Experience on the Use of Low Noise Road Surface to Reduce Road Traffic Noise in Hong Kong

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For Hong Kong, similar to other metropolitans, the major environmental noise problem encountered is excessive road traffic noise. In addition to landuse planning and appropriate road alignment selection, engineering solutions, such as barriers and low noise road surface, are the most common approaches adopted to minimize road traffic noise. However, installation of barriers in Hong Kong is often constrained by various factors, e.g., space requirement and social or aesthetic considerations. Paving of low noise road surface, though with a less noise reduction, would have a definite advantage over barriers on many situations. Nonetheless, the heavy traffic conditions and general road topography leading to a short life span of the surface limits the wide application of this approach in Hong Kong. It is generally found that paving of low noise road surface material on high speed road (with speed limit > 70 km/hr) would help to reduce about 5 dB(A) at the receiver end. However, the average life span of such surface is about 6 years and the noise reduction would greatly deteriorate to about 1 dB(A) near the end of its life span. This paper summarizes the experience gained in Hong Kong, i.e., the noise reduction achieved and the durability problems, and the possible way forward.

1 Introduction

Similar to other metropolitans, traffic noise is the major environmental noise problems encountered in Hong Kong. Over 1 million people (about 16% of the population) are exposed to traffic noise level above 70 dB(A)(L10(1hr)) (the planning standard for new roads in Hong Kong). Pre-emptive planning, through better landuse planning, use of mass transportation, alternative road alignment and tunnelling, is the primary approach to prevent the problem from occurring. However, because of the land scarcity and the compact environment in Hong Kong, it is not always possible to have sufficient separation between sensitive receivers and major roads. Direct mitigation measures at source, e.g., barriers and low noise road surface, are always required in order to abate or minimize the disturbance.

As shown in Figure 1, the practicability and effectiveness of barriers/enclosures installation is always constrained by the Hong Kong compact environment and close proximity between high-rise residential buildings and major roads. For most of the areas in Hong Kong, installation of barriers is technically infeasible because of fire fighting, space and traffic safety consideration. The barrier should be of good aesthetic design if it is to be accepted by the public. Paving of low noise materials is a promising alternative approach to reduce the traffic noise exposure.

Figure 1 Complex noise environment in Hong Kong
There are already a number of examples on the noise reduction effectiveness of porous road surface materials in overseas countries. Nonetheless, the application of porous road surface in Hong Kong is seriously constrained. Majority of roads in Hong Kong are of relatively steep gradient (for which the engine noise would contribute more than that for level road) and there are frequent starts and stops due to road junctions and traffic lights. This would significantly degrade the possible noise reduction achieved as compared with a level road with free flow traffic as in overseas countries. On road maintenance aspect (i.e. durability of the materials), due to the hot and humid climates, as well as high traffic volume flow and high % of heavy vehicles, such porous material is subject to rutting and rapid wear off and frequent resurfacing is required.

This paper illustrates the experience gained in Hong Kong for applying this kind of low noise materials to high speed roads and extending its application to urban local roads.

## 2 Paving of low noise materials on high speed roads

In November 1987, low noise material was first applied in Hong Kong on a portion of major trunk flyover (called Island Eastern Corridor with speed limit of 70 km/hr), with a length of about 300 m long, for trial. Figure 2 shows the road section under trial and the surrounding environment. The flyover is initially of brushed concrete surface carrying some 55,000 vehicles daily with the percentage of heavy vehicles of about 25%. The trial overlay primarily consists of a 50 mm thick polymer modified friction course (30 mm thick open textured macadam surface above a 20 mm thick asphapol cushion course). The low noise materials contain about 18 % to 25 % air voids.

The reduction effect was measured by comparing the noise levels (in $L_{10}(1hr)$) at two locations neighbouring the road, one with road section paved with low noise materials and the other without. Figure 3 shows the locations of the 2 measurement points.

Five rounds of comparative measurements were made at about 1 month, 1/2 year, 2 years, 4 years and 5 years after the completion of resurfacing work. It was found that there would be around 5 dB(A) reduction, as compared with the original brushed concrete surface, when the low noise material was freshly laid, but deteriorated to approximately 1 dB(A) after five years [1,2]. Figure 4 shows the deterioration of noise reduction effect of the polymer modified friction course against time. Also, the maintenance records indicate that service life of friction course on high speed roads is around 5 years [3].

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**Figure 2** Road section of Island Eastern Corridor under trial

**Figure 3** Locations of noise measurement points

**Figure 4** Noise reduction characteristic of polymer modified friction course
Subsequent to the trial, the Environmental Protection Department commissioned a programme to resurface suitable high speed road sections with free flow traffic running at 70 km/hr or above with polymer modified friction course to reduce the traffic noise exposure of the neighbouring residential developments. The programme was completed in 1999 with 11 kilometres of highways resurfaced, benefiting about 16,000 homes. To realise the full noise reduction benefits from resurfacing work, the roads under consideration must meet with the following criteria [5]:

i) The road should be relatively level (otherwise engine noise will dominate);

ii) The road should originally be paved with brushed concrete or other similar non-open textured surface (producing a high level of tyre/road noise);

iii) The road must carry smooth high speed traffic (where tyre/road noise will be a problem) with a low percentage of heavy vehicles; and

iv) The traffic noise from the road is a dominant noise source (reducing which will become tangible).

As a current practice, the polymer modified friction course is used as a standard road surface paving materials for new high speed roads.

### 3 Applications of low noise materials to low speed roads

Besides expressways/highways, other countries also apply friction course on low speed roads (with speed limit of 50km/hr or less) for noise reduction purpose. Polymer modified friction course, however, is not a structural layer and is susceptible to damage when subjected to the acceleration, braking, turning and parking movements commonly found on low speed local roads.

In order to study the practical problems and cost effectiveness on the use of polymer modified friction course as noise mitigation measure on low speed roads, a study was carried out in 1995 for laying 4 different mixes of friction course materials on 5 road sections [3, 4]. Detail composition of the different mixes is shown in Table 1.

| Material A | 30mm thick 10mm nominal size polymer modified friction course on 45mm thick wearing course |
| Material B | 30mm thick 14mm nominal size polymer modified friction course on 45mm thick wearing course |
| Material C | 50mm thick 20mm nominal size polymer modified friction course on 45mm thick wearing course |
| Material D | 30mm thick 10mm nominal size polymer modified friction course on 50mm thick 20mm nominal size polymer modified friction course on 45mm thick wearing course |

During the trial, the noise reduction effect was observed for a period of 2 years, while the durability of the different friction course materials was checked for a period of 3 years. The trial study results found that a maximum of 4dB(A) reduction, immediately after laying of friction course, was measured at some road sections. However, the noise reduction dropped sharply, without any major pavement defects observed, after 12 months’ time. Major pavement defects were observed about 18 months after laying and the noise reduction eventually dropped to about 1.5dB(A) at the end of the 24-month period.

Based on the results of the study, it was found that a particular mix of friction course (30mm thick 10mm nominal size polymer modified friction course on 45mm thick wearing course) could be applied for low speed roads subject to the following conditions [3, 4]:

i) Not on inclined roads;

ii) No sharp bend in road geometry;

iii) Average annual daily traffic not exceeding 18,500 in traffic volume and percentage of commercial vehicles not exceeding 35 %; and

iv) Not on roads where a minimum crossfall of 2.5 % cannot be practically achieved to drain water to the roadside gullies effectively (for minimizing occurrence of flooding in the porous friction course material).

Currently, the government, with the introduction of a new policy in 2000 to retrofit barrier/enclosure on existing roads, has launched a programme to resurface...
about 70 local low speed roads with polymer modified friction course in order to reduce the road traffic noise experienced by the nearby residents. The programme was started in 2002 and was expected to complete in 2010, benefitting about 40,000 dwellings. Nonetheless, this will mean that quite a number of them may need to be resurfaced once every 2-3 years, while resurfacing for normal asphalt will be once every 6 years.

4 Considerations of other noise reducing road surfacing materials

4.1 Trial of Stone Mastic Asphalt

In addition to the polymer modified friction course, the Highways Department have considered the applicability of other possible noise reducing road surfacing materials. There have been trials of in some other countries that Stone Mastic Asphalt, which provides good skidding resistance at all speeds and facilitates the drainage of surface water, is quieter than traditional bituminous surfacing by about 2-3 dB(A).

A trial was carried out in Hong Kong on 2 local road sections, one at Lung Cheung Road and the other at Siu Lek Yuen Road. A noise reduction of about 1 to 3dB(A) was recorded immediately after the laying. The reduction dropped significantly with one of the road section dropped to about 0.4dB(A) at about 12 months after the laying. Meanwhile, road defects, e.g. pothole and flushing, were observed about 14 to 16 months after laying [4]. Further trial has to be made before using it as a noise reducing road surfacing material in Hong Kong.

4.2 Other potential noise reducing road surfacing materials

Two other types of noise reducing surfacing materials, i.e. Exposed Aggregate Concrete Surface (commonly known as ‘whisper concrete’) and proprietary thin surface layer, have been considered. For the whisper concrete, it requires the aggregate to have a minimum polished stone value, which is not available in the current local quarries. Meanwhile, the limited range of aggregate size available in the local market has also constrained the trial of other types of low noise materials in Hong Kong.

5 Conclusions

As noted in number of research or studies in overseas countries, low noise road surface material is a promising alternative noise mitigation measure to barrier/enclosure for reducing road traffic noise. However, it is their weak point that the reduction effect is normally not sufficiently high (i.e. normally less than 5dB(A)) and could not persist for a reasonable time. Given the hot and humid climate in Hong Kong and the general road geometry, such materials would generally be subject to rapid wear and tear. The frequent maintenance would be costly and cause significant disturbance to the road users, shop operators and the nearby residents, especially when carried out during night-time. The Environmental Protection Department would keep in view of the development in overseas countries and arrange for trial with highways Department in Hong Kong if new materials are found to be likely applicable in Hong Kong.

References