

## **Creating pathways to reduce noise pollution in facilitative innovation approaches, leads to entire road traffic pollution abatement**

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**Abstract:** *Measures to prevent noise as a pollution variant have been a long-past attempt in better road-life creation. There are attempts like noise barriers which can mitigate an area (surrounding) to be out of such pollution. But those certainly do not much care about on-the-road existence of the pollution itself. This study has taken care of this segment of discussion that there must be variety of creations possible enough to reduce noise levels on along the road & also that could make free the road's surrounding areas from sound or noise pollution. The study has opened up interesting insights of engineering & science in collaboration with arts & philosophy. However with the basic objective fulfillment the study has achieved the realization to enhance to get to the platform of zero noise-level benchmark on the vehicular activities to provide on all along as long the traffic noises could go away & reach on by its effect. Several new approaches are hereby expected on the learning outcome of the study as well.*

**Keywords:** Amplitude, Sound power, Noise pollution, Bent noise wall, Curve wall, Sound absorption material, Laser application, Source-location re-structuring.

### **INTRODUCTION**

Road-level noise pollution is everyday problem & its pollution (noise) to the surrounding places is a grievous one. Exposure to sound pollution increases energy impacts on all its objects of impaction. Though it is a fact that various initiatives like (road-side tree plantation, sound-proofing measures on vehicles, buildings etc.) impose the alarming pain-points of noise pollution, coming out as health hazard or energy impaction factor to human/human civilization. Figure 1 gives an idea to how to create a noise-pollution reduction system along the road-side environment – it could also facilitate the ambience to cause to particulate/gaseous pollution reduction. Figure 2 & Figure 3 encourages innovation-making ideas to make roads well up to a level of low-level noise pollution that could be a tolerant one to ‘comfortable’ human senses. In order to do this all, all taken-part members (like vehicle, road quality, surrounding situation, etc.) to the noise pollutions should be graded accordingly. Figure 4 shows like the one.

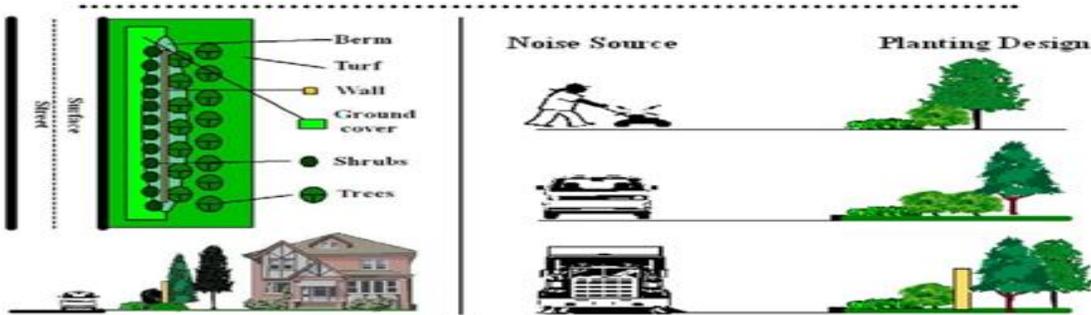


Figure 1: Tree plantation to reduce noise pollution (Source: Web)



Figure 2: Sound-proofing shed & architecture (Source: Web)

**The global experience in using low-noise road surfaces: A benchmark report**



Figure 3: Noise-controlled road by speed level etc.

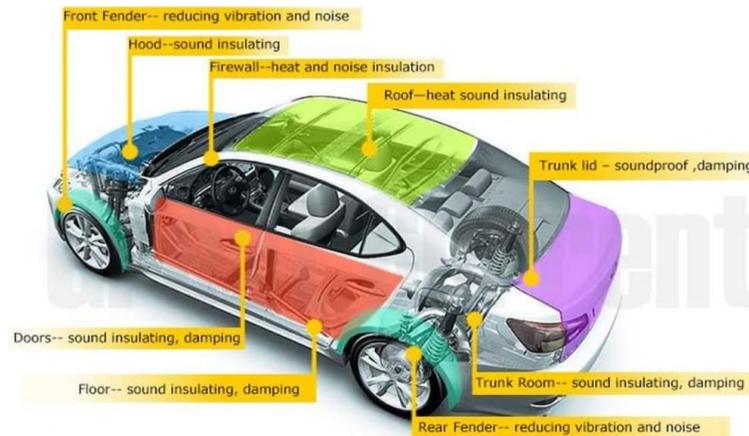


Figure 4: Sound-proofing parts in a car (Source: Web)

In this study, the main target to achieve is mitigating noise pollution or sound pollution effects. With an aim<sup>(1)</sup> of finding something as innovative as the solution-maker to the pollution, several Innovative measures have been described. Those are not only to reduce the pollution especially but also that shall be able to attract & remove out other pollutions (like particulates, various gases, etc.) from ambient air medium. Implementation of technology has also taken its position to the

required place in the innovation. This study has shown a prospect to construct a future city constituting with zero-pollution level on vehicular emissions plying on road. The innovations shall lead to transformation of a city's noisy road situations into noise-free road activities by its vehicles.

The concept of the innovation is a fundamental proposition<sup>(2,3)</sup> with the aim of building road-traffic's noises to bring into free of noise pollution to people/Infrastructural structures surrounding the road and the road length itself. By this innovation, as a whole, it would be possible to bring down noise pollution of roads (like national highways, state highways, grand trunk roads, etc.) to zero-level of noise (sound level). Being having such reduction, people availing & surrounding a road would become 'free of noise-hazards'<sup>(4)</sup> from roads' noise pollutions of variety of amplitude. Such innovation should provide benefit to specially care zone like school, hospital, old-age homes, sanity places, etc.<sup>(5)</sup> Besides it, the innovation proclaims to remove out particulate & gaseous pollutants of air pollution, in particularity, which are emitted out from the road vehicles & atmospheric particles<sup>(6)</sup>, on the road surface.

It is a common picture everywhere to have a road-traffic scenario like Figure 5 & Figure 6 where sounds get easily flown over to the nearby surrounding places to buildings, pedestrians, etc. This going is often enhanced by unclean road surfaces or unwashed objects like unwanted steel post, flocs of materials here & there, unplanned road-side activities/shops, etc. While everyone is aware about ordaining their indoor acoustic systems (Figure 7 & Figure 8) but they're less awareness of sound-proofing system that has not yet been made to control to outdoor environment pollution by road-traffic noise, except imbibing traffic 'noise' policies.



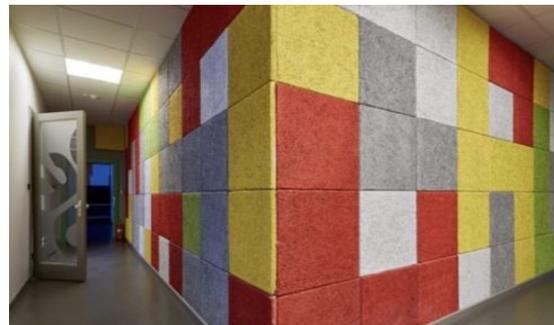
**Figure 5: Road open to surrounding places**  
(Source: Web)



**Figure 6: Road not clean causing to sound reflections**



**Figure 7: Indoor decorative works (Sound-proof)**  
(Source: Web)



**Figure 8: Decorative but Sound-proof walls**

The study has focused on creating innovative measures to protecting surrounding places to road-traffic's noise pollution scenario. It has described three innovations by a facilitative approach discussed afterwards. More with it, several recommendations are given to highlight the protections on the all.

**OBJECTIVE**

- To minimize noise pollution levels to its zero-pollution reduction.
- To provide innovation provisions to solve noise pollution as a problem.
- To cover up noise pollution caused by vehicular traffics on road and establish structural provisions to minimize the pollution.
- As road traffic is considered in the study as generating noise pollution, to build up innovations to reduce such pollution to any desired level or even zero level is the ultimatium of the study.
- To describe various associated functionalities & limitations of the innovation.
- To catch & remove out particulates from the road-air by the same innovation applied for noise pollution solution.
- To give scope to various research interests to evolve out materials & engineering.
- To set up & provide a noise-free ambience to both road-traffics & outsiders (that is, surrounding place/object) to the traffics.
- To establish traffic-riding quality with respect to noise level a hazard free & healthily.

**METHODOLOGY**

In this study three distinct categories are prescribed as the innovation of the methodology. Searching of better composition or innovation has been though a continuous effort in the subject<sup>(7-18, 19, 20, 21-28)</sup>. However the three innovations are -

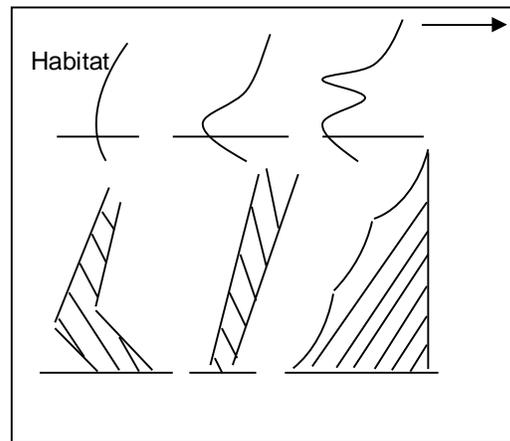
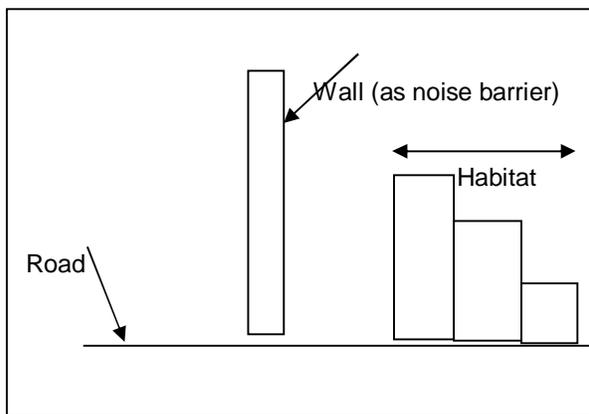
- **Innovation Wall (Noise Barrier)**
- **Laser Technology Application**
- **Sound Absorptive Material**

All the innovations are to the degree of suitability, to use.

Let's these describe one after one.

**Innovation 1: Innovation Wall/Barrier – Bent/Curved Wall (as Noise Barrier)**

This is though conventional but not its bent form or of its curved one which is one of the innovations of this study. It would act as a wall or barrier to noise pollution at a suitable distance from the pollution source. Its design when curved or bent, suitably, on its dimensional pursuits would facilitate noise to become distributed over spatial distances atop. By providing such, the noise could not be able to stand within the road at ground-level, instead, it would rise up gliding the bent or curved surfaces of the barrier or wall (to upper atmosphere) and finally all the road-noises thus would play across spatial heights, much above the road level at ground, in the upper atmosphere. Deflection of sound by such curved or inclined surfaces must be to meet several requirements at the location, its surrounding & spatial provisions/obligations.



**Figure 1.1: Conventional 'Straight' Wall (as noise barrier) Figure 1.2: Different shapes (6 types) of innovation wall**

**Figure 1: Perspective of conventional versus innovation wall**

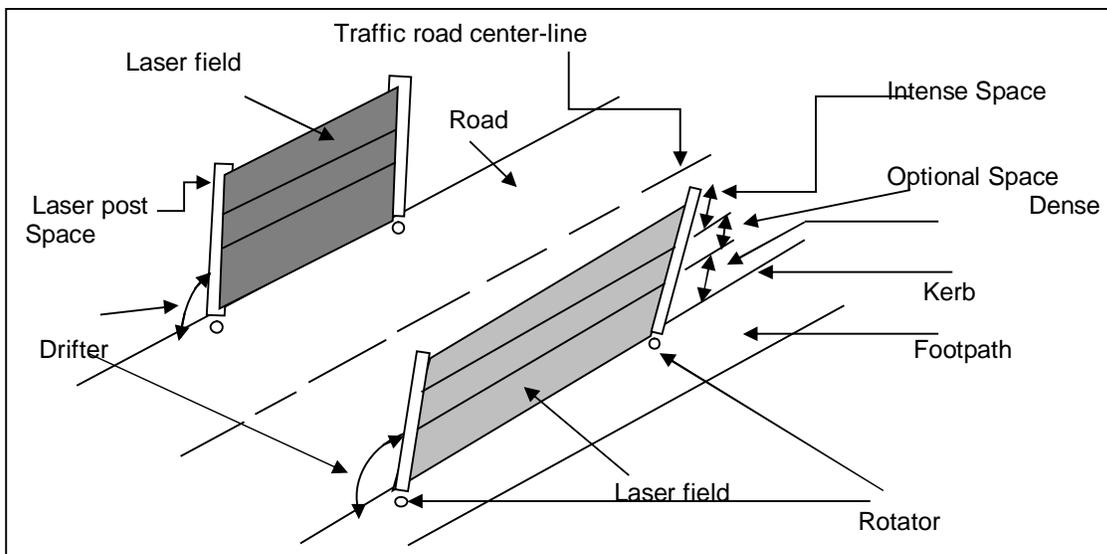
In Figure 1.1, conventional form of the barrier is shown & the innovation types (six numbers which may be more in numbers of the suitability & creativity; each type in independent & individually distinct) in Figure 1.2. The given six types of the innovation do make the significant contrast in the use & research interest. All the innovation types make one thing so clearly that they transfer the road-traffic noises to go upwards, to the upper atmosphere on & surrounding the road. With such innovation barriers, surrounding places would not only be protected & prohibited but it is also possible to take away all the sounds from the road regions at ground level. Such innovation should indeed maintain the minimum noise level that would be required to maintain the traffic or vehicular movement engineering which should always go with following the provisionary system. It is nonetheless by the innovation by a fact that it would bring a new opening in noise pollution & pavement design engineering alongwith its emphasis of science & art.

**Working Philosophy:**

To deflect sound in the way to get out of its pollution zones to spatial (to its upper atmosphere).

**Innovation 2: Laser Technology Application**

The philosophy of sound deflection is to be kept unchanged in this case also. Field of protective layer or shield is required to be prepared & implemented just beside of road by pointing laser post (Figure 2). Intensity and degree of flexibility to use laser as a protective material should be inclusive of needs & research interest. Laser film or field would provide resistant against spread of noise pollution around the traffic road. Sound deflection in this case may be governed & operated by providing a facility of rotation (by rotator or such) at bottom of laser post. Thicknesses of the field may vary over site location's pollution intensities. There is an angular movement (called as drifter) to be operated by rotator. Drifter of the laser field would take all the road-traffic noises onto higher spatial above the ground level of the road. This type of innovation, on the whole, would be able to minimize road-level noise pollutions by utilizing on-the-top atmosphere at road traffic. As there is no output of environmental concern with respect to pollution emissions or such effects of an innovation system (as innovation's pollutions or bad effects or such), so this type of innovation could be regarded as *green innovation* owing to regard of the natural atmosphere utilization without any bad attribution directly/indirectly over it. It is completely pollution free & out of any unnecessary hazards.



**Figure 2: Application of facilitative (Laser) innovation on a given traffic road section**

Sophistication does highly exist in laser type of innovation to the noise pollution reduction. Laser field should always be made to be out any danger to human perceptibility. It'd be therefore amazing field of application of laser if provided with

no visionary existence, no human perceptible senses, while acting as a noise barrier on the road. Selection of such innovation needs to be on choice-based tracks.

**Table 1: Laser application variation to the nature of traffic**

Space in laser field	Type of vehicle	Space character by sound intensity	Example	Character of laser in laser field <sup>^</sup>	Remarks
Intense Space	Heavy-duty vehicle	Mostly horn sound	Truck, Lorry, Bus, etc. (four & more than four wheelers)	Thin thickness but strong & resilient (thickness width less)	Sensor based (preferable) <sup>^</sup>
Optional Space	Heavy to Medium duty vehicle	Mixture of horn & engine sound	Sound dispersion of intense & dense space	Quality & quantity varies in between intense & dense space	
Dense Space	Medium-to-Low duty vehicle	Mostly vehicular engine sound	Cycle, Bike, Auto, Van, Taxi, etc. (two & three wheelers)	Thick thickness, strong & resilient but not robust economically (thickness width more)	

<sup>^</sup>its intensity may vary with traffic amounts on vehicular pavement.

<sup>^^</sup>it depends on traffic volume, traffic density, probability of noise occurrence on nature of SD; (SD= sight distance).

More detail description is given in tabulation in Table 1 where three zones have been created in a laser field, based on the type of wheelers of road vehicle on traffic road. Cross-sectional thickness would vary over these three zones. Most of the specifications are optional nature at it requires further experimentation & rational realization, it is, however, considered to provide sensor combination to the laser innovation to very specialized road track (Table 1). In this way, the laser application blended with variety of new-age technologies would bring & make the vehicular noise pollution to pollution free & take the upper atmosphere to get its (noise pollution) residence after the deflection by drifter or rotator or any backward support to the innovation structure.

**Working Philosophy:**

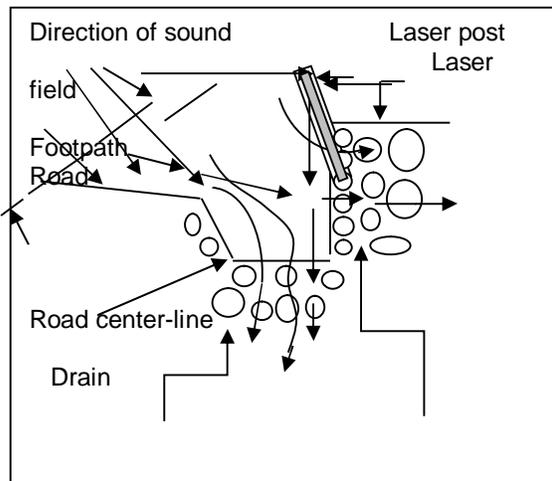
To transfer sound in the way from its pollution source spectrum to spatial (to its upper atmosphere).

**Innovation 3: Innovation By Design (Using Sound Absorptive Material)**

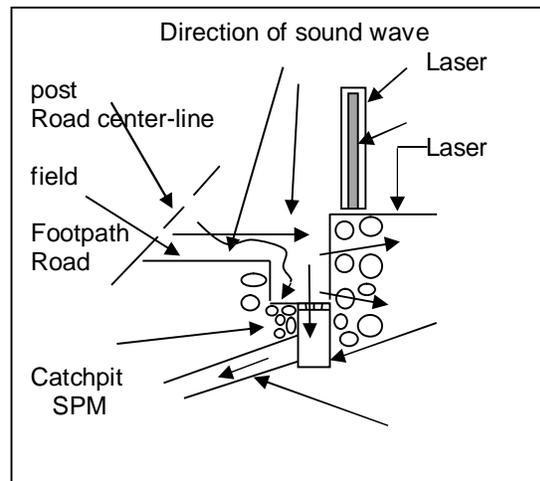
It is the innovation where sound pollution or noise would get absorbed in (by applying Sound-proof materials (SPM)) than the deflection as described in innovation by laser & bent/curved wall or barrier. Innovation is the design style, creation & orientation of the discussion point here. SPM as innovation, though conventionally used, would become a point of innovation when it is applied in the constructive way as shown in Figure 3. In the schematic figures, it is recognizable that how noise pollution could be transferred & moved into SPM provisions (Figure 3.1) and/or underground sewerage system via catch-pit (Figure 3.2).

In this study, as shown in Figure 3, SPMs are marked by circle or round shape as for indicating its absorptive feature.

Deflection & absorption property of sound could be applied by an approach of innovation which may be otherwise, even to the one so discussed & shown. Different space-oriented sounds (Figure 2) from road would get the deflection by any wall (curved wall/laser field/any such wall) on the road-kerb & get absorbed by the SPM If provided by an approach or manner as shown in Figure 3. After deflection, portion of the sound (that is not absorbed at first instance of the deflection) would go further to another bed/wall made up by SPM or to any suitable track to divert & propagate the sound from getting stagnant at any place on the road-traffic.



**Figure 3.1: Road-drain with laser & SPM**



**Figure 3.2: Drain-cum-catchpit with laser & SPM**

**Figure 3: Innovation by design with the conventional 'SPM' material**

SPM by its general character absorbs the sounds within its reception zone. By applying it suitably in or with the formwork or structure of walls, curtains, thin wall structures, etc. noise pollution levels could be minimized to distinctive level. Also, pavement design (slanting, camber slope, & etc.) in compatible to adjacent drain (road drain) could be rationally feasible to reduce the noise pollution by the provisional spread of SPM.

In this study, it is suggested to use the material on the following scopes on pavement design –

- ✓ Along kerb wall (road facing)
- ✓ Along drains (road-side)
- ✓ By applying road design (to facilitate the noise to get absorber by the material at the location so provided)
- ✓ Into sewer system (through catchpit of road)

It is therefore evident that SPM could act & work efficiently if it is made up with suitable & compatible design & provisions. Such material could be the research point of interest regarding proportion to use or mix with road materials, by its use by form work/chemicals to apply of, any creativity, etc. Combination of such material with laser or wall could be more prospective to noise pollution reductions.

Design of site-layout, vehicular engine-cum-horn system of engineering, road slope, camber, height & shape of kerb & footpath, greenery, drain outlooks, safe disposal to receptible & etc. would be speculative one to the aspect of effectiveness in the entire innovation to gain to an ultimatum.

It is clear that there are already lots of provisions & manners to use on road surfaces of the material to serve the purpose of the study, that is, to *take away the road-sounds away well off the habitation zone.*

**Working Philosophy:**

To absorb sound by a narrowing down approach by structures or materials use at or of the traffic road to minimal level.

With all these, three innovations so described would be the new one to minimize noise pollution from the ground level to heights well above the road-pollution zones. Earlier innovations (that is noise walls & laser field) though independently

strong & individually distinctive could be in use while using SPM as the innovation (that's to be) acting individually to reduce the noise pollution.

When it comes to performance, then it is the evaluation stage where vantages are illustrated & experimented. Table 2 gives such illustration not to the exhaustive list to raise up various corners of the innovation with regards to their applicability, limitations, benefits of use, various concerns, etc.

**Table 2: Limitations & advantages of the innovation**

Sl.	Innovation	Advantages	Limitations
1.	Sound absorptive material	It has ability to absorb noises at site location.	It has variable abilities based on features of materials so used in.
2.		Sound having higher amplitude could be easily stopped to go through & thereby absorbed.	Higher amplitude (with/without frequency), higher be the quality (& quantity) of materials, leading to costly implementation.
3.		Other pollutions like RSPM (respirable suspended particulate matter), benzene compounds, etc. in vehicular-traffic air could also be possible to be removed by it. Associative arrangement for that purpose can be easily applied with it.	Operating maintenance would be higher totally, especially to the associative arrangements.
4.		It can provide long term service till its replacement.	Security is to be a provision of it to keep it protected & safe from theft, weathering, accidents if any, etc.
5.		Holistic initiative to prepare a pollution free ambient environment to road traffic.	It may not be suitable to rural or unimportant areas/places, though it could be suitably placed anywhere with little degree of uncertainty.
6.	Laser technology application (Laser Field)	It provides as a guard against noise pollution from spreading it to outside the road traffic. It is technology based.	It is costly basically & changeable due to technology & over modifications.
7.		Control is better than any other physical absorptive material. Its sophistication & efficiency make it popular to specific, economic zones.	Its implementation may be applicable more on developed areas than developing/under poverty level of areas.
8.		It's completely pollution free, technology embedded & its function is to regulate the traffic pollution to self-dilution (into upper atmosphere).	As upper atmosphere gets filled up with the reflected sound/noise, care needs to be given onto the atmosphere where the self-dilution of noise pollution shall take place.
9.		Regulation & self-purification of particulates by laser application as discussed to the noise pollution in this study may be thought of & applied.	Cost may again become a factorial matter as particulate removal (by Deflection or else) would be not indifferent like sound's diversions & obviously quite complex by nature.
10.		Flexible lasers are comparatively better than Rigid lasers so far as the noise pollution by levels is concerned alongwith various structural obligations to the pollution removal within the laser zone's prevalence.	Long term or time-bound use of lasers would be costly on type of lasers (rigid/flexible) used.

11	Noise Barrier Wall	As already established, it is otherwise highly applicable once it is slanted suitably, especially its curved wall shape, to regulate the traffic noise towards upper atmosphere, not allowing it to surrounding/adjoining lower atmosphere of the human habitat zone.	Structural design & stability could govern over the wall's durability. Also, maintenance of such 'slanting' & 'curved' wall is high.
12		The framework could be designed suitably & it could be any material, not necessarily concrete/steel. This framework provision could also be provided alongwith other innovations (absorptive material/laser technology).	Cost of framework would rise up if it is 'uniquely' built up by laser technology. Durability & stability is a concern again.
13		Horizontal distance to adjacent structure would be changed if slanting and/or curved wall is applied.	Many things would need to be revised & changed as against the wall like distance (Eq.) & all.
14		Whether laser application or implementation of absorptive material can be applicable or not to the pattern & formation as that of the wall itself (alongwith framework indeed) is a point of research interest.	Immense scope of doing creativity does exist but that must not beyond sustain ability & all other endeavors to the structural stability & efficiency.
15		Layout provision of road drain & other components can be suitably adjusted with.	It is more applicable to technology based innovations & unique creativity.

Framework application over structural part of the innovations is compatibly interesting field of creativity as connected to its lower part of the innovation.

**RESULT & DISCUSSION**

- Pollution caused by noise of vehicular traffic is a growing concern to become a much-speculative fact to nearby coming futures as city planning systems are getting upgraded & going to receive more & more vehicles to fulfill demand of future generation masses. To provide new innovations to mitigate noise pollution is a dutiful task of its concerned department of state & central repute.
- Road traffic should be considered as a track of zero noise of pollution. Much is required to make it more pollution free & well controlled by use of equipment & technology.
- In propagating with the pollution-abatement concept, choosing material is a vital point of decision. Also, provision of combination of materials, equipments, technology, etc. to road-lanes as needed is a task of prudence judgment over noise pollution minimization.
- Several policies may be determined & made applicable practically ontowards implementation feasibility of the innovation.
- Though it always needs to justify through scientific models to negotiate with the innovations so prescribed in this research paper it in its own way of rational exploration has unfolded lots of research scopes to realize & appreciate the true proclamation & postulates as discussed by the study itself.

**CONCLUSION**

- Lots of research scopes are necessitated by the paper itself.
- As this paper demands the best innovation model to be out by necessary researches, it is after all to be considered as beginning by its kind as the way is required to be laid down to arrive at & fulfill the objective on the whole.
- Serviceability & sustainability<sup>(29)</sup> should be present at every point on the road consisting with such innovations.
- Ultimate objective should be to minimize/optimize the pollution by level by offering less hazardous to human & others; be it during its construction or service by monitoring governance<sup>(30)</sup>.

- With such innovation a smart city would look smarter than ever & creation of zero noise pollution would safely be possible to provide & prevail<sup>(31)</sup>.

#### **RECOMMENDATION**

Following prescriptions are given in order to minimize road-level traffic noise:

- Using AI: To reduce noise pollution on vehicular traffic, we can build an ecosystem among vehicles with the help of Artificial Intelligence. Every vehicle can automatically communicate with each other and maintaining a safe distance. By this way, Noise can be reduced.
- Using GPS: We can use GPS navigation features in our vehicles. By this, we can see real time traffic movement while driving. So, unnecessary horn blows and noise can be reduced.
- Using modified horns: We can use modified horns which are not blows in high frequency, and sounds better.
- Giving training to drivers: We can organize driving workshops and properly giving training to drivers. After getting training their driving skills will improve. By this, unnecessary noises on vehicular traffic can be reduced.
- Maintain and repair roads: Well decorated and maintained roads are very smooth for driving. Vehicles can move very easily and doesn't create noises. Where roads are not properly repaired yet, we need to repair those roads and also need to maintain them. By this, noise can be reduced.
- Following traffic guidelines: Each person should follow traffic guidelines. It is very important to maintain free flow of vehicles. So, traffic guidelines also useful for reduction of noise.
- Road design policy
- Plastic use in combination with sound-proof materials<sup>(32)</sup>
- Vertical gardening alongwith energy efficiency<sup>(33)</sup>, especially above laser post (Figure 2).
- Micro-surfacing layers into road pavement design & construction (material innovation).
- Traffic design & control.
- Awareness to indoor gardening & renovation.
- Combination of new research materials, methods & approaches.
- Notify authorities about disobedience of noise rules Introducing low noise road surfaces - traffic control and police measures.
- Following the limits of noise level - create healthy noise (such as music, singing birds or waterfalls in homes or offices or road-side parks or crossing) to eliminate unwanted noise.
- Use proper lubrication and better maintenance for car - use noise absorbent machineries in car.
- Close windows & shut the door facing towards the noisy road traffic.
- Use of earplugs to road traffic noise.
- Enclosing machines (at road-site) in sound proof enclosures.
- Strictly enforce 'No Horn' near schools, hospitals, places of worship, places of heritage. Instead, use horns producing lower pitch sound.
- Ban crackers.
- Avoid resonance.
- Avoid traffic jams on major thoroughfares.
- Build heavy industries away from habitations.
- Regularly check noise level.
- Spreading awareness among road-side human populations.
- Open Challenge Project (OCP) – a prescriptive approach:  
It is expected that every ward or locality would be in competence based output-giving tendency to perform, excel & rational deliverance. Based on this expectation, several projects may be announced & inaugurated to get up an individual effect (by locality basis) to be as contributory as responsible citizenship to the noise pollution. Such type of project may be called as OCP where certain road length should be given to the locality (& consequently locality onto vendors/contractors, etc.) to control of noise pollution by the innovations. Such OCP projects may also be called as

“air & noise pollution control project” (ANPCP) as the same could be developed to reduce particulate pollution also, by applying suitable incorporations as required to the three innovations. In an instance the cost estimate budget is evaluated as given in Table 3 which could show up annual cost requirement of such ANPCP by the innovations.

**Table 3: Annual cost estimation of the project, ANPCP – a paradigm outlook**

Traffic pollution reduction cost profile				
Pollution	Road length (km)	Rate	Cost (half-yearly)	Cost (annual)
Particulate	10	Rs. 10000/km	10*10000 =1,00,000	Rs. 2,00,000
Noise	10	Rs. 20000/km	10*20000= 2,00,000	Rs. 4,00,000
Total	10	Rs. 30000/km	Rs. 3,00,000	Rs. 8,00,000
Rs.8,00,000 annual expenditure per 10 km road length				

Such OCP or ANPCP could be arranged by imbibing several enhancements like the following –

- ✓ Award-giving programme.
- ✓ Special societal recognition (SSR).
- ✓ Facility to receive time-bound services/projects.
- ✓ Scope to focus on societal responsibility to augment related or other businesses.
- ✓ Rapid & growing pathway to enter into public domain with positive favours to facilitate various objectives to be into its own fulfillment.
- ✓ High field of entrepreneurship, innovation, research & business management.

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