FIFTH INTERNATIONAL CONGRESS ON SOUND AND VIBRATION

DECEMBER 15-18, 1997
ADELAIDE, SOUTH AUSTRALIA

Invited Paper

THE NOISE IMPACTS ASSOCIATED WITH A MAJOR ROAD INFRASTRUCTURE PROJECT IN A DEVELOPING NATION

Stephen Samuels
School of Civil and Environmental Engineering
University of New South Wales
Australia

Weeradej Cheewapattananuwong
Department of Highways
Thailand

Road traffic noise has been an issue of significance within the developed world for many years now. More recently it has been of increasing importance in the developing nations. This is particularly so in the South East Asian region where surging economic growth and development has resulted in considerable expansions to the road transport infrastructure networks. Bangkok, the capital of Thailand, provides a good example of this situation. The city is located on the Eastern bank of the Caho Phraya River, with the sister city of Thon Buri situated on the river's Western bank. Cross river traffic is high and increases dramatically during peak hours. Bromrajchonne Rd is a major arterial road in central Bangkok which is significantly affected by this cross river traffic congestion which has become extreme and this has led to increased traffic noise levels. Therefore a project is under way (at Thai Royal initiation) to upgrade Bromrajchonne Rd by adding several kilometres of elevated section. The paper focuses on this particular traffic noise issue and uses Bromrajchronne Rd as a case study example. Having explored the issue in some detail, the paper culminates with a series of amelioration strategy proposals.

1. INTRODUCTION

Road traffic noise is an issue that has been of significant importance in the developed nations for many years (OECD 1995). Much is now known about the generation, prediction, assessment and control of traffic noise. Indeed it is an issue of considerable substance in the impact assessment procedures applied to new road infrastructure projects and to the decision making processes associated with these projects (AEC 1988, OECD 1995). Such is not yet the case in developing nations located in regions like South East Asia, although this situation is changing considerably (IRDA 1994). The present paper focuses on these issues and utilises a major road infrastructure project in Bangkok by way of a case study.

2. A ROAD INFRASTRUCTURE PROJECT

2.1 BANGKOK

Bangkok, Thailand's capital city of about 6-7 million people, is one of the fastest growing cities in the South East Asian region (AIT and EIT 1994). This is largely due to the rapid economic growth that took off in earnest in the late 1980s created spectacular development and high economic demand. Furthermore, foreign investment applicants are still interested in business in Thailand and South East Asia. There are many problems, however, which include traffic congestion, pollution, a shortage of residences, as well as health and social issues (Williams 1993). Bangkok is a major commercial and transportation centre incorporating a railroad junction, a port and a large airport, all of which handle a high percentage of Thailand's total imports and exports. General industries in and around Bangkok include motor vehicle assembly, petroleum refining, and manufacture of processed food, cement, textiles and jewellery. Moreover, the headquarters of the United Nations (UN) Economic and Social Commission for Asia and the Pacific, together with other UN regional offices, are located there.

Owing to economic growth (10-11% pa), population growth (~1.8% pa), and insufficient road space (< 11%-16% of an international standard of total land area), the people of Bangkok live among great difficulties (AIT and EIT 1994, Williams 1993). Pollution, especially noise and air pollution, attains hazardous levels compared to the international safety standards. Typical Leq noise levels in Bangkok are between 72 and 95 dB(A), higher at principal intersections. (The World Health Organisations (WHO) sets 55 dB(A) as the maximum level before neurological, digestive and metabolic disorders occur.) Furthermore some 20% of traffic policemen are suffering from heart disease owing to air pollution (Williams 1993). Because Bangkok's public transportation systems are insufficient and uncomfortable to use, vehicle ownership (cars and commercials) has been growing at a rate of 14% pa. This has resulted in a motorisation rate of nearly 100 cars/1000 population. In addition, motorcycle ownership has increased to about 80 vehicles/1000 population. Presently, the government has constructed and increased road space to nearly 9.5% of total land area (AIT and EIT 1994). Bangkok is confronted, however, with severe traffic congestion due to the high traffic volume on the road network, which lacks minor and distribution roads.

JICA (Japan International Co-operation Agency) has indicated that daily personal mobility in Bangkok is about 1.83 trips per person, including walking and the use of non-motorised vehicles. Thus, the total demand for all movement is almost 19 million trips per day when this movement is combined with the movement of four nearby provinces. Around one quarter of these trips in the Greater Bangkok area are made using private transportation. Compared to Singapore or Kuala Lumpur, the total person trips in Bangkok are higher by factors of by about 12 and 5, respectively. Thus, it has been recognised that personal trip rates represent a principal factor of the urban transportation problems in Bangkok (AIT and EIT 1994). Therefore, the federal government of Thailand is actively addressing these problems and this has led to many transport infrastructure projects being constructed in Bangkok and nearby provinces.

2.2 BROMRAJCHONNE ROAD

The population and the number of households owning vehicles in the Taling Chan and the Bangkruai districts of Bangkok in the year 1994 were 264,343 and 24,669 respectively (OCMRT 1996). Compared with the projected data for the year 2000, the number of households owing vehicles will increase substantially (~31%) and this will adversely effect road traffic conditions, especially along Bromrajchonne Road, which is the major road in these districts. Moreover, the availability of road surface area will be limited by other infrastructure such as houses, department stores, residential developed areas and thus it will not be possible to increase the horizontal road surface. To overcome the problem, King Bhumiphol has recommended that road agencies address the traffic congestion problems in Bangkok, and one outcome of this is the construction of an elevated road on Bromrajchonne Road. Thailand Department of Highways (DoH) is one of the road agencies for constructing infrastructure projects and will construct this 13.20 km elevated road which is to be built with both reinforced and prestressed concrete components. A typical cross section of the road is an average 14.00 metres in height and 21.00 metres in width and it will provide the 4-lane traffic (two lanes each way).

2.3 EXISTING AND FUTURE TRAFFIC CONDITIONS

Bromrajchonne Road is one of the major roads to go to the south of Thailand. As indicated previously, the traffic volume on the road has increased considerably in recent years and the capacity of the road is consistently and regularly exceeded. Furthermore, the overall traffic congestion in Bangkok influences the poor traffic conditions along Bromrajchonne Road. Existing traffic volumes are very high in Bangkok, and evidenced by recent data presented in Table I for two four - lane arterials, including Bromrajchonne Road. By way of comparison, the Warringah Freeway just North of the Harbour Bridge and Tunnel in Sydney carries around 200000 vehicles per day spread across 15 lanes. Recent estimates by DoH (1996) are that over the period 1996 to 2001 traffic volumes will increase throughout Bangkok by around 4.3% per annum. It is not surprising, therefore, that DoH is actively pursuing traffic and road improvement projects.

Table I. Existing traffic conditions (July 1995) in two typical major roads in Bangkok (OCMRT 1996)

ARTERIAL ROAD	AVERAGE ANNUAL DAILY TRAFFIC VOLUMES (VEH/24 HR)		
	INBOUND	OUTBOUND	TOTAL
Sirinthorn	53,387	55,588	108,975
Bromrajchonne	61,906	67,823	129,729

Also relevance to the current paper is the make up of the vehicle fleet in service in Bangkok. As shown in Table II there is a predominance of cars and motorcycles. By Australian standards, the heavy vehicle content is also quite high. Metropolitan roads in Australian capital cities tend to carry about 5 to 10% heavy vehicles (Samuels 1990).

Table II. Make up of Bangkok's vehicle fleet (IIEC 1992)

TYPE OF VEHICLE	PROPORTION VEHICLE FLEET (%)
Motorcycles	34
Cars	41
LPG Vehicles (Taxi & Tuk Tuk)	1
Diesel Trucks	24

2.4 EXISTING AND FUTURE TRAFFIC NOISE CONDITIONS

Traffic noise data have been monitored and collated in Bangkok by the Department of Pollution Control (DPC) in conjunction with the Office of the Commission for the Management of Road Traffic (OCMRT). Modern instrumentation systems (such as the CIRRUS Model CRL236) have been adopted and the data collected in accord with routine, internationally accepted procedures (for example SAA (1984)). Typical examples of the traffic noise levels recorded are presented in Table III. These levels are representative of those prevailing at the front facades of buildings along Bangkok's major arterials. They vary with traffic characteristics and other relevant site dimensional and topographical factors (UK DOT 1988), but the latter are not of particular interest to the present paper. What is of note, however, is that the levels are indeed very high and exceed what is often considered to be a reasonable upper limit in developed nations such as Australia by around 15 to 20 dB(A).

Table III. Typical Traffic Noise Levels in Bangkok (Cheewapattananuwong 1996)

ROAD	AVERAGE VOLUME/DIRECTION (VEH/DAY)	Leq (24 HOUR) (dB(A))
Phaholyothin	57622	75.0
Rama IV	44713	81.4
Wireless	25142	77.8
Bromrajchonne	67823	76.0

With such high traffic volumes, it has been observed (OCMRT 1996) that Bangkok's arterials, such as those of Table III, are operating at very low levels of service, with frequent daily periods of congestion and travel delays. Given the 4.3% per annum traffic growth forecast (mentioned previously), the situation can only be expected to deteriorate further over time, should no preventative or ameliorative treatments be invoked. Without such treatments, and given the forward projections of OCMRT (1996), it could reasonable be expected that in 2001 the traffic noise levels at locations such as those of Table III would be around 3dB(A) greater than at present. In other words the future traffic noise scenario for the greater Bangkok area looks very bleak indeed in the absence of any specific countermeasure strategies.

2.5 NOISE AMELIORATION STRATEGIES

There are many techniques available for the control and amelioration of road traffic noise (OECD 1995), most of which have been tried and applied in developed nations such as Australia over the last decade or so (Australian Environment Council 1988). These techniques tend to have been evolved around the urban and road infrastructure conditions of the developed nations and have not hither to been widely applied in the developing nations such as Thailand. From what has preceeded in the present paper it is apparent that in a developing nation a city such as Bangkok has a number of attributes that pose substantial challenges to the effective mitigation of road traffic noise. These include the nature of the existing and developing road and surrounding infrastructure, the very high traffic volumes and the current excessively high levels of traffic noise. The questions arise, therefore, firstly as to how and what traffic noise control techniques could possibly be applied, secondly as to whether and how these treatments should be tailored to the particular conditions and as thirdly to the effectiveness of any such treatments.

Faced with these considerable technical difficulties, OCMRT and DPC established a suite of amelioration treatments for both the construction and the operational phases of the Bromrajchonne Rd Project. These are summarised in Table IV, along with estimates of the typical ensuing noise level reductions made according to UK DoT (1988) (Cheewapattananuwong 1996). Note that the latter are based on an assessment of the situation that might prevail in the year 2001. Thus they include predictions of the noise reductions of the treatments such as barriers and speed control plus and allowance for offsetting the projected traffic volume increases mentioned previously. For example, the typical level of 76.0 dB(A) currently existing in Bromrajchonne Rd (Table III) could reasonably be expected to reach 79.0 dB(A) in 2001, should the road improvement project and associated amelioration treatments not proceed. Given application of the treatments that appear in Table IV, the revised estimate for this level would be 70.2 dB(A). Although still high by standards adopted in developed countries, this level does represent a substantial 5.8 dB(A) improvement on the existing situation.

Indeed the noise level achieved by application of this suite of treatments is compatible with the current limit of 70dB(A) adopted in Thailand (DPC 1996). Again this level is well above those of developed nations, but the fact remains that it does exist. This observation, which could not be made of many other developing nations, augurs well for the future in Thailand. It is the present authors' personal observations that there is a concerted effort in Thailand to improve environmental quality and amenity and that this will gradually lead to improved standards and, in particular, reduced traffic noise limits.

Referring back to Table IV, it is clear that each of the strategies has been applied in developed nations such as Australia or the USA. This is entirely reasonable, given the nature of the traffic and road infrastructure conditions in Bangkok. However selection of the appropriate technology to transfer into such a situation must be done very carefully indeed in order to ensure that the technology is effectively and correctly applied and that the benefits obtained are generally as predicted and are sustainable. For example, the traffic management strategies proposed for the operational phase include techniques such as the introduction of reversible flow lanes and alternative optimisation of the signalisation phasing at selected intersections. Such strategies will only be effective if they are applied in appropriate ways, having due regard for the physical and operational nature of the local road network.

Table IV. Proposed Noise Amelioration Treatments for Bromrajchonne Rd

PHASE	PROPOSED AMELIORATION TREATMENTS	ESTIMATED EFFECT OF TREATMENTS (dB(A))*
Construction	• Regulation of construction processes and times of operation to daytime only • Installation of temporary barriers around construction sites • Substantial traffic management, including use of reversible lanes during peak hours • Enforcing traffic speed limit of 60 km/h and restricting heavy vehicles to no more than 20 to 40% of traffic volumes	8.9
Operation	• 2 m high absorption barriers on either side of elevated roadway • 3 m high absorption barrier along median of surface roadway • Enforcing speed limits of 80 km/h along Bromrajchonne Rd and 60 km/h along adjacent roads • Implementing a suite of traffic management strategies aimed at improving traffic flow conditions and reducting congestion	8.8

*(Cheewapathananuwong 1996)

3. CONCLUSIONS

By means of a major arterial road case study in Bangkok, the issue of road traffic noise in a developing nation has been explored. Traffic conditions are generally characterised by high volumes and substantial congestion, with forward estimates all pointing to general deteriorations in existing conditions. Noise levels are also high, particularly when considered relative to those typical in a developed nation. Appropriate and carefully selected amelioration strategies can, however, be effective in these situations.

4. REFERENCES

AUSTRALIAN ENVIRONMENT COUNCIL (1988) Traffic noise control excluding vehicle emission methods. AEC, Canberra, Australia.

ASIAN INSTITUTE OF TECHNOLOGY and ENGINEERING INSTITUTE OF THAILAND (1994). A symposium on Asian urban transportation (Bangkok perspective). Format Printing Co Ltd, Bangkok, Thailand.

CHEEWAPATTANANUWONG, W (1996). The impact of traffic congestion during construction of transport infrastructure projects in Bangkok. MEngSc Thesis, School of Civil and Environmental Engineering, University of NSW, Sydney, Australia.

DEPARTMENT OF POLLUTION CONTROL (1996). Results of air quality and noise measurements on Bromrajchonne Rd, Bangkok. DPC, Bangkok, Thailand.

DEPARTMENT OF HIGHWAYS (1996). The Bromrajchonne elevated road project. DoH, Bangkok, Thailand.

INDONESIAN ROAD DEVELOPMENT ASSOCIATION (1994). Symposium on Environmental Management and Infrastructure Development, Jakarta. IRDA, Jakarta, Indonesia.

INTERNATIONAL INSTITUTE FOR ENERGY CONSERVATION (1992). Assessment of transportation growth in Asia and its effects on energy use, the environment and traffic congestion. IIEC, Bangkok, Thailand.

ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (1995). Environmental impact assessment of roads. OECD, Paris, France.

OFFICE OF THE COMMISSION FOR THE MANAGEMENT OF ROAD TRAFFIC (1996). Measures taken to solve air and noise pollution problems during construction of transport projects. OCMRT, Bangkok, Thailand.

SAMUELS, S E (1990). Development and implementation of a new method for predicting traffic noise at a signalised intersection. Proc 15th ARRB Conf Pt 7 pp 123-9, Australian Road Research Board, Melbourne, Australia.

STANDARDS ASSOCIATION OF AUSTRALIA (1984). Methods for the measurement of road traffic noise: AS2702-1984. Standards Australia, Sydney, Australia.

UNITED KINGDOM DEPARTMENT OF TRANSPORT (1988). The calculation of road traffic noise. HMSO, London, UK.

WILLIAMS, L (1993). Spectrum. Sydney Morning Herald, Saturday 23 October, 1993. SMH, Sydney, Australia.