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Traffic Noise Criteria for Dwellings by D. M. Harman

The Basis of Criteria

Workable criteria are inevitably a compromise between the differing requirements of the inhabitants and the designer of a building. For the inhabitants the criteria is a form of protection and should allow for the compexities of the interaction between noise and people. On the other hand the criteria should also be simple enough, in both concept and application, to be used by designers who are often relatively inexpert in acoustics.

It is convenient to categorise the effects of noise as either subjective subjective responses like annoyance or activity disturbances like speech interference. Subjective responses are prone to interpersonal differences due to personality factors but there is reason to expect activity disturbances to be less susceptible to such variations. Therefore it should be more practicable to base criteria on activity disturbances rather than subjective responses.

Activities Sensitive to Noise

During the London Noise Survey it was found that the most widely disturbed activities in dwellings are sleep and speech based activities. (Radio and T.V. reception and conversations). Therefore, from the inhabitants point of view, these are obvious activities to be considered for criteria.

For the architects two of the major noise control decisions are the location of internal spaces and the size and type of windows to be used. Sleep takes place in bedrooms and the speech based activities occur mostly in living rooms. These spaces together make up the majority of the space in a dwelling and inevitably have windows to the outside. Therefore criteria based upon sleep and speech also have advantages for the architects in that they relate directly to important noise control decisions. It is suggested that there is a good case for having two criteria for

dwellings: one for living rooms based upon interfe nce with radio and T.V. reception and the other for sleeping areas based upon sleep disturbance.

Assuming that interference with radio and T.V. is essentially speech interference it should be quite straightforward to decide upon a suitable criterion. Therefore this aspect is concluded here except insofar as it is affected by the later comments on noise level prediction. Sleep is not generally well understood and so some of the relevant aspects are outlined in the following sections.

Sleep researchers have found that sleep is a cyclic process and that the average person moves between several different levels of sleep about five times per night. It has been established that the louder the noise the more likely it is to disturb and Jansen found that noise causes the sleep level to become less deep even though the subject does not necessarily awaken; he concluded that all sounds audible at night impair the quality of sleep. He also found that subjects react for several times as long as the duration of the stimulus and it has been suggested elsewhere that the effective disturbance may last for several minutes if the sleep level is significantly changed. Tizard found that the degree of psychological attention paid to the noise affects sleep but suggested that traffic noise is ignored. If this is true it implies that sleep disturbance should be relatively immune from differences due to personal susceptibilities. Scheiber found that noise can prolong the period of falling asleep; that it is easier to disturb someone in the shallow phases compared with the deeper phases; that as the morning approaches the average sleep level tends to become less deep and it therefore becomes easier to disturb sleepers.

Sleep Disturbance by Traffic Noise

At low traffic flows, below about 1000 v.p.h., the noise from the vehicles tends to become a series of discernable noise events, particularly for heavy lorries. This condition prevails at bedtime when the noise situation consists of a background level upon which is superimposed a series of distinct noise peaks. This situation is analogous to that produced by aircraft flyovers for which public reaction has been found to be a function of the number of flights and the mean peak noise level. It seems reasonable, on the results from sleep research, to expect sleep disturbance by traffic also to be a function of the average peak level and the total number of peaks. The background level and the duration of the peaks are

probably also of some importance. Accepting the importance of the noise peaks it is necessary to examine the possibilities of predicting these peak levels and to see if the more commonly used 10% levels will serve as a substitute. To predict noise levels a number of variables have to be taken into account of which the most important are the total vehicle flow rate and the proportion of heavy vehicles. But experience has shown that it is difficult to obtain future traffic flow figures which are sufficiently accurate for predicting the 10% level. There are other difficulties in using the 10% level such as the summing of noise levels for areas affected by two or more roads. Related to this is the problem of deciding the location of the effective noise source of a road; for wide roads the error in deciding the effective source can lead to quite large prediction errors at distances from the road.

These difficulties can be overcome if predictions are restricted to peak noise levels, that is, the noise from heavy vehicles. The maximum noise from such vehicles is unlikely to change significantly in the future. They can be treated as point sources at the centre of the appropriate traffic lane and the inverse square law applied for fall-off with distance. Of course the peak levels vary from vehicle to vehicle but there is evidence that the variation amongst the heavier vehicles is not prohibitively large. It must be pointed out that the problem of predicting the actual numbers of heavy vehicles still remains but it will be seen that this is not a serious problem when using the form of criteria suggested.

Conclusions

From the preceeding arguments it is concluded that the traffic noise criterion for bedrooms should be a sound level below which peak noise levels should be restricted. In order to set this level it is necessary to decide what levels of noise disturb sleep and how much disturbance is tolerable. To take into account the numbers of vehicles using the roads the basic criterion can be adjusted on an incremental basis. For example, with 0 to 5 heavy vehicles per hour at night time the basic criterion applies; with 6 to 25 heavy vehicles per hour subtract 5dB(A) from the tolerable level; over 25 vehicles per hour subtract 10dB(A).

There are disadvantages with this type of criterion, particularly because high background noise levels can diminish the effect of the peak levels and this is not taken into account. A criterion could be established in this form now but it would be limited by a lack

of relevant information on topics such as the noise levels that disturb sleep; the importance of sleep disturbance; and the ability to adapt to noise are both short and long periods of exposure.

References

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