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Consultants in Acoustics, Noise & Vibration

19157-R03-A

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Silk Street, Newton Heath, Manchester

RIBA Stage 2 – internal acoustics review

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Summary

Sandy Brown has been appointed by Faithful & Gould Limited to provide acoustic design guidance in relation to the proposed residential development at Silk Street, Newton Heath, Manchester.

The proposed development comprises 75 Modular Homes (21 Houses and 54 apartments), site parking and cycle storage.

This report provides a review of internal acoustic requirements for the scheme based on the Stage 2 architectural design. The following issues are covered:

- Internal sound insulation within the building, specifically the performance requirements for floors, partitions and doors
- Sound absorbent finishes to residential common areas
- Building services noise and vibration, specifically noise and vibration criteria and guidance on services routing.

Key acoustic issues are:

- Selection of sound insulation criteria for internal floors and partition based on achieving either the minimum standards set out in ADE 2003 or enhanced standards.
- The proposed layouts are stacked between the first and third floors. At ground floor level refuse stores are located under bedrooms. At fourth floor level the layouts change with bathrooms, kitchen areas and plant spaces located over third floor bedrooms. For these adjacencies an allowance for providing a standard 5 dB better than the minimum requirements of ADE 2003 is recommended.
- Enhanced sound insulation is recommended to control structure-borne sound transfer where bedrooms are adjacent to lift shafts, kitchens in other apartments or refuse stores.
- Careful consideration of drainage routes from kitchens and bathrooms to fourth floor apartments will be needed as the design develops to avoid unwanted noise transfer to bedrooms of third floor apartments.

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1 Introduction

Sandy Brown has been appointed by Faithful & Gould Limited to provide acoustic design guidance in relation to the proposed residential development at Silk Street, Newton Heath, Manchester.

The proposed development comprises 75 Modular Homes (21 Houses and 54 apartments), site parking and cycle storage.

This report provides a review of the Stage 2 design in relation to internal sound insulation and sound absorbent finishes. Assessments of external noise and requirements for the building envelope with reference to noise related planning conditions are detailed in Sandy Brown report 19157-R02-A Planning noise report.

A glossary of relevant acoustic terms is provided in Appendix A.

2 Basis of review

The design review is based on the SixTwo Stage 2 Design report (Issue 01, April 2019), received 3 May 2019.

3 Building regulations

Approved Document E 2003 Edition (including 2004, 2010 and 2015 amendments) to the Building Regulations 2010), referred to here as ADE 2003, sets out acoustic requirements for dwellings. These are summarised below.

3.1 Sound insulation

ADE 2003 specifies under requirement E1 that the minimum performance standards for airborne and impact sound insulation must be achieved to demonstrate compliance with the Building Regulations, these standards are set out in Table 1.

Table 1 Minimum sound insulation performances for separating elements between purpose-built flats

	Airborne sound insulation $D_{nT,w}+C_{tr}$ dB (Minimum values)	Impact sound insulation $L'_{nT,w}$ dB (Maximum values)
<i>Purpose built dwelling-houses and flats:</i>		
Walls	45	-
Floors and Stairs	45	62

The airborne performance requirements are given in terms of a level difference, and as such a higher number represents a better standard. The impact performance requirements are given in terms of a sound level in the receiving room, and as such a lower number represents a better performance.

3.2 Absorption in common areas

ADE 2003 specifies under requirement E3 that:

‘The common internal parts of buildings which contain flats or rooms for residential purposes shall be designed and constructed in such a way as to prevent more reverberation around common parts than is reasonable’

This means that there is a certain amount of sound absorbent finishes required in corridors, hallways, entrance halls and stairwells that give direct access to flats.

4 Internal sound insulation

This section discusses the sound insulation of internal floors, partitions and doors, along with initial comments on interface details.

4.1 Floors

4.1.1 Performance requirements

The minimum floor sound insulation performance requirements are set out in Table 2.

Table 2 Minimum floor sound insulation performances

Location	Minimum sound insulation performance
Floors between residential units and non-residential spaces (eg, plant room, bin store)	$D_{nT,w}+C_{tr}$ 50 dB (airborne)
Floors between residential units	$D_{nT,w}+C_{tr}$ 45 dB (airborne) $L'_{nT,w}$ 62 dB (impact)
Floors within residential units	R_w 40 dB (airborne)

Increasingly residential developments are adopting acoustic standards that exceed the requirements of ADE 2003. As such, providing a standard 5 dB better than the minimum requirements of ADE 2003 could be considered. The enhanced sound insulation performances would be:

- Floors between residential units and non-residential spaces (eg, plant room, refuse store) – $D_{nT,w}+C_{tr}$ 55 dB (airborne)
- Floors between residential units – $D_{nT,w}+C_{tr}$ 50 dB (airborne) and $L'_{nT,w}$ 57 dB (impact)
- Floors within residential units – R_w 45 dB (airborne).

The proposed layouts are stacked between the first and third floors. At ground floor level refuse stores are located under bedrooms. At fourth floor level the layouts change with bathrooms, kitchen areas and plant spaces located over third floor bedrooms. For these adjacencies an allowance for providing a standard 5 dB better than the minimum requirements of ADE 2003 is recommended.

4.1.2 Floor constructions

Indicative floor build-ups to achieve the minimum requirements of ADE 2003 ($D_{nT,w}+C_{tr}$ 45 dB) are provided in Table 3. It is possible to achieve the vertical sound insulation standards with thinner/lighter floor slabs but this can cause difficulties with the control of flanking sound transmission (under/over partitions) and places reliance on ceilings and floated floors.

Indicative floor build-ups to achieve the enhanced standard of ADE 2003 +5 dB ($D_{nT,w}+C_{tr}$ 50 dB) are provided in Table 4.

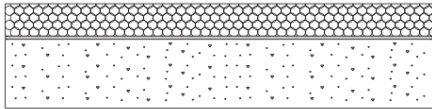
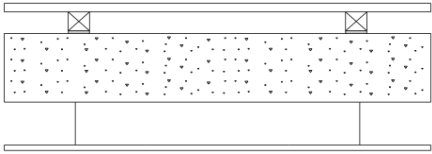
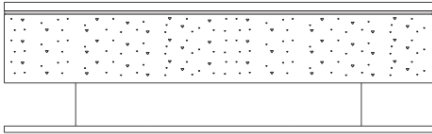
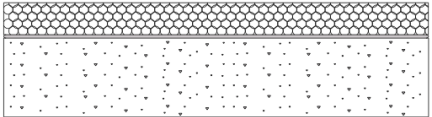
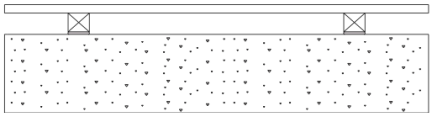
In order to meet the impact sound insulation requirement (minimum or enhanced), carpet or hard floor finish laid directly onto a suitable resilient layer would be required.

In the examples, the concrete floor slab is assumed to be solid with a density of not less than 2300 kg/m³ (normal weight concrete).

If the enhanced standard of ADE 2003 +5 dB is being targeted ($D_{nT,w}+C_{tr}$ 55 dB), then one of the following changes to the floor construction would need to be adopted:

- Increase the structural floor thickness to 300 mm concrete (assumed density ≥ 2200 Kg/m³)
- Provide a floated screed (surface density ≥ 80 kg/m²) on a suitable resilient layer
- Provides a suspended plasterboard ceiling (typical 150 mm overall zone).

Table 3 Indicative floor build ups for ADE 2003 with solid concrete structural floor

Floor slab thickness	Floating floor	Ceiling	Sketch
160 mm	Floated screed (minimum mass per unit area 80 kg/m ²) on suitable resilient layer	No ceiling	
160 mm	Floated timber batten floor forming 50 mm floor cavity on suitable resilient layer	1 layer of 12.5 mm plasterboard on 100 mm cavity (can have some recesses/penetrations etc)	
160 mm	Carpet (or timber finish laid directly onto a suitable resilient layer	1 layer of 15 mm plasterboard on 100 mm cavity	
185 mm	Floated screed (minimum mass per unit area 80 kg/m ²) on suitable resilient layer	No ceiling	
185 mm	Floated timber batten floor forming 50 mm floor cavity on suitable resilient layer	No ceiling	

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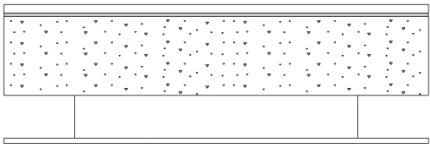
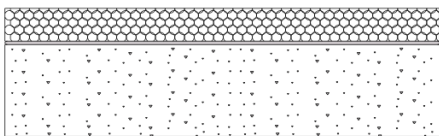
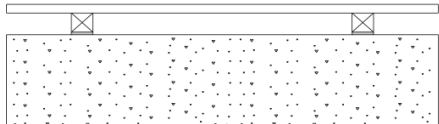
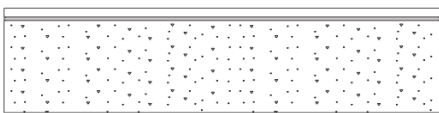
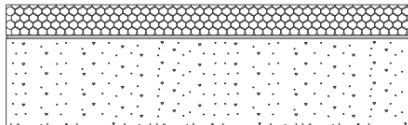
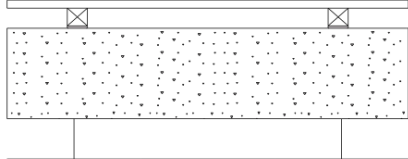
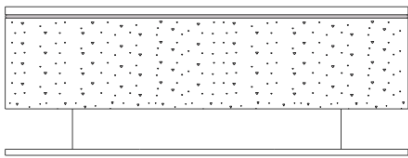
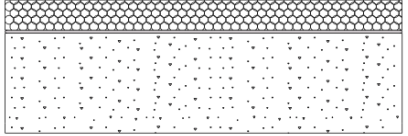
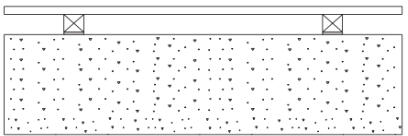
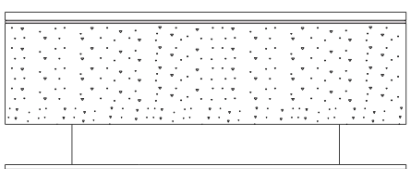
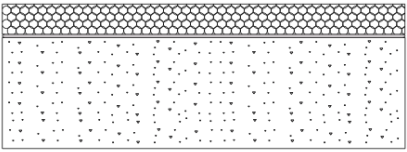
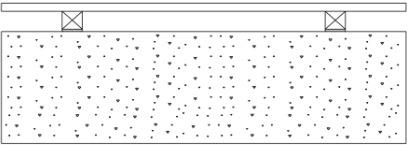
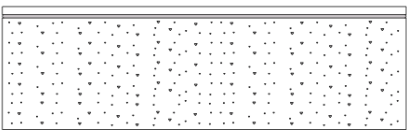
Floor slab thickness	Floating floor	Ceiling	Sketch
185 mm	Carpet (or timber finish laid directly onto a suitable resilient layer	1 layer of 12.5 mm plasterboard on 100 mm cavity (can have some recesses/penetrations etc)	
210 mm	Floated screed (minimum mass per unit area 80 kg/m ²) on suitable resilient layer	No ceiling	
210 mm	Floated timber batten floor forming 50 mm floor cavity on suitable resilient layer	No ceiling	
210 mm	Carpet (or timber finish laid directly onto a suitable resilient layer	No ceiling	

Table 4 Indicative floor build-ups for ADE2003 + 5 dB with solid concrete structural floor

Floor slab thickness	Floating floor	Ceiling	Sketch
225 mm slab	Floated screed (minimum mass per unit area 80 kg/m ²) on suitable resilient layer	No ceiling	
225 mm slab	Floated timber batten floor forming 50 mm floor cavity on suitable resilient layer	1 layer of 12.5 mm plasterboard on 100 mm cavity (can have some recesses/penetrations etc)	
225 mm slab	Carpet (or timber finish laid directly onto a suitable resilient layer	1 layer of 15 mm plasterboard on 100 mm cavity	
250 mm slab	Floated screed (minimum mass per unit area 80 kg/m ²) on suitable resilient layer	No ceiling	
250 mm slab	Floated timber batten floor forming 50 mm floor cavity on suitable resilient layer	No ceiling	
250 mm slab	Carpet (or timber finish laid directly onto a suitable resilient layer	1 layer of 12.5 mm plasterboard on 100 mm cavity (can have some recesses/penetrations etc)	

Floor slab thickness	Floating floor	Ceiling	Sketch
275 mm slab	Floated screed (minimum mass per unit area 80 kg/m ²) on suitable resilient layer	No ceiling	
275 mm slab	Floated timber batten floor forming 50 mm floor cavity on suitable resilient layer	No ceiling	
275 mm slab	Carpet (or timber finish laid directly onto a suitable resilient layer	No ceiling	

4.1.3 Floor constructions within residential units

Floors within residential units are required to achieve the minimum performance requirement of R_w 40 dB for floors or R_w 45 dB for the enhanced performance. A thinner structural floor construction could be used (minimum 100 mm normal weight concrete).

4.1.4 Washing machines

At this stage the location of washing machines has not been determined. This will need to be considered as the design develops. In the first instance it is recommended that they be located in stacked utility cupboards. Locations over bedrooms should be avoided. The potential for vibration from washing machines should be considered in designing the dynamic response of the of the structural floor. Floating platform inertia bases can also be considered to reduce potential vibration and structure-borne noise transfer.

4.2 Partitions

4.2.1 Performance requirements

The minimum partition sound insulation performance requirements are set out in Table 2.

Table 5 Minimum partition sound insulation performances

Location	Minimum sound insulation performance
Partitions between residential units	$D_{nT,w}+C_{tr}$ 45 dB
Partitions within residential units (this is not a requirement of ADE 2003 for internal partitions containing a door, eg, ensuite bathrooms)	R_w 40 dB

Increasingly residential developments are adopting acoustic standards that exceed the requirements of ADE 2003. As such, providing a standard 5 dB better than the minimum requirements of ADE 2003 could be considered. The enhanced sound insulation performances would be:

- Partitions between residential units – $D_{nT,w}+C_{tr}$ 50 dB
- Partitions within residential units – R_w 45 dB.

While not a requirement of the building regulations, the Stage 2 layouts have some adjacencies where a higher standard of sound insulation is recommended to control structure-borne sound through partitions. These are:

- All floors – lifts to bedrooms
- Ground to third floors – kitchens adjacent to bedrooms in another apartment
- Ground floor – refuse store to living/kitchen area.

For lifts, structure-borne noise is caused from the movement of lifts along rails. Where kitchens are located next to bedrooms, there is the potential for disturbance from closing of doors on wall-mounted cupboards and structure-borne noise from vibrating kitchen appliances and chopping for food preparation. Noises such as banging of bins against walls and dropping of bottles etc. are likely in the refuse store. Examples are marked on the ground floor layout in Figure 1.

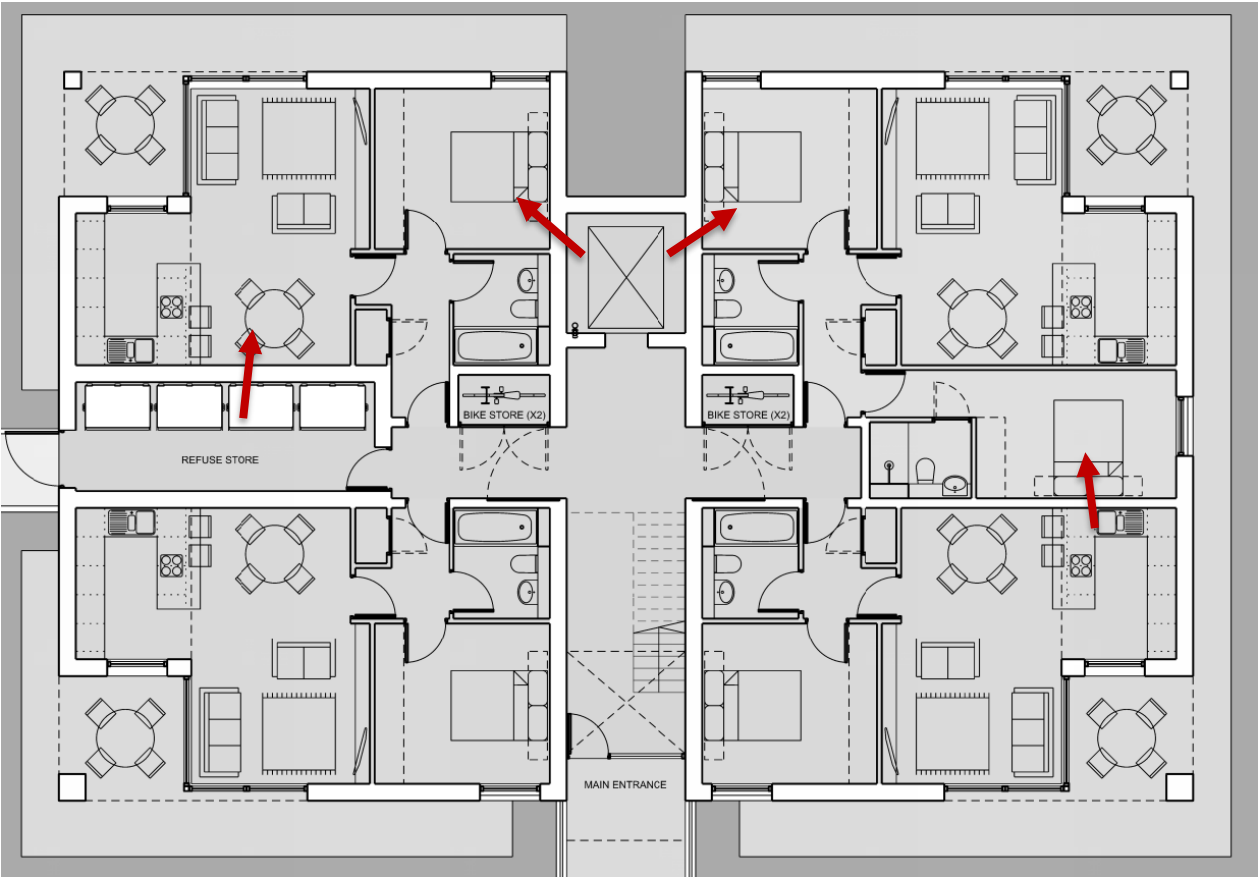


Figure 1 Potential structure-borne noise through partitions

4.2.2 Example partition constructions

Example partition constructions are set out in Table 6. These are examples only and there are other potential constructions that could be used.

Lift shaft walls may be of solid concrete. This would be suitable to control airborne sound insulation, though independent linings are recommended to control structure-borne noise transfer.

It is assumed that the refuse store will be an unheated ‘external’ space, as such an insulated cavity wall construction with independent leaves could be used to provide sound and thermal insulation. Alternatively, a floor mounted low level guard rail could be installed in the refuse room (alongside the party wall) with a resilient surface finish, eg rubber, in order to prevent bins from impacting the separating wall.

For drywall partitions with a minimum site sound insulation performance of $D_{nT,w}+C_{tr}$ 45 dB or higher, the laboratory rating (R_w+C_{tr}) should be at least 9 dB higher than the site performance.

Where plasterboard is specified it should have a density $\geq 640 \text{ kg/m}^3$ and where dense plasterboard is specified it should have a density $\geq 840 \text{ kg/m}^3$. Where mineral fibre insulation is specified it should have a density $\geq 30 \text{ kg/m}^3$.

Table 6 Example partition constructions

Minimum site sound insulation performance	Minimum laboratory sound insulation performance	Example partition construction
$D_{nT,w}+C_{tr}$ 50 dB (if targeting ADE 2003 +5 dB)	R_w+C_{tr} 59 dB (if targeting ADE 2003 +5 dB)	2 layers of 15 mm dense plasterboard to both sides of a 2 x 48 mm independent twin ‘I’ stud arrangement with 100 mm mineral fibre insulation in the cavity (minimum overall depth 250 mm)
$D_{nT,w}+C_{tr}$ 45 dB	R_w+C_{tr} 54 dB	2 layers of 15 mm dense plasterboard to both sides of a 2 x 48 mm independent twin ‘I’ stud arrangement with 50 mm mineral fibre insulation in the cavity (minimum overall depth 200 mm)
n/a	R_w 45 dB (if targeting ADE 2003 +5 dB)	2 layers of 15 mm plasterboard to both sides of a 48 mm ‘C’ stud (overall depth 110 mm)
n/a	R_w 40 dB	2 layers of 12.5 mm plasterboard to both sides of a 48 mm ‘C’ stud (overall depth 100 mm)

4.3 Doors

4.3.1 Entrance doors to apartments

For entrance doors to apartments to meet the requirements of ADE 2003 one of the following methods must be used:

- Install doors which have been tested in a laboratory and shown to achieve an acoustic rating of at least R_w 29 dB; or
- Install doors which meet the following parameters:
 - Door leaf to have a minimum mass per unit area of 25 kg/m²
 - Door to have good perimeter seals, including a threshold seal where practicable.

A 45 mm solid-core timber door closing onto a rebated frame with full perimeter seals along the head, jambs and threshold would be capable of meeting the performance requirement.

The door would need to be side hinged rather than pivoted.

It is recommended that doors to apartments be fitted with appropriate closers to minimise 'banging' particularly late at night.

4.3.2 Internal doors within apartments

There is no minimum requirement under ADE 2003 for internal doors within apartments.

4.4 Interface details

The site performance of all sound insulating elements will be dependent on the interfaces to adjoining building elements, especially those with higher sound insulation requirements.

The interface details will need to be developed as the design progresses in order that the sound insulation performances can be met.

4.4.1 Facade

An internal plasterboard lining (or equivalent) should run slab-to-slab in order to control horizontal and vertical flanking sound transmission. Where internal partitions abut the facade they should break this internal lining. A dense mineral fibre void barrier (density ≥ 80 kg/m³) should be provided at the partition line and the floor slab edge.

4.4.2 Partitions

Internal partitions should be built from slab-to-slab. To control flanking sound transmission, where internal partitions abut the external wall, they should break the internal linings with a dense mineral fibre cavity stops provided at partition lines.

5 Sound absorbent finishes

Requirement E3 of ADE 2003 means that a certain amount of sound absorbent finishes required in corridors, hallways, entrance halls and stairwells that give direct access to flats and rooms for residential purposes.

There are two methods described to satisfy requirement E3, Method A and Method B.

It is generally accepted that sound absorbent finishes are not required in fully enclosed stairwells or other common areas which do not have apartments located directly off, although this should be confirmed by the Building Control Body.

5.1 Method A

Cover a specified area with an absorber of an appropriate class that has been rated according to BS EN ISO 11654: 1997 *Acoustics – Sound absorbers for use in buildings – Rating of sound absorption*.

For entrance halls, corridors and hallways cover an area equal to or greater than the floor area with a Class C absorber or better. It will normally be convenient to cover the ceiling area with the additional absorption.

Currently there are no stairwells with direct access to apartments, as such no sound absorbent finishes would be required to stairwells. If this changes the requirements for sound absorbent finishes will need to be reviewed.

5.2 Method B

Determine the minimum amount of absorptive material using a calculation procedure in octave bands. Method B is intended only for corridors, hallways, and entrance halls as it is not well suited to stairwells.

In comparison to Method A, Method B takes into account the existing absorption provided by all the surfaces. In some cases, Method B can provide increased flexibility regarding the amount of absorption to be applied in the space.

In order to assess the amount of absorption required under Method B, octave band calculations (250 Hz to 4kHz inclusive) need to be carried out based on the proposed finishes within the space, to show that the following absorption areas are provided:

- For entrance halls provide a minimum of 0.20 m² of total absorption area for every cubic metre of volume
- For corridors or hallways provide a minimum of 0.25 m² of total absorption area for every cubic metre of volume.

The additional absorptive material should be well distributed within the space.

5.3 Example sound absorbent finishes

Example sound absorbent finishes that typically would be suitable include:

- Perforated plasterboard with a cavity behind containing sound absorbent insulation (subject to pattern, cavity depth, insulation thickness, etc)
- Perforated metal tile ceiling with a cavity behind containing sound absorbent insulation (subject to pattern, cavity depth, insulation thickness, etc)
- Class C sound absorbent tiles
- Acoustic plaster finish, typically a plaster finish on a sound absorbent substrate (subject to cavity depth, insulation thickness, etc).

6 Building services noise vibration

6.1 Internal noise criteria

The Manchester City Council (MCC) *Planning & Noise Technical Guidance* document dated December 2015 Section 3.6.1.1 sets the internal noise limits given in Table 7 for residential development.

Table 7 Manchester City Council internal noise criteria for residential developments

Internal space	Internal noise level L_{Aeq} (dB)	
	Daytime (07:00 to 23:00)	Night-time (23:00 to 07:00)
Living rooms	35	-
Bedrooms	-	30

It is also stipulated that individual events should not normally exceed L_{Amax} 45 dB within bedrooms more than 15 times during the night.

The levels given in Table 7 are the cumulative noise levels to be achieved by external noise ingress in combination with any noise from mechanical ventilation systems. The internal noise criteria for building services systems will therefore need to be considered in conjunction with the control of environmental noise ingress via the building envelope.

Typically the building services noise should be 3 dB below the internal noise criteria when providing background ventilation (ie L_{Aeq} 27 dB in bedrooms and L_{Aeq} 32 dB in living rooms).

The noise from building services plant and systems should also not contain any distinguishable, discrete, continuous notes (whine, hiss, screech, hum, etc) or distinct impulses (bangs, clicks, clatters or thumps) and should not be irregular enough to attract attention.

6.2 Vibration criteria

When all building services are operating at normal duty they should not:

- Exceed a Vibration Dose Value (VDV) of $0.1 \text{ m/s}^{-1.75}$ as given in BS 6472-1: 2008 *Guide to evaluation of human exposure to vibration in buildings: Part 1 Vibration sources other than blasting* in any residential apartment
- be of a magnitude which causes the internal noise criteria to be exceeded
- be of a magnitude which causes the vibration criteria for specific equipment to be exceeded.

In addition, vibration transfer from plant to occupied areas should not exceed 0.01 m/s^2 peak acceleration, based on W_b weighting as defined in clause 3.3 of BS 6472-1:2008.

6.3 Service routing

6.3.1 Services penetrations

Wherever possible building services should enter rooms via the room fronts. Services running between apartment should be avoided.

Where building services pass out of plant rooms or through walls, floors or ceilings separating spaces, care should be taken to avoid the degradation of the sound insulation between these spaces. Size builders work holes to accommodate the duct, pipe, trunking or conduit with the minimum clearance that is practicable. It is recommended that where pipes penetrate partitions they should be fitted with metal pipe collars on both sides of the partition in lieu of patching.

Service penetrations through partitions and other sound insulating elements will need to be acoustically sealed to ensure the sound insulation between rooms meets the specified requirements.

Example sketch details showing duct/pipe and cable tray penetrations through partitions are provided in Figure 2 and Figure 3.

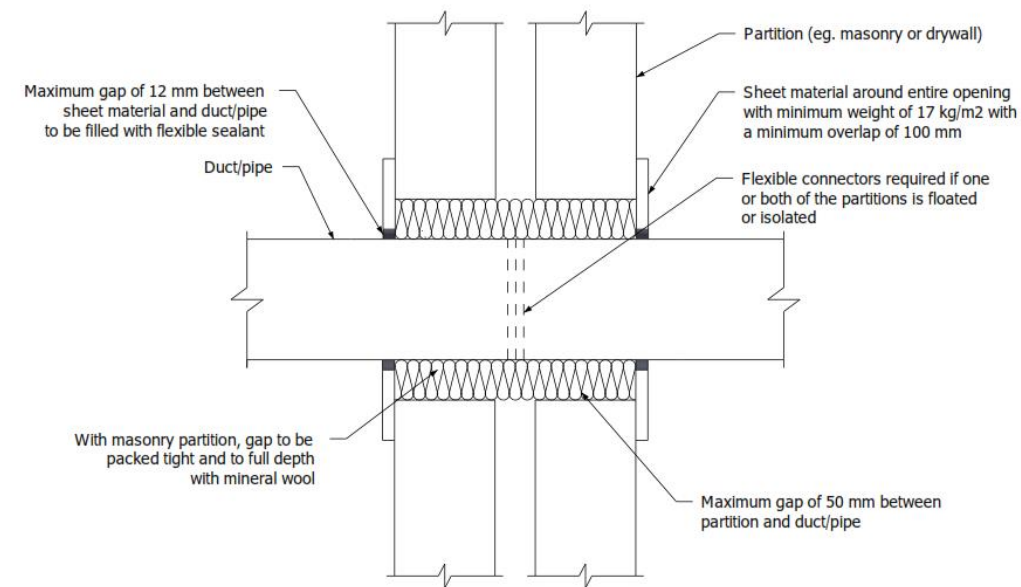


Figure 2 Example sketch detail – Duct/pipe penetration through a double partition

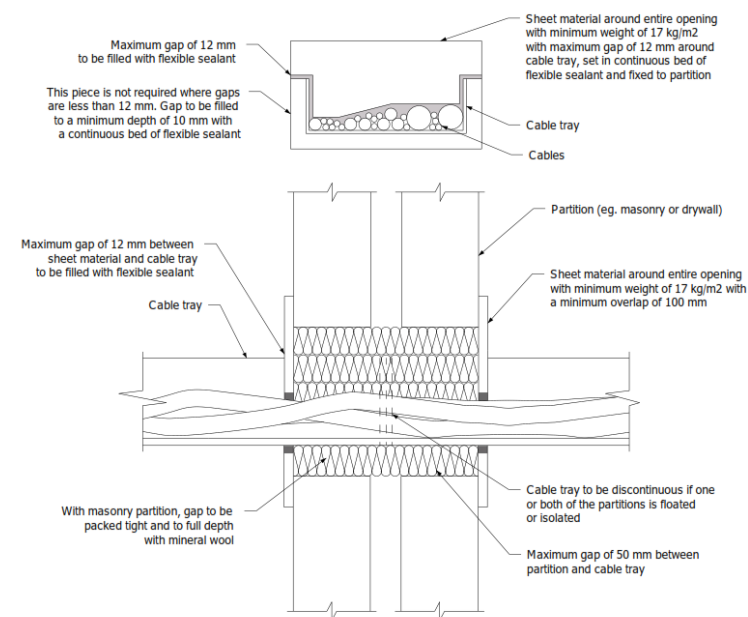


Figure 3 Example sketch detail – Cable tray penetration through a double partition

6.3.2 Recessed sockets, switches and fittings

All sockets and switches on separating walls should be fitted with appropriate acoustic backing boxes or proprietary putty pads so that the sound insulation performance is not compromised.

6.3.3 Ductwork

Where ductwork passes through sound insulating constructions, cross-talk attenuators should be selected where required to ensure that the sound insulation of the construction is not degraded.

6.3.4 Drainage

Rainwater pipes and other drainage routes should be routed in circulation areas away from noise sensitive areas, wherever possible. Where this is not possible they should be lagged with 25 mm mineral fibre insulation (density $\geq 30 \text{ kg/m}^3$) and boxed in with 2 layers of 12.5 mm plasterboard (density $\geq 640 \text{ kg/m}^3$).

The initial fourth floor layouts have bathrooms and kitchens partially over third floor bedrooms. This creates potentially awkward routing for drainage over sensitive rooms.

The drainage layouts and pipe construction will need to be reviewed as the design progresses, with use of boxing/lagging where required.

Syphonic drainage systems should be avoided where possible and should not pass through dwellings.

Wherever possible soil stacks etc should not run through habitable rooms. Where pipes must penetrate party floor slabs, the penetrations should be suitably detailed to minimise noise transfer via this route.

Penetrations through the party floor slab should be boxed in, in accordance with the typical detail in Figure 4.

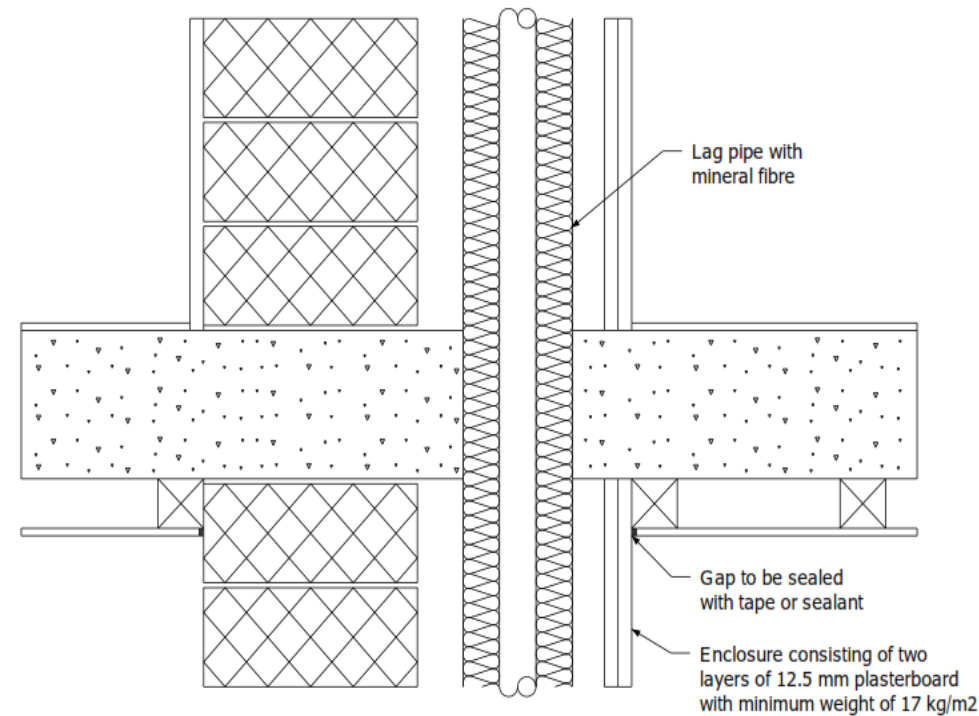


Figure 4 Example sketch detail – Pipe penetration through separating floor

The pipes should be wrapped with 25 mm mineral fibre, and the enclosure should consist of a board material which has a surface density $\geq 17 \text{ kg/m}^2$. This could be achieved using 2 layers of 12.5 mm standard plasterboard.

7 Construction (Design and Management) Regulations

The Construction (Design and Management) Regulations 2015 places legal duties on virtually everyone involved in construction work. Those with legal duties are commonly known as ‘dutyholders’ and include clients, designers, contractors and workers.

Typical risks specifically associated with acoustic design are:

- Access at height to install and to maintain such elements as acoustic absorbers
- Manual handling of heavy building elements such as high density concrete blocks.

Acoustic treatment is proposed which will require installation at height, eg soffit of spaces. However, this would be required in any event for installation of ceiling finishes, lighting, etc and is therefore not a risk specifically related to the acoustic design.

Man-made mineral fibres (MMMF) are used extensively in the construction industry and these are sometimes specified for their acoustic properties. When contractors make use of MMMF they should act on relevant legislation and the latest guidance issued by the Health and Safety Executive.

The above risks are not unusual and would be appropriately managed by a competent contractor.

Appendix A

Glossary of acoustic terms

General terms

Absorptive material	Material that absorbs sound energy. Soft or porous finishes such as mineral fibre are effective sound absorbers.
Acoustic absorption	The conversion of sound energy, often by the use of a porous material. It is a term used to describe the amount of sound absorbed by a finish or object within a room.
Airborne sound	Sound propagating through the air.
Airborne sound insulation	The ability of building elements or structures to reduce airborne sound transmission.
Direct sound transmission	The process in which sound that is incident on one side of a building element is radiated by the other side.
Flanking element	Any building element that contributes to the sound transmission between rooms in a building that is not the separating element in question. It is typically an element which continues past the separating element
Flanking sound transmission	Sound transmitted between rooms via flanking elements instead of directly through separating elements, or along any path other than the direct path.
Floating/isolated floor	A floating or isolated floor consists of a floating layer that is decoupled from the main structure by a resilient layer or other resilient element (see also ‘Resilient layer’ and ‘Floating/isolated layer’). The type of resilient element depends on the level of isolation required.
Floating/isolated layer	A surface that rests on a resilient layer or other resilient element and is therefore isolated from the main structure (see also ‘Floating/isolated floor’ and ‘Resilient layer’).
Frequency	The number of cycles per second. The unit of frequency is the Hertz (Hz). Frequency gives a sound its distinctive tone.
Frequency band	A continuous range of frequencies between stated upper and lower limits (see also ‘Octave band’ and ‘One-third octave band’).
Impact sound	Sound resulting from direct impact (such as footsteps) on a building element.
Impact sound insulation	The ability of building elements or structures to reduce impact sound transmission.
Independent ceiling or lining	A ceiling or lining which is mounted independently of (ie with no direct physical connections to) a separating floor or wall.
Isolation	The absence of rigid connections between two or more building elements.
Resilient layer/element	A layer or other resilient element that isolates a floating layer from a base floor and the surrounding walls.
Reverberation	The persistence of sound in a space after a sound source has stopped.
Reverberation time	The time, in seconds, taken for the sound in a room to decay by 60 dB after a sound source has been stopped.
Separating element	An element (such as a wall, floor, door, window) which separates buildings or parts of buildings.

Sound pressure level

A logarithmic measure of the effective sound pressure of a sound relative to a reference value, measured in decibels, dB. Sound pressure levels are dependent on the conditions under which they are measured.

Structure-borne sound

Sound which is transferred by vibration via the structure of a building.

Acoustic parameters

‘A’ weighting

Frequency weighting based on the frequency response of the human ear which has been found to correlate well with the subjective response to sound.

C_{tr}

The correction to a sound insulation quantity (such as R_w or $D_{nT,w}$) to take account of a specific sound spectrum with low frequency sound energy.

Decibel (dB)

A logarithmic unit used for many acoustic values to indicate the level with respect to a reference level

$D_{nT,w}$

A single number weighted quantity which characterizes the airborne sound insulation between rooms, corrected for reverberation time. A higher numerical quantity represents a better performance.

$L'_{nT,w}$

A single number weighted quantity used to characterise the impact sound insulation of floors. A lower numerical quantity represents a better performance.

$L_{Aeq,T}$

Equivalent A-weighted sound pressure level of a steady noise that has the same acoustic energy as a fluctuating noise over the measurement period (T). When not weighted it is denoted $L_{eq,T}$.

$L_{Amax,T}$

The highest A-weighted sound pressure level measured in the period (T) with either fast (L_{AFmax}) or slow (L_{ASmax}) time weightings. When not weighted it is denoted L_{Fmax} or L_{Smax} .

R

Sound reduction index. A quantity, measured in a laboratory, which characterises the airborne sound insulation of a material or building element in a stated frequency band. A higher numerical quantity represents a better performance.

R_w

Weighted sound reduction index. A single number quantity which characterises the airborne sound insulation of a material or building element in the laboratory. A higher numerical quantity represents a better performance.

α_w

Weighted absorption coefficient – a quantity characterising the effectiveness of a sound absorbing surface. The proportion of sound energy absorbed is given as a number between zero (for a fully reflective surface) and one (for a fully absorptive surface).

ΔL_w

The measured improvement of weighted impact sound insulation resulting from the installation of a floor covering or floating floor on a test floor in a laboratory. A higher numerical quantity represents a better performance.