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REMEDIAL SOUND INSULATION IN CONVERTED DWELLINGS: THE QUESTIONS

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Introduction

When investigating residents' complaints of poor sound insulation in converted properties it is convenient, although not a requirement, to consider the criteria laid down in the Building Regulations (1972); that is, the deemed-to-satisfy performance standards for party wall grade and airborne and impact standards for party floors. Do these represent adequate standards where they can be applied? Where they cannot be applied, what standards should be adopted? Finally, how can the desired standards be implemented in an existing conversion?

Are Existing Standards Adequate?

The adopted standards are based on BRS research largely conducted some thirty years ago.[1)2)3)4)] The following summary of the resulting grading system is found in BRE Digest 102.[5)]

> Party wall grade. This grade is based on the performance of the one-brick (9") party wall. It reduces the noise from neighbours to a level that is acceptable to the majority; a lower standard certainly could not be justified on present evidence. A higher standard is not yet practicable, mainly because at this level of insulation flanking transmission is usually about equal to direct transmission and there is little to be gained from improving only direct transmission.
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> Grade I. This is the highest insulation that is practicable at the present time vertically between flats. It is based on the performance of a concrete floor construction with a floating floor, which gives the best floor insulation obtainable by normal structural methods. Noise from the neighbours causes only minor disturbance; it is no more of a nuisance than other disadvantages which tenants may associate with living in flats.
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> Grade II. With this degree of insulation the neighbours' noise is considered by many of the tenants to be the worst thing about living in flats, but even so at least half the tenants are not seriously disturbed.
>
> Worse than Grade II. If the insulation between flats is as low as 8dB worse than Grade II, then noise from the neighbours is often found to be intolerable and is very likely to lead to serious complaints. With better insulation than 8dB worse than Grade II, the likelihood of complaint decreases gradually, but when there are also other reasons for dissatisfaction, serious complaints about noise may occur if the insulation is worse than Grade II.

Empirical validation of the airborne rating procedure has been provided by the results of recent BRE surveys of house[6)] and flat[7)] dwellers with the latter suggesting that, amongst flat dwellers, there is little demand for insulation

above the Building Regulations (1972) minima, ie party wall grade and airborne and impact Grade I for floors. This is encouraging to the consultant in that it suggests that the framework set out in Digest 102 can be useful in the assessment of complaints in existing flats. There are limitations however, as a closer look at the findings of the flat-dwellers' survey indicates [7]:

i. Impact Sound Measurements

Responses regarding structureborne sounds related not to the measured impact insulation but to the measured airborne sound insulation. It is concluded that the results suggest that the measurement of impact sound insulation of floors has little to recommend it, due to the difference between pre-occupancy conditions (hard floors) when tests are made, and post-occupancy conditions (90% installed a carpet). The survey also cites other researchers who have criticised the present impact measurement method.

ii. Survey Population

In the converted dwellings considered below, it has been common practice to house families with children in many flats. In the BRE survey [7] 90% of the survey population had no children and the sample was heavily weighted towards the elderly.

iii. 'Stacking' of flats

In the conversion from existing terraced houses to flats it is very difficult to keep the planning the same on all floors as in the examples investigated by BRE. Consequently, incompatible rooms are often found to be stacked one on top of the other.

iv. History of Complaint

The need for remedial work is invariably based on a history of complaint. The residents are often sensitised to noise from their neighbours and may not accept anything which does not completely eliminate the problem.

In summary therefore, the grading system still offers a useful framework against which complaints can be assessed, but differences between the specific circumstances surrounding the complaint and the data base used in supporting research should be considered. In practice, such considerations as ii), iii) and iv) above suggest that the Building Regulations *minima* are less likely to be adequate for many living in converted properties.

What other noise sources should be considered?

In addition to consideration of party walls and party floors, the BRE [7] survey of flat dwellers looked at other sources of noise identified by respondents. Although noises from outside the building were mentioned more often than those within the building, the latter appear to bother residents more. The most bothersome internal noise was found to be airborne and impact noise from the flat above; next came noise from halls and entrances followed by noise from neighbours below and next door (through the party wall). It was concluded that the results indicate the need to study ways of reducing the noise of doors being slammed and of improving the sound insulation of front doors.

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In the examples which follow it will be seen that there is particular concern amongst the occupants of converted flats over impact and airborne noise sources in common circulation areas, including the slamming of doors. As yet, no criteria have been formulated which could apply to such cases and consequently the architect has to resort to simple expedients to reduce the disturbance of such sources.

Example: London Victorian terrace converted to flats

RAP were engaged by a London borough to investigate reports of poor sound insulation in 35 flats converted from 13 terraced properties approximately six years ago. The flats are of brick construction with suspended timber floors. Figure 1 is an elevational diagram through Nos. 13-25 showing how the block divides into flats. In general, flat A occupies ground floor and basement and the remaining three floors divide into two or three flats. In the case of Nos. 15 and 19, larger three-bedroom flats are obtained by creating double-width flats and introducing doors into former party walls.

In general, repeated plans have been possible on the upper floors, ensuring compatible room uses with regard to noise and noise sensitivity. Where it has not been possible toachieve this, notably between ground and first floors, incompatible room stacking is more likely to cause complaint. For example, two bedrooms in flat 15B are immediately above kitchen/dining rooms in flats 13 and 15A.

Complaints received were of a general nature, including airborne sources such as voices, hi-fi and television sets and impact sources such as footsteps and movement of furniture. Between flats, the major cause of complaint was noise via party floors, particularly from above, although some complained of noise through party walls. Sources giving rise to complaint occur not only in other flats but also in common circulation areas. The degree of complaint was such that the client had been forced to allow approximately a quarter of the flats to remain void.

Party Walls

Initially it was thought that since the party wall construction was 13½" (340mm) solid brick construction (meeting the deemed-to-satisfy requirements of the Building Regulations with weight to spare), no measurement of sound insulation would be necessary. However, following complaints from a number of tenants, measurements were carried out in three locations where complaints had been received. As expected, party wall grade was comfortably achieved (see Fig. 2). In one case, the complaint related to flanking transmission where the measured sound insulation exceeded party wall grade by approximately 9dB. No remedial action was recommended for party walls.

Party Floors

The following floor/ceiling construction had been adopted:

22mm plain-edge floor boards (wide gaps)
225 x 50mm timber joists
Ceiling: two sheets 9.5mm plasterboard plus skim coat
(Total mass 46kg/m^2)

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The measured airborne and impact sound insulation is shown on Figs. 3 and 4. The results can be summarised as follows:

- Airborne sound insulation

  Bare floor boards: 9dB worse than GII
  With carpet or floor tiles on hardboard: 3dB worse than GII

- Impact sound insulation

  Bare floor boards: GII
  With carpet: GII

These results clearly substantiate the tenants' complaints, which are further influenced by the presence of children in many flats and the incompatible stacking of some rooms. These considerations and the history of complaints suggest that this is an instance where Grade I might not be adequate. However, a Grade I criterion was recommended to the client on the grounds that it would represent a significant subjective improvement over the tenants' current conditions and was thought to be an achievable target.

Consideration of the construction of the walls and partitions suggested that flanking transmission would not prevent the attainment of Grade I.[8) 9)] The wall construction is thick brickwork (340mm) and the partitions are of 75 x 50mm timber stud with 9.5mm plasterboard on each side. Both of these constructions are thought not to jeopardise the attainment of Grade I. This was supported by approximate calculations based on accelerometer measurements on the timber stud partitions.[10) 11)]

So far, the floating floor has not proved a reliable method to attain Grade I sound insulation, with BRE field surveys indicating a high risk of very poor sound insulation.[12)] There are other practical reasons why floating floors are difficult to incorporate in an existing building, notably difficulties associated with raising the floor level. In this case, the overwhelming factor against the adoption of a floating floor was structural - over their longest spans, the joists were already fully loaded and could not take the additional load of a floating floor. A ceiling on independent joists was therefore recommended, see Fig. 5. This form of construction had previously been successfully implemented in another conversion for the same borough, see Fig. 6.

Noise from Stairs and Circulation Areas

Airborne Sound

Communal staircases are separated from habitable rooms including bedrooms by timber stud partitions comprising 75 x 50mm studs and 12.7mm plasterboard. The results of airborne sound insulation measurements indicated a performance of approximately 8dB worse than Grade II. Partitions adjacent to stairs and circulation areas do separate residents from their neighbours using the stairs and must insulate against airborne noise sources, particularly voices, which tenants mentioned. In view of the limited time exposure of such events and the reduced level of conversational speech compared with other sources, it would be reasonable to assume that less than Grade I could prove acceptable. Consideration of levels of speech relative to the night-time background noise level suggest that Grade II would offer a reasonable degree of airborne sound insulation. Again

this should give a worthwhile subjective improvement for the residents. A decision of this kind is strongly influenced by the practicalities of improvement. In this case, the consequences of setting a Grade I criterion would possibly have been radical changes to the staircase structure with associated expense and inconvenience to the client and tenants, many of whom wished to remain in occupation during remedial works.

The following treatment was recommended for Grade II and is based on test results for similar constructions supplied by British Gypsum Limited:

- Remove plasterboard from one side of the timber studs, introduce absorbent quilt into the cavity (30-65kg/m^3) and fix 12.7 + 19mm plasterboard on resilient metal firring channels

Impact Sound

To assess the possible disturbance of footsteps on the stairs, an ad hoc test was devised. Sound level recordings were carried out in a room adjacent to the stairs whilst a person walked up and down the stairs, and then on the bare floor boards in the room immediately above the receiving room. The resulting levels were found to be similar. (Running on the stairs increased the level by approximately 5dB.) Using published impact insulation improvement figures for various floor finishes, it was inferred that a carpet on the stairs would be necessary to produce Grade I-equivalent conditions in the adjacent room.

Banging Doors

Sound level measurements were carried out to determine the level of noise in a first floor bedroom next to the stairs due to the banging of two doors: the communal front door at ground floor level, and the door to the second floor flat on the landing above. Levels between 48 and 54dB(A) were recorded. This could undoubtedly prove disturbing if heard against a night-time background noise level of approximately 30dB(A). Further measurements on the stairs next to the receiving room indicated that the transmission path was structureborne rather than airborne and consequently no improvement could be expected due to the proposed increase in airborne insulation of the partition. Two approaches to the reduction of the received level were considered:

i) 'Cushion' the impact between door and frame
ii) Reduce the velocity at which door and frame meet

Due to practical considerations the latter approach was recommended by fitting a special door closing device to communal doors and the front doors to individual flats. The device, when used in conjunction with a conventional closer, takes control of the final few centimetres of the door's movement by pulling it slowly but firmly closed.

All the remedial recommendations recorded in this paper and some other are currently included in a pilot study on two of the terraced properties containing five flats. They include some which relate closely to the BRE grading system and others which have been arrived at in response to specific needs which, although now recognised as bothersome to flat dwellers, are not covered by any published criteria.

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In remedial investigations of this type we find the BRE grading system a valuable tool in the assessment of complaints and we envisage that it will continue to be of value even if, as is presently rumoured, the deemed-to-satisfy numerical performance standards are removed from future Building Regulations.

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Figure 1 Elevational diagram

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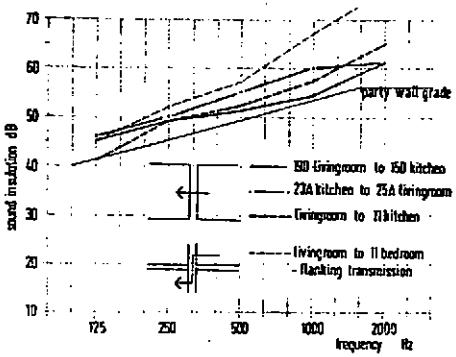

Figure 2 Party wall sound insulation

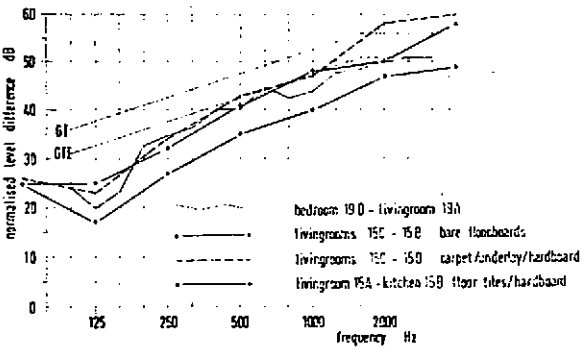

Figure 3 Party floors airborne sound insulation

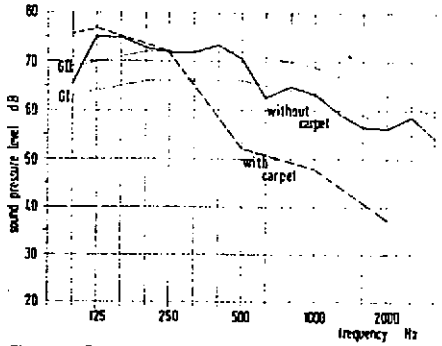

Figure 4 Party floors impact sound insulation

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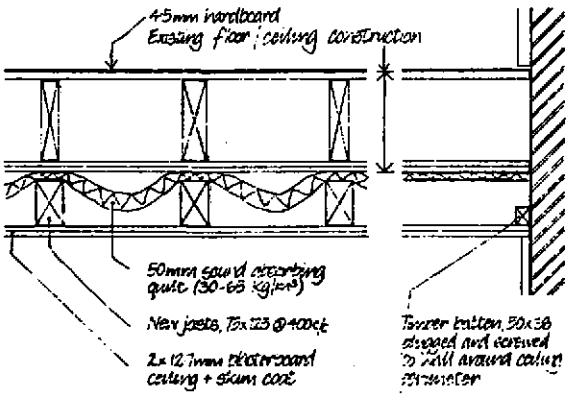

Figure 5 Ceiling on independent joists

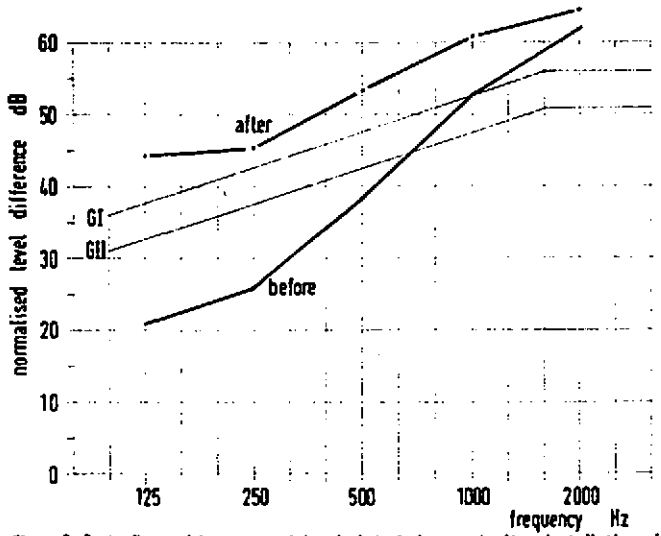

Figure 6 Party floor airborne sound insulation before and after installation of independent ceilings in a converted property