Proceedings of The Institute of Acoustics

THE TENTATIVE PREDICTION OF INTRUSIVE NOISE WITHIN CITY OFFICE BUILDINGS

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INTRODUCTION

This paper discusses some aspects of recent work which has re-examined the existing acoustic conditions within many office complexes in the Greater London area. In particular, the degree of intrusion arising from road and railway noise sources has been determined at buildings which are located in essentially noisy areas.

The measurements were undertaken for a large organisation having office buildings in urban areas throughout the country. The buildings were investigated for one of two reasons:

(a) occupants had complained of excessive noise intrusion or

(b) potential occupants required intrusive noise data to aid their selection of suitable premises.

The relationship between external and internal noise for a *given* office situation may be defined in terms of various parameters. The data obtained from the present series of measurements has enabled the effects of these parameters to be presented in a standardised format. This standardisation allows the inherent acoustic quality of a particular office to be determined and to be compared to that of another office. Differences which may have existed as a result of different secondary acoustic treatments can be rationalised so that readily understood comparisons can be made.

Office personnel are becoming increasingly aware that noise is a factor which affects their working environment and are now at pains to ensure that acceptable criteria are achieved.

CRITERIA

The criteria adopted by the organisation in question was originally 55dB(A) L_{10}, with windows open if no mechanical ventilation is supplied. A secondary criterion of 60dB(A) L_{10} has subsequently been set as the financial implications of the initial level were found to be excessive. The 60dB(A) level was considered as forming a reasonable compromise between desirable acoustic and economic objectives.

This criterion is related to the level at seated head height, 1 metre inside the window. A review of the literature (refs) would suggest that such a criterion was not far removed from levels which are normally considered acceptable in general office areas.

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BUILDING TYPES AND LOCATIONS

The position of measurement at 1 metre from the relevant window meant that invariably the controlling noise transmission path was via the window. Hence the type of building design and construction did not generally affect the external to internal level difference.

The types of building examined were numerous, from 1930's traditional brick, with metal framed windows, through 90% glazing to modern lightweight constructions.

The locations were invariably adjacent to busy roads, allied in a few cases to train noise.

Furnishings in the offices ranged from completely empty with no carpet or ceiling tiles, to occupied with carpet, acoustic tiles and armchairs and desks.

Office sizes ranged from large open plan type of approximately 300 square metres to small cellular approximately 8 square metres.

Reverberation times therefore varied from approximately 4 seconds in an empty, large office to less than 0.5 seconds in a small furnished office.

MEASUREMENT PROCEDURE

The criterion against which the measurements in this survey were assessed was L_{10} in dB(A).

Although shortcomings in units of measurement are bound to become apparent on a survey of this size, it is not the purpose of this paper to criticise the use of L_{10}. The criterion was specified in this unit and therefore the measurements were likewise restricted to L_{10} data only.

Ideally, the full working day L_{10} would be measured in all relevant offices. This was not practicable for financial reasons and the following procedure was adopted:

1. A central position was set up to continuously monitor the noise level throughout the working day. This enabled the noise 'profile' to be established for the particular building facade under investigation.

2. Half hour sample measurements were then carried out in all the relevant offices and related to the working day L_{10} at the central position. This enabled the effective working day L_{10} to be calculated at all offices on that facade.

This procedure was necessary as over 60% of occupants expressed the view that the sample measurement was being taken at the 'wrong' time for maximum noise. Despite this reaction from occupants, the maximum sample - working day correction was +2.5dB(A). In 80% of the surveys completed, the sample L_{10} noise level was within 1.5dB(A) of the complete working day L_{10}.

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RESULTS

Figure 1 presents the results of sound insulation measurements at a representative 14 sites, together with the average result.

FIGURE 1

Site No	Out/In Level Difference in dB(L_{10})		Window Insertion Loss	
	Windows Open	Windows Closed	Average	Range
1	9.2	24.1	14.9	12 - 16
2*	9.0	18.3/22.8	9.3/13.8	8 - 16
3	7.2	16.0	8.8	8 - 9.5
4	11.7	18.9	7.2	6.5 - 9
5	8.5	18.5	10.0	9.5 - 11.5
6	9.7	17.6	7.9	5.5 - 11.5
7	-	-	11.2	
8	-	-	9.6	6 - 14
9	-	-	7.7	5 - 10.5
10	-	-	9.8	6.5 - 11.5
11	-	-	9.0	8 - 10.5
12	-	-	10.2	6.5 - 12.5
13	-	-	9.5	6.5 - 11.5
14	-	-	9.2	7.5 - 13
Ave	9.2	18.9	9.6	7.2 - 14.9

* These windows were double glazed, the two results being with secondary glazing open and then closed. Average results include single glazed condition for site no.2.

The variation in the efficiency of window seal is reflected in the range of insertion loss values obtained.

These results include those in offices of all types i.e. large open plan, or small cellulor, occupied and unoccupied, furnished or completely empty.

As all internal measurements were taken 1 metre inside the windows to give (a) consistancy and (b) the most critical situation, the effects of room furnishing are perhaps not as great as those experienced further from the external wall. However, in identically sized offices, the introduction of a carpet (or acoustic ceiling) was found to reduce the internal noise level by some 2 - 3dB(A).

Horizontally hinged windows, when open, can produce directional effects on the noise source particularly as perceived on upper floors. Increases of some 3dB(A) have been measured in these situations over the levels experienced with vertically hinged or sash windows.

Variation of noise level with height was found to fluctuate considerably and depended in part upon

(a) nearby buildings reflecting the noise source and

(b) the number of additional noise sources 'visible' as one moves higher.

Figure 2 shows the variation of internal noise level (windows open) on two sites, all offices being of similar size and similarly furnished. Both buildings were subjected to one predominant noise source only, this being a busy road, some 3 metres from the building facade. Site A had no nearby adjacent buildings whilst site B had a six storey building immediately across the road.

FIGURE 2

Floor No	L_{10} in dB(A)	
	Site A	Site B
1	66.5	66.5
2	63.5	66.0
3	60.5	-
4	62.0	66.5
5	59.0	-
6	59.0	67.5
7	53.0*	66.5
8	-	67.0
9	-	-
10		60.0*

* The top floors were above a parapet which gave considerable screening

At a few of the survey sites railway noise sources also had to be considered. Perhaps somewhat surprisingly the client applied a similar noise criterion to this source as for the case of road traffic.

On one site, subjected to motorway noise and railway noise on the same facade, the most vociferous complaints were of the trains (75 - 85dB(A) in offices for 1 - 2% of the time) rather than of the motorway (L_{10} of 60 - 65dB(A)).

During the presentation of the paper the methods used to standardise results obtained in different office locations will be discussed.

CONCLUSIONS

The surveys reported in this paper were carried out to a specific requirement, rather than as a research project on intrusive noise. It is accepted that the results are therefore incomplete and should possibly be regarded as interesting

rather than statistically significant.

It is believed however that useful data has been obtained on the practical sound insulation of windows of many differing types and ages.

A tentative method has been formulated by which a standardised comparison of the noise environment within a given office may be compared to that of another office with differing internal treatments.

The reaction of office occupants has also been sought of many occasions. Those working on lower floors of buildings, with a large range of noise level in addition to a high L_{10} are found to be considerably more disturbed than those on the upper floors, often with a similar L_{10}, but without the high peaks experienced below.

A similar tendency was apparent with relation to railway noise. Although in the surveyed cases trains were only passing for some 1 - 2% of the time, and this may interrupt only two telephone calls per day for 15 seconds, this noise source was considered of great nuisance. The approximately constant motorway noise is apparently accepted since it does not actually prevent work function from taking place.

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