels at major signalized intersections during daytime and nighttime periods. It is evident that all signalized intersections record noise levels significantly higher than the permissible limits for commercial areas. North Gate Chowmuhani exhibits the highest noise levels, with average values of 89.8 dB(A) during daytime and 83.0 dB(A) during nighttime. The elevated noise levels can be attributed to prolonged vehicle idling, frequent stopping, and excessive horn usage at signal-controlled junctions.

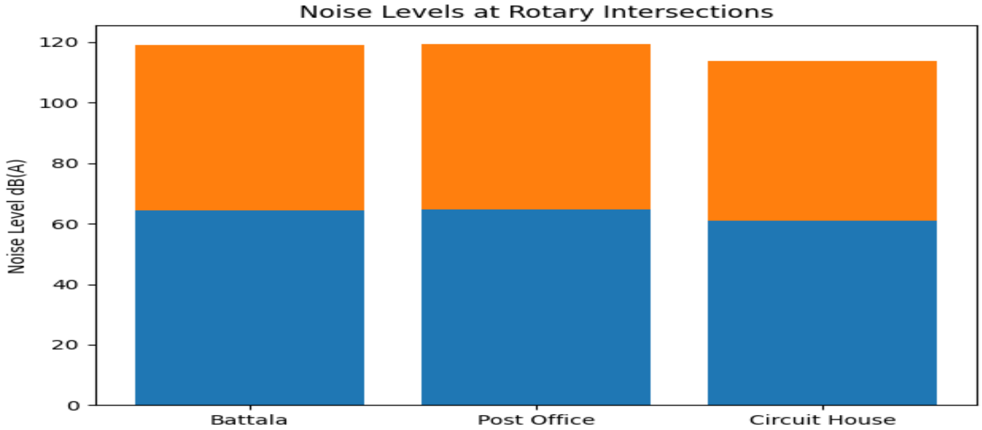

Figure 3: Average Noise Levels at Rotary Intersections

Figure 3 presents a bar chart showing the **average daytime and nighttime noise levels** at the three rotary intersections—Battala Rotary, Post Office Chowmuhani Rotary, and Circuit House Rotary.Figure 3 depicts the average noise levels observed at rotary intersections in Agartala city. Compared to signalized intersections, rotary intersections exhibit substantially lower noise levels during both daytime and nighttime. Circuit House Rotary records the lowest average noise levels, indicating the effectiveness of continuous traffic flow in reducing noise generation.

8.Analysis of Results

The analysis indicates that all selected signalized intersections recorded noise levels well above permissible limits. The average noise levels at signalized intersections were found to be 84.13 dB(A) during daytime and 76.93 dB(A) during nighttime. Among them, North Gate Chowmuhani emerged as the most critical location, with peak noise levels exceeding 108 dB(A).

Rotary intersections, on the other hand, exhibited substantially lower noise levels. The average daytime and nighttime noise levels at rotary intersections were 64.4 dB(A) and 55 dB(A), respectively, which fall within acceptable limits for commercial areas.

Field observations revealed that nearly all drivers at signalized intersections kept their engines running while waiting for clearance, and a large proportion frequently used horns without necessity. Such behavior was significantly reduced at rotary intersections due to smoother and more continuous traffic movement.

Despite handling comparable or higher traffic volumes, rotary intersections demonstrated a notable reduction in noise exposure—approximately 24.73% during daytime and 29.88% during nighttime—compared to signalized intersections.

9. Conclusions and Recommendations

The study confirms that signalized intersections are major contributors to urban traffic noise pollution. Rotary intersections demonstrate superior performance in controlling noise levels and improving environmental quality.

The following conclusions can be drawn from the study:

- Signalized intersections in Agartala city are major contributors to excessive traffic noise due to frequent stoppages, vehicle idling, and indiscriminate horn usage.
- Noise levels at all studied signalized intersections exceed Indian ambient noise standards during both daytime and nighttime.
- Rotary intersections maintain comparatively lower noise levels and largely comply with permissible noise limits.
- The reduction in noise levels at rotary intersections ranges from approximately 24% during the day to 29% at night.
- From an environmental and public health perspective, rotary intersections represent a more sustainable alternative to conventional signalized intersections in urban areas.

The study recommends greater adoption of rotary intersections in suitable urban locations as an effective strategy for mitigating traffic-related noise pollution.

Key conclusions:

- Signalized intersections exceed permissible noise limits
- Rotary intersections maintain noise within acceptable standards
- Driver behavior significantly influences noise generation
- Rotary intersections reduce noise exposure by up to 29%

Recommendations:

- Adoption of rotary intersections in suitable urban locations
- Public awareness campaigns to reduce horn usage
- Improved traffic management and signal coordination

References

1. Banik, B.K., Chowdhury, A.I., & Sarkar, S.K.A. (2009). Analysis of traffic congestion in urban road networks. *Journal of Indian Road Congress*, 70(1), 75–86.
2. Indian Road Congress (2002). *IRC:70 – Guidelines on Regulation and Control of Mixed Traffic in Urban Areas*.
3. Indian Road Congress (1990). *IRC:106 – Guidelines for Capacity of Urban Roads in Plain Areas*.
4. Khanna, S.K., & Justo, C.E.G. (2001). *Highway Engineering*. Neem Chand & Brothers.
5. Kadiyali, L.R. (2003). *Traffic Engineering and Transport Planning*. Khanna Publishers.
6. Mukherjee, A., & Mukherjee, G. (1998). Impact of automobile pollution on urban traffic personnel. *Man and Environment*, 19, 16–64.
7. Dhameja, S.K. (2008). *Environmental Studies*. S.K. Kataria & Sons.