PLANNING AGAINST TRANSPORTATION NOISE IN A METROPOLIS

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1. INTRODUCTION

The design of residential developments is increasingly being influenced by the need to combat noise from transportation. Many sites with potential for residential developments in Hong Kong are contiguous to trunk roads, railways or under the aircraft flight path. The forthcoming large developments of the new airport, expressways, rail link, reclamations and harbour crossings need effective planning and control to minimize the noise impact on the community. In the coming years, increasingly stringent noise guidelines and a higher community expectation will form the main driving force for the developers to achieve a quiet environment.

This paper will discuss the noise mitigation methods including the use of barriers (Ref 1, 2), placement and design of buildings in new developments to combat transportation noise in Hong Kong.

2. NOISE AFFECTING COMMUNITY IN HONG KONG

The economic progress of Hong Kong in the past two decades has resulted in rapid changes of land use patterns within the metropolitan areas. New transportation noise sources have encroached towards established noise sensitive uses, resulting in potential environmental degradation. These include the road networks from urban areas to new towns and the elevated waterfront highway, which are located at 10 - 30m away from residential high rise buildings. Driven by land scarcity, new noise sensitive land uses are also being developed close to transportation systems. These conflicting land uses reflect the need for careful planning against transportation noise impact.

2.1 Traffic noise

Traffic noise is of the greatest concern as it affects the highest proportion of the population and represents a consistent source of complaint received by the Environmental Protection Department (EPD) over the years. Hong Kong's roads have one of the highest vehicle densities in the world with 350,000 licensed vehicles running on some 800 kilometres of roads. Recent transport studies have projected significant increases in the vehicle fleet and travel demand, which would outgrow the increase in road capacity between 1996 and 2001. The volume of traffic on some main roads will double by the year 2001. Even with an accelerated development of new roads, traffic noise levels will continue to increase. There are many practical limitations on the measures that can be taken to reduce traffic noise impact at source. Effective control must also focus on the planning aspects of housing developments.

2.2 Aircraft noise

The existing Hong Kong Kai Tak Airport is located well within the metropolitan core of Hong Kong. Aircraft operations, including ground activities, have caused much inconvenience and discomfort to the 500,000 persons in Kowloon and the north-east side

of the Hong Kong Island. The effect on schools is particularly severe with many schools being inside the NEF 30 contour. Over the last three years, the Government Noise Abatement Measures for Schools programme (Ref 3) has invested US$10 millions in acoustic treatment to 38 of these schools.

2.3 Train noise

The two major railways of Hong Kong have greatly eased the life of the 2.5 million Hong Kong commuters. There are however some concerns with regard to noise, particularly from the over-ground rail operations. Despite the efforts put into the rail and depot design, the scarcity of land has resulted in developments close to the tracks and land use incompatibility. This produces intractable noise and vibration problems, especially when the building designers, without realizing the inherent noise generating mechanisms associated with an operating railway, fail to provide sufficient mitigation measures to their structures.

3. NOISE CRITERIA

3.1 Traffic noise, aircraft noise and train noise

The noise criteria (Ref 4) used in Hong Kong in planning considerations are summarised below:-

(a) Road traffic noise: 70dB(A) L_{10} (1 hr) for domestic property;
(b) Rail noise : 65dB(A) L_{eq} (24 hr) and 85dB(A) L_{max} (2300 to 0700 hr); and
(c) Aircraft : NEF 30 for the existing Kai Tak International Airport and NEF 25 for the new Chap Lap Kok Airport.

The above apply to uses which rely on opened windows for ventilation. Whilst rail noise is under statutory control, additional criteria are given in Ref 4.

3.2 Comparison with the U.K. noise criteria

A single noise criterion of 70dB(A) L_{10} is used in Hong Kong when assessing a new residential development to be affected by road traffic. Whereas, in the U.K. four noise exposure categories have been introduced in the revised "Planning and Noise". A quick comparison between the two criteria may show that the road traffic noise criterion adopted in Hong Kong is close to the upper limit of the Noise Exposure Category "B" currently proposed in the U.K. This category is for authorities to assess development proposals where noise should be taken into account for determining planning applications and noise control measures. Road traffic noise levels for noise exposure category "B" are in the range 55 - 63 dB(A) L_{eq} (0700 - 2300 hrs). The 70dB(A) L_{10} noise limit used in Hong Kong requires that the facade noise level of the domestic property shall not be exceeded during the morning peak hour and the afternoon peak hour, in the light that noise levels during these periods are much higher than during the rest of the day-time and evening period.

4. PLANNING CONSIDERATIONS FOR LAND DEVELOPMENT

Environmental considerations have been taken into account in the siting of the new Airport and the runway, which have resulted in the NEF 25 contour lying over open water (Figures 1 & 2). In the year 2030, approximately 500 residents are predicted to be within the NEF 25 contour. This impact is small for a major international airport and represents the

removal of a very undesirable noise impact from large areas of Hong Kong (Figure 3). The usefulness of proper land use planning has been demonstrated in the siting of the new Aiport.

The impacts on housing developments from road and rail cannot be eliminated solely by locating residential blocks as far away from the noise sources as possible. Experience has shown that there are many practical considerations which limit the scope to use setback as the sole noise control measure. These limitations may include the following:-

- o the shape of the plot does not allow a significant set back of the blocks from a main road;
- o other land use planning considerations such as 'visual corridor' constrain the location of blocks; and
- o track utilities and workshops restraint the placement of residential blocks over train depots.

In cases where simple setbacks are not sufficient, other more innovative measures are required. These are discussed below.

5. NOISE MITIGATION MEASURES

A range of mitigation measures employed to treat road and rail noise are described below. Treatment can be specified to the noise source (eg road surface treatment), noise path (eg acoustic screens, barrier buildings) and to the noise receiver.

5.1 Road surface treatment employing open-textured road surface

Vehicles running on an open-textured road surface typically generate less noise than vehicles on a concrete road. The open texture affects the tyre noise and is particulary effective when dealing with fast moving cars on level roads containing high percentage of light vehicles. Tests conducted in Hong Kong have demonstrated that noise reductions up to 5dB(A) can be achieved when compared with existing concrete roads (Ref 5, 6).

5.2 Barriers - road side barrier, podium, decking over road

A solid barrier structure located between the noise source and receiver will obstruct the noise propagation, giving 5 to 15dB(A) reductions to the noise travelling around the barrier. A very large barrier would be subject to high wind loads and may not be aesthetically acceptable to the community. Roadside barriers have been used in Hong Kong where they can integrate into road networks and thus be located very close to the noise source (Ref 1). Many of the larger residential developments have a podium incorporated in the building design. This gives an equivalent of 5-8 floors of commercial area, plant rooms, car park, office and sometimes a bus terminus or light rail interchange (Figure 4). It can provide screening of the lower floors if the podium is close to the road and the towers are located towards the back of the podium. The combination of screening and displacement can give an improvement of 10 to 15dB(A) for the worst affected flats. Decking over of noisy roads is an extension of a barrier. By routing the road beneath the podium, almost all of the development over the podium can be screened from the traffic (or rail) noise. The benefit of decking over the main road is approximately 8-15 dB(A) for the majority of the flats (Figure 5).

5.3 Orientation and shape of tower and flats
Orientation of a building by reducing the amount of road visible from a window will reduce the facade noise levels. The shape of the tower can be used to reduce the maximum noise level at the facade. Some typical self-screening shapes are illustrated in Figure 6. Improvements of 10 to 15dB(A) within a building can be achieved by ensuring that no windows face the noisy source (road or rail). The non-sensitive facade can then be used to screen noise sensitive areas in other nearby buildings.

5.4 Self screening and internal planning
Effective planning within a development can offer an economical solution to transportation noise problems. There are several examples in Hong Kong where a commercial complex has been located close to a main road so as to screen the residential areas behind. Indoor sports and recreation facilities can also be used as screening elements in residential developments. Some outdoor facilities such as tennis courts, swimming pools, landscape gardening and internal access road can also be allocated close to the main road in order that the towers are located at the 'shadow' with a typically 10-15dB(A) reduction.

Internal planning can be effective in reducing the noise impact to sensitive areas (eg bedrooms and living areas). Noise tolerant areas can be used to create a buffer zone between the noise sensitive areas and the noise source. The buffer zone contains non-sensitive areas such as lift lobbies, staircases, corridors, store rooms, bathrooms and kitchen areas. This method can be particularly appropriate where there is a comparatively more attractive view at the facade not facing the main road traffic.

5.5 Upgrading facade insulation - the last resort
All of the measures described above have concentrated on reducing noise levels outside the facade. In some cases, these are not sufficient to enable the noise criteria to be met and upgrading the sound insulation of the glazing is the only option available. A typically 15 to 25dB(A) noise reduction can be obtained if the window is closed. However, the hot and humid summer of Hong Kong requires the provision of air conditioning. Increasing the thickness of the glass to 6mm is normally sufficient if the external traffic noise is in the range 70 to 80dB(A).

6. PLANNING FOR CORE PROJECTS

The Hong Kong new international airport at Chek Lap Kok is scheduled to have the first runway in operation by mid 1997. The related airport core projects include an expressway and a high speed rail link connecting Hong Kong Island to the airport. It is imperative that the expressway and the airport railway are completed before the new airport opens. These transport links will inevitably place serious constraints on the core projects including the urban development of the West Kowloon Reclamation. Apart from the future land uses consideration, the well-being of the existing waterfront noise sensitive receivers is another important element that requires careful planning to avoid causing serious annoyance during construction and future operation. The Western Harbour Crossing is one of the core projects that exemplifies these planning considerations.

6.1 West Kowloon Reclamation
The West Kowloon Reclamation covers an area of land approximately 428 hectares (Figure 1). Whilst the expressway and airport railway have a combined landtake equivalent to

approximately one third of the Reclamation, the remaining landfall can never accommodate the land use objectives while fulfilling environmental standards without recourse to an innovative integrated package of noise mitigation measures. These measures include noise sensitivity consideration (i.e. land use compatibility), location consideration (i.e buffer, building placement using noise tolerant buildings as screens, orientation, internal design, etc.) and mitigation consideration (i.e barriers, decking overs, enclosures, quiet road surface, etc.)

The northern section of the Reclamation, being close to the operating container terminal, is predominantly planned for industrial use. No planned residential developments are contiguous to industrial uses. Large open space in excess of 150m buffer between existing residential buildings and the expressway is provided for amenity and noise amelioration purposes. Roadside barriers of 3m high and open-textured road material are also incorporated on the expressway to maintain road traffic in the year 2011 at the existing residential buildings at noise levels below the stipulated 70dB(A) noise criterion. Despite a major part of the airport railway runs below the expressway, trackside barriers will be employed along the rail to meet the statutory noise limits.

Whilst a complete cover up of the expressway is considered not practical in terms of traffic considerations, the requirement for a number of sites in the central and southern sections of the Reclamation for railway stations together with property developments on top of their podia demands innovative noise concept in the course of planning land use disposition. Early planning discussions were made with the project planners and architects to arrange noise tolerant commercial, office, retail and car-parking buildings to line parallel with the expressway and railway. The preliminary master plans (Figure 7) have incorporated careful building placement, orientation and internal design. Furthermore, a number of proposed noise tolerant buildings contiguous to the expressway are now effectively acting as screens for the noise sensitive residential buildings behind. The concept has basically achieved the noise standards without recourse to massive road covers. The interfacing problems between the land use arrangement of the Reclamation and the transport links have brought together planners, acousticians and architects in formulating a plan to prevent future intractable noise problems.

6.2 Western Harbour Crossing

The Western Harbour Crossing connects the southern part of the expressway of the Reclamation to a third cross harbour tunnel which will provide a transport link between Hong Kong Island and the Kowloon Reclamation (Figure 1). This Crossing will be served by a 2km long, dual-3 lane, submerged tunnel. It will be due for completion in early 1997. The Reclamation offers adequate space at the tunnel portal for new land uses to be planned meeting the noise criteria. The new Interchange of the Crossing at the Hong Kong Island, however, has to fit itself into a narrow strip of reclamation due to restriction imposed by ship fairway. The associated road networks of the interchange will add seven additional lanes of high speed highway to the existing eight lanes highway, which passes at less than 35 metres from existing buildings. About 2200 residential premises of the existing building along the work area of the Crossing would be exposed to high traffic noise levels of up to 83 dB(A) L10(1h).

In additional to the noise redress in the form of mitigation measures such as buffer, barriers, etc., upgrading facade insulation in the form of improved windows and air-

conditioners is considered as effective means for noise amelioration. The total estimated cost of the insulation measures for the 2200 residential premises is about US$16 millions which equates to 3% of the tunnel project cost. Detailed site survey will be conducted to ascertain the extent of insulation provision. The entire insulation programme will be completed by late 1993 before the major construction work occurs. The insulation programme will in fact serve a dual purpose both to mitigate against noise from construction activities and to redress operational road traffic noise impact.

7. REFERENCES

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8. BIOGRAPHY

Mr Sam Wong is a Senior Environmental Protection Officer with the Environmental Protection Department. He received his BSc degree from Manchester University and his MSc degree from Imperial College of the University of London. He is responsible for noise planning related matters within the Noise Policy Group of the EPD, including the planning assessments of new property developments, core infrastructure projects and new town development relating to the new airport in Hong Kong. He is a Member of the Institute of Acoustics and the Membership Sub-committee Chairman of IOA HK Branch

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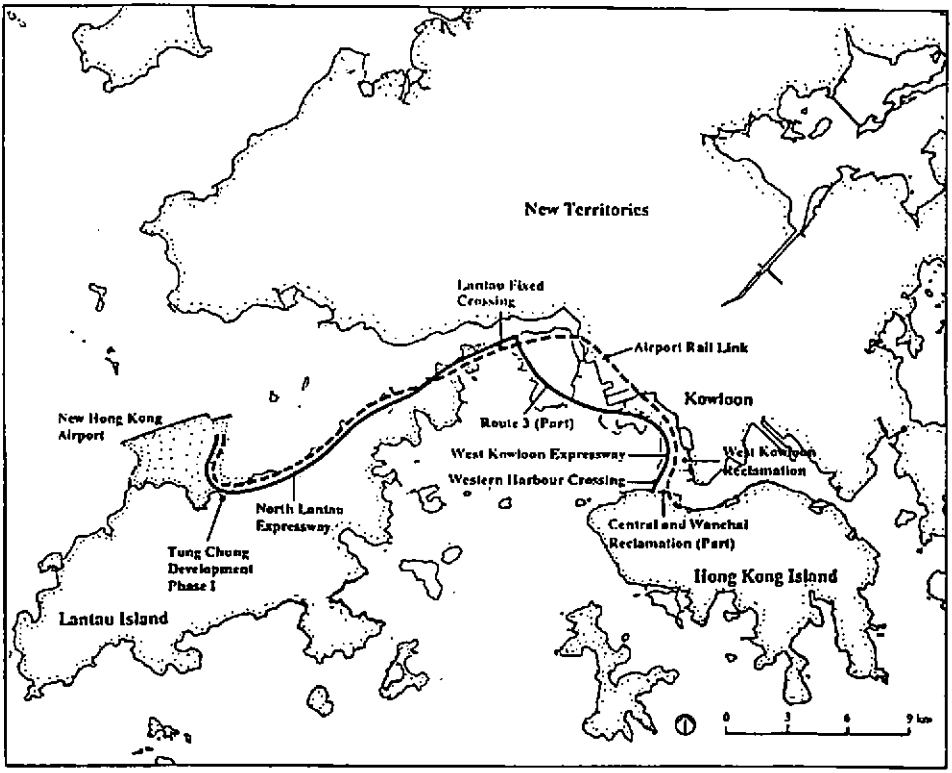

Fig 1. Airport site and core projects

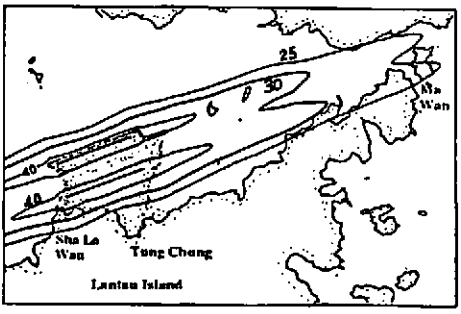

Fig 2. New Hong Kong Airport - NEF Noise Contours, Year 2030

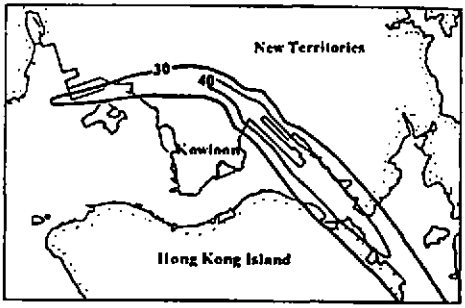

Fig 3. Existing Kai Tak Airport - Maximum Capacity

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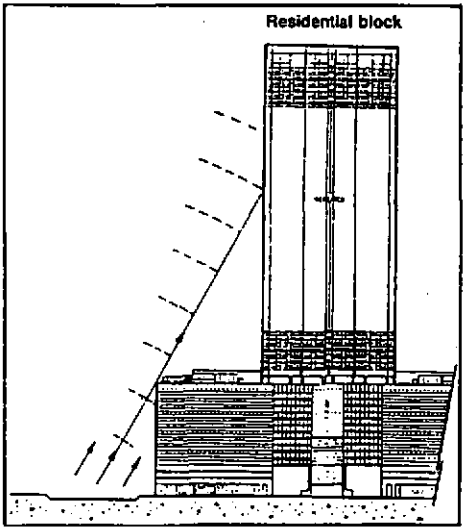

Fig 4. Noise screening by garden podium

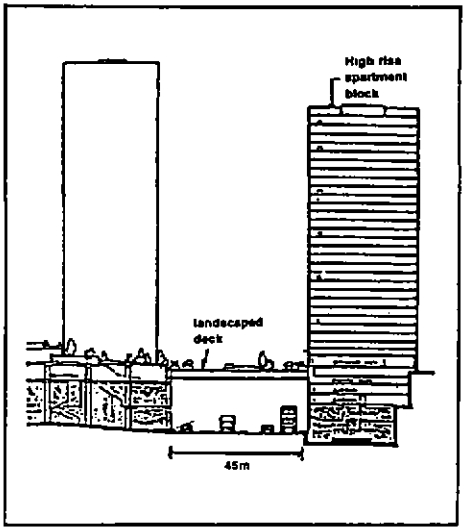

Fig 5. Noise screening by decking over main road

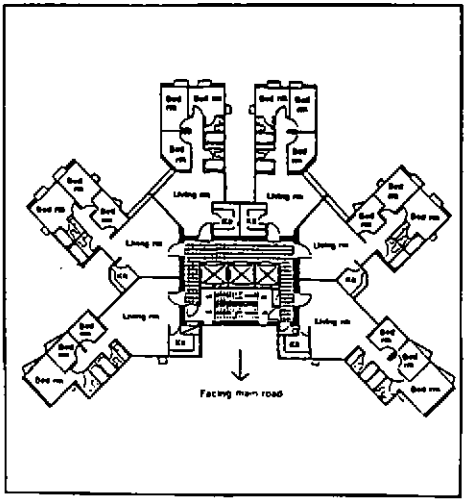

Fig 6. Self screening building shape

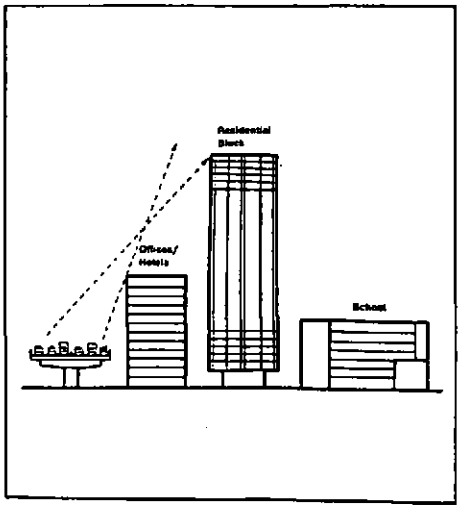

Fig 7. Noise sensitive areas screened by commercial complex