Road Traffic Noise Pollution Reduction by Barriers: A Review

Kanakabandi Shalini[1], Brind Kumar[2]
[1,2]Department of Civil Engineering
Indian Institute of Technology (BHU), Varanasi, Varanasi-221005, U.P, India

ABSTRACT

Noise contamination owing to transportation in cities is one of the most important environmental health consequences that must be solved. Traffic noise is one of the significant sources of the noise in cities compared to the other sources such as industrial noise, airport noise and community noise. It will be a larger and serious social problem in the future if effective precautions are not taken accordingly. In recent years, noise control by barriers has become a common measure of environmental protection. Construction of noise barriers between the roadways and the affected receivers would reduce noise levels by physically blocking the transmission of traffic-generated noise. In this method, the noise at the receiver is reduced to the smaller portion which arrives via diffraction over the barrier top or around its ends, via reflection from other buildings, and via scattering and refraction in the atmosphere. It is usually reduce the traffic sound levels at nearby locations by between 5 and 10 dB(A) and occasionally by even less and barrier performance can generally be improved by increasing their height. The purpose of this paper is to discuss the road traffic noise reduction by barriers.

Keywords: Noise, Traffic noise, Diffraction, Noise barriers, Height

1. INTRODUCTION

Noise, an ubiquitous environmental pollutant, is a public-health issue because it leads to annoyance, reduces environmental quality, and might affect health and cognition. The sources responsible for noise pollution are traffic noise, industrial noise, construction activities, and community noise. Traffic noise is one of the significant sources of the noise compared to the other sources. Traffic noise, itself, is categorized in four major groups: vehicular noise, airport noise, railway noise, and seaport noise. Vehicular traffic noise source includes all the vehicles in roads and streets of a city: cars, vans, trucks, buses, motorcycles, etc. This type of noise pollution is considered one of the most invasive types of noise pollution [11]. It will be a larger and serious social problem in the future if effective precautions are not taken accordingly. Investigations in different countries in the past several decades have shown that noise affect different activities badly and cause sleep disturbances and a poorer life quality. Therefore, there is an essential need to control the noise induced by road traffic [3].

There are several options that can be used to reduce the traffic noise. These include traffic management, highway design, poroelastic road surface and noise barriers. In recent years, noise control by barriers has become a common measure of environmental protection. Construction of noise barriers between the roadways and the affected receivers would reduce noise levels by physically blocking the transmission of traffic-generated noise. The current article briefly reviews the road traffic noise reduction by using barriers.

2. METHODOLOGY

Traffic noise control by barriers has become a common measure of environmental protection. Traffic noise from roads, can be shielded by a barrier, which intercepts the line-of-sight from the source to a receiver. Noise barriers are typically constructed of cast-in-place concrete or masonry block. In some areas, where space allows and soil material is available, earth berms are constructed as noise barriers.

In the barriers the noise at the receiver is reduced to the smaller portion which arrives via diffraction over the barrier top or around its ends, via reflection from other buildings, and via scattering and refraction in the atmosphere. In addition to the measurable acoustical effect, there is much evidence that the visual shielding of the noise source by a barrier has a considerable psychological effect [6]. A schematic diagram of noise barrier is given in figure 1.

An efficient sound barrier must shield the receiver against the predominant portion of the sound energy radiated from the source and directed toward the reception point. At the same time it has to be acceptable in its visual appearance, structural stability and cost, and from the viewpoints of safety and access [6].

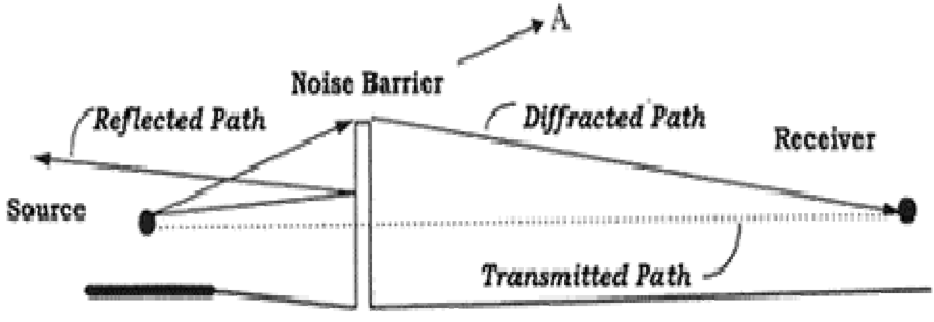

Figure 1: Noise barrier

3. LITERATURE ON ROAD TRAFFIC NOISE REDUCTION BY BARRIERS

May (1980) study the two major sound paths between a highway and receivers when a noise barrier is interposed: over-barrier sound (i.e., diffracted) and through-barrier sound (i.e., transmitted). They reported the procedure to maximize the benefit/cost of highway noise barriers. They reported for steel noise barrier, the optimum surface mass density is 7.5 to 15 kg/m^2 for barrier heights of 3 to 6 m respectively.

May and Osman (1980a) used various barriers were thin, wide, T-profiled, cylindrically topped, corrugated, inclined, Y-profiled, arrow-profiled and of the thnadner principle, and some were treated with sound absorptive material. They reported that higher noise reduction was found for wide top barriers, especially those of T-profile, and especially T-profile absorptive top barriers with cap widths of 0.6 m (2 ft) or more and of small cap thickness for the single barrier, protected receiver case. Absorptive side treatment was effective in reducing a small, but measurable sound increase found when a reflective sided barrier is installed.

May and Osman (1980 b) used 4 m high highway noise barrier in Toronto was tested first with an absorptive side, second with a reflective side, and finally with a horizontal cap 75 cm (30 in) wide mounted on its top to create a T-profile. They reported that T-profile barrier to produce a noise reduction 1-1.5 dB(A) greater than the same barrier without the cap. There was no statistically significant difference between the noise reductions produced by the absorptive and the reflective configurations.

Hothersall et al. (1991) presented a report on experimental modeling and field measurement of the insertion loss produced by T-, Y- and arrow-profile noise barriers. They reported that the introduction of absorbing upper surfaces produces a significant increase in insertion loss. The Y- and arrow-profiles perform less efficiently than the T-profile. The marked increase in barrier efficiency when a very thin narrow cap is added to a vertical wall which has been reported by other workers was not observed.

Watts et al. (1994) used T-shape, multi edge barriers, and double barriers for traffic noise reduction. They reported that the average increase in acoustic screening of 2 m high T-shaped, multiple edge and double barriers compared with a simple plane reflecting barrier of identical overall height ranged from 1.4 to 3.6 dB(A) depending on detailed design.

Crombie et al. (1995) used a boundary element model technique which enables the insertion loss for various noise barriers of complex profile and surface cover. The model is applied to single-foundation noise barriers to which additional side-panels are added to create fork-like profiles.

They concluded that multiple-edged barriers show a significant increase in acoustic efficiency over a simple vertical screen. This type of barrier would also allow the height of the construction to be kept to a minimum.

Watts and Morgan (1996) used sound-interference- type barrier profile which has been added to an existing noise barrier for screening traffic noise and modeled with the boundary element method approach. They reported that when the additional height of the barrier is taken into account the device provides an estimated gain in average screening performance of 1.9 dB(A) of which 0.7 dB(A) is considered to be due to an interference effect.

Watts (1996) used reflective traffic noise barriers. They reported that the screening performance of a single 2 m high barrier on the nearside is reduced by 4 dB(A) when a reflective barrier of similar height is erected at the edge of the far side carriageway. Both sound absorptive barriers and tilted barriers were found to be effective in counteracting the degradation in single barrier performance resulting from unwanted reflected paths.

Fujiwara et al. (1998) used three different surfaces (rectangular, T-shaped and cylindrical edge barriers) as a barrier. These were: a rigid surface, absorbing surface, soft surface and a two-dimensional boundary element model has been used to calculate the insertion loss of barriers. They reported that the most efficient design was a T-shape with an upper surface which was soft for all frequencies. This produced an improvement in mean insertion loss over that for a plane screen of 8.3 dB(A).

Watts and Godfrey (1999) used sound absorptive materials for reducing noise reflected from noise barriers. They reported that the maximum reduced sound 2.1 dB(A) was recorded at a site with parallel barriers 3.7 m high set 34 m apart.

Ishizuka and Fujiwara (2004) performed the experiments with barriers having different shapes and surface conditions and tested using the boundary element method in a well-controlled environment. They found that absorbing and soft edges significantly improve the efficiency of the barrier, but configuration modifications provide only a slight improvement. The soft T-shaped barrier produces the highest performance. A 3 m high T-shaped barrier provides the same performance as a 10 m high plain barrier.

Mun and Cho (2009) used simulated annealing algorithm to optimize the noise barrier parameters like material and construction costs, as well as satisfying the target sound pressure levels at receiver points on the condition of traffic noise.

4. CONCLUSION

Barrier is alternative method to reduce the road traffic noise. The study provided a summary of noise barrier profiles, identified the types of barriers commonly used in practice. It is usually reduce the traffic sound levels at nearby locations by between 5 and 10 dB(A) and barrier performance can generally be improved by increasing their height. Absorber barrier reduces noise by absorbing noise and eliminating reflected noise off the face of the barrier. In addition, since the absorptive material is applied up to the top edge of the barrier, the diffracted noise over the top of the barrier is also reduced. Other studies have been conducted on barrier designs, usually involving scale model testing or mathematical calculations of noise reduction benefits. Finally concluded that a sound barrier, eventually, will become part of the surrounding landscape and improved in sleeping conditions is the most appreciated positive effect of the barrier. On the other hand, the loss of sunlight and visual dominance were the most negative impacts.

REFERENCES

[1] Crombie, D. H., Hothersall, D. C., & Chandler-Wilde, S. N. (1995). Multiple-edge noise barriers. Applied acoustics, 44(4), 353-367.

[2] Fujiwara, K., Hothersall, D. C., & Kim, C. H. (1998). Noise barriers with reactive surfaces. Applied acoustics, 53(4), 255-272.

[3] Gundogdu, O., Gokdag, M., & Yuksel, F. (2005). A traffic noise prediction method based on vehicle composition using genetic algorithms. Applied acoustics, 66(7), 799-809.

[4] Hothersall, D. C., Chandler-Wilde, S. N., & Hajmirzae, M. N. (1991). Efficiency of single noise barriers. Journal of Sound and Vibration, 146(2), 303-322.

[5] Ishizuka, T., & Fujiwara, K. (2004). Performance of noise barriers with various edge shapes and acoustical conditions. Applied Acoustics, 65(2), 125-141.

[6] Kurze, U. J. (1974). Noise reduction by barriers, The Journal of the Acoustical Society of America, 55, 504.

[7] May, D. N. (1980). The optimum weight of highway noise barriers. Journal of Sound and Vibration, 68(1), 1-13.

[8] May, D. N., & Osman, N. M. (1980 a). Highway noise barriers: new shapes. Journal of Sound and Vibration, 71(1), 73-101.

[9] May, D. N., & Osman, M. M. (1980 b). The performance of sound absorptive, reflective, and T-profile noise barriers in Toronto. Journal of Sound and Vibration, 71(1), 65-71.

[10] Mun, S., & Cho, Y. H. (2009). Noise barrier optimization using a simulated annealing algorithm. Applied Acoustics, 70(8), 1094-1098.

[11] Rahmani, S., Mousavi, S. M., & Kamali, M. J. (2011). Modeling of road-traffic noise with the use of genetic algorithm. Applied Soft Computing, 11(1), 1008-1013.

[12] Watts, G. R., Crombie, D. H., & Hothersall, D. C. (1994). Acoustic performance of new designs of traffic noise barriers: full scale tests. Journal of Sound and Vibration, 177(3), 289-305.

[13] Watts, G. R., & Morgan, P. A. (1996). Acoustic performance of an interference-type noise-barrier profile. Applied Acoustics, 49(1), 1-16.

[14] Watts, G. R. (1996). Acoustic performance of parallel traffic noise barriers. Applied Acoustics, 47(2), 95-119.

[15] Watts, G. R., & Godfrey, N. S. (1999). Effects on roadside noise levels of sound absorptive materials in noise barriers. Applied Acoustics, 58(4), 385-402.