Proceedings of the Institute of Acoustics

THE BUILDING REGULATIONS 1991 - CRITERIA AND EXPECTATIONS

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INTRODUCTION

In the UK, complaints about "neighbour noise" have been increasing over a period of several years. Such complaints have involved both external environmental noise (ie noise generated outside a building, whether in multiple occupancy or not) and noise generated internally, by a neighbour occupying the same building.

External noise is generally controlled at source, by the provisions of the Environmental Protection Act, 1990; the Control of Pollution Act, 1974 (for construction noise) and local authority implementation of, for example, The Noise Council's *Code of Practice on Environmental Noise Control at Concerts*. Planning Guidance, such as PPG 24 can also be used to ensure control over the juxtaposition of noise generating and noise sensitive uses of land. The Noise Act, 1996 has also been introduced to reduce disturbance at night to occupants of residential dwellings from amplified music from neighbouring dwellings.

Whilst these provisions seek to control noise at source, it is clearly necessary also to address the problem of the provision of adequate sound insulation to achieve an appropriate balance between the right of one person to the undisturbed enjoyment of his property and that of another to use his property for his own lawful enjoyment, which can, of course, include noise generating activities.

It is with the aspect of sound insulation in dwellings that this paper is concerned.

CRITERIA FOR SOUND INSULATION IN DWELLINGS

The primary source for controlling the sound insulation in dwellings in the UK is the Building Regulations 1991, *Resistance to the passage of sound*. These Regulations are based on the stated aims that:

"*... the relevant parts of the dwelling are designed and built in such a way that noise from normal domestic activities in an adjoining dwelling or other building is kept down to a level that will not threaten the health of the occupants of the dwelling and will allow them to sleep, rest and engage in normal domestic activities in satisfactory conditions.*"

Quantitative criteria are then specified, which are considered appropriate to meet these aims, as tabulated below:

Test Element		Airborne sound $D_{nT,w}$dB	Impact sound $L'_{nT,w}$dB
Walls	- 4 or less	53	not specified
	- individual	49	
	- 8 or more	52	not specified
	- individual	49	
Floors	- 4 or less	52	61
	- individual	48	65
	- 8 or more	51	62
	- individual	48	65

TABLE 1: Building regulations criteria for sound insulation in dwellings

These criteria address the problem of internally generated intrusive noise, but equivalent criteria relating to externally generated noise are not provided, although this is dealt with, to a limited extent by the recommendations of the British Standard, BS 8233[1].

There is provision in PPG 24 to control the transmission of transportation noise, through planning conditions which require adequate measures to mitigate such noise where land to be used for residential development falls into noise exposure categories B and C. The Noise Insulation Regulations 1975 (amended 1988) and the more recent Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1995 also provide for additional sound insulation for doors and windows to habitable rooms, where new or altered roads or railways cause noise levels from these sources to exceed threshold levels.

LEVEL OF SATISFACTION WITH CRITERIA

Over recent years there has been an increase in the number of complaints about intrusive noise, particularly with reference to internally generated noise and lack of privacy in multiple occupancy dwellings.

The complaints usually relate to airborne and structureborne noise from reasonable domestic activities, including use of televisions and hi-fi equipment, kitchen appliances and bathrooms and also audibility of speech, footfalls, etc, rather than those activities for which the Environmental Protection Act and the Noise Act were developed. It is, therefore, appropriate to question whether the criteria adopted are appropriate. The complaints arise from occupants of a variety of building types, particularly modern, low cost/lightweight constructions and conversions of old buildings to multiple occupancy use, but also, for example terraced and semi-detached houses at the higher quality end of the market. There is an additional problem where commercial and residential properties adjoin and higher levels of noise than would be experienced from "normal domestic activities" can occur. In such cases, an improved level of sound insulation is likely, therefore, to be needed to achieve satisfactory conditions.

Some indication of the extent and context of this problem was provided in a paper by Colin Grimwood[2], although this was necessarily limited to properties where complaints had occurred, so did not determine, for example, such aspects as the percentage of the population dissatisfied with standards of domestic privacy.

It is useful to reiterate some of the conclusions drawn from Grimwood's study, which sought to investigate complaints about poor sound insulation in dwellings, in order to determine the types of noise which cause complaint and whether it was common for complainants to live in dwellings where the sound insulation was below the level regarded as reasonable.

The complaints related to both airborne and structureborne sound, resulting from "normal domestic activities", such as use of television, radio and hi-fi equipment, voices, footfalls, banging of doors, and use of bathrooms and domestic equipment, including operation of electrical switches and sockets.

The investigation showed that:

- in 98% of cases investigated, the complainant blamed the standard of insulation;
- in 85% of cases, the neighbour believed the complaint to be reasonable;
- 93% of complainants and 83% of neighbours claimed to have modified their behaviour because of the problem.

Grimwood also assessed the sound insulation in dwellings where complaints occurred and determined that:

- the airborne sound insulation for walls was below the required mean value in 70% of cases and below the required value for individual partitions in 35% of cases;
- the airborne sound insulation for floors was below the required mean value in 86% of cases and below the required individual value in 61% of cases;
- the impact sound insulation values of floors were above (ie worse than) the required mean value in 57% of cases and above the required individual value in 20% of cases.

It was also shown that, when the mean value for airborne sound insulation is met, people do not generally complain about normal conversation, but only the louder everyday noises (raised voices, coughing, sneezing, snoring, impacts, etc).

It was concluded from this study that the mean values for sound insulation specified were approximately correct, but that poor quality of construction led to shortfalls in the sound insulation in practice. It can, however, be argued that this conclusion can be questioned, for a number of reasons.

The Building Regulations provide a *minimum* standard, which is adopted as the norm by a construction industry, but is by no means a desirable design target. In several cases assessed by Arup Acoustics it has been shown that normal, everyday sounds (not just the louder sounds) are clearly audible and perceived to lead to a loss of privacy by the occupants, even though properties have met the requirements of the Building Regulations.

Higher expectations, however, coupled with improvements in living standards and lower background noise levels resulting from improved glazing standards in new buildings, may have led to an increased awareness of, and sensitivity to, intrusive noise. High quality multi-occupancy dwellings, both new and conversions of larger buildings, such as old warehouses, barracks and country houses are also now being developed, for which expectations are significantly higher than the average dwelling.

It is also clear that the policing of the Regulations is inadequate and that greater control over construction methods and practice is needed. Many "deemed to satisfy" constructions barely meet the requirements of the Regulations when tested under laboratory conditions - on site such constructions can easily fall short of their design performance as a result of poor construction practice.

It may also be argued that, were the requirements set higher, there would be a higher probability of the aims of the Regulations being met.

PARAMETERS USED TO SPECIFY SOUND INSULATION

It is relevant to look at the parameters used to specify sound insulation - R_w, $D_{nT,w}$ and $L'_{nT,w}$. Unlike the American STC (sound transmission class) these values do not include a limit to the individual adverse deviations in each ⅓-octave band - it is only necessary to *report* adverse deviations in excess of 8dB. This can lead to high adverse deviations at specific frequency bands, which can result in a significant loss in the perceived sound insulation.

In modern lightweight constructions, very good high and mid frequency attenuation can be achieved, but large deviations, in excess of 10dB, can occur at low frequencies. This leads to problems with disturbance from low frequency impact noise (usually described as "thumps") and such effects as high levels of bass from neighbour's music systems.

A recent study by Blazier and Du Pree[3] investigated complaints of low frequency footfall noise in wood frame multiple occupancy buildings in the USA. This study showed that thuds, thumps and booming intrusive noises were evident even when floors were carpeted and occupants walked barefoot or wore soft-soled shoes. Objective tests showed high levels of transmitted noise in the frequency range 20Hz-100Hz, below the limit of the standard sound insulation tests. It was also noted that natural frequencies of constructions often fall in the range 15Hz-30Hz.

This effect has also been identified in a recent study undertaken by Arup Acoustics on a high quality conversion of a barracks, where several residents had complained of disturbing levels of footfall noise. The impact sound insulation of representative floors was shown to be better than 42dB $L_{nT,w}$, well below the minimum standard required to comply with the Building Regulations. Mid and high frequency noise from the tapping machine could not be measured, in spite of low background noise levels. The weighted impact sound pressure level was determined only by energy in the 100Hz-160Hz ⅓-octave bands. An analysis of the spectrum of noise from the tapping machine showed that significant impact noise occurred only between 20Hz and 200Hz and resulted from the response of the long span, wooden joist floor construction.

In practice, this problem cannot be resolved by increasing the stiffness of timber floors, only by the use of materials such as concrete, which typically has a stiffness an order of magnitude greater than that achievable with timber or steel joist systems.

Clearly, lightweight, low stiffness floors result in a perceived impact noise problem, which is neither detected nor controlled by the current Building Regulations lower frequency limit at the 100Hz ⅓-octave band centre frequency.

SOUND INSULATION STANDARDS IN OTHER COUNTRIES

A comparison of sound insulation criteria for various countries is difficult, even within the EC, because of variations in the parameters used. Germany and Sweden, for example, base their criteria on the use of R'_w for airborne noise and the $L'_{n,w}$ for impact noise, whilst France and Spain use a dB(A) sound insulation value, in the former case relative to a level of pink noise in the source room. Both France and Germany require minimum levels of sound insulation against transportation noise. In Germany minimum criteria are set for airborne sound insulation of doors separating rooms from communal (circulation) areas and for the impact sound insulation for staircases in multiple occupancy dwellings. A comparison of the UK, Swedish and German criteria (those which can be compared directly) is shown in Table 2, below.

Country	Airborne Sound	Impact Sound
UK - walls - floors	$D_{nT,w}$ = 49dB-53dB $D_{nT,w}$ = 48dB-52dB	not specified $L'_{nT,w}$ = 6dB1-65dB
Sweden - walls - floors	R'_w > 52dB-53dB R'_w > 52dB-53dB	not specified $L'_{n,w}$ < 58dB
Germany - walls - doors (halls/stairs to halls) - doors(halls/stairs to occupied areas - floors - stairs (multi storey)	R'_w > 53dB-55dB R_w > 27dB R_w > 37dB R'_w > 52dB-55dB R'_w > 52dB or R_w (door)+15	not specified $L'_{n,w}$ = 46dB-53dB $L'_{n,w}$ = 58dB
Germany - walls - floors - stairs (semi-detached)	R'_w = 57dB R'_w = 57dB not specified	not specified $L'_{n,w}$ = 48dB $L'_{n,w}$ = 53dB

TABLE 2: Comparison of sound insulation criteria

It can be seen that the German criteria (specified in DIN 4109) are more stringent than those for the UK. Impact noise criteria are significantly more stringent. Whilst the French standards cannot be directly compared with those in the UK, it is apposite that new regulations were introduced in 1994, which sought to improve standards of insulation in dwellings by 3dB(A), in comparison with the former regulations (1969, updated 1975).

CONCLUSIONS

An assessment of published data on sound insulation standards in dwellings, and studies carried out by Arup Acoustics in response to complaints regarding privacy in dwellings have shown that, not only do a high proportion of constructions not meet the Building Regulations in practice, but even where these are met, there is dissatisfaction with levels of privacy and freedom from disturbance from normal domestic activities in multi-occupancy dwellings. This can, in lightweight constructions, be exacerbated by poor low frequency isolation of impact noise.

Experience has tended to show that the expectations of occupants are higher than would be implied by the stated aims of the Building Regulations, a problem aggravated by the criteria being used as a general design aim rather than as minimum acceptable standards, regardless of the quality of the buildings.

It is concluded that there is a clear need for the Building Regulations criteria to be improved and for an improved level of control over the implementation of the Regulations on site.

REFERENCES

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