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THE SOUND INSULATION OF SMALL STUDIOS

D B FLEMING

BICKERDIKE ALLEN PARTNERS, LONDON

INTRODUCTION

As part of an on going programme to refurbish and extend the facilities of a central London Music College, eight new practice/teaching rooms have been completed. This papers reports on some aspects of the design and construction together with measurements of the sound insulation achieved.

The rooms are in the basement, on-grade, in the configuration shown in Figure 1. Only Room PR 7 is a teaching room, it is an electronic music studio for composing and teaching. An unfortunate but unavoidable feature of the planning was the placement of the percussion practice room, PR 8, adjacent to this studio. There are three practice rooms (PR 1, 2, 3) adjacent to Rehearsal Studio 3 which often serves as a recital room and is therefore considered a critical area from the point of view of sound insulation.

Calculations of the required sound insulation between rooms were based on nominal background noise levels from air conditioning of NC 25 in receiving rooms. Average source room sound levels of 95 dB were assumed for all but the percussion room where 105dB was taken. A criterion of equality with the background noise was taken for all receiving rooms except the recital room where the criterion was - 10 dB re. the background noise ; all sound levels being reverberant sound pressure levels in octave bands from 63 Hz to 4000 Hz.

On this basis the required "party wall" sould reduction indices, summarised in Table 1, were calculated.

	125 Hz	500 Hz	2000 Hz
Inter-practice room :	57	69	67
Practice room to Rehearsal Studio 3 :	56	65	72
Percussion to Electronic Music Studio :	66	79	86

<u>Table 1</u> Required "party wall" sound reduction index, R dB.

Similar levels of sound insulation were required for the other elements of the construction but those could be met by double doors, double windows and relatively straightforward mechanical services design, primarily because each element occurs twice in each transmission path and need therefore provide only half of the required total sound attenuation. We were more apprehensive about achieving the required "party wall" attenuation in a confined space.

DETAILED DESIGN

Each room was structurally independent. The form of construction for the small practice rooms is shown in Figure 2. Details were as follows :

Walls : 110mm brick, 19mm sand cement render, 15mm plaster ; mass/leaf 270 Kg/m², 150mm air gap with Mineral fibre quilt (on wire mesh), 50mm thick, density 96 Kg/m³.

Floor : Concrete "floating" reinforced slab ; 100mm thick, mass 230 Kg/m² 50mm Air space to basement slab (on-grade). Neoprene bearings.

Ceiling : 2 x metal lath and plaster ceilings supported on walls only, separated by 200mm containing air supply/extract attenuators. 100mm airspace to soffit of structural slab of 200mm thick concrete. Mass of each ceiling 25 Kg/m². Mastic seals, top of walls to soffit.

Doors : Double, solid core, 40 Kg/m² per leaf, 100mm airspace between, absorbent in cavity ; inner door magnetic seals three sides, outer door copper strip seals three sides, thresholds rubber seals fixed in floor.

Windows : Double glazed in common frame, glass/gap/glass, 16/200/6 mm, 40/0/15 Kg/m² ; absorbent reveals four sides.

For the larger percussion and electronic music studios, the construction was similar except that the wall thickness and separation were doubled to 230mm per leaf and 300mm respectively, and the ceilings were single elements, metal lath and plaster (45Kg/m²) with minimum air space above of 100mm containing a mineral fibre quilt 50mm thick, density 96 Kg/m³.

The existing wall of Rehearsal Studio 3 was of 9" brick built on the base slab up to the structural soffit. A 150mm airspace was allowed between this and each practice room wall. Much design and supervision time was spent to eliminate mistakes on site ; particular attention was paid to the prevention of cavity bridging and to the proper sealing of interfaces, services penetrations etc.

SOUND TRANSMISSION MEASUREMENTS

To monitor progress on site we carried out sound transmission tests when the first pair of rooms were nearing completion. The results, shown in Figure 3, were disappointing, but calculations based on acceleration measurements on different surfaces confirmed that the problem was of leakage through various gaps (round windows, doors and services) where the building work was incomplete. The sound insulation upon completion is also given in Figure 3 and shows a substantial improvement at all frequencies due to sealing the gaps. Measurements in Rehearsal Studio 3 and between the percussion and electronic music studio gave similar results. The latter was disappointing and the reasons for it are not known. The sound pressure level differences for adjacent rooms were measured in each case ; the mean and range of results are shown in Figure 4, together with the measured background noise level for which we were not responsible and which is also disappointingly low.

Nevertheless, the client reported that first reactions were "decidedly favourable" and that between the percussion and electronic music rooms neither party seemed to be able to hear the other, which was a "decided achievement" ! In view of the sound insulation and background noise achieved in this case, we were bound to agree !

Measurements before and after the installation of the mechanical services ducts and attenuators confirmed that these elements were not degrading the sound insulation of the building elements. Estimates of the sound transmission via the door/window assemblies and corridor transmission path are shown in Figure 4 and appear to be the limiting factor for adjacent rooms.

Acceleration measurements were made in octave bands to obtain a rough guide to the achieved sound reduction index of the party wall. These results were used in two ways to estimate R for the party wall.

a. The acceleration level difference ΔAL was calculated :

$$\Delta AL = 20 \log {}^{a_1}\!/a_2$$

where, a_1, a_2 = space average r.m.s. acceleration in octave bands, (1) source room, (2) receiving room, m/sec^2, each side of the party wall.

The total sound reduction index is estimated by $R' + \Delta AL$ where R' is a laboratory measurement of the sound reduction index for a single 110mm thick brick wall plastered both sides (NPL 1966).

b. The sound power radiated by the party wall in the receiving room was calculated from the a_2 measurements and compared with the sound power incident on the party wall in the source room. The ratio of these sound powers gives an estimate of the total sound reduction index for the party wall.

These two estimates of total sound reduction index are shown in Figure 4. Not only are the values surprisingly high (at mid frequencies the total is double what would be expected for a single leaf) but in the circumstances the agreement between the two estimates is remarkably good. A radiation factor of unity has been assumed in the calculations (the critical frequency for each leaf is about 150 Hz).

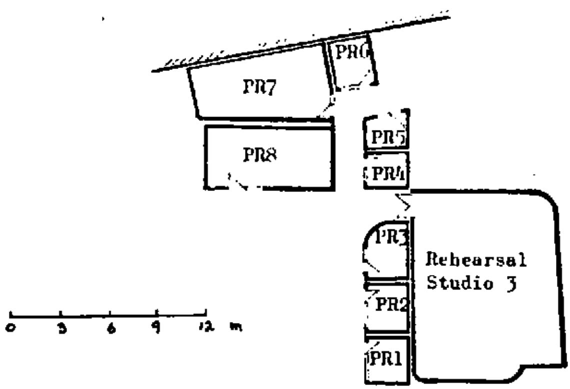

FIGURE 1 General Arrangement

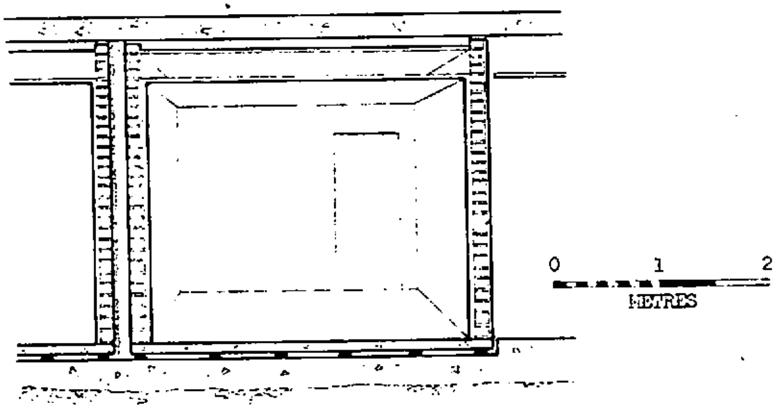

FIGURE 2 Typical section showing constructional details.

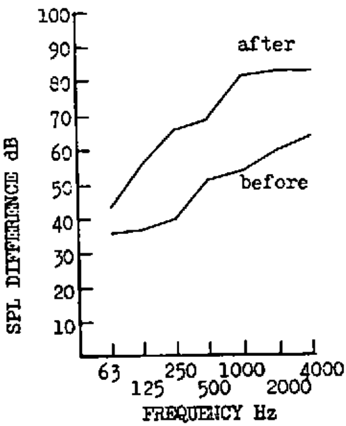

FIGURE 3 Reverberant SPL difference PR 1/2 before and after completion

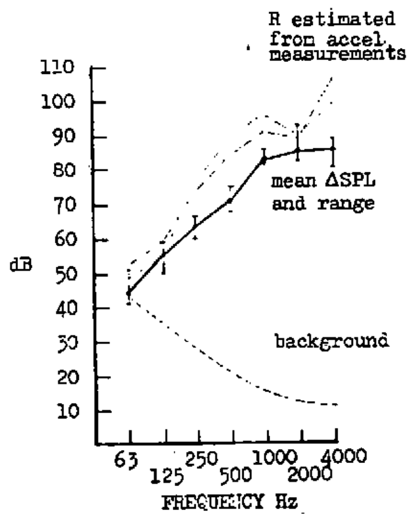

FIGURE 4 see text