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IMPROVING SOUND INSULATION OF FLOORS IN FLATS - A CASE STUDY

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INTRODUCTION

Complaints from residents about excessive airborne sound transmission between vertically disposed dwellings in a purpose built development of flats and maisonettes led to an investigation of the alleged problem. Measurements of sound insulation were conducted in a large proportion of the dwellings to ascertain the degree and nature of any shortcomings, and a scheme of works was devised with a view to effecting a significant improvement in sound insulation within the practical constraints imposed in an existing building. Re-testing in a sample of dwellings following completion of the works demonstrated that a satisfactory outcome was achieved.

INITIAL INVESTIGATIONS

Following the receipt of residents' complaints, the developer was keen to identify and minimise any sound insulation problem and accordingly initiated some measurements which were carried out by others. These sound insulation tests indicated that the performance was quite variable but generally below that required by The Building Regulations 1976 [1] . Also, a "three storey" test showed only a small improvement in sound insulation compared with a normal two storey test. This, together with disappointing results from a trial substitution of a floating screed for the original timber platform, pointed towards flanking transmission as having a major influence on the sound insulation characteristics in these flats. The developer's early attention was focused on the possibility of sound transmission via the external wall cavity, e.g. between closers and lintels at the window openings, but without obtaining any improvements.

APPRAISAL OF THE PROBLEM

AIRO was asked to appraise the situation with a view to establishing whether it was feasible to obtain improved sound insulation and, if so, by what means.

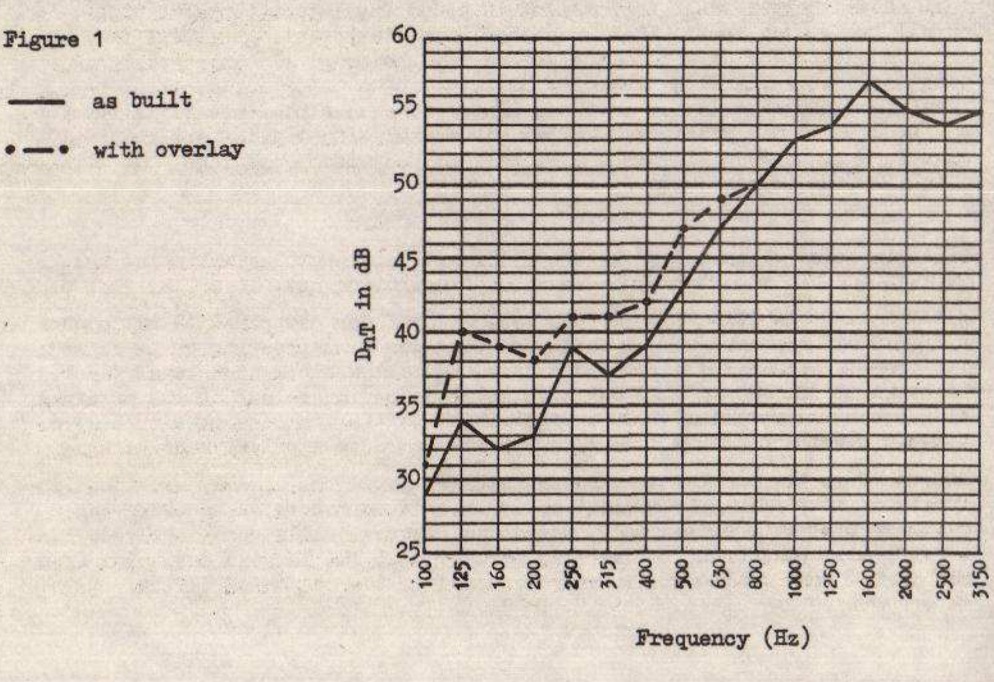
The original specification for the separating floor comprised 18 mm tongued and grooved chipboard on polythene sheeting on 40 mm flooring grade foamed polystyrene over a 150 mm concrete beam and hollow block structural floor. The ceiling finish was lightweight plaster. The inner leaf of the external walls was constructed of 100 mm lightweight concrete blockwork with a 25 mm thermal board dry lining made up of plasterboard on a polystyrene backing.

On reviewing the earlier measurement data we noted the already mentioned indications of flanking transmission, which were corroborated by observing a tendency towards a worse result where two external walls were involved, i.e. a gable end situation. It was also evident that the largest deviation from the party floor grade consistently occurred in the region of 250 Hz.

The floor specification used did not meet any of the constructions designated in Schedule 12 of The Building Regulations 1976 by virtue of the use of polystyrene as the resilient layer and a wooden platform as the floating membrane. Our own general experience of the use of polystyrene from laboratory and field measurements suggested that it is too stiff a medium to act effectively as a resilient layer in many types of separating floors. Of the various grades available, the specially pre-compressed variety is the only one which is regarded as possibly suitable and even this needs to be adequately loaded to obtain effective isolation. We formed the opinion that the use of polystyrene under a lightweight platform might be expected to exhibit a resonance at frequencies well with the lower part of the normal measurement range of 100Hz to 3150Hz, and thus contribute towards the noted shortfall in performance around 250Hz.

In order to check whether the direct transmission through the floor was in fact as important as the flanking paths, AIRO organised a comparative test on one separating floor where its sound insulation was measured as built and again when overlaid with 75 mm mineral wool and 22 mm chipboard. The results of this exercise are shown on Figure 1 where it can be seen that a significant improvement was obtained over the lower half of the test frequency range, the Aggregate Adverse Deviation (AAD) being reduced from 56 to 23 on the basis of The Building Regulations 1976. Using the rating scale of the subsequent 1985 Regulations [2] the $D_{nT,w}$ improved from 48 to 50 (BS5821:1984 [3]).

Figure 1



This test appeared to confirm our belief that there were in fact overlapping effects of both direct sound transmission via the floor itself, predominantly in the low to middle frequencies, and flanking transmission via the blockwork inner leaf of the external wall, extending across the frequency range but predominantly in the middle frequencies. We postulated that the flanking transmission was attributable to the lightweight blockwork which had been used, not helped by the application of a stiff facing, and that it was possible that the flanking problem may have been exacerbated if perimeter infill blocks had been omitted where floor beams lie parallel and close to the flanking walls, thus giving rise to inadequate bonding. We formed the view that in order to effect a significant overall improvement in sound insulation it would be necessary to tackle both aspects of the problem simultaneously in an appropriate programme of works.

SPECIFICATION OF THE IMPROVEMENT WORKS

The first stage of the works specification was to discard the original floating floor and wall linings and, having exposed the structural elements, to make good any defects in the sub-floor and walls with mortar or grout. In principle our objective was to introduce a fairly heavy floating membrane laid upon a properly resilient interlayer. Realising that there could be problems regarding room heights, floor loading and wet trades in existing occupied buildings, we discounted the possibility of laying thick concrete screeds either on the sub-floor or as a floating element. As we wished to have a uniform bearing surface for the new floating floor a thin levelling screed was specified which would also have the benefit of sealing the sub-floor surface. A latex based material was selected for this purpose having the attributes of ease of application and fairly rapid hardening. Our specification for the floating floor comprised a 25 mm resilient layer of mineral wool of density 64 kg/m^3 overlaid with a composite platform of 19 mm plasterboard with taped joints and 22 mm tongued and grooved chipboard, stuck together with resilient wallboard adhesive dabs at 300 mm centres. The usual precautions were taken to avoid bridging the resilient layer through contact of the floating element with the perimeter walls. To inhibit the radiation of sound from the external walls these were to be re-lined with panels of 10 mm plasterboard laminated to approximately 30 mm of mineral wool or glass fibre. These linings were anticipated to offer similar thermal properties as the original wall linings but, because of their more resilient backing, a much greater decoupling of the plasterboard room surface from the blockwork walls. It was decided to implement these improvements, and a programme of works was instigated which aimed to complete the exercise with the minimum of disturbance to residents but with strict control over the quality of workmanship which can often have an important bearing on sound insulation.

The works programme went ahead smoothly and incidentally provided the opportunity of inspecting the exposed structural elements. It was found, for example, that some of the hollow floor blocks were cracked but more importantly several instances were discovered where the specified solid floor perimeter blocks had been omitted. It will be re-called that this had been postulated as a contributory cause to the sound insulation problems.

MEASURING THE IMPROVEMENT

With a view to monitoring the improvement works, AIRO measured the sound insulation performance of 92 of the separating floors and associated structures prior to the work being implemented, using a standard measurement procedure [4]. Of these, 27 were re-tested in the same manner upon completion of the programme and a marked improvement in sound insulation was found to have been achieved. This can be seen from Figure 2 which compares the mean results of all the before and after treatment measurements, showing an improvement from an AAD of 64 to 8, and from a $D_{nT,w}$ of 46 to 54.

Figure 2

——— before treatment

•———• after treatment

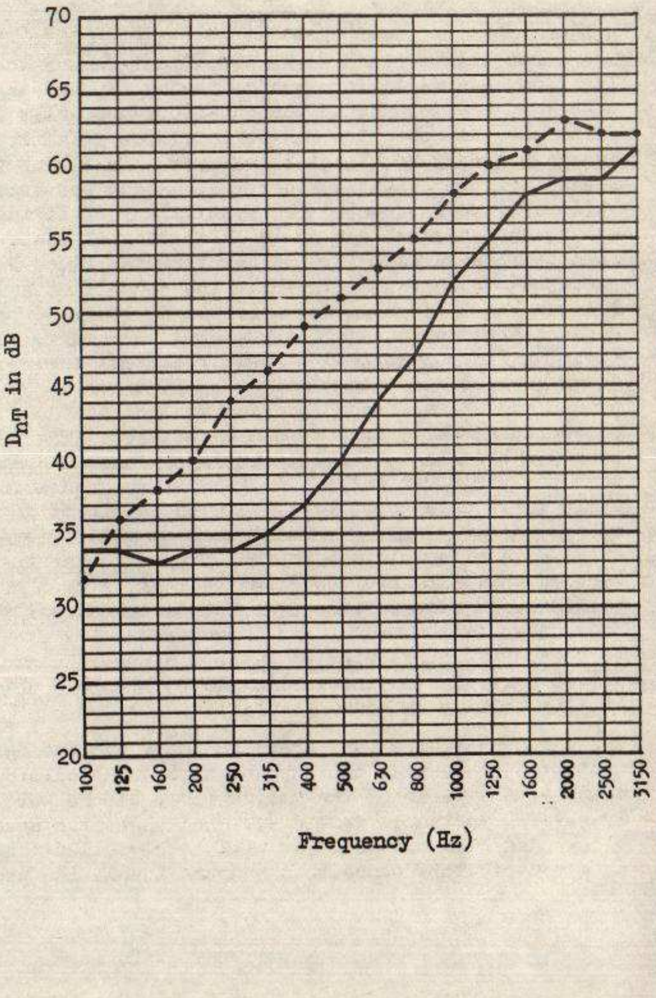


Table 1 below summarises the improvements in sound insulation by comparing the measured values of weighted standardised level difference ($D_{nT,w}$) in the particular cases of the 27 pairs of flats which were tested both before and after the improvement works were carried out.

Table 1. Summary of test results in 27 pairs of flats monitored before and after improvement works

Condition	Weighted Standardised Level Difference ($D_{nT,w}$)		
	Mean	Standard Deviation	Range
Before Improvement	45	2	40-48
After Improvement	54	2	50-59

N.B. The Building Regulations 1985 require the $D_{nT,w}$ of each floor to be at least 48 and the mean of eight or more measurements to be at least 51.

CONCLUDING REMARKS

It can be seen from the above results, and bearing in mind the current benchmark of The Building Regulations 1985, that a satisfactory standard of separating floor sound insulation was attained as a result of the works. Indeed, the post improvement results would surpass the more stringent requirements set down in the Regulations for separating walls, and feedback from the residents has substantiated the marked improvement achieved.

ACKNOWLEDGEMENT

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REFERENCES

1 Part G "Sound Insulation", The Building Regulations 1976, HMSO

2 Approved Document E "Sound", The Building Regulations 1985, HMSO

3 British Standard 5821:1984, "Rating the Sound Insulation in Buildings and of Building Elements", BSI.

4 L.C. Fothergill, "Recommendations for the Measurement of Sound Insulation Between Dwellings", Applied Acoustics, Vol.13, no. 3,171-187, (1980).