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HIGHWAY DESIGN TO REDUCE NOISE

L H WATKINS AND D J RUSSELL

TRRL DTp

Introduction

The noise nuisance from road traffic can be reduced either by attention to the noise source, which means reducing the noise emitted both by the vehicle itself and also by the tyre/road interface, and by separating the source from the receiver by interposing an obstruction or distance. A further option of removing the source by some re-routeing of traffic is a planning option and not discussed in this paper which takes for granted a certain road layout and flow of traffic. If these options fail to reduce the nuisance below an acceptable level, current legislation allows for compensation of those suffering the nuisance. These matters relate not only to traffic using the finished road, but also to construction operations.

Reduction At Source

Reducing the noise made by the vehicles themselves is the obvious first choice, provided that it is consistent with operating efficiency and economic common sense. Limits of noise emission under standard driving conditions are now set for all classes of vehicle, and are subject to negotiation with the EEC. A programme of research and development sponsored by the Transport and Road Research Laboratory has been in hand for some time[1] to quieten the heavy lorries that are amongst the noisiest of vehicles, and there are proposals to extend this programme to cover other types of vehicle.

The development of road surfaces to improve safety by providing better skid resistance has led in some cases to high levels of surface/tyre noise. The problem came to the fore because of the suitability of a concrete surfacing for accepting, and retaining, a deep texture whilst in the plastic state during construction. To study this problem measurements were made[2] at road sites chosen to include the range of concrete and asphalt surfaces encountered on trunk roads and motorways in the UK. It was found (Figure 1) that there was a unique relationship between the noise emitted from each surface and a function of the skidding resistance, expressed as a percentage change in braking force coefficient (BFC) as vehicle speed increased from 50km/h to 130km/h. Noise was measured at a vehicle speed of 70km/h. Five low-texture depth brushed concrete surfaces were among the quietest and least skid resistant, and the deep grooved concrete available at the time the tests were done was at the other end of the scale. This research now enables either bituminous or concrete surfacings to be designed to meet a specification that takes note of both noise and resistance to skidding; for example, a bituminous surfacing with 2mm of texture emits the same noise and has the same high speed skidding properties as transversely textured concrete surfacing with randomly spaced grooves 3mm wide and 5mm deep (ie zero change in BFC and about 79 dB(A)).

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Noise Prediction

The most commonly employed procedure for predicting noise levels in the UK is that published in 1975 by the Department of the Environment and Welsh Office[3]. This provides simple charts relating noise with traffic flow, speed, percentage of heavy vehicles and other relevant parameters.

Apart from the statutory method of prediction, computer programs are also available which can be used to predict the effect on traffic noise of different planning options. For example, the TRRL computer model of traffic noise has been used to demonstrate the long term benefits of quieter vehicles and to explore the relations between environmental noise and different freight policies. The program has also been used to evaluate the changes in traffic noise levels resulting from the construction of by-pass routes in certain towns.

Separation Of Source From Receiver

Methods currently in use to minimise the noise effect of a road are:-

a. Locating the road as far away from existing dwellings as possible.

b. Lowering the road to run in cutting near dwellings or other sensitive areas.

c. Screening the road from view by constructing earth banks and planting, or by fencing or by a combination of these devices.

d. In urban schemes "cut and cover" or tunnelling is sometimes used.

e. In New Towns, planning of development has enabled screening to be achieved by siting industrial buildings between major traffic noise sources and residential areas. New residential development can also be designed to take account of noise from adjoining roads.

The typical beneficial effect of a well designed and sited noise barrier can be of the order of 7-9 dB(A). Effective screening by large buildings saves about 15 dB(A) in the lee of the buildings.

Noise screens vary in cost between £27 and £50 per metre. The alternative might well be insulation of individual properties, the cost of treating a typical 3-bedroom house being in the range of £600-£900 depending on location although considerable variations can also arise due to the design of individual houses.

Legislation and Compensation

Until the Land Compensation Act 1973 became part of British Law, Highway Engineers had to work within the powers already vested in Highway Authorities. In general terms this meant that acquisition of land and property was limited to what was actually required for highway construction. Compensation likewise related to what was acquired for the work of constructing a new highway or improving an existing one. Designs for roads were therefore bound by the legal constraints which applied at that time, and comparatively little could be done to make a new road acceptable to those most closely affected.

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Since the Act took effect, following Government acceptance of the recommendations of the Urban Motorway Committee that roads should be fitted better into their surroundings and that action should be taken to mitigate the adverse effects, engineers have been provided with the necessary guidelines and legal framework to enable them to reduce some of the more seriously intrusive effects of new roads on the environment.

Traffic noise is the cause of most complaints judging by the social surveys. This was singled out for particular attention in Section 20 of the Act which empowered the Secretary of State to make Regulations defining the eligibility for noise insulation and the manner in which it is to be carried out. The Noise Insulation Regulations 1973, more recently superseded by those of 1975, fulfil the requirements of Section 20 of the Act.

Construction Noise

Noise during road construction works is a special case of noise nuisance. The nuisance may well be very acute, especially during the earth-moving phase, but it is of course transitory and gives way in time to the traffic noise nuisance discussed previously. Nevertheless, measures to minimise the nuisance or compensate for it follow the same broad lines as those relating to traffic noise.

A method for predicting Leq (the most suitable unit) at road construction sites has been derived so that noise assessment can be carried out at the planning stage[4]. The method is based on an equation to calculate a basic Leq level for a particular operation, together with corrections to allow for distance attenuation over soft ground, the screening effect of barriers and the combination of noise from different operations.

Information is now available[5] concerning the cost penalties for various methods of control of construction site noise. As an example the experimental use of belt conveyors for earthmoving on part of M27 near Portsmouth proved successful environmentally although it introduced other problems. Nuisance to the inhabitants was largely avoided during the construction period by using a belt-conveyor to carry chalk excavated from a deep cutting in the Downs to its place of deposition in Portsmouth Harbour. This avoided transport of this material by trucks through built-up areas. Although this road was constructed before the Control of Pollution Act, 1974 took effect, it indicates the growing awareness of the need to devise constructional methods to minimise noise and interference with the lives of people living in the vicinity. Another example is the growing use of quieter piling methods in built-up areas. The Act itself now places an obligation upon developers to obtain the local authority's consent to their proposed plan and method of construction for any new project. The local authority may:

a. Specify plant that may, or may not be used.

b. Specify hours during which the works may be carried out.

c. Specify levels of noise which may be emitted from the site or which may be emitted during specified hours.

d. Provide for any change in circumstances.

In doing this the local authority has to have regard to the "Code of Practice for

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Noise Control on Construction and Demolition Sites" BS 5228 .

Conclusion

Traffic noise is now recognised to be an important factor in the choice of the alignment of a new road, and at an early stage in the design consideration is given to the propagation of noise both during construction and when the road has been built and opened to traffic. This paper has attempted to indicate the broad nature of the problem and of the steps now being taken to minimise the nuisance.

References

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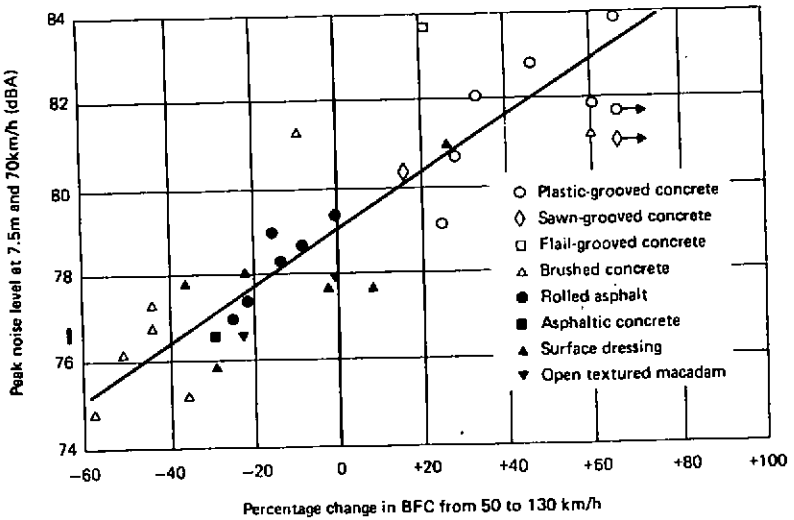

Fig. 1 RELATIONSHIP BETWEEN BFC AND NOISE