SERVICES NOISE CONTROL & CROSS-TALK IN CURTAIN WALLED BUILDINGS

P.H. Allaway

Grootenhuis Allaway Associates, 40 Hay Street, Steeple Morden, Royston
Herts. SG8 OPE

THE SPECIAL PROBLEMS OF CURTAIN WALLED BUILDINGS

The usual construction adopted for plant rooms and many of the occupied areas in offices, hotels, hospitals, etc. comprises concrete floors and ceilings with brick or dense concrete block walls built on the solid floor. As sound insulation is closely related to the mass per unit area of the barrier constructions this type of building start with the advantage of considerable weight. The old Imperial Units had a convenient relationship which said "4.5 inch brick = 45 lbs/ft^2 = 45 dB" - the SI system equivalent of "114mm brick = 220 kg/m^2 = 45 dB" does not have the same mnemonic effect!

Curtain walling systems for buildings are generally of relatively light weight and, importantly, the walling passes the intermediate floors so that a potential gap is left between the walling and the solid floor. Figure 1 shows this principle.

The potential for transmitting noise is clearly greater than for conventional building styles in brick and concrete. This greater potential exists for horizontal transmission as well as vertical transmission between floors; the internal walls containing plantrooms, or between offices for instance, have to abut the external wall so that a good seal is obtained. This is frequently not easy with the profiled shapes of proprietary walling systems but even if a good seal is obtained then "flanking transmission" along the light weight walling from the room containing the source of noise to the adjacent room(s) is a potential problem.

These special factors related to curtained walled buildings are discussed in this short paper; the presentation will include several slides showing the problems which can arise.

STANDARDS OF NOISE INSULATION

The standard of noise insulation required depends on the noisiness of the plant and the allowable noise level in the adjacent room, or the degree of acoustic privacy required between two rooms.

These aspects of design are discussed in services noise guides [eg ref 1] and in building acoustics text books [eg ref 2]. No space can be spared here to repeat their recommendations but it must be remembered that noises with a "meaning", like speech, and noises with a "warning", like sudden machine noises, are more intrusive than indeterminate noises like that of distant road traffic or of air conditioning.

CURTAIN WALLED BUILDINGS

NOISE INSULATION OF TYPICAL CONSTRUCTIONS

The insulation obtainable from solid materials used for walls and floors, such as brick and concrete in several thicknesses and arrangements, is published in many references [see 2, for instance]. The well known "mass law" which predicts the insulation solely from the known weight of the barrier is equally well known for not being very accurate.

For solid constructions, typical selections might be:

insulation standard	concrete	brick	block
	thicknessses (mm)		
marginal	70	100	125
moderate	100	150	190
good	150	225	270
high	250	300	350

(brick & block are plastered)

For light weight constructions, however, the available insulation is normally less. When there are openings in the barriers the resultant insulation will be degraded by an amount which depends on the area of the opening relative to the area of the total barrier - areas of lower insulating constructions have a similar effect. Again, the text books give the details of how to calculate the Composite Sound Reduction Index (SRI).

A TYPICAL PROBLEM IN A CURTAIN WALLED BUILDING

Consider a plantroom above an office - both are situated at the perimeter of the building and a curtain wall system forms a common external cladding to both. Figure 2 shows the arrangement in principle. There is a horizontal dimension of 150 mm. between the edge of the solid concrete floor and the inside of the curtain walling panels. This opening has to be filled or protected so that the resultant noise insulation of solid floor plus gap meets the criterion. Table 1 shows the resultant insulation, SRI, spectrum, at octave centre frequencies, for a solid 125 mm. thick concrete (plus 50 mm. screed) and for the same floor but with a gap which is either fully open or filled with less efficient noise insulating constructions than the concrete floor. This table ignores the effect of, for example, the Blind Box/Fire Barrier shown in Figure 2. The relative areas are taken to be 4.85 m. x 10 m. for the solid floor and 0.15 m. x 10 m. for the gap.

CURTAIN WALLED BUILDINGS

TABLE 1

SOUND REDUCTION INDICES FOR COMPOSITE FLOORS

Construction. 125mm concrete plus 50mm screed. (45 dB average)	gap filling	Frequency, Hz. 125	250	500	1k	2k
" "	open	15	15	15	15	15
" "	(a)	28	34	39	45	51
" "	(b)	29	33	37	43	47
" "	(c)	32	37	42	49	58
" "	no gap	35	37	42	49	58

(a) 16g. steel sheet (1.6 mm.)
(b) 10 mm. plasterboard sheet.
(c) 2 x 9.5 mm. plasterboard sheets with 60 mm. interspace.

These calculated data are for the prediction of the average, reverberant, sound field in the Receiving Room. If the actual listening position happens to be close to the open gap, or to an area of lower insulation, then the received noise level will be more nearly controlled by the lower insulation value. This is often the case so it is necessary to select a gap filler with an insulation value in its own right which is close to the required minimum value. It will be seen from Table 1, for instance, that a Composite SRI of only 15 dB. would result from a fully open gap. Figure 2a shows a possible solution.

Calculated values for these average, or Composite, SRI values are a first step but unless the gap filler is sealed perfectly to the curtain wall system the achieved SRI will be even less good. Mastic fillets can be helpful.

FLANKING TRANSMISSION

One form of flanking transmission is caused by the acoustic excitation of a light weight panel which forms a boundary to both a noisy room and to an adjacent room which is quieter. The acoustically generated vibration in the panel facing the noisy room travels along the panel to the quieter room where its vibration pushes sound waves into the air; these are perceived as noise and may therefore bypass the insulation of the "party wall".

This form of flanking transmission is, in practical terms, impossible to quantify in advance though it is usually possible to evaluate its importance in a completed building - see for instance ref. [3]. At the design stage therefore the Noise Control Engineer is faced with the choice of either (i) taking every precaution which might just be desirable, or, (ii) risking a noise transmission which might be excessive.

The first option probably involves expense to his client and may involve delays on site if the work proposed is unexpected in terms of programme or nature. The second option may place the Noise Control Engineer at risk if the agreed criteria are not met; this option should not be adopted without the client being made aware of the judgement and proposed action.

SECONDARY WALLS

A simple and effective control method, for this type of flanking transmission, may be to create a conventionally built plantroom within the curtain walled structure. This will probably involve placing brick or block secondary walls on the solid floor of the plantroom so that an independant barrier to noise transmission is obtained. This barrier reduces the noise impinging on the curtain walling system and so cuts the flanking transmission. This solution, though expensive, may be essential in some cases. Figure 3 is an example of this approach in which the new wall, a flank wall, is extended only a limited distance into the plantroom; this is a compromise solution.

PLANTROOM NOISE CONTROL

As the level of flanking transmission is related, but not necesssarily linearly, to the level of noise in the plantroom, it may be a useful approach to reduce the plantroom noise level by (i) increasing the attenuation of, say, plant casings, (ii) by using light weight internal walls in the plantroom to contain the noisier items, and (iii) by using heavy lagging to duct walls, and so forth.

The reason for the possibly non-linear relationship between the plantroom noise level and the strength of the flanking transmission is the Q factor of the curtain walling system. A system with a high Q has little damping and will resonate strongly at its natural frequencies even if the input energy is relatively low; this resonance will transmit readily to the panel facing the quiet room and so will radiate acoustic energy to that room. To limit this form of transmission it may be desirable to provide damping to the curtain walling in the form of, say, fibrous cladding to its inner surface, or, theoretically at least, by applied damping panels to these surfaces - as used in car bodies. It will be helpful also to introduce damping to the support members of the curtain walling as this will damp the angular motion of the panel, at this position, which is the mechanism by which the vibration is transmitted to the adjacent room. Many curtain walling systems will have appreciable integral damping by virtue of the fibrous thermal insulating material contained within them. The addition of extra damping, at acoustically important frequencies, requires care in selection and application; Ref. [4] discusses the use of visco-elastic damping with structures.

RELATED PROBLEMS

The total transmission of noise from the plantroom, or adjacent office, will be the sum of the transmission by all paths. These will include the main floor or the internal walls and, more importantly, the openings for services ducts and pipes, the doors, the over-ceiling void and so on. All these aspects must be considered and controlled.

ACKNOWLEDGEMENTS

The slides shown with the presentation of this paper were obtained by kind permission of Williams & Glyn's Bank plc..

REFERENCES:

[1] CIBS Guide. The Chartered Institution of Building Services, 1970 (revised and/or reprinted by Chapters)

[2] Parkin, Humphreys and Cowell. "Acoustics, Noise and Buildings." Faber and Faber, 1979.

[3] G. Rosenhouse. "A Modified Formula for Absorption Influence on Sound Transmission Through Partitions: Part 2-Flanking Between Coupled Rooms in Terms of Modified Partition Area." Applied Acoustics. Vol 18. No 1. 1985.

[4] P. Grootenhuis. "Damping Mechanisms in Structures and some Applications of the latest Techniques." Symposium at ISVR, Southampton, April 1972.

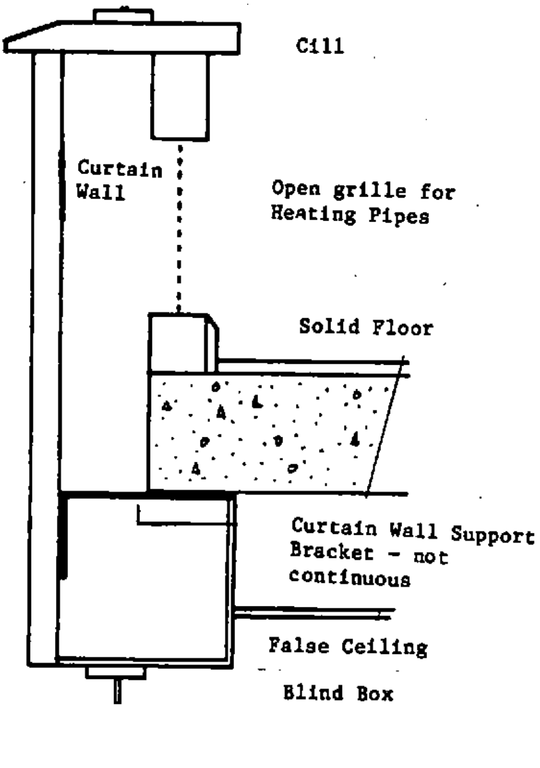

FIGURE 1
Schematic detail at edge of floor.

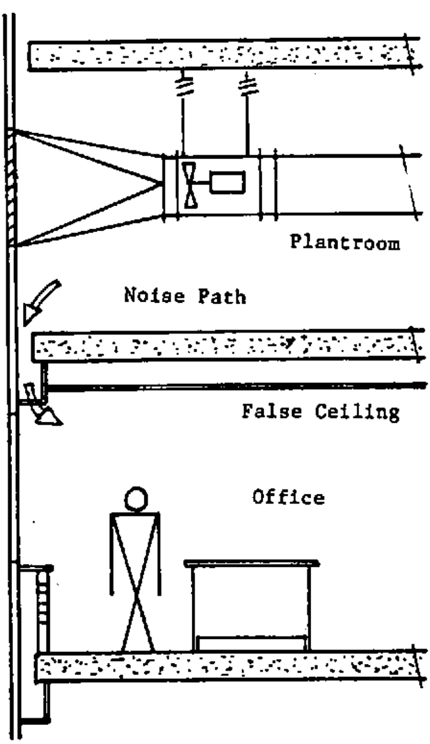

FIGURE 2
Plantroom above office

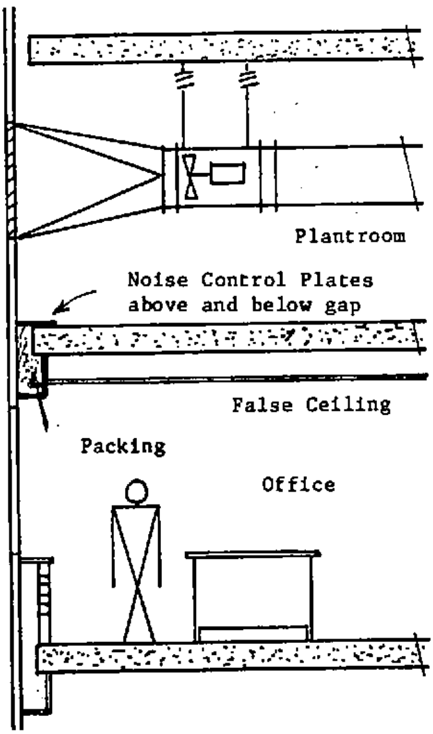

FIGURE 2a
Plantroom above office - possible noise control

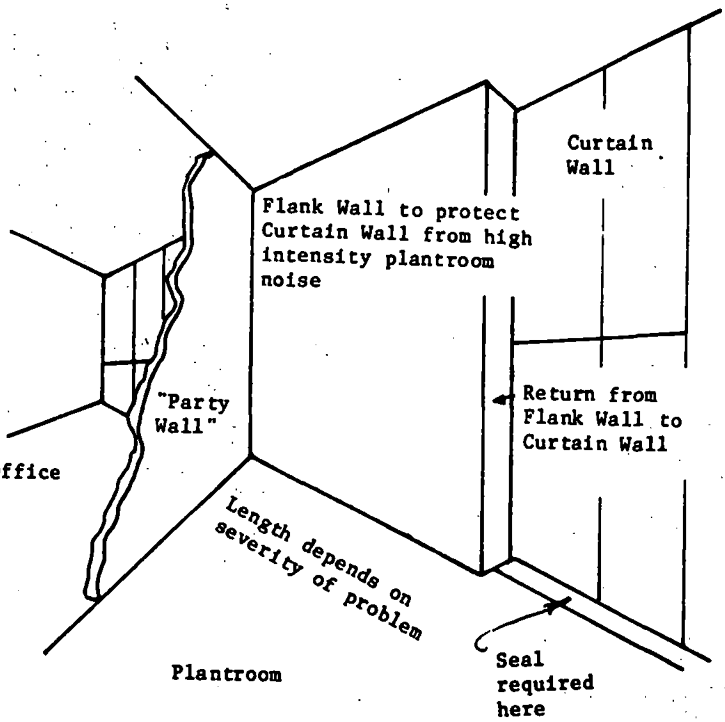

FIGURE 3
Example of use of flank wall