Passive noise control measures for traffic noise abatement in Delhi, India

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This study proposes a comprehensive noise abatement programme following the best practicable and economical option (BPEO) for implementation in metro city like Delhi for reducing annoyance and ill effects of traffic noise. It reviews potential applications of noise control barriers and vegetation for reducing road traffic noise and presents a design morphology and decision matrix using TOPSIS (Technique for order preference by similarity to ideal solution) approach for selection of appropriate sound barriers.

Keywords: Best practicable and economical option (BPEO), TOPSIS (Technique for order preference by similarity to ideal solution), Traffic noise

Introduction

Total vehicle population in Delhi¹ city has amounted to more than three other metro cities (Mumbai, Kolkata and Chennai) put together, and has almost doubled from 3.05 million in 1998-99 to 6.30 million in 2008-09, whereas road network has increased from 28,508 km in 2000-01 to only 30,985 km in 2007-08. Thus, it is imperative to devise noise control strategies for abatement of traffic noise for reducing annoyance and health effects caused. A socio-acoustic survey, which was conducted amongst 520 individuals (age < 30 y) in Delhi city, revealed that > 50% people are disturbed from road traffic and horn noise and 17% are annoyed due to aircraft noise (Fig. 1). Metro trains² cause an increase in ambient noise level by 2-3 dB (A) in medium and high traffic density areas and thus causes a relatively less impact on community as compared to road traffic noise. When exposed to traffic noise, people of Delhi felt as follows: stressed, 28; mentally tired, 25; irritated and angry, 21; sleep disturbances, 9; and headache, 7%. Tang³ investigated correlating noise indices with population density and traffic volume based on daily noise measurements at 12 independent sites in Hong Kong using $L_{\text{Aeq},24\text{h}}$ = $a \log Q + b \log P + c$, where $Q$ is daily traffic volume and $P$ is local population density within each km² of area and constants $a$, $b$ & $c$ for $L_{\text{Aeq},24\text{h}}$ have been found to $a=2.59$, $b=2.33$ and $c=47.7$. Substituting the value of $Q$ as 30,000 and $P$ as 9430 for Delhi city, value of $L_{\text{Aeq},24\text{h}}$ comes out to be 69 dB(A), which is rather very high value when compared to Central Pollution Control Board (CPCB) limits.

This study discusses passive noise control strategies (application of barriers in conjunction with vegetation) for traffic noise abatement and formulation of a comprehensive noise abatement programme in Delhi city.

Noise Abatement Programme and Noise Goal

European noise abatement programmes [HEAVEN⁴ (Healthier Environment through Abatement of Vehicle Emission and Noise), SilVia⁵ (Sustainable road surfaces for traffic noise control), CALM⁶ (Community noise research strategy plan) and ROTRANOMO⁷ (Development of a microscopic road traffic noise model for the assessment of noise reduction measures)] are the best inspiration for devising action plan and modalities of a noise abatement programme in Indian perspectives. Dutch noise innovation programme⁸ (budget, 50 million Euro) based on the idea of decreasing the number of houses exposed to a noise level > 70 dB(A) by 100%, number exposed to a noise level > 65 dB(A) by 90% and number exposed to a noise level > 60 dB(A) by 50% by year 2030 is an excellent illustration of such a noise

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abatement programme with a noise abatement goal. EU directive\textsuperscript{9} 2002/49/EC imposes member countries to develop noise maps and action plans and as such it is imperative in Indian conditions also to conduct frequent noise monitoring along with GIS mapping using a validated noise model.

Efficient traffic management is one of the vital reforms to combat the high ambient noise levels in various areas of Delhi city. Restrictions in use of horns especially near sensitive spaces like hospitals, schools etc., reducing speed limits, timing traffic lights to achieve smooth traffic flow, smooth driving avoiding frequent acceleration & deceleration and prohibiting heavy vehicles in certain road and streets can be very fruitful in achieving the desired objectives. Land use planning and management is also another factor minimizing traffic noise impact. Placing as much distance and non compatible activities like parking bays, open areas etc between source and receiver is also helpful. Noise control at the receiver is another important aspect to focus. The shape, orientation and location of building and arrangement of internal spaces should be chosen to reduce potential noise problems. Reduction of noise by the building itself should only be considered as a last resort when insufficient reduction can be made at the source or between the source and the building\textsuperscript{10}. For balconies located well above the level of road traffic, the underside should be designed to reflect the sound away from windows at lower levels or it should be covered with a sound absorbing material. Tyre width, tyre hardness, tread patterns, groove depth and road surface are pivotal factors affecting the tyre noise. An optimal combination of tyre and road surface is instrumental in reducing road noise. European studies\textsuperscript{7} revealed the difference in noise level between quietest and noisiest tyre/road surface combination was 9 dB(A) for cars and vans and 7 dB(A) for trucks. Low noise road surfaces can be divided into thin dense surfaces, porous surfaces and poroelastic pavements. Porous asphalt has potential for reduction of vehicle noise by 5-8 dB, while poroelastic pavements that combine porous structure with a soft aggregate showed reductions for normal tires (10-12 dB) and studded tyres (13-15 dB)\textsuperscript{11}. Sandberg\textsuperscript{12} revealed that tyre and road construction result in concentration of major noise generating and influencing mechanisms (700-1300 Hz), and suggested a softer tyre/road contact with softer tyre treads as well as road surface that increase belt stiffness but decrease contact stiffness and porous road surfaces designed for favourable sound absorption (800 - 1250 Hz). Reducing vehicle speed by 10 km/h, a noise reduction by 2-3 dB(A) is achieved\textsuperscript{13}. Certification procedures periodically followed and made mandatory at least twice a year, wherein noise and emission limits are to be strictly adhered for all vehicles plying on Delhi roads can be very influential step in exercising control at source. Pivotal factors significant in reducing road traffic noise are assimilated in a cause and effect analysis (Fig. 2).

Laboratory experiments\textsuperscript{14,15} serve as a benchmark for ascertaining sound insulation and absorption properties of materials, which can be referred by designer for selecting best acoustical materials for achieving a desired noise reduction. Transmission Loss (TL) is a performance of sound insulation measured in reverberation chambers. Sound Transmission Class (STC) is an integer rating of how well a building partition attenuates airborne sound. The better the STC of materials, better sound insulation it provides. Strengthening facades of dwellings, use of high sound insulative windows and doors, proper treatment of ceilings, and re-orientation of interior spaces in dwellings (shielding living rooms etc from external noise) prove to be the best measures for acoustic comfort. Success of noise abatement measures requires a strategic noise abatement planning with formulation of noise abatement goal (Fig 3). Noise zoning based on land use criteria and strict implementation of CPCB noise limits [industrial area, 75 dB(A) $L_{eq}$; commercial area, 65 dB(A); residential area, 55 dB(A); silence zones, 50 dB(A)] for during day time and a relaxation of 5 dB(A) for night time is to be strictly implemented and enforced.
for success of noise abatement programme. A validated road traffic noise model integrated with GIS interface is very essential for noise predictions, forecast and management. Identification of hot spots having \( L_{eq} \) (T ≥ 8 h) more than 60 dB(A) and implementing the best practicable and economical option (BPEO) among various alternatives to these hot spots is essentially required for achieving the targets. Optimistic target value [60 dB(A)] of noise abatement goal is selected for implementing a strict and comprehensive noise abatement programme in each hot spots identified in Delhi city. Performance of such a noise control programme can be periodically monitored in terms of noise abatement accomplished in incremental steps of 5 dB(A).

An alternative option of bypass/highway or a roundabout is to be decided in case noise control measures become inadequate to achieve the target of 60 dB(A). Adherence to a noise goal by a stipulated time and periodic management review of progress brings synergy to whole program for accomplishing the targets. Erection of noise barriers should be made mandatory in future projects planned. An opinion survey\(^6\) has also explicitly presented a clear public perception with a majority of respondents (80%) demanding for erecting...
noise barrier along national highways and willingness (66%) of respondents for incorporating the concept of noise barrier in future design or modification of existing boundary walls.

**Barriers Applications & Design Considerations**

Noise barriers derive their performance by blocking the line of sight, thus creating a sound shadow. Cohn proposed principal limitation in obtaining high insertion loss is in maintaining an adequate line-of-sight break. Major innovative diffraction-edge modifications include T-shaped barriers, multiple-edge barriers, Y-shaped barriers, tubular capping, and phase interference devices. Cohn & Harris studied five special barrier treatments (absorptive T-top, Y-top, slanted top, single barrier absorptive, and parallel barrier absorptive) in four US highway projects, and observed that: i) Absorptive T-top barriers provide 0.7-1.0 dB per 0.3 m additional attenuation (with minimum top width of 0.9 m); ii) Y-top barriers provide 0.4 dB per 0.3 m additional attenuation (with minimum top width of 0.9 m); iii) Absorptive single barriers provide 1-2 dB additional attenuation with minimum 0.9 m absorptive strip at the top; iv) Absorptive parallel barriers eliminate IL degradation with a minimum NRC of 0.65; and v) Slanted top barriers provide positive aesthetic impacts. Fujiwara & Furuta reported a benefit of 2-3 dB(A) in frequency range 1 - 1.6 kHz due to a 0.5 m diameter absorptive cylinder capping, equivalent to what would have been obtained by raising height of a vertical plane barrier by 2 m. Shima et al developed a Y-shape barrier with two small Y-shapes at the ends of larger Y-shaped barrier, thus creating four diffracting edges. Sound
Sound absorbing materials can substantially improve the performance of both single and parallel noise barriers. Dispersive barriers having contoured surfaces (zigzag, wavy, castellated) scatter sound waves thus preventing unwanted reflections and serve as an alternative solution to performance degradation of barrier due to reverberant sound field attributed to traffic noise in parallel barrier configurations or multiple reflections from high rise buildings.

Design aspects for erection of noise barriers of optimum dimensions providing a high insertion loss is essential and depends upon site and situation. Barrier thickness is insignificant, but diffraction over the top edge of a barrier is affected by its cross section. Barriers with cross sections having corners and curved shapes are not as effective at reducing noise as those with sharp edges\textsuperscript{21}. Effectiveness of a thin barrier can be increased by bringing diffracting edge nearer to the noise source, thus increasing path difference. Increasing number of diffracting edges can also improve attenuation considerably. Transparent barriers, tilted and dispersive barriers and multiple edge design barriers prove to be fruitful options for road traffic noise abatement. A design morphology (Fig. 4) has been formulated from exhaustive literature survey\textsuperscript{21,22} for sound barriers. A suitable barrier, compatible for a particular road network, depends upon acoustic attenuation, economical, structural, aesthetic constraints, compatibility with environment, installation, maintenance and safety aspects. T-shaped barriers with an absorptive material have a significant potential of reducing noise levels by 2-3 dB, which could reduce barrier height by an average 1.5 m, however, they suffer from persistent maintenance and replacement of absorbing material after sometime. Evaluation matrix could be used to score the best practicable option based on acoustic performance as well as economic.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
Requirements & Types & Material aspects & Design considerations \\
\hline
Effectiveness & Reflective & Steel (galvanized, Stainless) & Minimum height such that line of sight between source & receiver is \\
Structural Integrity & Absorptive & Aluminium & 1.5 $\text{dB}(\text{A})$ additional noise reduction for each 1 m increase in height after line of sight is intercepted \\
Compatibility with Environment & Earth berms/bio-barriers & Polycarbonate/Acrylic & Proximity to source or receiver \\
Maintenance & Mixed & Concrete/Brick Masonary/GRC/Hollow Blocks & Should extend 4 times as far as in each direction as distance from receiver to barrier \\
Safety & Durability & Sound Absorbing Materials & Extra diffracting edge \\
Easy installation & Multiple Edges & Earth berms & Surface mass atleast 20 $\text{kg}/\text{m}^2$ for adequate T.L \\
Corrosion/Ageing Resistance & Random Edges & Proprietary made Acoustic panels & Sound transmission loss of barrier material must be at least 10 $\text{dB}$ higher than the required barrier attenuation. \\
Economic Considerations & Reactive & Glass, Wood & QRD (Quadratic Residue Diffusers)/PRD (Primitive Residue Diffusers) option additionally included \\
Ventilation, Lighting & Dispersive (zigzag, wavy Castellated) & Composites & T-Profiled barriers with absorptive material are most effective \\
Drainage issues & Helium filled for temporary Applications & Enclosure, Inclined, Cantilever & \\
\end{tabular}
\caption{Design morphology for sound barriers}
\end{table}
Table 1—Scale of attribute weights and ratings correlated with linguistic variables as positive trapezoidal fuzzy numbers

<table>
<thead>
<tr>
<th>Scale of attribute weights</th>
<th>Scale of attribute ratings</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Very Low</td>
<td>0.050</td>
<td>Poor (P)</td>
</tr>
<tr>
<td>Very Low</td>
<td>0.125</td>
<td>Medium Poor (MP)</td>
</tr>
<tr>
<td>Low</td>
<td>0.175</td>
<td>Fair (F)</td>
</tr>
<tr>
<td>Medium Low</td>
<td>0.225</td>
<td>Medium Good (MG)</td>
</tr>
<tr>
<td>Medium</td>
<td>0.275</td>
<td>Good</td>
</tr>
<tr>
<td>Medium High</td>
<td>0.325</td>
<td>Intermediate values</td>
</tr>
<tr>
<td>High</td>
<td>0.375</td>
<td></td>
</tr>
<tr>
<td>Very High</td>
<td>0.425</td>
<td></td>
</tr>
<tr>
<td>Very Very High</td>
<td>0.475</td>
<td></td>
</tr>
</tbody>
</table>

constructability, maintenance and aesthetic considerations. Arizona Department of Transportation (ADOT)\textsuperscript{23} recommends T-top design with absorptive material over conventional barrier of concrete or masonry construction.

TOPSIS\textsuperscript{24} (Technique for Order Preference by Similarity to Ideal Solution), based on the concept that chosen alternative should have the shortest distance from positive ideal solution (PIS) and farthest distance from the negative ideal solution (NIS), is very useful approach for solving a multiple criteria decision making problem. TOPSIS method selects the alternative that is closest to ideal solution and farthest to negative ideal alternative. An integration of TOPSIS and fuzzy linguistic variables is proposed to consider both quantitative and qualitative factors for choosing the best practicable and economical (BPEO) barrier option amongst the available barriers. Attribute weights and rating values are assigned to various available barrier options against the requirements and finally constructed a decision matrix (DM), which is further modified to a weighted normalized DM and distance of each alternative from PIS and NIS is computed. Relative closeness to ideal solution is calculated in terms of closeness coefficient for selecting the most desirable barrier option. Either actual values of the requirements against various barrier alternatives or the use of linguistic variables correlated with fuzzy numbers to identify the ratings and weights could be input in DM\textsuperscript{25}. Table 1 shows the scale of attribute weights and ratings chosen as linguistic variables and correlated with positive trapezoidal numbers. Jadidi \textit{et al}\textsuperscript{26} proposed a procedure for formulation of a DM and found the best alternative using TOPSIS approach and finally calculated the relative closeness coefficient as

\[ C_i^* = \left( \frac{S_i^-}{S_i^+ + S_i^-} \right), \ 0 \leq C_i^* \leq 1 \]

where \( S_i^+ \) is distance of each alternative from ideal solution and \( S_i^- \) distance from negative ideal solution. When \( C_i^* \) is bigger, the ranking order of \( S_i \) is better. From observed value of closeness coefficient (Table 2), concrete barriers, transparent barriers, metal/composite/polycarbonate sheets are the best options for road traffic noise abatement.

Perforated metal sheeting on one side with inclusion of absorptive material within and corrugated profile add more value to insertion loss provided by barrier. However, conventional concrete or masonry structure serves to be the best practicable option for highway barriers considering the long term stability and maintenance free services as there are some limitations associated with transparent and polycarbonate barriers. Laminated glass requires frequent cleaning due to accumulation of dirt, while polycarbonate sheets become opalescent over time as it can absorb water. Plastics are prone to damage from fire and vandalism and some plastics (polyethylene) become brittle after prolonged exposure to sunlight. Application of multiple edges noise barriers or profiled noise barriers having better acoustical performance than conventional concrete structures can be very effective for specific applications wherein a single source has to be screened. Noise barrier designed for Delhi Metro Rail Corporation (DMRC)\textsuperscript{27} consisting of half Y shaped structure that includes a 2 mm thick aluminium alloy as back plate, 1 mm thick aluminium alloy sheet (30% open) as facing surface, 50 mm thick glasswool (density 40 kg/m\textsuperscript{3}) wrapped in tissue bags and polythene cover and the whole assembly fixed in GI framework serves as an illustration of specific source noise mitigation. TOPSIS approach can be thus helpful for designer for selecting the best practicable option considering all pros and cons as long term stability of barrier and compatibility with local environment is equally important as the acoustical considerations especially for road traffic noise abatement.
Vegetation can be used in urban areas for transportation noise control as relatively inexpensive and aesthetically pleasing noise barriers. A minimum of 2-5 m wide dense shrubs followed by medium height trees are effective in offering 2-5 dB(A) noise reduction from traffic noise in residential areas. Although a degree of maintenance is required to achieve optimum performance throughout the life, yet noise barriers are often associated with vegetation to produce visually attractive and acoustically effective combinations.

Attenuation offered by trees and shrubs as noise barrier depends upon their placement, density, tree height and belt width. Vegetation effect is often described as a mid and high frequency absorption per meter, which is added to frequency dependent attenuation due to soft ground. Fricke demonstrated that scattering rather than absorption is the more important attenuating phenomenon in the mid frequencies, while absorption plays a dominant role at high frequencies. Harris observed that a vegetative barrier could be expected to provide an insertion loss for highway noise of 0.3-0.6 dB per m and that a belt of mature vegetation could reduce the level by 4-6 dB (A). Notable experiments conducted under Indian conditions by Santra et al. also substantiated the effectiveness of vegetation for reducing traffic noise. Tyagi concluded that attenuation maxima were observed at 400 Hz, 3.15 kHz and between 10 and 12.5 kHz, with attenuation increasing with frequencies.

Pathak experiments also validated usefulness of vegetative species (*Putranjeva roxburghi*, *Cestrum nocturnum*, *Hibiscus rosasinensis* and *Murraya peniculata*) in reducing traffic noise in Varanasi. Depending upon the availability of space and other statutory requirements, one can work out suitable noise control packages consisting of earth berms, plantations, bushes, shrubs, small noise barriers etc. keeping in view of economy, logistics, aesthetics of surroundings etc. into...
consideration. Investigations conducted near Common Wealth Games (CWG 2010) site in Delhi and a comprehensive noise abatement plan proposed growing of a 30 m wide vegetation belt of small trees (av. ht, 5 m) planted along the slope of railway embankment effective in providing an average 5-8 dB (A) sound attenuation for train noise. However, a dense but smaller width of plants (5 m) planted behind a concrete wall (ht, 1.5 m) facing the highway cause an effective sound attenuation of 8-10 dB (A).

Delhi can boast of an uninterrupted history of official patronage to maintain its horticultural diversity since the time of imperial days. The commonest trees of Delhi include ashok, neem, amaltas, jamun, semul, siris and gulmohar. Thus, exploiting natural vegetation available along with earth berms and tress planted in staggered rows with shrubs planted under trees so as to provide visual screening could effectively reduce traffic noise by 3-5 dB(A). Various vegetative species could be instrumental for reducing traffic noise. Ornamental and evergreen trees can be preferred in city to enhance aesthetics of surroundings, while foliage trees can be used to decorate pavements and road dividers.

### Conclusions

Design aspects and passive noise control strategies are presented for accomplishing noise abatement programme. A design morphology and DM using TOPSIS approach for selection of best practicable noise barrier in a particular area is presented. Apart from scientific solutions, administrative measures for noise zoning of areas, restrictions in horn noise, efficient traffic management and restricted entry of heavy vehicles in residential areas for removing traffic congestion are required. Regulatory incentives at least twice in a year can also be useful for road traffic noise mitigation. Responsible public attitude and strict implementation of noise ordinances formulated by CPCB can be a major

| Table 3—Vegetative noise barriers for urban noise abatement

<table>
<thead>
<tr>
<th>Trees</th>
<th>Shrubs</th>
<th>Ornamental grasses &amp; plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakul (<em>Mimusops elengi</em>)</td>
<td>Bougainvillea</td>
<td>Upland Sea Oats</td>
</tr>
<tr>
<td>Banyan (<em>Ficus bengalensis</em>)</td>
<td>(Bougainvillea <em>spectabilis</em>)</td>
<td>(Chasmanthium latifolium)</td>
</tr>
<tr>
<td>Bher (<em>Zizyphus mauritiana</em>)</td>
<td>Basak (<em>Adhatoda vasica</em>)</td>
<td>Pampas Grass</td>
</tr>
<tr>
<td>Ashoka (<em>Polyalthia longifolia</em>)</td>
<td>Croton (<em>Croton devaricata</em>)</td>
<td>(<em>Cortaderia selloana</em>)</td>
</tr>
<tr>
<td>Anujar (<em>Ficus carica</em>)</td>
<td>Mussaenda</td>
<td>(Dwarf Pampas Grass)</td>
</tr>
<tr>
<td>Gul Mohr (<em>Delonix regia</em>)</td>
<td>(Mussaenda <em>erythrophylla</em>)</td>
<td>(*Cortaderia selloana ‘Nana’)</td>
</tr>
<tr>
<td>Tulip (<em>Thespesia populnea</em>)</td>
<td>Rangon (<em>Ixora coccinea</em>)</td>
<td>Porcupine Grass</td>
</tr>
<tr>
<td>Kadampan</td>
<td>Tagar</td>
<td>(*Miscanthus Sinensis ‘Strictus’)</td>
</tr>
<tr>
<td>(Anceophalus cadamba)</td>
<td>(Tabernaemontana coronaria)</td>
<td>Zebra Grass</td>
</tr>
<tr>
<td>Neem (<em>Azadirachta indica</em>)</td>
<td>Tecoma (<em>Tecoma stans</em>)</td>
<td>(*Miscanthus Sinensis ‘Zebrinus’)</td>
</tr>
<tr>
<td>Pipal (<em>Ficus religiosa</em>)</td>
<td>Lantana (<em>Lantana camara</em>)</td>
<td>Switch Grass</td>
</tr>
<tr>
<td>Tamardin (<em>Tamarindus indica</em>)</td>
<td>Carrisa Holly</td>
<td>(Panicum virgatum)</td>
</tr>
<tr>
<td>Siris (<em>Albizia lebbek</em>)</td>
<td>(Ilex cornuta ‘Carissa’)</td>
<td>Putranjeva roxburghi</td>
</tr>
<tr>
<td>Atlas Cedar (<em>Cedrus atlantica</em>)</td>
<td>Dwarf Chinese</td>
<td>Cestrum nocturnum</td>
</tr>
<tr>
<td>Deodar Cedar (<em>Cedrus deodara</em>)</td>
<td>(Ilex cornuta ‘Rotunda’)</td>
<td>Hibiscus rosasinensis</td>
</tr>
<tr>
<td>Arizona Cypress</td>
<td>Fortunes Osmanthus</td>
<td>Murraya peniculata</td>
</tr>
<tr>
<td>(<em>Cupressus arizonica</em>)</td>
<td>(Osmanthus <em>s fortunei</em>)</td>
<td>Ficus benjamina</td>
</tr>
<tr>
<td>Common Chinafir</td>
<td>Dwarf Burford</td>
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<tr>
<td>(<em>Cunninghamia lanceolata</em>)</td>
<td>(Ilex cornuta ‘Dwarf Burford’)</td>
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<tr>
<td>White Pine (<em>Pinus strobus</em>)</td>
<td>Dwarf Yaupon</td>
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<tr>
<td>Virginia Pine (<em>Pinus virginiana</em>)</td>
<td>(Ilex vomitoria ‘Nana’)</td>
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<tr>
<td>Leyland cypress</td>
<td>Pfitzer Juniper</td>
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</tr>
<tr>
<td>(<em>Cupressocyparis leylandii</em>)</td>
<td>(Juniper chinensis ‘Pfitzeriana’)</td>
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<tr>
<td>Pinus taeda (<em>loblolly Pine</em>)</td>
<td>Chinese Loropetalum</td>
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<tr>
<td>Sweetbay Magnolia</td>
<td>(Loropetalum chinensis)</td>
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<tr>
<td>(<em>Magnolia virginiana</em>)</td>
<td>Dwarf Waxmyrtle</td>
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</tr>
<tr>
<td>Dawn Redwood</td>
<td>(Myrica cerifera ‘pumilla’)</td>
<td></td>
</tr>
<tr>
<td>(<em>Metasequoia glyptostroboides</em>)</td>
<td>Madhabilata (<em>Quisqualis indica</em>)</td>
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</table>
landmark in victory against accentuated traffic noise levels in metro cities like Delhi. A noise abatement goal in line with Nordic and Dutch perspectives of decreasing the number of houses exposed to a noise level > 70 dB (A) by 100% and number exposed to a noise level > 65 dB (A) by 90% by next decade is to be strictly adopted for tackling adverse effects of alarming increase in population and vehicular density in Indian scenario.

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