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NOISE CONTROL FOR A BETTER ENVIRONMENT

Land Traffic Noise Management at Recipient's End in Singapore

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ABSTRACT

With rising urban density and competing land uses for economic and transport activities, residents in Singapore are being exposed to more noise. At the same time, there is growing public expectation of a quieter living environment. Singapore has implemented a noise management framework [1] which includes a set of noise standards and guidelines to protect public health and minimise nuisance. The National Environment Agency (NEA) ensures that noise impacts are factored into land use planning and design of proposed developments through land traffic noise impact assessment. In Jul 2016, a set of technical guidelines for land traffic noise impact assessment [2] was introduced for residential and noise sensitive developments that are in close proximity to road and rail infrastructures. Residential and noise sensitive developments should be designed to meet the noise limits required in the technical guidelines. If the development is unable to comply with the noise limits, mitigation measures will have to be implemented.

This paper provides some of the mitigation measures that are being explored at source, pathway and recipient's end under natural ventilated condition to achieve a conducive living environment. It also shares the approach taken to manage public expectations on traffic noise nuisance.

Keywords: Traffic Noise, Land Traffic,
I-INCE Classification of Subject Number: 30

1. INTRODUCTION

Singapore is an island city state of about 724 square kilometres [3]. We have a population of 5.6 million and a population density of about 7,804 per square kilometre [3]. In this island state, we have about 9,293 lane-km of expressways, major arterial and collector and local access roads as well as 228 km of mass rapid transit (MRT) and light rail transit (LRT) rail lines [3]. We have also close to a million vehicle population.

As urban development in Singapore continues to increase to cater to increasing population, buildings for residential, schools, hospital etc. are built closer to expressways, major arterial roads and MRT tracks. Improvement to accessibility for the public through expansion in transport infrastructure has also contributed to the land traffic noise in Singapore. As part of the Singapore government's continuous effort to provide a conducive living environment amidst developments, we had implemented measures to manage noise from the land traffic and to be future ready to meet growing public expectation of a quieter living environment.

2. LAND TRAFFIC NOISE MANAGEMENT

Land traffic noise management in Singapore consists of (i) enforcement and requirements, (ii) mitigation measures at source, pathway and recipient's end; (iii) managing public expectation.

2.1 Enforcement and Requirements

Vehicular noise emission control is an essential part of the urban noise management. Regulatory noise limits are imposed on new and in-use motor vehicles. Regular checks or enforcement actions are conducted to ensure that the vehicles are maintained properly. Tables 1a and 1b below are the set of noise limits imposed on new and in-use motor vehicles [4] respectively.

Table 1a: Standard for Noise Emission for New Motor Vehicles

Class of Vehicle	Noise Level in Decibels (A)	Standard for exhaust noise emission
(a) Motor cycle (with or without a side car), scooter or trivan	94	(i) Directive 97/24/EC of the European Parliament and of the Council of 17th June 1997 on certain components and characteristics of 2 or three-wheel motor vehicles; or (ii) Articles 30 and 65 of the Safety Regulations for Road Vehicles as amended by the Ministry of Transport Ordinance No. 5 of 21st February 2000 and No. 66 of 20th December 1996, respectively, of Japan
(b) Motor car, taxi or station engine is at wagon (whether rear end) for passengers only or for goods and passengers)	96 or (if the engine is at rear end) 100	(i) EC Council Directive 70/157/EEC of 6th February 1970 as last amended by Commission Directive 96/20/EC of 27th Mar 1996; or (ii) Articles 30 and 65 of the Safety Regulations for Road Vehicles as amended by the Ministry of Transport Ordinance No. 5 of 21st February 2000 and No. 66 of 20th December 1996, respectively, of Japan
(c) Goods vehicle or bus with gross vehicle weight not exceeding 3.5 tons	97	
(d) Goods vehicle or bus with gross vehicle weight exceeding 3.5 tons	99	

Table 1b: Noise Limits for In-use Motor Vehicles

Standard for Noise Emission for In-use Licensed Motor Vehicles Registered before 1st Jul 1999	
Class of Vehicle	Noise level in Decibels (A)
(a) Motor cycle (with or without a side car), scooter or trivan	106
(b) Motor car, taxi or station wagon (whether for passengers only or for goods and passengers)	105
(c) Light goods vehicle	109
(d) Goods vehicle or bus with engine capacity not exceeding 10,000 cubic centimeters	113
(e) Goods vehicle or bus with an engine capacity exceeding 10,000 cubic centimeters	115
Standard for Noise Emission for All In-Use Motor Vehicles Other than Licenced Motor Vehicles Registered before 1st Jul 1999	
Class of Vehicle	Noise level in Decibels (A)
(a) Motor cycle (with or without a side car), scooter or trivan	99
(b) Motor car, taxi or station wagon (whether for passengers only or for goods and passengers)	103
(c) Goods vehicle or bus with gross vehicle weight not exceeding 3.5 tons	103
(d) Goods vehicle or bus with gross vehicle weight exceeding 3.5 tons	107

While we control noise emission from each vehicle. there are other components of road traffic noise such as road and tires interaction, travelling speed, road paving material, etc. Hence, we had implemented in Jul 2016 a set of technical guidelines for land traffic noise impact assessment [2] applicable to new residential and noise sensitive developments that are in close proximity to road and rail infrastructures. The noise levels at any façade of the buildings of new residential and noise sensitive development to be within the noise level of 67 dBA (Leq 1 hour) and the indoor noise level to be within the noise level of 57 dBA (Leq 1 hour) under natural ventilation. These guidelines are also applicable to new transport-related developments including expansion of existing transport-related infrastructures.

New residential and noise sensitive developments are required to study the impact of the road traffic noise to their development while new transport-related developments are required to study the impact of their development to neighbouring residential and noise sensitive development. The noise assessment includes baseline noise monitoring at the site and to model the predicted noise on the facade and indoor under natural ventilated condition to determine whether their development could meet the noise limits stipulated in the technical guidelines. If the development is unable to meet the noise limits, mitigation measures will have to be implemented.

2.2 Mitigation Measures for Land Traffic Noise Implemented in Singapore at Source, Pathway and Recipient's end

Mitigation at Source

Singapore Land Transport Authority (LTA) has been conducting trial to develop and implement low-noise surfacing on the roads [5]. The trial is to study whether the inclusion of material such as latex or rubber into current asphalt mix is effective in reducing traffic noise at source.

Mitigation along Pathway

LTA had built noise barriers at selected above ground MRT tracks to reduce passing railway noise [6]. They had also work with train operators to mitigate railway noise through the fitting trains with noise-damping wheels, using ballast and concrete sleepers for better absorption of noise, increasing the frequency of servicing the train wheels and tracks. LTA has also been conducting trial to test the effectiveness of noise barriers along at-grade roads with high traffic volume and noise levels [5].

Figure 1: Noise Barriers at above ground MRT track

The noise mitigation along pathway also include siting noise tolerant buildings to shield residential buildings from land traffic noise. One example of such building is multiple storey car park (MSCP) in public housing developments.

Figure 2: Using noise tolerant buidling as shielding (e.g. MSCP)

Mitigation at Recipient's end

a) Layout of Building

One of the approach taken is to minimise the line of sight for the openings of the noise sensitive uses in a residential development from the noise sources. It is recommended that gable end wall to face the noise source to minimise the noise intrusion into the residential units, particularly the bedrooms and living room. This approach has been taken by some residential developments in Singapore.

Figure 3: Adopting gable end wall fronting the noise sources

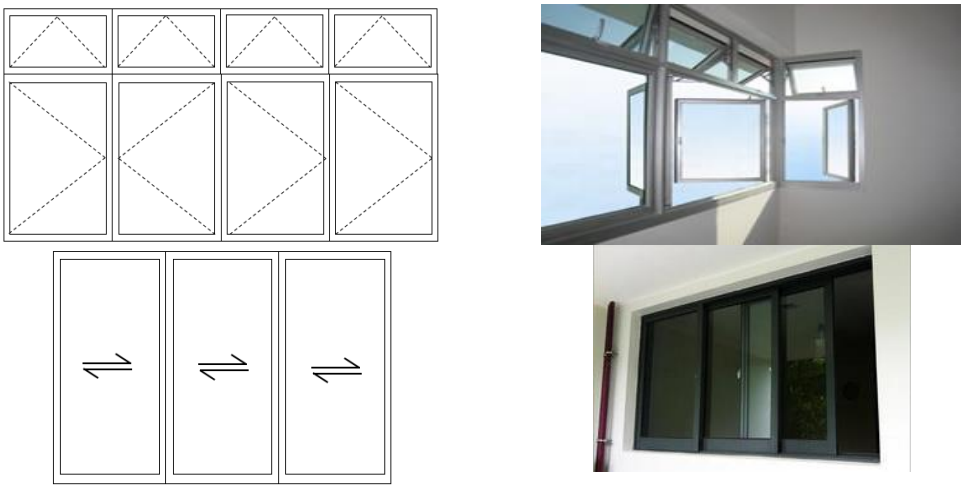
b) Secondary Facade

Another approach taken is the use of secondary façade which is incorporated into the design of the development. It acts as a noise barrier to reduce the noise transmission into indoor spaces. This had been implemented in some developments and the noise reduction from façade to indoor under natural ventilation condition is 15-18 dB.

Figure 4: Secondary façade in development - nursing home (Top Row), residential building (Botteom Row)

c) Window Configuration

Window is a significant factor in mitigating noise from land traffic at the recipient's end as majority of traffic noise enters the interior of residential building through window. We have studied the "insertion loss" performance of different type of window configuration (such as double layer windows, double layer with laminated glass, double layer with bottom hung windows, double layer with fins, a noise lock and service yard). The study showed that the double layer with bottom hung window configuration was the most effective which can provide 1-3 dB noise reduction.



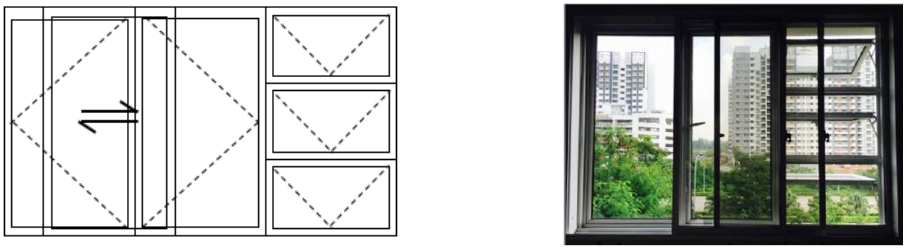


Figure 5: Examples of different window configuration in public housing (i) casement window and a row of top hung window (top), (ii) sliding window (second row), (iii) double layer consisting of casement, sliding and top hung windows (third row)

d) *Acoustic Ceilings*

Acoustic ceilings are installed in balconies of residential developments affected to mitigate road traffic noise. It consists of sound absorbing material to reduce the reflection of noise into the living spaces and estimated noise reduction is approximately 3 dB.

Figure 6: Acoustic ceilings on balconies in residential development

e) *Restrictors*

Residential development had also installed restrictors to restrict the window opening and sliding door opening to minimise the noise intrusion from external to internal spaces. The restricted openings have to meet the natural ventilation requirement required by Singapore Building and Construction Authority (BCA). The restricted opening typically yields a noise reduction of 1-3 dB.

Figure 7: Window restrictor on the windows

f) *Installation of barrier at balcony*

The barrier with no gaps at balcony serves to reflect noise and reduce the noise transmission into the balcony and living spaces. The noise reduction is about 4 dB at balcony.

Figure 8: Glass barrier at balcony in residential development

g) *Acoustic Blinds*

Acoustic blinds are installed in living spaces of the residential units. These blinds are made of sound absorbing material to reduce noise from entering the units and estimated noise reduction is about 3-5 dB depending on the density of the acoustic blinds.

Figure 9: Acoustic blind in residential development

It is often that one mitigation measure at the recipients' end would not be sufficient to reduce the land traffic noise impact sufficiently to meet the noise requirement. Multiple mitigation measures have to be applied concurrently to achieved higher reduction. At times, noise mitigation measures have to be implemented at recipients' end, pathway and also at source to meet the noise requirement.

2.3 Managing public expectation

As noise annoyance is subjective, despite the efforts from the various government agencies to reduce traffic noise impact on residential developments discussed in the earlier sections, there would be some residents affected by the land traffic noise.

Developers play an important role in managing residents' expectations regarding traffic noise. Estate agents representing the developer could inform potential buyers of units close to noise sources of potential noise nuisance. This would allow buyers to make informed decision on whether to proceed with the purchases if they are concerned that the land traffic noise would affect them. Contractually, developers should also consider stating information relating to traffic noise in the Sales and Purchase agreement, sales brochure and website of the proposed development.

3. SUMMARY

While this paper provided some of the mitigation measures that were explored at source, pathway and recipient's end under natural ventilated condition to achieve a conducive living environment, there are challenges ahead. As the urban density continues to rise and economic and transport activities continue to intensify, residents in Singapore are expected to be exposed to more noise nuisance in the coming years. Due to the growing public expectation for a quieter living environment, there is a need to manage public feedback on traffic noise nuisance. We will continue to look for innovative solutions and strategies to manage land traffic noise.

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