BRITISH ACOUSTICAL SOCIETY

BUILDING ACOUSTICS

8th - 10th April 1970

REAL WINDOWS

P.T.Lewis.

INTRODUCTION

Buildings in our environment are being subjected to a steadily increasing bombardment by noise from road traffic. There are a number of reasons for this. Firstly, the desire for better communications is leading to an expansion of the road network which in turn is causing new roads carrying large volumes of high speed traffic to penetrate hitherto quiet areas. Secondly, the increase in the number of vehicles is resulting in existing roads having to carry greater and greater volumes of traffic. Thirdly, due to the high cost of land it is economically necessary to build closer to both new and existing roads than is environmentally desirable.

This inevitable progressive increase of noise energy generation and the bombardment of buildings by it is being accompanied by a rising awareness of the environment and its pollution in all its forms. Higher standards of comfort are thus being demanded whilst at the same time being increasingly more difficult to obtain.

METHODS OF TRAFFIC NOISE CONTROL.

There are four methods by which traffic noise can be controlled.

1. Reduction at Source.

Whilst it is undoubtedly the most desirable and effective method of control, it is not realistic to expect a substantial reduction in vehicle noise for some time. There are two reasons for this. Firstly, the principal offenders are commercail vehicles and impending legislation will not only increase their maximum permissible laden weight, but also stipulate a minimum power to weight ratio. In order to keep the noise outputs of commercial vehicles at their present level, engine manufacturers are having to put into practice most of the technical advances that have, at great expense, been made up to the present. Secondly, any developments are highly dependent on economic factors. Legislation is, of course, the only certain way of reducing noise but legal limits are themselves bound by technical possibilities and economic realities.

2. Reduction by means of Barriers.

The sound attenuation of a barrier is a function of the extra distance sound waves have to travel in negotiating it compared with the distance of the direct path (Maekawa, 1969). The magnitudes involved are such that in order for a barrier to achieve a significant reduction even when the road is at or below ground level and the receiving point is at ground level, fairly substantial barriers are necessary. Nonetheless, in this the most ideal case, they do hold promise. The problem becomes, of course, much more difficult when the road is on an embankment and even worse in the case of multi-level intersections. Under such circumstances the use of effective single purpose barriers is likely to be unrealistic, if not impossible. If the buildings to be protected are medium or high rise, the height of an effective barrier would also be prohibitive if its sole purpose was sound attenuation, whatever the type of road. A more efficient solution is to use buildings themselves as barriers for the height is then no longer a serious constraint.

3. Reduction by means of Distance.

Noise reduction can be achieved by making use of the natural reduction in intensity that occurs with increasing distance from the source. As has already been noted, land is expensive and the economic pressures to build closer and closer to roads is very strong. In urban areas especially, the necessary distances are likely to be prohibitive.

4. Reduction by the Building Facade.

It is clear that there will be many situations in which it will be left to the facade of a building itself to provide the protection of its inhabitants from external noise, and that their number will increase in the future. The sound insulation of such a facade will be strongly influenced, if not determined, by the sound insulation of its window and it is therefore essential to fully understand the performance that is achieved by windows in practice and the factors that can influence this.

The information which has been available up to the present concerning the sound insulation of windows is discussed in another paper. It will suffice to say that there were many gaps in previous work and that a comprehensive laboratory study in a single experimental installation was required, together with a field study of the standards that are generally attained by actual windows mounted under normal conditions. A programme designed to do this is now discussed.

EVALUATION OF THE FACTORS THAT CAN AFFECT THE TRANSMISSION LOSS OF A WINDOW.

1. The Adequacy of Sealing.

The transmission loss of a structure is largely determined by that of its weakest link. The weakest link in a window construction are gaps that arise because of inadequate sealing. As a general rule, the standard of sealing of a window will be the dominant factor in its sound insulating performance.

In general four types of gap can occur:

i. Between the glass and its frame.
ii. Between an opening frame and a fixed frame or a subframe.

iii. Between a fixed frame and subframe.
iv. Between a subframe and the opening.

A series of measurements has been carried out to determine the magnitude of the effect of each type of gap on the sound insulation of a wide range of window types.

2. The Method of Edge Mounting of the Glass.

The sound energy radiated by a window is determined to a certain extent by the degree of damping present and part of this damping takes place at the edges of the glass. Consequently it is possible that the method by which the glass is mounted and sealed in its frame could make a difference to the transmission loss of a window. Three types of edge mounting have been compared.

i. The edge suspended in non-setting mastic.
ii. The edge clamped between hardwood beads.
iii. The edge compressed between neoprene strips.

3. The Size of the Glass Panes.

With the same overall area of glazing, the sound insulation of a window could depend on the size of its panes in two distinct ways.

i. The frequencies of the basic resonances of a panel are a function of its dimensions; the smaller the size the higher the frequencies and vice versa.

ii. For a constant total area of glass, the smaller the size of the panes, the greater the total length of edge. As has been noted, the sound energy in the glass is absorbed to a certain extent by the edge, the greater its length the more absorption will take place, and the lower the resulting energy level of waves in the glass.

In order to evaluate the significance of these effects, the sound insulations of single and double windows have been measured with both large and small panes.

4. The Types of Frame.

The type of frame could affect the sound insulation of a window in two ways:

i. The gaps that could result from inadequate sealing are different.
ii. The edge mounting conditions are different.

For the present purpose, frames can be classified into two types - timber and metal. The sound insulation of both single and double windows has been measured with both types of frame.

5. Lining the Reveals of Double Windows with Absorptive Material.

Whilst it is generally believed that lining the reveals of double windows with absorptive material will improve their sound insulation, it is not known to what extent this improvement depends on the values of the absorption coefficients of the materials used and what improvement is to be expected with different types of window. Four types of absorbent material have been tested together with the effect of absorbent on a wide range of window types.

6. Cavity Resonances.

The cavity of a double window is a small reverberant room and has its own set of resonances. Their frequencies will, of course, depend on the dimensions of the cavity and it is possible that some sizes of cavity will emphasize these more than others. The transmission loss of two types of window has been measured, each with two sizes of cavity - 12' x 6' and 6' x 4'.

7. The Weights of the Glass and the Depth of the Cavity of Double Windows.

Two thicknesses of glass are in general use in this country - 4 mm and 6.5 mm. Measurements have been carried out to determine the transmission loss of single windows with both weights of glass, and of double windows with 100 mm, 200 mm and 400 mm deep cavities, with and without absorbent reveals, also with both thicknesses. In addition, double windows with one window of 4 mm and the other of 6.5 mm glass and cavity depths of 100 mm, 200 mm and 400 mm have been measured with and without absorbent reveals.

FIELD MEASUREMENT OF THE SOUND INSULATION OF WINDOWS.

Whilst laboratory experiments serve to indicate the potential sound insulation of various types of window, the ultimate concern is the performance of real windows in buildings and not samples in the laboratory. There are a number of difficulties associated with a field technique for the measurement of the sound insulation of windows and no laboratory or field technique that has been used in the past is entirely suitable. Such a technique has, however, been developed, using road traffic as a noise source and has been used to measure the sound insulation of a number of these windows. These include (i) single window of 4 mm glass with the building facade both parallel to and at right angles to the road. (ii) single windows of 6.5 mm glass. (iii) Thermal double glazing. (iv) Acoustic double windows.

The results confirm that the most important factor influencing the sound insulation of windows is their standard of sealing and some of the results obtained compare with the worst values measured in the laboratory.