inter·noise 83

INSULATING DWELLINGS AGAINST ROAD TRAFFIC NOISE

J.W. Sargent, W.A. Utley and E.C. Keighley

Building Research Establishment,
Garston, Watford, Herts, UK.

INTRODUCTION

In 1962 a trial installation at the Building Research Station showed that rooms in dwellings could be successfully insulated against outdoor noise by the use of double windows whilst still providing fresh air ventilation, the latter being achieved by a sound attenuating mechanical ventilator. This experiment was reported in the Wilson Committee Report (1) and subsequently the method was used in a scheme to alleviate the noise problem in dwellings near Heathrow Airport. Prior to the introduction of a scheme to improve the noise insulation of dwellings subjected to high levels of traffic noise from new or modified roads BRS undertook a further study using a dwelling situated close to an existing motorway (2). The results of this study together with experience gained with the Heathrow scheme were used to draw up a specification for a package (3) that would increase external insulation while ensuring that acceptable thermal conditions could be maintained and that adequate ventilation was provided both for comfort and safety.

Since the implementation of the Noise Insulation Regulations over 30 000 dwellings have been provided with this remedial package as a result of major road building schemes. The Building Research Station has recently undertaken an investigation into the effectiveness of the package and its acceptability to residents.

THE REMEDIAL PACKAGE

In order to obtain protection against external noise it is necessary to keep windows closed. The fitting of double windows with a wide cavity between the panes will provide further protection. Unfortunately these measures may lead to other problems such as overheating and inadequate ventilation. The remedial package consists therefore of four elements, double windows, a venetian blind, a powered

ventilator and a permanent vent. Detailed specifications for each of these elements are contained in Regulations (3). The package is installed in living rooms and bedrooms that have windows exposed to noise from the new or modified road.

The minimum cavity width for the double windows is specified in relation to the thickness of glass used for the inner pane. For 4 mm glass the cavity width would need to be at least 150 mm. The Regulations require that both outer and inner windows should have effective sealing at the edges but that they should remain openable. At least two of the reveals must be lined with sound absorbent material. When the window faces a direction from north-east through south to north-west a venetian blind is fitted between the panes of the double window in order to help control solar gain and prevent overheating.

The specification for the powered ventilator includes minimum ventilation rates with the fan operating, minimum effective area with the fan off, maximum noise levels from the fan and maximum sound transmission through the ventilator. The noise generated at the maximum ventilation rate must not exceed 40 dB(A) in the room (at least 1 metre from the unit). This ventilation rate will seldom be needed and at more usual fan settings the noise level would be below 35 dB(A). The sound attenuation required through both the permanent and powered ventilator is specified in terms of a normalised level difference in 1/3rd octave bands between 100 Hz and 3150 Hz. The specification is such that it would allow the complete package to achieve an overall reduction in road traffic noise levels of 35 dB(A). The permanent vent reduces the back pressure on the powered ventilator unit particularly when the room is well sealed and thus ensures that the required airflow rate is maintained. Its effective area also contributes to the total area required for safety reasons when flued combustion appliances are present in the room.

INSULATION PERFORMANCE

Insulation measurements were made on 154 installations carried out under the Noise Insulation Regulation. These were at 27 sites chosen for the questionnaire survey.

The measurements were made using the road outside the dwelling as the noise source. Simultaneous tape recordings were made for 15 minutes outside and inside each insulated room. The microphone inside was moved to three positions within the room and the outside microphone was placed 1 metre from the insulated window. These recordings were analysed in dB(A) and 1/3 octave bands in terms of L_{10}. This was carried out using a real time analyser and mini-computer.

The mean value of the level differences was found to be 34 dB(A), however the highest was 41.5 dB(A) and the lowest 25 dB(A). The results show that the differences in traffic noise spectrum from site

to site account for some of the variation in the measured dB(A) level differences. For example at one dwelling where the insulation in 1/3 octave band was substantially the same in the living room and bedroom the weighted level difference was 5 dB less on the ground floor where a wall between the road and the house had reduced the high frequency noise and produced a spectrum with relatively greater low frequency content. For the sample as a whole, rooms on the first floor had, on average, a 1 dB(A) higher level difference than rooms on the ground floor.

The mean values of the 1/3 octave level difference increased from about 20 dB at 31.5 Hz to about 44 dB at 1250 Hz where it remained roughly constant up to 3150 Hz. The average level difference over the frequency range 100-3150 Hz and the weighted sound level difference using the rating method in BS 5821 (4) were also determined and both these values were invariably found to be higher than the dB(A) difference.

It was possible to attribute certain examples of particularly low insulation performance to constructional details of the facade. For example at one site two of the dwellings measured had front doors which opened directly into the living rooms. The insulation for these rooms was about 10 dB below the average at the rest of the site. At the site with the poorest performance (average 28 dB(A)) the facades of the dwellings were of lightweight construction. An examination of the insulation vs frequency curves shows a particularly poor performance at low frequencies consistent with significant sound transmission through the lightweight facade.

THE QUESTIONNAIRE

The questionnaire, which was designed to cover all aspects of the insulation package, was tested in a pilot survey of 94 interviews carried out at 3 sites. As a result of feedback from the pilot study additional questions were included to cover vibration and transmission of noise from untreated parts of the dwelling into treated rooms. The resultant questionnaire was administered by trained interviewers and 882 completed questionnaires obtained from a further 24 sites.

The questions can be divided into seven categories. The first is general information about the respondent and the household. Next is the respondent's general likes and dislikes of the area and dwelling. The third covers details of the house including which rooms had been treated and the type of heating used. Next is a series of questions concerning the respondent's feelings about individual items of the package and these are followed by a section dealing with attitudes to noise. The sixth section deals with other aspects of the internal environment in the dwelling and includes questions about thermal and ventilation conditions and about condensation. The questionnaire

concludes by seeking the respondent's attitude to the remedial package as a whole.

A number of questions about response to traffic noise are the same as those used in an earlier investigation concerned with untreated dwellings (5). This should permit a comparison between the response of residents in treated and untreated dwellings and thus enable an assessment to be made of the effectiveness of the remedial measures in reducing noise annoyance.

An initial analysis of the data indicates that only a small proportion of respondents (8%) consider the remedial package as a whole to be unsatisfactory. Questions about individual parts of the package show that while a high proportion of respondents consider the double windows and venetian blinds to be satisfactory (88% and 90%) only 58% thought that the ventilators were satisfactory. The main reasons for disliking the ventilators were that they caused draughts, were unsightly and too big or bulky.

The level of traffic noise in their insulated living rooms was considered satisfactory by 84% of respondents and 75% sleeping in insulated bedrooms considered them satisfactory as regards traffic noise level.

During summer the temperature in living rooms was considered to be more comfortable after the package was installed by 34% of respondents while only 12% considered it less comfortable.

More condensation was reported by only 10% of respondents whereas 25% say they have had less, since the package was installed. Further analysis of the data is expected to reveal a more detailed picture of the effectiveness of the package in maintaining an acceptable environment within the dwelling.

The responses to questions about noise are also being analysed in conjunction with the measurements of noise level and insulation.

REFERENCES

[1] Noise. Final report of the committee on the problem of noise. Cmnd 2056, HMSO 1963.

[2] E.F. Stacy et al 1974, An experimental investigation of motorway noise and sound insulation alongside the Midland Links motorway. BRE current paper 48/74.

[3] Statutory Instrument 1975 No 1763. The Noise Insulation Regulations 1975. HMSO 1975.

[4] British Standard BS 5821:1980. Method for rating sound insulation in buildings and of building elements. British Standards Institution 1980.

[5] F.J. Langdon 1976, Journal of sound and vibration, 47(2), 243-263. Noise nuisance caused by road traffic in residential areas: part 1.