RESEARCH PAPER

Pollution Resulting from Noise Produced by Different Sources and Measures for Attenuation using Bla Concrete Barrier

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ABSTRACT
Contemporary society faces three critical challenges that threaten the survival of current and future generations: population growth, poverty, and pollution. These issues have emerged as consequences of modern living standards, industrialization, and rapid urbanization. Without immediate intervention, humanity faces an uncertain and deteriorating future.

Urban noise pollution has become a prevalent concern, with citizens frequently voicing complaints about excessive noise levels in metropolitan areas. The primary culprits identified include commercial vehicles and two-, three-, and four-wheelers, which significantly contribute to elevated background noise levels. Additionally, loudspeakers used during special occasions such as holidays, weddings, and birthday celebrations create substantial disturbances to public peace through excessive noise generation.

This study investigates environmental noise levels at 12 strategically selected locations, including construction zones (boring and vibrator operations), pedestrian areas, national highways, hospital surroundings, and river beds. Noise parameters such as Leq, L10, L50, L90, Lmin, Lmax, Lave, and Lnp were recorded using a calibrated noise level meter and compared with the regulatory limits defined by the Central Pollution Control Board (LCPCB).

The results reveal that boring operation points (P1 and P2) recorded the highest Leq values of 119.94 dB and 113.95 dB, exceeding the 75 dB standard by over 50%, with Lnp values crossing 150 dB, indicating high peak noise levels. National highway locations (P7 and P8) also showed elevated noise with Leq values of 87.57 dB and 85.29 dB, exceeding the standard by 59.22% and 31.22%, respectively.

Pedestrian and hospital zones, although quieter, still registered Leq values between 64–68 dB, which is 25–36% higher than the permissible 50 dB, raising concern for vulnerable populations. Only the river bed sites (P11 and P12) remained within a relatively acceptable range, with Leq values around 58 dB, slightly exceeding the threshold but with minimal Lnp variation. Overall, the analysis emphasizes the urgent need for noise mitigation strategies, particularly in construction and high-traffic areas, and advocates for continuous monitoring in sensitive zones such as hospitals and residential regions.

The paper reports that during traffic data recording, the equivalent continuous noise level (Leq) measured 103.2 dBA and 92.23 dBA at the respective locations. Following the installation of barriers constructed from concrete blocks with partial replacement of cement by Bamboo Leaf Ash (BLA), these levels decreased significantly to 70.09 dBA and 79.11 dBA, respectively. This outcome highlights the effective role of these barriers in reducing noise levels.

Keywords: Erection noise, Noise Pollution, Noise Barrier, Noise Reduction, Bamboo Leaf Ash(BLA).

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INTRODUCTION

Pollution – Noise

The word *noise* originates from the Latin term for *nausea* and is generally described as an undesirable or disruptive sound. And it is considered a potential threat to health as well as an environmental communication hazard due to its negative effects on those exposed to it involuntarily. In essence, noise refers to any sound that is undesirable or disturbing.

Although music is a type of sound that provides enjoyment to listeners, noise is typically associated with discomfort and annoyance. The line between music and noise is often subjective—what one individual considers music may be perceived as noise by someone else.

Sound itself is a form of energy created by vibrating objects. These vibrations travel through a medium and, upon reaching the ear, stimulate the auditory nerves, enabling the sensation of hearing. Yet, not every vibration produces sounds that humans can detect. The normal audible frequency range for humans extends from 20 Hz to 20,000 Hz.

Encyclopedia Britannica defines noise in the context of acoustics as any unwanted sound. We can further clarifies the distinction between "noise" and "noise pollution." While noise is described as any sound, especially one that is harsh or unpleasant, noise pollution refers specifically to excessive or bothersome levels of noise in a particular area—such as that produced by traffic or aircraft engines—which can adversely affect the environment and public health.(6,7).

Sources of Noise Pollution

Similar to other types of pollution, noise pollution is primarily a consequence of modern development, urban growth, and industrial activities. Broadly, its sources can be divided into two major categories: industrial and non-industrial.

i) Industrial Sources: Industrial noise pollution originates from factories, manufacturing plants, and large machinery operating at high speeds and noise intensities. Common sources include heavy machinery and equipment, Generators and compressors, Industrial processes such as metal fabrication, textile production, and construction activities
ii) Non-Industrial Sources: Non-industrial noise pollution primarily arises from transportation and other urban activities. Key sources include road traffic - Cars, buses, motorcycles, and trucks are major contributors to urban noise. Aircraft, airports and flight paths generate significant noise, especially near residential areas.Railways - Trains and railway stations contribute to noise pollution, particularly in densely populated regions.Construction activities, building construction, demolition, and roadworks are frequent sources of high noise levels. Consumer products, household appliances, lawn mowers, and entertainment devices add to background noise in residential areas.
iii) Natural vs. Artificial Sources: Noise pollution can also be categorized as natural or artificial sources. Natural Sources are thunderstorms, earthquakes, and volcanic eruptions produce natural noise, but these are typically less frequent and less impactful than human-made sources. Artificial Sources most noise pollution in urban environments is generated by human activities, as outlined above.
iv) Construction: *Construction and demolition works are inherently noisy and often take place in otherwise quiet areas such as residential neighbourhoods. Even when temporary, the noise and disturbances generated can significantly impact the comfort and well-being of both residents and workers nearby.*

To mitigate these effects, local authorities are granted powers under various legislative measures to regulate construction-related noise. For instance, in the United Kingdom, the *Control of Pollution Act 1974* and the *Environmental Protection Act 1990* authorize councils to address noise and other nuisances caused by contractors and subcontractors. If informal discussions fail to resolve the issue, councils may impose restrictions—such as limiting working hours, requiring quieter machinery or noise-control techniques, and mandating specific noise-reduction measures.

Such regulations aim to reduce the adverse effects of construction noise on surrounding communities while allowing essential development to move forward without compromising public health or overall quality of life.

Effects of Noise Pollution

Although noise pollution is often a gradual and less noticeable threat, efforts to address it have been limited. Like other types of pollution, noise pollution significantly impacts quality of life. Even at low levels, it can negatively affect human health. Noise pollution may contribute to hypertension, disturb sleep patterns, and impair cognitive development in children. In severe cases, prolonged exposure to high noise levels can result in permanent memory loss or even lead to psychiatric disorders.

Adverse Effects of Noise Pollution on Human Health / Vegetation / Animals / Property

i) Reduced Efficiency – Exposure to noise can lower an individual's work performance and overall effectiveness.
ii) Impaired Concentration – Continuous noise makes it challenging to focus, resulting in reduced productivity.
iii) Fatigue – Prolonged noise exposure can lead to both mental and physical exhaustion.
iv) Hypertension – High noise levels are associated with increased blood pressure.
v) Hearing Impairment – Loud noises can cause temporary or permanent hearing loss.
vi) Sleep Disruption – Noise can interfere with normal sleep patterns, contributing to insomnia and related health problems.
vii) Psychological Effects – Long-term exposure to noise may trigger stress, anxiety, and in severe cases, psychiatric disorders.
viii) Poor Crop Quality - Excessive noise can negatively affect plant growth and reduce crop yields.

ix) Nervous System Impact - Noise pollution can disturb the nervous system of animals, causing them to lose control and become aggressive or disoriented.
x) Structural Damage - Intense sound waves can create vibrations that weaken the structural integrity of buildings, potentially leading to damage over time.

Noise Pollution Control Rule
There are certain guide lines containing information and procedures for noise control on 2000 under Environment Protection Act 1996 and are presented in Table-1 and in Table-2.

Table-1: Standard Values Issued By Ministry of Environment and Forests (MOEF)

Category	Typical Limiting Value (dB(A))	Remarks
(a) Window Air Conditioners (1 to 1.5 tonne)	55–60	Measured at 1 meter from appliance; indoors
(b) Air Coolers	50–55	Indoor units; noise level depends on fan speed
(c) Refrigerators	40–45	Standard domestic refrigerators
(d) Diesel Generators (domestic use)	75–80	Measured at 1 meter; may vary with capacity
(e) Construction Equipment:		Noise measured at ~15 m from source
• Compactors (rollers)	75–80	Varies with type and operating conditions
• Front Loaders	75–85	Heavy machinery; temporary exposure limits
• Concrete Mixers	75–85	Continuous operation may require hearing protection
• Cranes (movable)	75–80	Depends on lifting operation and engine type
• Vibrators	85–90	Typically short-term use; high noise peak
• Saws	85–90	Hand-held or industrial; use PPE recommended

Table-2: Liming Value Specified by Central Pollution Control Board (CPCB)

Area/Zone	Day Time (6:00 AM to 10:00 PM)	Night Time (10:00 PM to 6:00 AM)
Industrial Area	75 dB(A) Leq	70 dB(A) Leq
Commercial Area	65 dB(A) Leq	55 dB(A) Leq
Residential Area	55 dB(A) Leq	45 dB(A) Leq
Silence Zone	50 dB(A) Leq	40 dB(A) Leq

CONTROL OF NOISE POLLUTION
Most of our daily activities contribute to the generation of noise. The healthy human ear responds to different sound pressure levels (SPL) as follows: the hearing threshold is at 0 dB, sounds become uncomfortable at 100–120 dB, and pain is experienced at 130–140 dB. Noise should be managed because of the numerous negative effects it has on both people and the environment. The degree of noise reduction needed, the type of equipment being used, and the cost-effectiveness of the various methods will determine which technique—or combination of techniques—should be utilized for noise management.

Figure-1 shows the different processes that make up the noise control technique. Noise management strategies not only involve the use of personal hearing protection and engineered controls to reduce noise at its source or redirect sound waves, but also include limiting the duration of exposure and separating affected individuals or species from the noise sources.

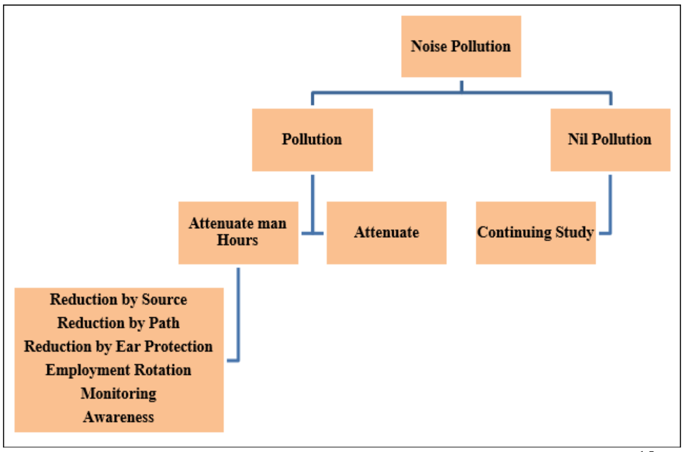

Fig-1: Noise Control Strategy in Hierarchical Manner[15]

MATERIALS AND METHODOLOGY

Need for barriers

It is crucial to employ methods that reduce noise either at the roadside or directly at the source. Various strategies are available for mitigating sound, which can generally be categorized as either passive or active methods. Active noise control techniques use external energy to minimize sound, while passive methods rely on materials that absorb or dampen noise. These passive materials reduce noise by dissipating acoustic energy and converting it into heat.

Noise barrier provided

The noise barrier was installed as a rectangular hut measuring 1mX1mX0.6m along the roadside. Figure 2 illustrates a noise barrier, showing a concrete shed built using both conventional concrete and Bamboo Leaf Ash (BLA) concrete, constructed along National Highway P-7 Double Road, Shanthinagara. The recorded noise pollution levels and associated details are presented in Table-3.

Figure-2: Noise Barriers as a Hut constructed at National Highway P-7 Double road Shanthinagara, Bengaluru

Table-3: Details of Traffic Noise Pollution Recorded

Sl. No	Location	Type of Description and Duration - 2 Hrs.	
1	National Highway P-7 Double road Shanthinagara	P7/1	Open place
		P7/1-1	Hut - M30 mix concrete
		P7/1-2	Hut - M30 mix concrete with BLA
2		P8/1	Open place
		P8/1-1	Hut - M30 mix concrete
		P8/1-2	Hut - M30 mix concrete with BLA

The survey data were compared with the noise level standards set by the Central Pollution Control Board (CPCB) and are presented in Figure 3 for both locations.

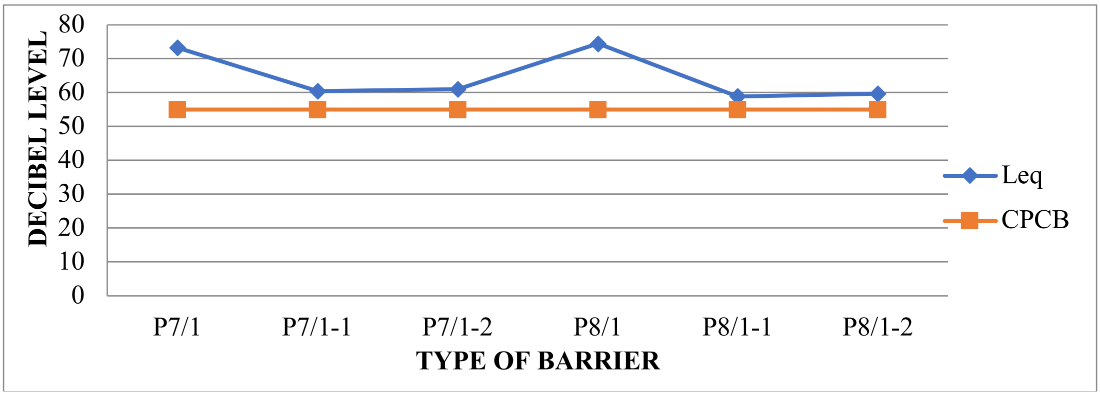

Fig-3: L-equivalent and CPCB values collected from the barrier constructed Location

Study Location / Data Observed

The noise from various building activities, foot traffic, and train noise close to train stations are the main topics of the current study. Both mechanical and human factors are taken into account when selecting the study area. Table-4 lists the many causes of noise pollution along with the number of hours that each source produces noise.

Table-4: Location and data collected

Sl. No.	Place nos	Description of Location	Time Duration
1	P-1 to P-2	Boring of pile operation drilling, casing and concreting)	3 hrs @ two points
2	P-3 to P-4	Needle vibrator while concreting	45mins @ two points
3	P-5 to P-6	Walkers location	6 hrs @ two days
4	P-7 to P-8	National highway (traffic location)	6 hrs @ two days
5	P-9 to P-10	Hospital	6 hrs @ two days
6	P-11 to P-12	Near River Bed	6 hrs @ two days

PARAMETERS CALCULATED FROM PRIMARY SURVEY

Noise parameters, including the equivalent noise level and the noise pollution level, were determined from the primary survey and are presented in Figure 4. The parameters L_{10}, L_{50}, and L_{90} represent the noise levels exceeded for 10%, 50%, and 90% of the measurement period, respectively. Other calculated values include L_{eq}, L_{np}, L_{min}, L_{max}, and L_{ave}, which provide a comprehensive characterization of the recorded noise.

$L_{eq} = L_{50} + (L_{10} - L_{90})^2/60$

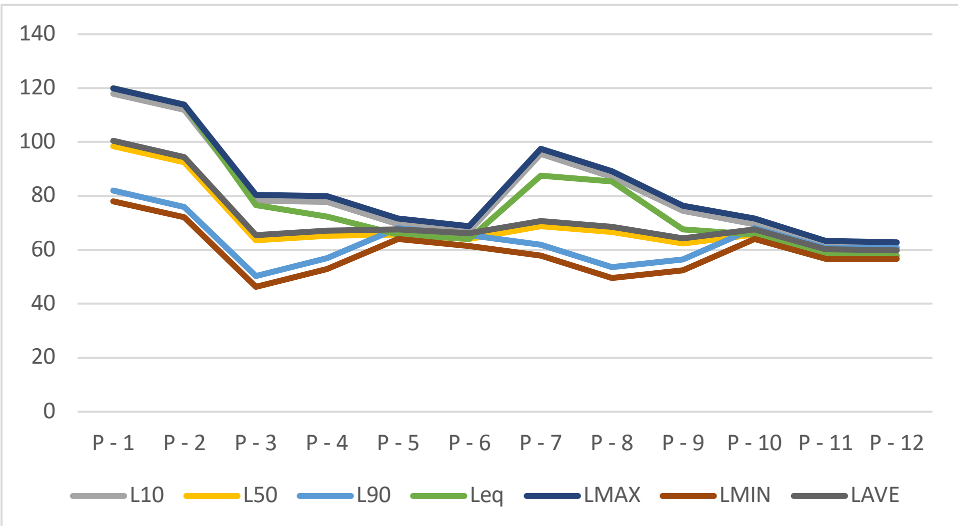

Fig-4: Comparison of Noise Parameters at all locations

Observations:

Boring Operations (Points P1 & P2) extremely high Leq values were recorded: 119.94 dB (P1) and 113.95 dB (P2).L10 values at both locations were above 110 dB, indicating frequent exposure to very loud noise.The difference between L10 and L90 was large (>30 dB), implying significant fluctuation and high peak events.Lnp values crossed 150 dB, the highest among all locations.

Vibrator Operation (Points P3 & P4) Leq values were moderate: 76.55 dB (P3) and 72.42 dB (P4).P3 marginally exceeded the LCPCB limit (75 dB).Lnp values were considerably higher than Leq due to a large spread between L10 and L90, indicating burst noise during operation.

Walker Locations (Points P5 & P6) Leq levels were 65.66 dB and 64.10 dB, respectively.Although these values are lower than those recorded at mechanical operation points, they still exceeded the LCPCB threshold for pedestrian areas (50 dB).Noise variation was minimal (L10–L90 difference <5 dB), indicating a steady but elevated background noise.

National Highway (Points P7 & P8) High Leq values were observed: 87.57 dB (P7) and 85.29 dB (P8).L10 values crossed 95 dB, suggesting regular vehicle horn bursts or engine roars.Lnp values were among the highest, reflecting constant high-peak events due to traffic flow.

Hospital Area (Points P9 & P10) Leq values were 67.66 dB and 65.66 dB respectively.Although not as high as industrial zones, these values are excessive for hospital environments.The difference between L10 and L90 was moderate, indicating both steady and short-lived noise disturbances.

River Bed (Points P11 & P12)- These were the quietest locations measured.Leq was around 58 dB, only slightly exceeding the 50 dB standard.Minimal fluctuation was observed in L10–L90 range, indicating a consistently low noise environment.

RESULTS AND DISCUSSION

The results are compared with the standards outlined in Tables 1 and 2, and are shown in Figure 2. The boring operations (P1 & P2) exhibit the highest noise levels, exceeding the LCPCB standard by over 50%, and pose a serious noise pollution concern. The Leq values at vibrator operation sites (P3 & P4) show moderate exceedance, but Lnp indicates substantial short-term peaks, suggesting the need for operational noise control.

Pedestrian (walker) areas (P5 & P6) record Leq values about 28–31% above the standard, necessitating barriers or quiet zone enforcement.National highway points (P7 & P8) demonstrate a major exceedance, with Leq values 31–59% over the limit and Lnp values indicating extreme fluctuations from vehicle traffic.

Hospital area readings (P9 & P10) surpass the recommended noise limits by over 30%, which is undesirable for a sensitive zone, affecting both patients and staff well-being.River bed locations (P11 & P12) are within acceptable acoustic conditions, with Leq and Lnp levels only 15–17% above the standard, indicating a low-risk environment.

At every area, the noise level is higher than what the appropriate authorities have recommended. The noise limit is exceeded even by the Lmin value itself. This demonstrates that noise pollution is a major problem everywhere. According to the CPB, the exposure duration for Leq for the machinery is only five minutes; nevertheless, the data indicate that the exposure time exceeds this restriction. The noise intensity at pedestrian places ranges from 60 to 110 decibels. The noise level at the railroad crossing is between 45 and 110 decibels. The aforementioned conclusion indicates that noise pollution is a major issue from all angles.

The measured noise levels were compared against CPCB standards, with all limits illustrated in Figure 3. The results demonstrate a notable decrease in noise levels following the application of noise control measures.

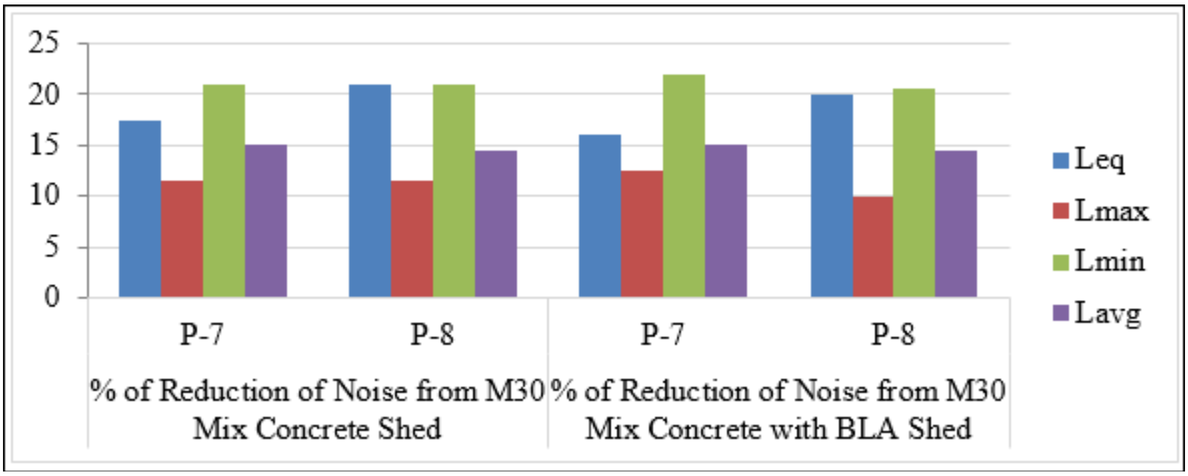

Figure-5: Details of Noise Reduction at both locations

Figure-5: illustrates the extent of noise reduction achieved, while the data show that noise pollution levels are up to 50% higher than CPCB guidelines when no barrier is present.

The equivalent noise level (Leq) recorded in 2024 was 73.3 dBA, which increased to 105.10 dBA at Location-1 and 91.10 dBA at Location-2 in 2025. Inside the work areas at

Location-1, noise levels ranged from 70.09 dBA to 74.11 dBA, while at Location-2, levels were between 79.11 dBA and 79.64 dBA. The decreases in noise levels within the workspaces are summarized in Table-3. In general, the daily rise in noise is associated with the increasing traffic volume on the road. An analysis of the CPCB standards further indicates that noise levels are increasing at an approximate rate of 17.25 dBA.

Both conventional concrete and BLA concrete show that noise barriers can be installed as precast units along roadsides. Although the study used a concrete shed, there is minimal loss in sound reflection because the structure is composed of plain concrete.

Table-5: Noise Drop levels at both places

	Reduction of noise level in decibels			
Type of Shed	**Conventional Concrete**		**BLA Concrete**	
Location	Location-1	Location-2	Location-1	Location-2
Leq	13.95	13.23	12.11	10.67

The reductions shown in Table-5 indicates that noise levels decrease by approximately 10.67 to 13.95 dBA when noise barriers are installed around work areas. The BLA concrete provides a noise reduction of 16.64%, which is comparable to that achieved by ordinary concrete. Using concrete sheds as barriers demonstrates a significant potential for noise level reduction. Additionally, BLA concrete offers an equivalent reduction in noise compared to traditional concrete but allows for a notable decrease in the amount of concrete used, as BLA acts as a partial replacement. This results in cost savings compared to conventional concrete, making BLA a viable alternative material, especially considering the daily increase in concrete and cement prices. The selected area is a suitable location for barrier installation due to its highly congested nature.

CONCLUSION

Everyone contributes to noise pollution, often unknowingly, as most daily human activities generate some level of noise. Despite being frequently overlooked, noise pollution has harmful effects, including irritation, reduced concentration, and even hearing impairment. Identifying and evaluating the primary sources of elevated noise levels is essential for effective mitigation.

A noise level study conducted at two key traffic zone points revealed alarming environmental and public health concerns. In particular, locations near national highways (P7 and P8) recorded Leq values as high as 87.57 dB—exceeding permissible limits by 59%. Lnp values further indicated extreme peak noise levels, confirming the severe impact of vehicular traffic. Immediate interventions such as noise barriers, speed controls, and horn regulations are imperative.

To mitigate such noise, initial attempts focused on basic noise control measures, resulting in only marginal improvements. However, a more scientific approach was adopted through the construction of noise barriers and structural elements made from concrete in which cement was partially replaced with Bamboo Leaf Ash (BLA). These BLA concrete structures demonstrated a notable reduction in noise transmission compared to conventional concrete, owing to their improved acoustic insulation properties. This indicates that incorporating BLA into structural concrete not only promotes sustainability but also enhances noise mitigation, aligning with statutory exposure limits and improving environmental quality.

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