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MUSIC ROOMS FOR SCHOOLS

D B Fleming and G Irvine

Fleming & Barron, Unit A2 4th Floor, Linton House, 39-51 Highgate Road, LONDON NW5 1RT

1. PRELUDE

Besides classrooms and larger spaces for group or ensemble practice or even for orchestra rehearsal and performance, music departments in schools need small rooms for individual tuition (Teaching Rooms) and for pupils to practice in (Practice Rooms). These range in size from about 20m³ to 50m³, the larger rooms being for Teaching, which sometimes double as staff offices, and the smaller ones, of which it seems there can rarely be enough, for Practice. These two types of room are distinguished not only by their size and occupancy but also by the standards of sound insulation which are acceptable - Miller [1]. It appears that teachers expect and can demand higher standards of sound insulation than their pupils. This paper gives some examples from recent projects.

2. SOUND INSULATION

Figures 1 and 2 show in section and in plan the form of construction for a group of four Teaching rooms, each 40m³, completed in 1995. The floors are of screeded beam and block and the walls in blockwork, with external cladding in brick. Additionally, independent plasterboard wall linings over a 150mm cavity were provided on each party wall and a floating timber floor was installed in each room to assist in the control of flanking transmission through the base floor. Ceilings in double 12.5mm plasterboard were included in each room, partly to control flanking transmission but also to provide sound insulation to and from the orchestra rehearsal studio above. Although a concrete floating floor was proposed for the orchestral rehearsal studio, this was deleted on cost grounds in favour of a timber floating floor.

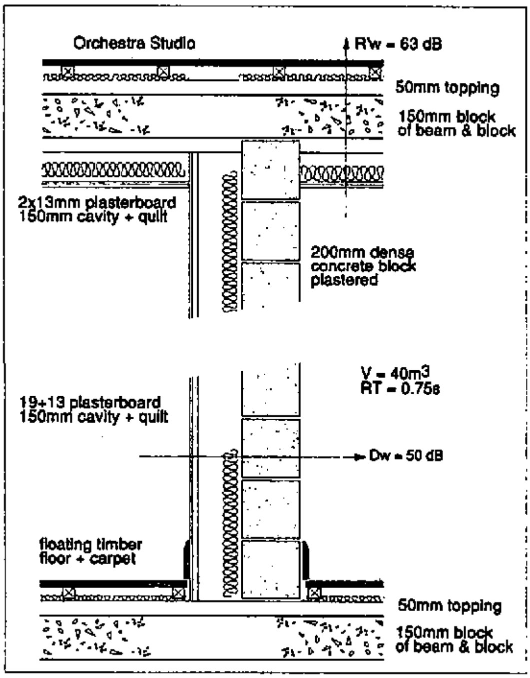

Fig 1 Section, party wall between Teaching Rooms

As the building neared completion, the sound insulation between adjacent rooms was measured at D_w=50dB, significantly less than the target of D_w=55dB.

To explore the reasons for the shortfall, normal velocity measurements were made on the masonry walls of the receiving room and the calculated radiated noise level L_2

used to estimate the apparent level difference $D|_x$ for the wall (x) according to

$$D|_x = L_1 - L_2 = L_1 - (L_v + 10\log(S/A) + 10\log(\sigma) - 28)\ \text{dB}$$

based on the usual expression for the radiated sound power $W = \rho c S \langle v_{rms} \rangle^2 \sigma$ watts, where S is the radiating wall area (m²), $\langle v_{rms} \rangle^2$ is the square of the average rms normal velocity, A is the room absorption, σ is the radiation ratio (unity above the critical frequency), L_1 and L_2 are the source and receiver room average sound pressure levels respectively, and L_v is the velocity level in dB relative to 10^{-9} m/s.

The results of these measurements and calculations are shown in Fig 2 and include flanking transmission for which some but not all of the possible paths are indicated in the figure.

The calculated combined contribution from the three walls is D_w=54dB which does not explain the overall airborne sound insulation measurement of D_w=50dB. It remains a mystery, though the most likely explanation is a gap at the junction of the party wall and inner leaf of the external wall, where a restraining steel beam runs the length of the building along the top of the external wall. This beam is enclosed in a plasterboard bulkhead but may not have been sealed where it penetrates each party wall between Teaching Rooms.

This beam does not appear on the drawings and is an example of a change made in this design-build project without its implications being appreciated.

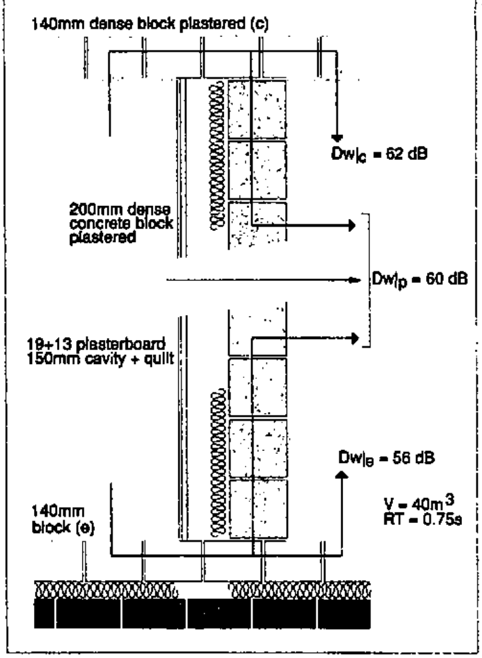

Fig 2 Plan, party wall between Teaching Rooms, showing Dw for masonry wall radiation obtained from normal velocity measurements

Another unfortunate example was found in the Practice Rooms which are in the centre of the building and therefore mechanically ventilated. In this case a ducted air extract system was changed at the last minute by inserting air transfer grilles in the walls of each room to the corridor, reducing the sound insulation between rooms to D_w=36dB. Where there was a corridor door between rooms which could be closed, D_w=45dB was obtained.

The second example is Phase II of a steel framed building for which the strategic acoustic design was undertaken by John Miller after his successful completion of Phase I which comprised a 300 seat recital hall. Phase II, for which Fleming & Barron took over as acoustic consultants, was extensive by most schools' standards and included 3 Classrooms, a music Library, 11 staff Teaching Rooms, 10 small Practice Rooms and 10 intermediate sized Teaching/Practice Rooms for peripatetic tutors.

Fig 3 illustrates the form of construction but is not strictly representative of the disposition of rooms. The original conception included floating timber floors in each Teaching Room to control flanking sound transmission through the concrete floors, but because the latter were pre-stressed concrete planks (initially with a camber) and therefore uneven, floating concrete screeds were employed. The other main departure from the initial design was the replacement of sound lobbies by single doors to each Teaching Room as shown in the general arrangement of the first floor Teaching Rooms in Fig 4. The main argument for doing so was operational - to reduce the number of doors which children carrying musical instruments must negotiate and in particular to provide disabled access which would otherwise require very large sound lobbies. The doors are 44mm thick solid core timber doors, with wipe seals on three sides and no threshold seal but a close fit to the carpet. Immediately inside each Teaching Room, the walls are treated with fabric faced 75mm thick Rockwool absorbers; there is a dropped ceiling in acoustic tiles over the entrance alcove and the corridor has floor carpet and an acoustically absorbing ceiling.

The target sound insulation between Teaching Rooms was D_w=58dB; alternate rooms were internally treated with independent wall linings in 2x12.5mm plasterboard over a minimum

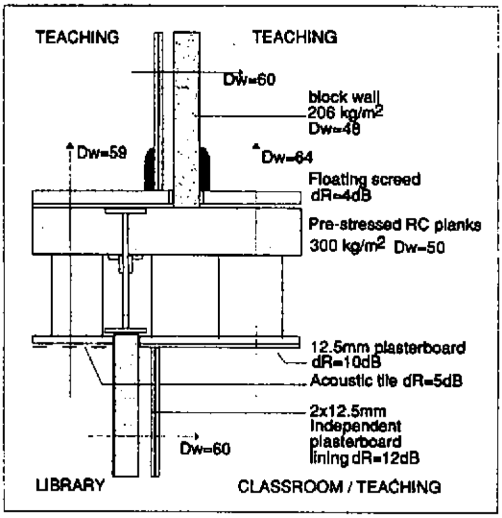

Fig 3 Wall/floor/ceiling junction showing forms of construction and preliminary estimates of sound insulation

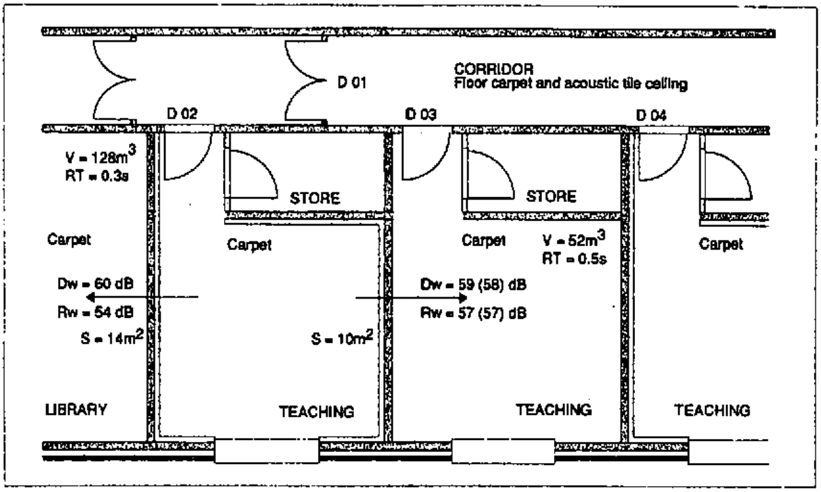

Fig 4 General arrangement of 2nd floor Teaching Rooms

75mm cavity with quilt. The whole building is mechanically ventilated using a low velocity displacement system with regrettably long duct runs from a plantroom at one side of the building. Services noise levels (which we have not measured) are correspondingly low.

Upon completion of a building, no news is good news. Apart from dissatisfaction with a sliding/folding partition between Classrooms, the client has been mute on the subject of acoustics. While measuring the partition performance, we took the opportunity to test room-to-room sound insulation between the first floor Teaching Rooms and Library and the ground floor Classrooms. Some of the results are shown in Fig 4 and all are tabulated in Table 1.

Room-to-Room	RTs	V m³	Sm²	R'w	Dw	dB(A)
1st fl Teaching -> Teaching	0.5	52	10			
Corridor doors D01 open				57	59	
Corridor doors D01 closed				57	59	
1st fl Teaching -> Library	0.3	128	14	54	60	
1st fl Teaching -> gnd fl Classroom	0.95	104	17	61		
gnd fl Classroom -> Classroom	0.95	104	15			28
New Sliding/folding partition				32	33	
Old Building	0.95	194	18			43-38
Existing Sliding/folding partition				29	32	

TABLE 1 Results of airborne sound insulation measurements

By measuring the sound insulation between Teaching Rooms with the corridor doors D01 open and closed, we found that room-to-room transmission via the doors of each Teaching Room was not significant, the maximum difference being 3dB at around 1600Hz and not enough to affect the overall D_w rating.

The apparent sound reduction index of the wall to the Library is slightly less than between Teaching Rooms for reasons unknown, though subjectively there was evidence of leakage in one corner.

The measured sound insulation vertically between the first floor Teaching Rooms and the Classrooms below is gratifyingly high.

The *in situ* performance of the new sliding/folding partition, which has a laboratory rating of Rw=51dB, is disappointing in view of the attention paid to detail in the surrounding construction. There are some obvious leaks which must be addressed but we are not confident that much improvement will be obtained by this means. Avenues of redress for the client are being explored.

Comparison of the old and new sliding folding partitions is instructive. Not surprisingly the new one is considered unsatisfactory by staff, whereas the old one, which has slightly lower sound insulation, is nevertheless felt to be satisfactory. No doubt expectations of a new building are high and there may also be differences in the way the rooms on each side of the partitions are used, the old one being a more or less permanent separation between a small, lightly used space and a large classroom, whereas the new one equally divides the space. However, it appears that the prevailing background noise level is also important. The values shown in Table 1 are internal L_{Aeq} for noise from road traffic, the higher value for the old partition being an estimate for the single glazed windows which have recently been replaced by thermal double glazed units to conserve heat (not to reduce noise), which was the condition actually measured. It remains to be seen whether the old partition will continue to prove satisfactory now that the background noise level has been reduced by some 5dB(A). We await the start of the new term with interest.

Following Miller's [1] guidelines the sum of the background noise level and the D_w rating in each case is 61dB for the new partition and currently 70dB for the old, a difference of nearly 10dB (the difference would have been nearly 15dB before the windows were replaced in the old building). Here at least is a measure of the improvement likely to be necessary in the new partition if it is bear comparison with the old.

3. ROOM ACOUSTICS

The sound studio fraternity will tell you to distort simple rectangular volumes into awkward irregular shapes, at least with non-parallel walls and floor/ceilings - a necessity for which there is little evidence in practice. In our experience, room acoustics difficulties arise from other issues, such as:

- Teaching rooms which are simply too small or lack sufficient height
- Small rooms being used for brass ensemble teaching
- Rooms designed for ensemble music being used as classrooms
- Staff having different tastes in room acoustics
- Jazz and Pop using amplification in live spaces designed for "acoustic" instruments

Much depends on the client providing a clear brief, having the financial resources to back it and recognising his responsibilities as the owner of a new building.

In Teaching Rooms a fairly successful strategy has been to provide a small amount of acoustic absorption to achieve a reverberation time of about 0.5 seconds in an unoccupied volume of about 50m^2 (ie domestic) with the proviso that the client should keep some funds in hand to increase absorption if individual staff insist.

Classrooms require good speech intelligibility which may demand that they have shorter reverberation times than would be ideal for the playing of music. Practice rooms are usually very small and will benefit from a small amount of acoustic treatment on one or two walls in addition to a carpet. Where plasterboard ceilings are required for sound insulation purposes in Teaching Rooms, acoustic tile ceilings are inappropriate and in our experience unnecessary.

4. ADDITIONAL SOUND INSULATION RESULTS

Table 2 shows some additional sound insulation results in the same style as those reported by Miller [1], to which the following comments apply.

In the Convent School in Essex, the architect wanted to provide the appearance of painted brick on the party walls between Teaching Rooms. To this end the wall was constructed in two half brick skins with a 20mm thick mortar septum between. The sound insulation was unsatisfactory and velocity measurements confirmed that this wall itself was providing only R'w=47dB, a result which remains a mystery.

Although in the Practice Rooms in West Lavington the sum Dw+dB(A) is high, this is because the ventilation system noise is unacceptably high, the sound insulation is poor and should not be taken as a satisfactory design target.

Mechanical ventilation was provided in less than 50% of these examples but could not be relied upon to give adequate background noise levels, that is levels sufficiently high to have much real influence on overall privacy. Though background noise levels of 30 or even 35dB(A) would be acceptable in individual tuition and practice spaces it is probably unrealistic to hope to achieve these, particularly where crosstalk attenuators are fitted to control sound insulation. In schools, though not in Music Academies [2], satisfactory results seem to be obtained in Teaching Rooms with Dw=55dB and in Practice Rooms with D_w=50dB.

5. FINALE

Forms of construction and their measured sound insulation have been illustrated for Teaching Rooms in schools music departments. But the best intentions are all too easily frustrated and to guard against this may require a level of site attendance during construction which might surprise our clients. To achieve the sound insulation standard usually accepted for Teaching Rooms it is not necessary to resort to cumbersome doors with compression seals or sound lobbies, both of which may be impracticable for disabled access.

6. REFERENCES

[1] John Miller, Design Standards for the Sound Insulation of Music Practice Rooms, Inst Acoust Acoustics Bulletin, Vol 18 No 6, Nov-Dec 1993.

[2] D B Fleming, Public buildings, Music Teaching Rooms and Council Chambers, Inst Acoust Acoustics Bulletin, p 14-16 & 21, January 1985.

Building	Location	Room Type	Mech	dB(A)	Dw dB	Dw+dB(A	Remarks
Convent School	Essex	Teaching	No	25	47	72	Unsatisfactory
Convent School music department (1991)	Surrey	Teaching Teaching Practice Classroom Ensemble	No	28 22 22 22 22	37 57 45 - 47 60 48 - 57	65 79 67 - 69 82 70 - 79	Old facility - inadequate Dw as intended Dw as intended Dw = 55-60 intended one poor Dw result
Public School music department (1995)	West Lavington Wilts	Teaching Practice	Yes	 50	50 36 - 45	 86 - 95	Dw = 55 dB intended Air transfer grills in corridor wall!
Public School music department (1996)	Warwick	Teaching Practice Classroom	No	25	55 50 50		Intended - not measured Intended - not measured Intended - not measured
Music College (1987)	Oman	Teaching Practice	Yes	Low	70 50		Reported Inaudibility
Music Academy (1994)	Oman	Teaching Practice	Yes	Low	70 50		Inaudibility
School	Bradford on Avon	Practice	No		36 - 45		old facility
County Music Centre (1997)	Bradford on Avon	Teaching	No	Rural	53		seems satisfactory
Public School music department (1998)	Berkshire	Practice Teaching Classroom Classroom High sound	Yes	 28 38 - 43 28	53 58 32 33 63	 86 70 - 75 61	Intended - not measured Measured Existing sliding folding partition New folding wall Rw(lab)=51dB Intended - not measured

TABLE 2 Sound insulation in schools music rooms