Proceedings of The Institute of Acoustics

THE EFFECTS OF ROAD TRAFFIC NOISE

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BUILDING RESEARCH ESTABLISHMENT

1. THE IMPACT OF TRAFFIC NOISE. Before going on to discuss what we know of the effects of traffic noise it may be useful briefly to summarise the extent of its impact on the population and the rate at which this is continuing to grow. A recent survey(1) based on a representative national sample concludes that some 89% of the population hear road traffic when indoors, and that 23% are annoyed by it. This figure may be compared with the estimate of the MOT Working Group who in their 1970 Report(2) claimed that between 19 and 45% were likely to be bothered, and predicted that this proportion would increase to between 30 and 61% by 1980. If the figure cited in the more recent study, based on 1972 data, is projected forward to 1980 the expected proportion of people annoyed rises to 35%. The proportion 'seriously disturbed', subjected to traffic flows of over 2000 vehicles per hour, may be put at between 7 and 10%.

If these figures are compared with other sources of noise nuisance, traffic noise emerges as by far the most serious disturbance. A BRS survey(3) suggests that after road traffic the next most widespread nuisance is noise from neighbours, estimated at about 8% of those in attached properties, a figure in good agreement with that given in the study cited(1), while all other forms of noise nuisance have a comparatively low incidence. Thus not only is nuisance from road traffic by far the most serious of all noise nuisances, it is also continuing to increase along with the continued growth of road traffic. The picture is even more depressing in the case of Central London, cited by the survey as 'a special case'. Here, 36% of the sample were bothered by traffic noise in 1961, 77% of residents hearing traffic when indoors. This had grown to 39% in 1972, with 90% hearing traffic, while 24% regarded traffic noise as the worst single feature of their environment - a source of more nuisance than any other topic mentioned. In the light of all the foregoing, the topic of traffic noise nuisance is therefore well qualified to receive the degree of attention which it has done from researchers, engineers and administrators over the last fifteen years or so.

2. MAIN EFFECTS OF TRAFFIC NOISE. The effects of traffic noise may be grouped under a number of heads, those of annoyance and general dissatisfaction, more specific causes of dissatisfaction such as interference with conversation, listening to radio or TV, or having to keep windows closed in warm weather. Other effects are disturbance to sleep and rest, and finally a loss of environmental amenity resulting in perceived or real fall in property values. All these effects relate to the general resident population. Adverse effects also arise in the case of particular groups, such as school children and teachers, hospital staff and patients, etc, though these have tended to receive less attention than the general population, perhaps because their problems can often be dealt with ad hoc. Nevertheless, a study of the effects of traffic noise on schools in the Greater London area is now in progress(4).

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Results from a number of social surveys(5,6,7) have indicated that when scales of a 'global' character, generalising dissatisfaction or annoyance have been employed, the range of the scales is bounded by the 20 dB lying between 60 and 80 dB(A) L_{10} or L_{eq}. From these surveys it may be concluded that in general, noise levels at a dwelling facade exceeding 64-65 dB(A) L_{10} result in measurable annoyance or dissatisfaction. For an urban community to experience a high level of satisfaction with the environment, daytime levels need to be below 60 dB(A). The National survey cited(1), indicated that at levels above this, and corresponding roughly to 18 hour flows of about 300-400 vph, dissatisfaction begins to rise sharply. But below this level, the approach to full satisfaction for the entire population is very slow, so that the attainment of such an objective is likely to be outside the realm of practical possibility. Noise controls have therefore tended to concentrate on upper limits in order to avoid extreme dissatisfaction, and that embodied in present legislation(8) (68 dB(A) L_{10}) is the level at which less than 50% of the population is likely to be dissatisfied.

Although specific activities disturbed by traffic noise have been studied in some detail, the main use made of the results has been to calibrate general scales of annoyance. Activities disturbed by noise have been shown to correlate closely with general annoyance, though having different regression slopes and intercepts. These inherent differences, which result from the differing proneness to disturbance of different activities, make them unsuitable for use as indices of noise nuisance. Listening to radio or TV or taking part in conversation is more prone to disturbance than say, reading. Moreover, it has been suggested that activities such as conversation exhibit a 'threshold' effect so that instead of a graded increase in disturbance there tends to be a point at which the activity suddenly becomes difficult and tiresome. It is interesting to note that the point at which this change has been observed is the same as the external level at which dissatisfaction appears; namely, about 64 dB(A) L_{10}.

Effects of traffic noise on sleep have proved somewhat resistant to scientific investigation. On the one hand, physiological studies have indicated measureable shifts in the patterns of brain activity represented by EEG traces, along with other biological parameters. The difficulty has been to attribute particular significance to these changes that would enable us to conclude that the quality of sleep has been impaired. This shortcoming is now being made good through a current EEC study(9) which attempts to combine physiological sleep records with standardised tests of mental task performance in the period following sleep, for populations exposed to different levels of traffic noise. On the other hand, few surveys have yielded useful results in terms of measureable sleep disturbance, though such effects have been measured in the case of aircraft noise(10). A recent study by BRS(11) however, was able to estimate the extent to which people at different noise levels between the hours of 22.00 and 06.00 experienced difficulty in getting to sleep. By taking account of whether residents slept at the front or rear of the dwelling and with bedroom windows open or closed in warm weather, a high correlation between noise levels and reported sleep disturbance was obtained. The results indicate that to sleep in comfort with windows open (as in warm weather), external noise levels at the dwelling facade would need to be below 40 dB(A) L_{10}. In practice, this state of affairs could be achieved by only 30% of the survey sample, for night noise levels, as measured in Greater London, do not generally fall to such a level.

Finally, there remains the effect on property values. While it seems generally agreed that traffic noise reduces the value of nearby residential property - an effect allowed for in property rating and valuation, and by the provisions of the Land Compensation Act(8) - attempts to quantify this in monetary terms through systematic research have not been very successful. The value of being able to do so is fairly obvious. Unlike annoyance scores, monetary units are objective measures, they can be related to other economic criteria, and can be entered as 'social costs' of noise in cost-benefit analyses. Although useful results have been obtained from studies of aircraft noise, all having a fair degree of agreement(12), the search for economic indicators has proved disappointing in traffic noise studies. Results from House Price Depreciation studies have been either negative(13) or inconsistent(12 op cit). Only one UK study(14) has yielded positive results and this employed social survey rather than HPD methods. From this study it was estimated that perceived loss of amenity, measured in 1972 prices, ranged from some £20 in the most favourable, to about £60 pa in the least favourable conditions. This latter figure is roughly equivalent to about £130 at present prices and may be capitalised as approximately 3% of house price, a figure in fair agreement with results from aircraft noise studies.

In reviewing the findings of some major studies, only the effects of noise from free flowing traffic have been considered, most of the studies cited, and those recently brought together by Schultz(15), having in this way been confined. It is becoming increasingly clear that in non-free flow conditions, more typical of traffic conditions in large urban centres, existing noise indices are unable to produce accurate predictions of annoyance. The chief factor to which attention has been drawn is the part played by heavy vehicles. Surveys by Langdon(16), Rylander(17), and Vallet(18) have introduced further variables, either the number or the proportion of heavy vehicles in the traffic stream over a given period as a useful indicator of annoyance. Vallet, in particular, has drawn attention to the fact that during the evening period, shown to be the most important for rest and relaxation, total traffic flows on major routes tend to decline while the number of heavy vehicles does not. In consequence, the passage of individual very noisy vehicles is less masked by the overall noise level and hence tends to become an insistent and directly perceptible source of annoyance. In general it may be said that a major aspect on which all these studies agree is that the annoyance produced by heavy vehicles is disproportionately greater than their contribution to the overall noise level, as measured by existing acoustic indices, and that some way needs to be found of allowing for this effect, preferably in acoustic terms.

A problem recurrent in discussions about predicting traffic noise nuisance is that of the accuracy and reliability of social survey results, for long the only source of such predictions. It would seem common ground that for practical purposes it is necessary to be able to forecast at an acceptable level of certainty, say, $p < 0.001$, the result, in terms of community annoyance, of a change of no more than 5 dB(A) in measured or predicted noise levels, or their equivalents in traffic volume or composition. Merely to identify a statistically significant trend will not provide the basis for schemes of traffic management, road planning, remedial measures or graded compensation. By now, the major studies have made it possible for prediction of annoyance to meet the above requirements.

What is less certain is the degree of success in predicting individual response. Although data yielding predictions for groups within the community appear to have high reliability - though note must be taken of criticisms(19) that indicated levels of annoyance are influenced by the range of noise levels explored - it would seem that this is less so for individuals. None of the studies cited account for more than about 11% of total variance in individual response. This has led to claims that noise controls based on group data ignore the requirements of large segments of the population. The large scatter of group scores, it is argued, suggest that people particularly sensitive to noise are not fully taken into account(20). Though this may be true, to a very limited extent, it is pertinent to observe that a recent study of score reliability(21) has shown, by means of repeated measures, that only 37% of individual score variance is reliable. This being so, it would seem that physical measures in reality account for much more than at first sight appears, perhaps as much as 40% of systematic variance. In consequence, it is likely that estimates derived from group data are on the whole correct and reasonably reliable, and that the real extent of divergence of particular individuals from community opinion is collectively somewhat less than has been suggested.

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