

Assessment of Vehicular Noise Impact Along the Alignment of Rani Durgawati Setu (Elevated Corridor) In Jabalpur City

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Abstract

The current focus of urban environmental governance is on the traffic noise pollution caused by road transportation. Elevated roads, defined as transportation systems comprising elevated roads and underlying ground-level roads, exhibit unique traffic noise distribution characteristics due to the presence of double-decked roads. This study conducted noise measurements at 13 locations of elevated roads and at ground level road in Jabalpur, including assessing noise levels at the road boundaries and examining noise distribution at different distances. The results show change in noise level before and after the construction of Rani Durgawati Setu the newly inaugurated elevated road connecting two parts of the city spanning between Madan Mahal and Damohnaka over the total length of 7.25kms with 8 ramps for incoming and outgoing vehicles, the horizontal distance attenuation of noise in adjacent areas exhibits no significant difference from that of ground-level roads, but substantial discrepancies exist in vertical height distribution. The under-viaduct rotary space experiences more severe noise pollution than areas above the viaduct height, systematic noise mitigation strategies should be developed for elevated composite road systems. Additionally, the study reveals that nighttime noise fluctuations are significantly greater than those during the day, further exacerbating residents' noise annoyance.

Keywords: Noise pollution, Elevated roads, Double decked roads, Sound level, Noise annoyance

1.0 INTRODUCTION

Noise pollution has emerged as one of the most pressing environmental issues attributable to road traffic. Recent research in the field of modern medicine has unequivocally established that traffic noise originating from urban roads poses a substantial risk to human health. The primary threats associated with traffic noise include an increased risk of cardiovascular diseases, diabetes, and hypertension, as well as the development of depression, sleep disorders, and adverse effects on children's cognitive function. Furthermore, recent studies have also established a link between road traffic noise and the prevalence of obesity.

With the development of cities, the relentless expansion of road networks, aimed at accommodating the increasing volume of traffic, has led to a substantial increase in noise levels in many urban areas, severely disrupting residents' daily lives. Especially in densely populated cities, the high density of traffic and towering building patterns make traffic noise a potentially more significant disturbance for residents. Using three-dimensional technology and the ISO 9613-2 method, Brown et al. conducted a traffic noise

simulation across Hong Kong. The findings indicated that the percentage of the Hong Kong population exposed to noise levels exceeding 70 dB(A) was comparable to that in Europe. However, in comparison to European cities, a significantly higher percentage of the Hong Kong population was found to be exposed to noise levels between 60 dB(A) and 64 dB(A). Consequently, as the primary source of noise in urban areas, road traffic noise has attracted significant attention from city managers.

Accurate assessment of citizens' noise exposure is essential to inform evidence-based decision-making. To this end, countries including the European Union, the United Kingdom, the United States, China, and Germany have successively introduced noise prediction models. These models incorporate both emission and propagation modules, enabling researchers to leverage non-acoustic data to forecast the spatial distribution of road traffic noise. They have been validated for application in urban road networks, yet the noise sources of the validation datasets are predominantly from surface roads that are consistent with the road types utilized in model development. The study by Melo et al. proposes that the road noise prediction model is suitable for estimating urban roads with similar traffic characteristics and road layouts. In addition, the spatial structure of buildings in high-density cities also influences the propagation and distribution of noise. Huang et al. conducted field tests on noise in high-rise buildings along highways and discovered that the FHWA model underestimated the height of the maximum noise level on high-rise buildings compared to actual conditions. Therefore, conducting on-site tests for traffic noise in typical areas with special road types and exploring the distribution of noise, is significant for scientifically assessing the impact of traffic noise in high-density urban and designing noise reduction measures.

Elevated roads represent the primary form of urban transportation expansion aimed at enhancing traffic efficiency. In major cities, elevated roads are often constructed above ground-level roads parallel to their alignment, thus forming an elevated complex road system. The complex arrangement of double-story noise emission sources and viaducts gives rise to alterations in traffic noise propagation patterns. However, no studies have systematically addressed noise propagation in elevated complex road systems. Furthermore, noise barriers are effective noise reduction measures for elevated roads, but their application in elevated complex roads still lacks post-evaluation.

The main objective of this study is to investigate the impact of traffic noise generated by elevated complex roads Rani Durgawati Setu on the sound field distribution in adjacent areas through field tests and to assess the effectiveness of noise mitigation measures. Additionally, this study discusses the temporal variations in traffic noise during different periods of urban traffic operation. Through this study, we hope to offer valuable insights into noise monitoring assessment and reduction strategies for existing road structures of this kind, while also serving as a reference for the construction of elevated roads in other areas of city as a number of elevated roads are proposed in town, experiencing rapid growth in motor vehicle traffic and urban development.





2.0 STUDY AREA & LOCATION

Jabalpur is located at 79.56E longitude and 23.10N latitude district of Madhya Pradesh at an elevation of about 412 meters above mean sea level. The area of Jabalpur is 367 square kilometers approximately. Black and Mixed Black soils are found here which are quite rich in fertility. The area near Jabalpur is rich in mineral like marble. Jabalpur is situated in a bank region of river Narmada. Being in a state, which has depended on Road and Railway Transport for decades.

Jabalpur has a good connectivity to the other towns on the State with an average frequency through Road and Railways. Jabalpur city is connected with National Highways NH-30, NH-45 and SH-11 & SH-22 to the towns and cities of Madhya Pradesh.

A newly constructed flyover (RDS) inaugurated on 23rd of August 2025 designated as Rani Durgavati Setu the longest flyover bridge of MP total length 6.855 km (5.905+0.905) connecting two adjacent parts of the

city between Madan mahal (Dashmesh dwar) and Damohnaka carrying a high vehicular traffic of LMV, HMT, Two and Three vehicles’ has been selected for the study to identify and remedy the effect of noise pollution on human health and environment , as a number of elevated corridors are under consideration for the smooth traffic movement across the city the study aims at providing a frame work to take initiative towards reducing noise pollution often ignored which possess a serious health risk to the society

The analysis data was collected in the vicinity of elevated complex roads in Jabalpur. The city hosts a permanent resident population density of 482 individuals per square kilometre, with the Madhya Pradesh central urban area reaching a staggering 236 people per square kilometre. Alongside this dense population, Jabalpur has constructed an extensive network of roads. This robust road transportation system, coupled with the dense population distribution, has significantly increased the exposure risk of citizens to traffic noise.

In the urban core of Jabalpur, thirteen points on elevated road were selected as test areas. The selection criteria for the test area are as follows:

the primary noise source in the area is road noise generated by traffic flow on elevated roads, The ground-level road under the viaduct serves as a key arterial road. The rotary and intersection on ground level road accumulates traffic merging from all directions, serving as a vital link between districts and primarily fulfilling traffic functions.

Table1 Details of elevated corridor

	Description	Remark
1	Total length	6.855kms
2	Width	8.4mt side ramps 12.9mt main carriageway
3	Total cost of project	1055.49crore
4	Time period of construction	5years
5	Construction start date	05-05-2020 (main) 09-01-2023 (extension)
6	Benefiting population	Around 15lakhs
7	Time saving	It will reduce the time of travel from 60minutes to 6 minutes
8		Longest flyover of MP at present
		It houses an extra dome cable stay bridge over Madan mahal railway station 193.5mt long
		Only flyover in India with 2 elevated rotaries
9	Green features	50,000 plants have been planted below elevated complex
		Parks and sports area have been developed below it
10	Commissioning date	23-8-2025

3.0 AIM AND OBJECT OF STUDY

3.1 Aim

The aim of this study is to find out the impact of vehicular noise along the vicinity of Rani Durgawati Setu. In absence of RDS noise pollution in selected area was basically due to vehicular movement at ground level road. After the commissioning of RDS the vehicular traffic has been diverted and further channelised to provide ease in movement. Thereby the necessity of measuring noise level along RDS alignment arose. Accordingly, the noise pollution was measured on selected points along the alignment of RDS at ground level road as well as just above it on Elevated corridor and impact on noise pollution was assessed.

3.2 Object of the study

- To study the pattern of noise due to vehicles on elevated corridor
- To find out level of noise on elevated corridor and ground level road and their comparison w.r.t before commissioning of elevated road
- To find out difference in day and night noise level
- To assess the stations with least and most impacted by noise
- To find out change in noise level as compared to standard permissible level of noise permitted for residential and commercial areas.
- The paper also takes into account the environmental noise as it is not possible to distinguish vehicular noise with environmental noise with ordinary measuring devices.

4.0 METHODOLOGY:-

4.1 Selection of sampling station

The sampling stations were selected on basis of heavy traffic movement areas and landings of elevated corridor a total of 13 locations were selected to collect samples on elevated corridor and 13 stations at ground level road were marked the points comprised of locations hosting high traffic merging from no. of directions, commercial area, residential areas.

Station 1 – Madan mahal

Station 2 – cable stay bridge (CSB)

Station 3 – Ranita

Station 4 – Baldeobagh

Station 5- Damohnaka

All the 8 landings of flyover used for incoming and outgoing traffic were selected for study.

Landing 1 – Mahanadda ramp

Landing 2- Gulati petrol pump Ramp

Landing 3 – Madan Mahal railway station Ramp

Landing 4- Sneh Nagar Link-road

Landing 5- towards Malviya chowk (Adv. Jamunalal Bajaj chowk)

Landing 6- Towards Yadav Colony

Landing 7- Gohalpur ramp

Landing 8- Damohnaka ramp

4.2 Measuring instrument

A sound level meter is a fundamental requirement for measuring the noise level it is designed to estimate the sensitivity level of loudness for the human ear and gives the desired, reproducible measurement for the sound pressure level. to determine the frequency range spectral weighting of sound, along with the

function of time constants, and computation of the equivalent continuous level the sound level meter does more complex work. it consists of a microphone which acts as a transducer to convert the sound into its equivalent electrical signal. the magnitude of the electrical signal is small which comes out of the microphone and then this low electrical signal is amplified by a pre amplifier and output of which is connected to a frequency weighing network “A” or “C” and the output of filter is again amplified and is then given to an microcontroller which has an analog to digital converter which converts the analog signal to digital and then the output is given to an averaging system for data storage facility and then we have display unit which display the desired noise level digitally

The sound level meter was held at a height of 1.2mt-1.5mt above ground level as suggested by pollution control board. the SLM100 sound level meter has been designed for ease in field operation. all features considered essential for field surveys have been included. the SLM100 is a type 2 integrating sound level meter designed to meet the requirements of IS 15575 (part1) 2005. the A network largely filters out very low and very high frequencies below about 200hz and above about 10000hz. the instrument has a frequency weighing of “A” type and allows the user to select slow or fast mode measurement

Simple to operate instrument gives reading of sound pressure level (SPL) LEQ and SEL on a digital display.



5.0 EQUATIONS

5.1 Equivalent Continuous Sound Level (Leq) Calculator

- Description: Calculates the equivalent continuous sound level (Leq) over a period based on fluctuating noise levels.

- Formula:

$$L_{eq} = 10 \log_{10} \left(\frac{1}{n} \sum_{i=1}^n 10^{L_i/10} \right)$$

Where:

- Li: Individual noise levels (dB)

- n: Number of samples
Equivalent Continuous Sound Level (Leq) Calculator

Calculate the equivalent continuous sound level (Leq) based on fluctuating noise levels.

Enter Noise Levels (dB, separated by commas): Calculate

Equivalent Continuous Sound Level (Leq): — dB

6.0 Conclusion

The flyover has efficiently serving its purpose (acted as a means of travelling) connecting two parts of the city the demand of developing an alternate route/alignment to diverge the traffic of city was under demand/consideration from a long time but it has also to be kept in mind to control environmental pollution and follow guidelines and laws prescribed by CPCB and WHO, as noise pollution is often ignored but it is a major source affecting the health of citizens

Alternatively it can be said that the bridge has reduced the burden of traffic on the existing alignments/roads of the city (Radi chowki-Ghamapur chowk-high court-collectorate-Russel chowk-shastri bridge)which were under use from a long time giving relief to the citizens of core area of the city majority of vehicles which need to cross the city via Adhaar-Taal to Madan mahal need not to enter the city anymore reducing the vehicular noise pollution as air quality of inner city circle.

It was observed that despite (change/division) divided volume of traffic as previously all the vehicles took ground level road no such change in noise level was observed rather the traffic was divided into elevated corridor and ground level road at rotaries the noise level was found to be higher and annoying majorly as the sound echoed due to massive concrete structure whereas under the carriageway the effect of reverberation was limited and the noise level was also similar prior to the commissioning of flyover

The object of the study was to find out the change in vehicular noise pattern after the start of elevated corridor (RDS) by considering 5 intersection points below and above the EC and considering all 8 landings, the data was compared to the standards given by CPCB

A no. of hospitals and educational institutions are situated near to this area study must also be conducted to know about its impact for further use in upcoming flyover projects

On elevated corridor noise from vehicles dispersed in environment due to presence of open areas and trees further study has to be carried out to access the impact of noise on residents living close to flyover.

8.0 Suggestions

- Sharp landings near railway station should be aligned
- Measures should be adopted near Ramp 5 landing for smooth movement of traffic as ramp of flyover is near to road intersection and volume of traffic is quiet high at this point causing traffic congestion also speed of vehicles should be minimized
- Barrier walls should be installed at points to provide privacy to nearby residents as incidence of hinderance have been observed vertical garden concept could be adopted a low-cost measure
- A number of hospitals lie close to flyover acoustic wall and sound insulators in window and front walls could be used to provide sound proof environment
- Reverberation of sound was observed at rotary and ducts
- It was observed that noise generated under the rotary was higher as compared to open areas
- Sound level on EC was low as compared to existing road
- On flyover proper sign indications

- Vehicles entering and existing from wrong sides should be prohibited
- Curtain / barrier walls should be installed on flyover to clinch the privacy of nearby residents
- Some ramps (railway station end up on turns) creating accidental points
- The time taken to travel from Madan mahal to Damohnaka has been reduced to around 7 minutes with vehicles running at a constant speed without any obstruction reducing the travel time and fuel usage and less emission from engines
- Turning should be geometrically well designed
- It was observed that no certain change in noise level occurred below the rotary (Madan mahal, Ranital, Damohnaka, station 1,3,5). due to reverberation of sound the noise level was high (Madan Mahal, Ranital, Damohnaka, station 1,3,5)
- below cable stay bridge other factor contributing to noise level is sound of railway engines and wagons due to Madan mahal railway station

9.0 Result

Comparing 15 days leq readings to which station has maximum noise level

	Leq after completion				Leq before completion	
	Day		Night		Day	Night
Location	EC	GLR	EC	GLR	GLR	GLR
STATION 1	83.6	82.5	56.7	60.0	86.4	61.5
STATION 2	84.3	83.3	60.8	59.7	84.9	62.3
STATION 3	87.1	85.4	58.7	59.1	87.5	65.4
STATION 4	83.8	84.6	56.1	58.7	87.0	63.7
STATION 5	86.5	88.1	53.6	55.6	89.2	66.1

	Day	Night	Standard residential		Standard commercial	
			Day	Night	Day	Night
LANDING 1	84.8	53.6	55	45	65	55
LANDING 2	85.2	58.3	55	45	65	55
LANDING 3	79.4	52.8	55	45	65	55
LANDING 4	77.3	50.9	55	45	65	55

LANDING 5	87.1	51.7	55	45	65	55
LANDING 6	82.5	52.3	55	45	65	55
LANDING 7	86.0	52.1	55	45	65	55
LANDING 8	84.4	51.9	55	45	65	55

10.0 Summary of study

The findings of the study tell us that maximum amount of noise level was observed at station 5 followed by station 3 and station 1 all the three stations correspond to rotary intersections which accumulates to high noise levels at these areas,

At landings the maximum level was observed at landing 7,8,1 and 2 as these are the main ramps at the starting and end flyover situated near commercial areas while landing 1,2,8 directly guides the traffic to national highways across the city NH -30 , at ramps 7 and 8 due to ISBT, Krishi upaj mandi and presence of a narrow culvert the traffic is high here resulting in considerable amount of noise pollution

Ramps 2 and 3 situated near cable stay bridge are used only for one way traffic housing low volume of vehicles

Due to the presence of small rotary vary close to ramp no. 5 the traffic is high engine noise and honking Comparing the noise level before and after the construction of elevated corridor it can be concluded that there has been any elaborate change in noise level as the dB(A) values do not differ much but it can be said that the number of vehicles using the ground level road and elevated corridor has divided the volume of traffic in two levels due to which a feasible environment w.r.t continuous noise emission from vehicles and nearby residents has been generated.

It was observed that the level of noise was more than 75dB(A) at all the study locations which is more than the permitted noise level for residential 55dB(A) and commercial 65 dB(A) in day conditions and similarly for night the noise level was observed more than 55 dB(A) at maximum no. of locations which is more than permitted level 45dB(A) and 55dB(A) for night, as the no. of vehicles at night is very less as compared to day time hence the effect of noise pollution is low measures must be taken to manage noise pollution.

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