WEMBLEY ALTO, NW06

Acoustic Design Review

Wates Construction

ABOUT US

MACH Acoustics is a fast- growing consultancy with a staff of 20, who all share a passion for acoustics and a commitment to sustainable architecture.

Based in Bristol and London, our exceptional team of highly qualified engineers, project managers, data analysts and acoustic modellers love solving acoustic challenges across all building sectors.

OUR APPROACH

We use rigorous mathematics and creativity to come up with simple, effective designs that solve a problem. For us the right solution also has to be aesthetically pleasing and cost effective.

SUSTAINABILITY

We work across all sectors, including educational, residential, commercial and arts/entertainment and always look for ways in which we can enhance the scope of the buildings we work on and the services we provide.

Sustainability is at the core of our work -for us it goes hand in hand with acoustics. We specialise in façade designs that allow for natural ventilation even on noisy sites and enable beautiful, low carbon buildings.

COMMUNICATION

To find the best acoustic solution, we must communicate and collaborate effectively with the design team. But acoustics are often invisible and complex, and decibels are meaningless to a non-acoustician.

There are two ways that we achieve this:

CLARITY

Firstly, we keep the jargon to a minimum and provide clear tables and marked up drawings indicating required performance targets, constructions and acoustic treatment.

VISUAL

Alternatively we can create simple visual simulations and auralisations (the aural equivalent of visualisations) that allow design teams to 'see' and hear the sound in a building. This ensures the team fully understands the performance requirements of a completed building and frequently it results in cost savings, as less noise mitigation is required than previously thought.

In this document are some of our example reports, exactly as they were delivered to past clients. Design reports are tailored to each individual client and include a high graphic content that demonstrates both the principles of acoustics and our design. Acoustic treatments and design solutions are set out with a greater level of precision and detail than many of our competitors' reports, as we always make clear exactly what the sound reduction will be and how we will achieve it.

WEMBLEY ALTO, NW06

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00	First Issue	Phil Jordan	13/05/2016

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1.0 EXECUTIVE SUMMARY

MACH Acoustics have undertaken a detailed review of the proposed acoustic design for the residential areas of this development. This executive summary provides comment on the areas of design which MACH Acoustics would like draw particular attention to.

Report Section	Item	Comment
4.2.3	Alternative core wall construction	MACH Acoustics suggest that separating walls between stair cores and dwellings have the plasterboard lining reduced from 2x 15mm plasterboard (12.5kg/m^2) down to 1x 12.5mm plasterboard (8kg/m^2) as this is seen to be an excessive design.
4.2.6	Internal wall IWS 4b	As per the Speedline package this wall construction is not seen to achieve the minimum requirements of Regulation E2 of the building regulations and should therefore not be used for internal walls within dwellings where there is not a door.
6.3.1	Curtain walling	Mullions and transoms should not be continuous across separating walls and floors as it has the potential to compromise the sound insulation performance, therefore the OCL facades should confirm that this is the case as it is not clearly shown in technical submittal.
6.3.2	Flanking path	In order to prevent flanking via the external wall where there are windows within the façade. It is essential that there is a metal flanking plate at floor level and a minimum of two layers of board at head detail below the slab.

2.0 INTRODUCTION

MACH Acoustics have been appointed by Wates Construction to provide detailed acoustic design advice for the Wembley Alto, NW06 development, NW06. The proposed development will introduce a new residential development comprising of two main sections up to sixteen storeys in height. The proposed development is a stone's throw from Wembley stadium and will include a number of non-residential areas such as community space including a gym as well as a community plant room at ground level providing heat and power to this and number of proposed new developments.

This report is concerned with the acoustic design of the residential areas within the proposed development which are being designed and built to comply with Approved Document E of the Building Regulations 2003.

2.1 Building Regulations – Approved Document E

Approved Document E (ADE) provides acoustic performance standards which must be achieved when refurbishing or developing a new residential building. A summary of performance requirements of ADE applicable to this development are presented below. For further information on the regulations of ADE, please see Appendix A of this report.

2.1.1 Regulation E1 - Protection against sound from other parts of the building and adjoining buildings

Table 1 below provides the sound insulation requirements of ADE applicable to the purpose built dwelling houses and flats within this development.

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

Table 1: ADE Sound Insulation Performance Requirements – Dwelling-Houses & Flats

2.1.2 Regulation E2 - Protection against Sound within a Dwelling House or Flat

Table 2 provides a summary of the sound insulation requirements for internal walls within this development.

Internal Element	Airborne Sound Insulation R_W dB
Walls	40

Table 2: ADE Sound Insulation Performance Requirements – Internal Walls

2.1.3 Regulation E3 - Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes

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 the common parts than is reasonable.

Regulation E3 only applies to corridors, stairwells, hallways and entrance halls which give direct access to a flat or room for residential purposes.

It is seen that there are only common hallways and corridors which provide direct access to flats or rooms for residential purposes to which Regulation E3 applies. Stairwells are not seen to provide direct access and therefore Regulation E3 does not apply in these areas.

For guidance on the control of reverberation within these areas, please see Section 8 of this report.

2.2 The Code for Sustainable Homes

The Code for Sustainable Homes (CfSH) is an environmental assessment method for rating and certifying the performance of new homes. Within the Health and Wellbeing section HEA02 there are credits available which relate to the sound insulation performance of new homes. This report only addresses the credits available within the HEA02 section of the scheme.

It is understood that three credits are being targeted for exceeding the performance requirements of ADE by +/- 5dB.

2.3 Employers Requirements

The Employer's Requirements outline the planning obligations applicable to this development which relate to the following areas of acoustic design:

- The sound insulation requirements of ADE are to exceeded by +/-5dB
- Internal noise requirements 33dB $L_{Aeq,15m}$ between 11pm to 7am and 38dB LAeq,15m between 7am and 11pm with windows closed.
- External plant noise levels achieve a rating level of 10dB below background noise level as defined in BS4142:2014. ' Method for rating industrial noise affecting mixed residential and industrial areas.
- Car parks – treated to avoid wheel squeal and noise breakout
- Vibration levels will be accordance with BS 6472:2008 'Guide to the evaluation of human exposure to vibration in buildings'

There are also a number or requirements outlined within the ER's which are seen to be as follows:

- Noise from commercial units must be limited to:
  - NR 25 dB Leq within adjacent business units
  - NR 15 dB Leq within adjacent residential units
- Noise from plant rooms must be designed to achieve:
  - NR 15 dB Leq within residential units
  - NR 25 dB Leq within commercial or leisure units
- Noise from ventilation units within dwellings should be designed to achieve:
  - NR 20 dB Leq within bedrooms
  - NR 25 dB Leq within other habitable rooms
  - NR 25 dB Leq within all habitable rooms is acceptable during comfort heating / cooling.

2.4 Non Residential Areas

Following a review of the architectural plans, it is seen that there are non-residential areas adjacent to habitable areas of this development. The non-residential areas are seen to be as follows:

- Car park
- Plant rooms
- Office space
- Communal Areas
- Commercial units
- A Gymnasium

The minimum sound insulation requirements for this development may not be sufficient in preventing noise from the non-residential areas contributing to noise levels within habitable and which may therefore be disturbing to the residents. Although this report has highlighted these areas an assessment between non and residential areas has not been addressed within this report and is provided within the MACH Acoustics Design Note – Assessment of Non-Residential Areas.

3.0 TECHNICAL INTRODUCTION

The sound insulation between two rooms is made up of the sum of the direct path and any flanking paths between the two rooms. Figure 1 below indicates some of the flanking paths between two rooms.

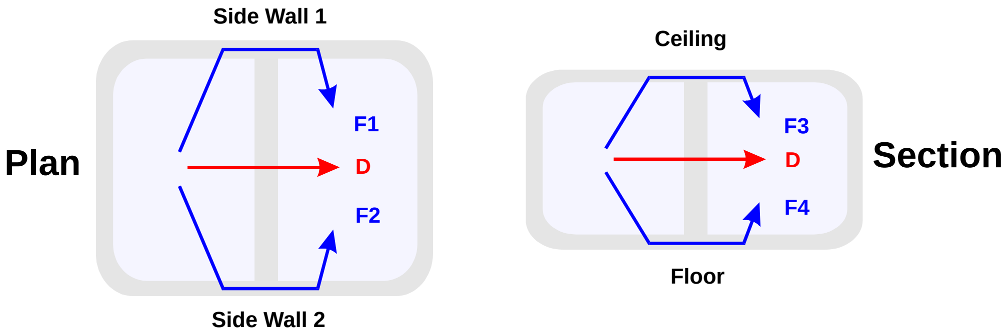


Figure 1: Transition paths between rooms

Where D is the direct sound path, F1 Flanking via the sidewall 1, F2 Flanking via the Sidewall 2, F3 Flanking via the Ceiling, F4 Flanking via the Floor

In other words, the sound insulation between two spaces is not only dependent upon the construction of the separating wall or floor, but all the levels of separation provided by the building structure and the sound insulation across details.

3.1 Passage of Sound through the Building Structure as Percentages

The passage of sound through the building frame is dependent upon a number of factors, including the mass of the slabs, how these slabs are supported (load bearing or non-load bearing), the finishes to the slab – MF Ceiling / Floating Timber Floors, as well as a number of other factors. Such to assess the level of sound passing through the building structure, modelling to BS12354 'Estimation of acoustic performance in buildings from the performance of elements - Airborne sound insulation between rooms', has been undertaken.

The advantage of this type of calculation is that the percentage of sound passing through the different elements forming the sound insulation across a separating element, can be understood. Knowing the percentage of sound passing through the different elements means that it is possible to identify the weakest links within a separating element. Appendix C provides the results of detailed flanking calculations to the floor slabs within this development.

3.2 Terminology

The words 'separating wall/floor' and 'party wall/floor' are regularly used throughout this document. Their meanings are identical and refer to walls and floors which separate a flat / residence.

4.0 SOUND INSULATION

4.1 Summary of Airborne Sound Insulation Requirements

Table 3 below provides a summary of the sound insulation requirements applicable to this development.

Separating Element	ADE Requirements $D_{nT,w}$ +C_{tr} (dB)	CfSH - 3 Credits $D_{nT,w}$ +C_{tr} (dB)
Walls	45	50
Floors and Stairs	45	50

Table 3: Summary of airborne sound insulation requirements

The ADE performance standards, specified as $D_{nT,w}$ + C_{tr} relate to the on-site sound insulation values. For design purposes however, the $D_{nT,w}$ + C_{tr} must be translated into known sound insulation properties of the various components making up partition walls and floors so that appropriate constructions can be determined. The sound insulation of various construction elements is usually measured and rated in acoustic test laboratories and quoted in terms of the Sound Reduction Index, R_w + C_{tr}. As required by ADE this includes the C_{tr} correction to account for low frequency noise.

MACH Acoustics have therefore calculated the minimum performance requirements for separating elements within this development in terms of R_w + C_{tr} which has taken into account the room and separating partition dimensions. Details of these calculations are presented within Appendix D of this report.

Table 4 below provides a summary of the sound insulation requirements applicable to this development.

Separating Element	Airborne Sound Insulation Performance Requirements R_w + C_{tr} (dB)
Walls	57
Floors and Stairs	56

Table 4: Summary of calculated sound insulation performance requirements

4.2 Separating Walls - Current Architectural Design

4.2.1 Lightweight Separating Walls

Table 7 illustrates the proposed lightweight separating walls and the estimated sound reduction performance of each wall construction.

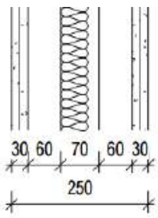
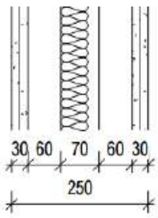
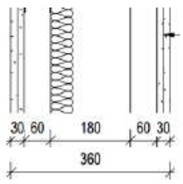
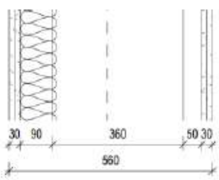
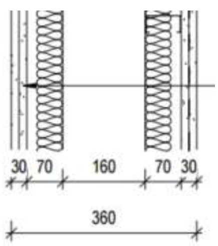
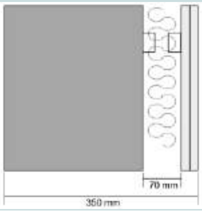
Wall Type	R_W+C_{tr} Rating	Illustration of construction	Description	Total Thickness (mm)	Achieves R_w+C_{tr} Requirements
IWS -01	61*		• 2x 15mm Knauf Soundshield plus (12.8kg/m²) • Twin Speedline C studs (unbraced) at 600mm centres • 2x 50mm APR insulation • 2x 15mm Knauf Soundshield plus (12.8kg/m²)	250	Yes
IWS -02	61*		• 2x 15mm Knauf Soundshield Plus (12.8kg/m²) • Twin Speedline C studs (unbraced) at 600mm centres • 2x 50mm APR insulation • 2x 15mm Knauf Soundshield Plus (12.8kg/m²)	250	Yes
IWS -03	64*		• 2x 15mm Knauf Soundshield Plus (12.8kg/m²) • Twin Speedline C studs (unbraced) at 600mm centres • 2x 50mm APR insulation • 2x 15mm Knauf Soundshield Plus (12.8kg/m²) • Nominal wall thickness 360mm	360	Yes
IWS -17	65*		• 2x 15mm Knauf Soundshield Plus (12.8kg/m²) • Twin Speedline C studs (unbraced) at 600mm centres • 2x 50mm APR insulation • 2x 15mm Knauf Soundshield Plus (12.8kg/m²)	560	Yes
IWS-58	64*		• 1x 15mm Knauf Impact Panel (12.8kg/m²) • 1x 15mm Knauf Soundshield Plus (12.8kg/m²) • Twin Speedline C studs (unbraced) at 600mm centres • 2x 50mm APR insulation • 1x 15mm Knauf Impact Panel (12.8kg/m²) • 1x 15mm Knauf Soundshield Plus (12.8kg/m²)	360	Yes
* Sound insulation performance predicted using INSUL modelling software					

Table 5: Proposed separating wall constructions – lightweight stud

It can be seen that the proposed separating walls meet the sound insulation requirements for this development and are therefore considered to be suitable in this instance.

4.2.2 Concrete and Masonry Separating Walls

Table 8 illustrates the proposed concrete and masonry separating walls and the estimated sound reduction performance of each wall construction.

Wall Type	R_w+C_{tr} Rating	Illustration of construction	Description	Total Thickness (mm)	Achieves R_w+C_{tr} Requirements
Core Walls	74*		• 250mm core wall • 70mm void • 50mm insulation • 2x 15mm plasterboard (12.5kg/m^2)	350	Yes

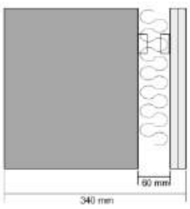
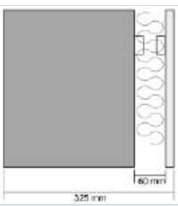
* Sound insulation performance predicted using INSUL modelling software

Table 6: Proposed separating wall constructions – concrete / masonry

It can be seen that the proposed separating walls meet the sound insulation requirements for this development and are therefore considered to be suitable in this instance.

4.2.3 Alternative Separating Wall Constructions

In addition to the currently proposed architectural wall types, MACH Acoustics have suggested some alternative wall constructions which meet the performance requirements for this development and provide a potential value engineering option.

Wall Type	R_w+C_{tr} Rating	Illustration of construction	Description	Total Thickness (mm)	Achieves R_w+C_{tr} Requirements
Core Alt 1	73*		• 250mm core wall • 70mm void • 50mm insulation • 2x 15mm plasterboard (12.5kg/m^2)	340	Yes
Core Alt 2	67*		• 250mm core wall • 60mm void • 50mm insulation • 1x 12.5mm plasterboard (8kg/m^2)	323	Yes

* Sound insulation performance predicted using INSUL modelling software

Table 7: Alternative separating wall constructions

Core Alt 1 – This wall has been proposed by the design team for separating walls between lift cores and residential and is seen to be a suitable alternative to core wall shown in Table 6 previously.

Core Alt 2 – This is considered to be a suitable alternative wall construction between stairwells and residential dwellings. This is seen to easily meet the sound reduction requirements whilst reducing the overall build-up of the gypsum boards down from two layers of 15mm dense board to a single layer of 12.5mm standard board. Due to there being no mechanical services within the stair cores it is considered to be suitable in meeting the requirements between residential dwellings and stairs.

4.2.4 Corridor Walls

Part E requirements with respect to corridor walls are provided below:

> 2.25 The separating walls described in this section should be used between corridors and rooms in flats, in order to control flanking transmission and to provide the required sound insulation. However, it is likely that the sound insulation will be reduced by the presence of a door.
>
> 1.8 Testing should not be carried out between living spaces, corridors, stairwells or hallways.

In effect, this text states that walls adjacent to corridors should have the same construction as those between dwellings.

Corridor walls are seen to be of the same construction as the separating walls detailed in Table 5 and are therefore compliant with ADE.

As noted by ADE and other documents, walls to corridors are unlikely to meet the requirements of ADE Irrespective of their constructions. This is due to the limiting performance of the door. If alternative constructions i.e. non-compliant constructions were to be used, proposed designs would need to be approved by Building Control.

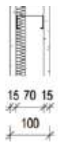
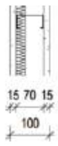
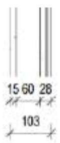
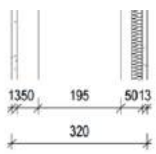
4.2.5 Doors into Dwellings

To maintain a reasonable level of sound insulation between living spaces and circulation spaces, ADE advises that the sound insulation of the door achieves 29dB R_w (measured according to BS EN ISO 140-3:1995 and rated according to BS EN ISO 717-1:1997). To achieve this level of sound insulation, these doors should have a good perimeter sealing, a threshold where practical and a mass greater than 25kg/m^2.

Note that this advice only applies to doors between houses and flats and circulation spaces and not for doors between two living spaces. There is no guidance or recommendation given in the latter case.

4.2.6 Internal Walls

Internal walls and floors between bedrooms or a room containing a water closet and other rooms must achieve 40dB Rw as discussed within Section 2.1.2 previously. The internal wall constructions proposed for this development are seen to be as shown in Table 8 below and have been taken from the Speedline project pack and from architectural drawings.

Wall Type	R_W Rating	Illustration of construction	Description	Total Thickness (mm)	Achieves R_w Requirements
IWS – 04	43 dB		• 15mm wallboard • 70mm C studs • 25mm insulation • 15mm Wallboard	102	Yes
IWS – 04b	36 dB		• 12.5mm wallboard • 70mm C studs • No insulation • 12.5mm wallboard	100	No
IWS - 05	44dB*		• 12.5mm Wallboard • 60mm Rigid stud • insulation • 15mm Fermcell board • 12mm porcelain	103	Yes
IWS - 06	42 dB		• 2x 12.5mm Fire Panel • 48mm C studs • No insulation • 2x 12.5mm Fire Panel	112	Yes
IWS – 06b	41 dB		• 25mm Coreboard • 60mm I Stud • No insulation • 2x 15mm Fire Panel	92	Yes
IWS - 12	>42 dB		• 12.5mm Wallboard • 50mm braced C studs • 25mm insulation • 50mm braced C studs • 12.5mm Wallboard	150	Yes
IWS - 13	>42 dB		• 12.5mm wallboard • 50mm braced C studs • 25mm insulation • 50mm braced C studs • 12.5mm wallboard	320	Yes

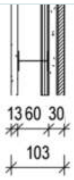
IWS – 15	>42 dB		• 15mm Wallboard • 60mm I Studs • 15mm marine ply • 15mm moisture board	102	Yes
IWS - 16	41 dB		• 19mm Coreboard • 60mm I stud • No insulation • 2x 15mm Fire Panel	103	Yes
* Sound insulation performance predicted using INSUL modelling software					

Table 8: Proposed internal wall constructions

It can be seen that the sound insulation requirements for internal walls will be achieved based upon the wall types proposed for this development for all walls with the exception of IWS -4b which is seen to fall short of the minimum 40dB Rw requirement for internal walls. Please note that as per ADE, internal walls do not include:

- A door
- Those which separate an ensuite from the associated bedroom;

Should the IWS 04b be proposed for use as an internal wall then it is advised that 25mm insulation is included within this construction.

All other internal walls are seen to meet the requirements with a small tolerance and are therefore seen to be suitable for this development.

4.3 Sound Insulation - Floors

This section of the report is concerned with the airborne and impact sound insulation design of the separating floors within this development.

4.3.1 Separating Floors - Current Architectural Design

The separating floors within this development are understood to be 225mm RC slab construction with suspended MF plasterboard ceiling. Table 9 provides a summary of the proposed floor constructions.

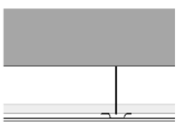
Floor Type	R_W+C_{tr} Rating	Illustration of construction	Description	Total Thickness (mm)	Achieves R_w Requirements
Proposed	59dB*		• 225mm RC slab • 200mm Void • Mf system • 12.5mm plasterboard (8.5kg/m^2)	440	Yes
* Sound insulation performance predicted using INSUL modelling software					

Table 9: Proposed separating floor construction

4.4 Ceilings

There will be a suspended MF plasterboard ceiling within residential areas of this development which are understood to be a 1x12.5mm plasterboard (8.5kg/m^2), with a 200 mm ceiling void suspended with MF system.

4.5 Airborne Sound Insulation

The airborne sound insulation requirements for separating floors has been calculated to be 56 dB R_W+C_{tr}.

The sound insulation performance of the floor has been predicted using INSUL modelling software where the ceiling has been considered but the floor finishes have not.

As shown in Table 12 previously, the airborne sound reduction of the proposed floor construction is seen to be 59dB R_W+C_{tr} which meets the minimum requirements for this scheme and is therefore considered to be suitable for this development.

4.6 Impact Sound Insulation

Table 10 below provides the impact sound insulation requirements for separating floors.

Separating Element	ADE Requirements $L'_{nT,w}$ (dB)	CfSH - 3 Credits $L'_{nT,w}$ (dB)
Floors	62	57

Table 10: Impact sound insulation requirements

The ADE performance standard for impact sound insulation is specified as $L'_{nT,w}$ and relates to the on-site impact sound pressure value. For the purposes of design, the $L'_{nT,w}$ value has been converted in to a $L_{n,w}$ value to allow for the floor construction to be accurately accessed.

MACH Acoustics have therefore calculated the maximum impact sound insulation performance requirements for separating floors within this development in terms of $L_{n,w}$ which has taken into account the room dimensions. Details of these calculations are presented within Appendix D of this report.

Table 11 below provides a summary of the calculated impact sound insulation performance requirements applicable to this development.

Separating Element	Impact Sound Insulation Performance Requirements $L_{n,w}$ (dB)
Floors	51

Table 11: Impact sound insulation requirements

Through calculation MACH Acoustics have calculated the impact sound insulation performance of proposed separating floor construction shown in Table 9 previously and is seen to be 57 dB $L_{n,w}$.

In order to achieve the impact sound insulation requirements for this development the resilient layer within floor construction should provide reduction of 6 ΔL_w impact isolation as a minimum. However, it is advised that a much higher level of impact insulation is provided.

4.6.1 Resilient Layer

Original proposals for the resilient layer within dwellings was seen to be a ISORubber product bonded to the floor slab as per Robust Details E-FC-10.

It is however understood that an alternative resilient layer is proposed throughout residential areas of this scheme which is understood to be Durafit 650 underlay which can achieve a reduction of 29dB ΔL_w impact isolation. This is therefore seen to satisfy the impact sound insulation requirements for this development and is considered to be a suitable product.

5.0 SOUND INSULATION FLANKING THROUGH THE BUILDING STRUCTURE

As mentioned in the Technical Introduction, the acoustic performance of the separating walls and floors is not only a function of their construction but also of the surrounding elements and the junctions between them. It is therefore important to ensure that the sound insulation performance is not compromised by the passage of sound through junction details or through the building structure itself.

This section of the report therefore provides an assessment of the passage of sound through the proposed construction as a whole, i.e. including flanking transmission. The assessments provided in this section of the report have been undertaken in accordance with the British Standard BS12354 and is presented below.

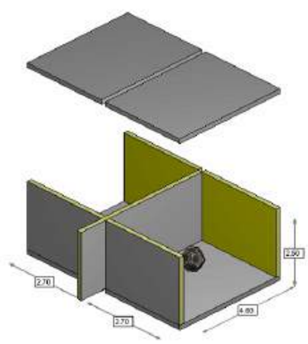
Please see Section 5 of this report for guidance on junction detailing.

5.1 Performance Requirements

The onsite performance requirements for this development have been identified previously within this report and are presented within Table 3 previously. These performance requirements relate to an onsite target and therefore include contributions directly through the separating partitions and also the flanking paths. To account for construction and onsite tolerances a correction needs to be applied to the calculations. MACH Acoustics typically use +5dB as a modelling tolerance however this may vary depending on the construction type being assessed.

5.2 Horizontal Flanking

This section of the report details the horizontal flanking assessment across separating walls.



		Sending Room		Junction	Receiving Room		DnT,w (0.5 s) + Ctr	
M	1	Basic Element	Additional Layer	Type-No.	Basic Element	Additional Layer	dB	%
X	d	WS1 - 250mm 2x 15mm Knauf Soundshield, independent C studs					59.7	27
X	f1	12mm cp with 150mm SFS and 2x12.5mm wallboard		20	12mm cp with 150mm SFS and 2x12.5mm wallboard		61.5	0
X	f2	12.5mm plasterboard 10.5kgm2 70mm stud + insulation		19	12.5mm plasterboard 10.5kgm2 70mm stud + insulation		62.5	14
X	f3	BAST: concrete floor (2300 kg/m³) 220 mm		18	BAST: concrete floor (2300 kg/m³) 220 mm		58.1	40
X	f4	BAST: concrete floor (2300 kg/m³) 220 mm	220mm RC slab with 200mm void m/f plasterboard ceiling	18	BAST: concrete floor (2300 kg/m³) 220 mm	220mm RC slab with 200mm void m/f plasterboard ceiling	61.4	19
						Total	[illegible]	100

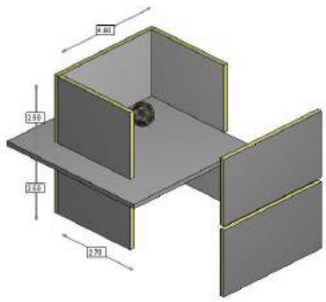
Figure 2: Horizontal flanking assessment

It can be seen that the sound insulation requirement of 54.6dB $D_{ntw}+C_{tr}$ and is seen to meet sound insulation requirements for this development.

A difference of +/-4dB is considered to provide a suitable design tolerance for this scheme.

5.3 Vertical Flanking

This section of the report details the vertical flanking assessment across separating floors.



		Sending Room		Junction	Receiving Room		DnT,w (0.5 s) + Ctr		L'nT,w (0.5 s)	
M	I	Basic Element	Additional Layer	Type-No.	Basic Element	Additional Layer	dB	%	dB	%
X	d	BAST: concrete floor (2300 kg/m³) 225 mm				225mm RC Slab with 12.5mm wallboard mf ceiling no insul	60.7	90	50.5	59
X	f1	BG 250mm 2x15mm Soundbloc twin braced C Stud		13	BG 250mm 2x15mm Soundbloc twin braced C Stud		86.0	0	38.3	4
X	f2	12mm cp with 150mm SFS and 2x12.5mm wallboard		14	12mm cp with 150mm SFS and 2x12.5mm wallboard		70.8	9	46.8	25
X	f3	BG 250mm 2x15mm Soundbloc twin braced C Stud		13	BG 250mm 2x15mm Soundbloc twin braced C Stud		83.7	0	49.7	6
X	f4	BG 250mm 2x15mm Soundbloc twin braced C Stud		13	BG 250mm 2x15mm Soundbloc twin braced C Stud		83.7	0	49.7	6
						Total	60.6	100	52.5	100

Figure 3: Horizontal flanking assessment

It can be seen that the sound insulation requirement of 60.6dB $D_{ntw}+C_{tr}$ is seen to meet sound insulation requirements for this development.

A difference of +/-10dB is considered to provide a suitable safety margin.

6.0 DETAILING

This section of the report looks at the proposed detailing for this development and provides comment where necessary.

6.1 Separating Walls

6.1.1 Separating Walls Junction Details

Figure 4 below illustrates the proposed junction details for separating walls within this development.

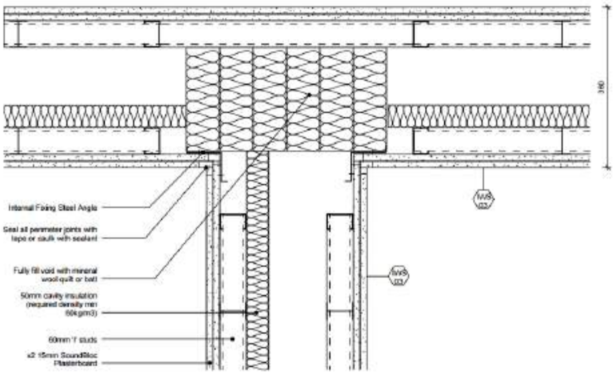


Figure 4: Proposed separating wall junction details

The proposed separating wall junction details considered to be suitable. All junctions and joints should be fully sealed with tape or caulk with non-hardening mastic to ensure required performance is achieved.

6.1.2 External Wall Junction Detail

Figure 5 below illustrates the proposed detail where separating walls interface with the external wall.

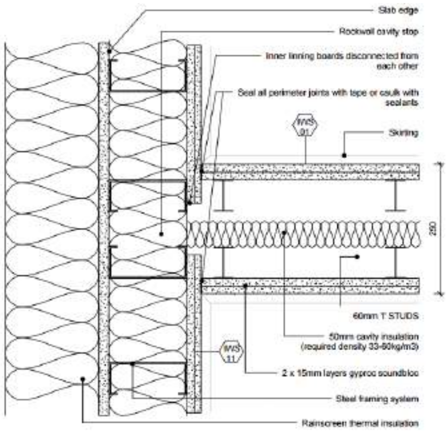


Figure 5: Proposed separating and external wall interface

The proposed interface detail is considered to be suitable. All junctions and joints should be fully sealed with tape or caulk with non-hardening mastic to ensure required performance is achieved.

6.1.3 Separating Wall Head Detail

Figure 6 below illustrates the proposed head detail.

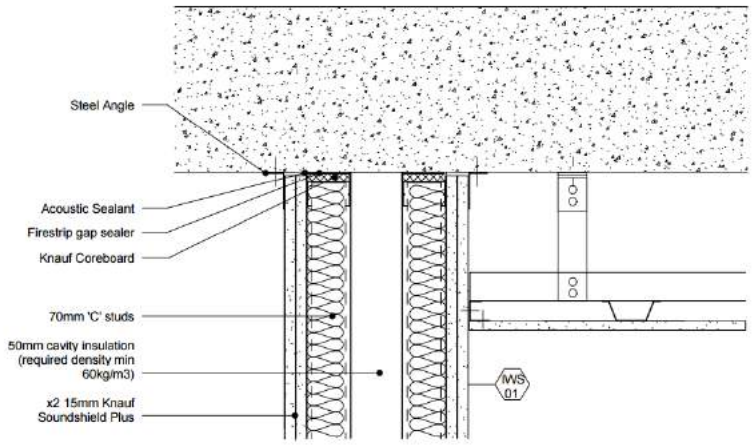


Figure 6: Proposed separating wall head detail

The proposed head detail is considered to be suitable, however it is considered that unless required for other reasons, the steel angle is not considered to be necessary.

6.1.4 Separating Wall Foot Detail

Walls are to be built directly off the slab and is considered to be suitable. Where boards interface with the floor slab there should be a flexible or acoustic seal to make good. The resilient layer on the slab should be continuous up to the wall and therefore should continue beneath skirting boards.

6.1.5 Concrete Columns

Figure 7 below illustrates the proposed detail where separating walls interface with concrete columns.

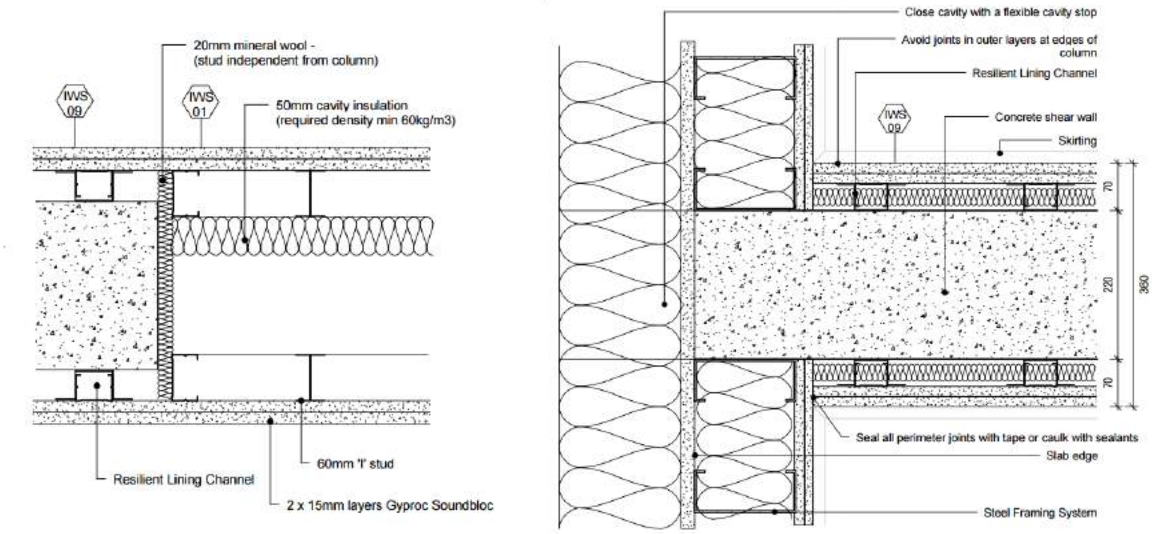


Figure 7: Proposed concrete column detail

The proposed foot detail are considered to be suitable. It is important that the small cavities between concrete columns and wall linings which fly by columns include insulation as per IWS – 09 such to prevent resonances within small cavities which can affect performance.

6.2 Internal Walls

6.2.1 Junctions with Separating Walls

Internal walls can abut separating walls and should be fully sealed with non-hardening mastic.

6.2.2 Junction with external Wall

Internal walls can abut external walls and should be fully sealed with non-hardening mastic.

6.2.3 Internal Wall Foot Details

Internal walls can be built directly off the slab.

6.2.4 Internal Wall Head Details

Internal walls should be built up to the underside of the slab.

6.3 External Wall

6.3.1 Curtain Walling

Where curtain walling spans across separating walls and floors it has the potential to compromise the sound insulation performance. Therefore, transoms and mullions must not be continuous across separating walls or floors and should therefore be split or capped at the separating interface.

Following a review of the OCL Facades Technical Submittal NW06-TS-A-11-03 it is understood that some areas of the façade the curtain walling is to be constructed with unitized panels and are therefore typically seen to travel slab to slab and is not seen to span across separating walls. It is however noted that in a number of locations there are windows systems which are seen to span across separating floors. Where these occur it crucial that the mullions are not continuous across separating floors. Within the technical submittal type CW.36 provides an illustration of one of the curtain walling systems which span separating floors and is shown in Figure 8 below.

As can be seen in Figure 8 it appears that the mullions are continuous across separating floors and therefore poses a risk to the sound insulation performance. The manufacturer should therefore confirm whether mullions and transoms are to be continuous across separating elements. If they are continuous then it is crucial that the flanking sound performance of these systems is provided such that this can be reviewed.

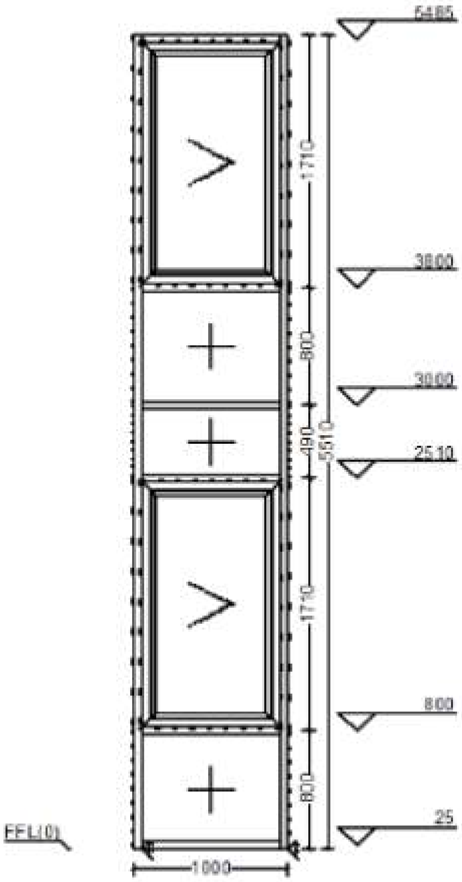


Figure 8: Example windows continuous across slab

MACH Acoustics advise that curtain walling including any internal wall lining must achieve a minimum flanking performance of 57dB $D_{nfw}+C_{tr}$. The curtain walling manufacturer should demonstrate that these requirements can be achieved.

6.3.2 Separating Floor

The slab will not be built up to the external façade as shown in Figure 9. It is however seen that in general the SFS will be built off of the slab and therefore the internal wall lining will provide protection from flanking transmission between the slab and the external wall. Figure 9 shows this detail which is considered to be suitable.

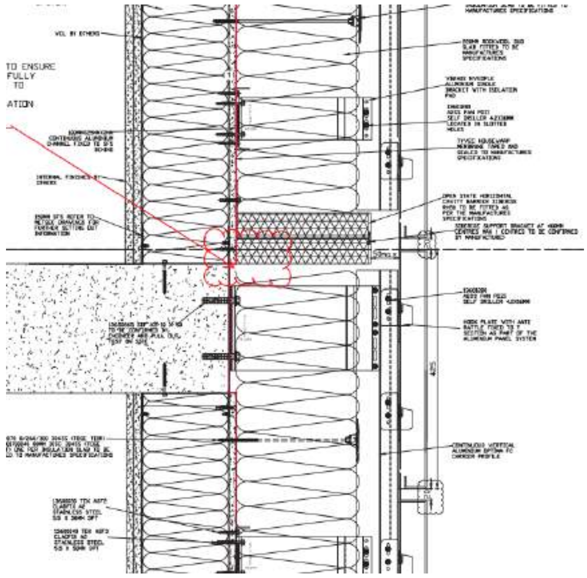


Figure 9: Proposed concrete column detail

Where there are windows within the façade, there will be no SFS section with internal lining and therefore the floor will be built up to the external wall as shown in Figure 10 below. This has the potential to provide a flanking path across separating floors. It is however understood that at slab level there will be 3mm steel flanking plate closing the gap between the slab and the façade. In order to preventing flanking via this path underside of the slab should box in with 2 layers of board to the external wall and the cavity should be sufficiently closed with a flexible cavity closer.

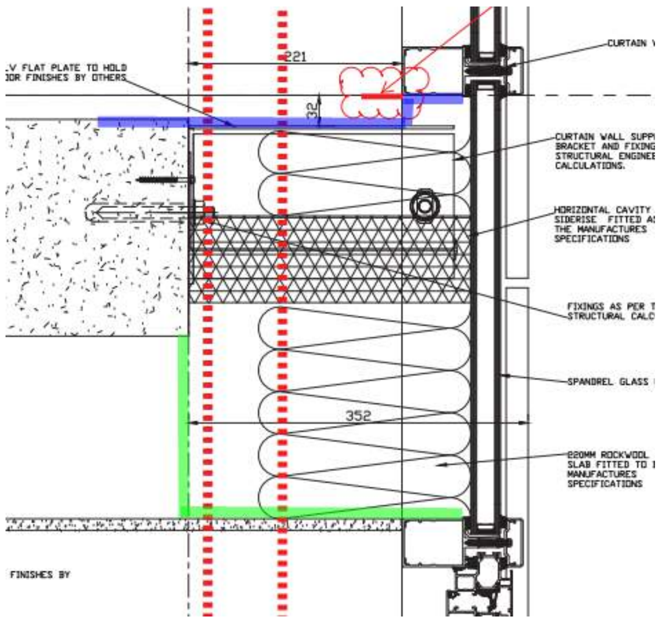


Figure 10: Proposed slab and window curtain walling interface

The blue line represents the location of the steel flanking plate which should fully close the gap between the slab and external wall.

The green line represents where a second layer of board is seen to be required. It is considered suitable for this green line to be either a 10mm CP as proposed to be fixed to the SFS or 15mm plywood which is proposed for the additional board for the ceiling.

6.3.3 Separating Wall

Please Section 6.1.2 for further details.

6.4 Cavity Stops

Flexible cavity stops should be used to prevent flanking via air paths within all external walls and should installed at the junction of all separating walls and separating floors.

7.0 M&E ISSUES

MACH Acoustics responsibilities are with architectural acoustics only. The responsibility of the transfer of sound through M&E systems is seen to be the responsibility of the M&E engineers. The text below should therefore be used as guidance only.

7.1 Penetrations in Separating Walls

Ductwork and other service penetrations must not reduce the sound insulation. The best principle is to avoid holes being cut through critical separating walls altogether and ensure that all services enter the room via a corridor and do not pass directly from room to room. If absolutely required, penetration details must follow what is stated for a high degree of sound insulation. Where lightweight constructions are used follow the upper half of each image, for block work use the lower half.

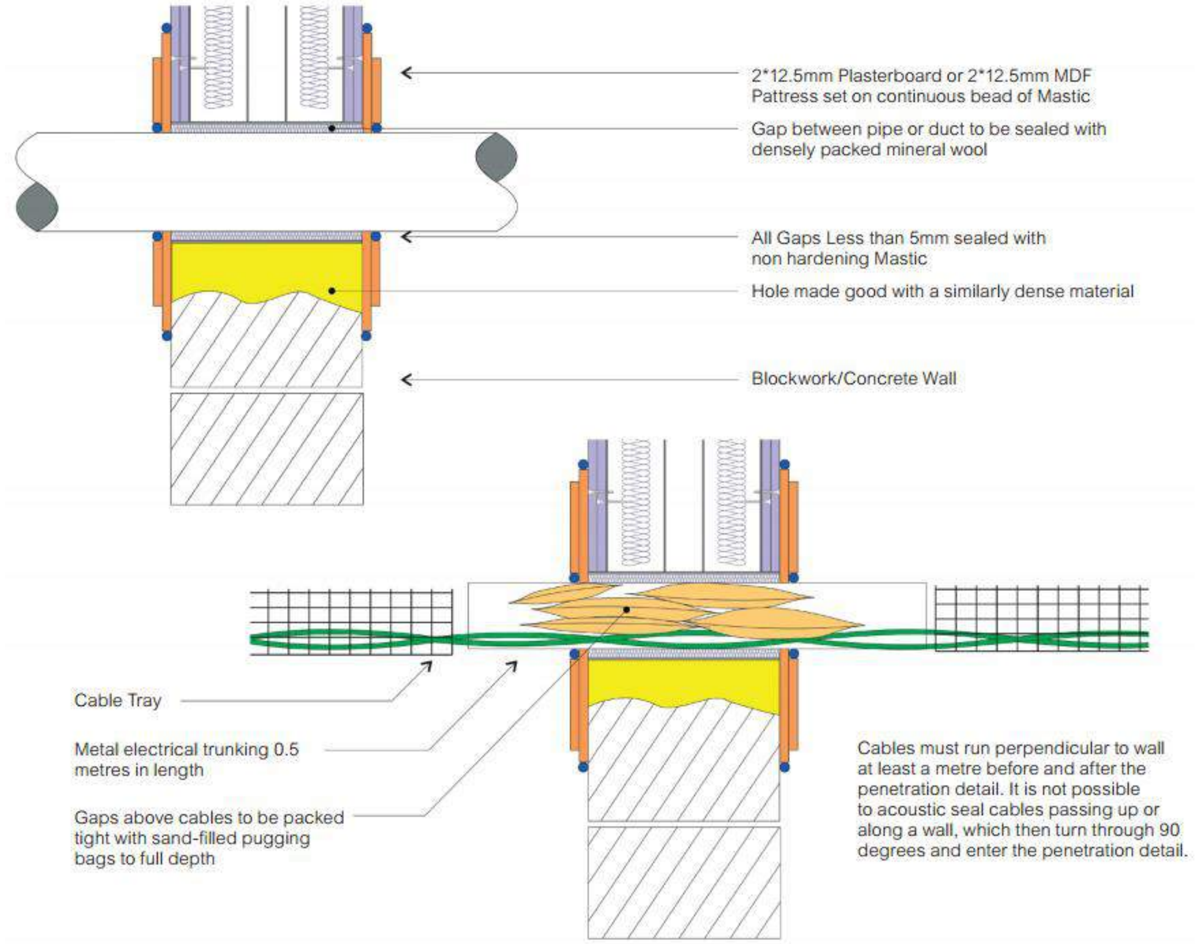


Figure 11: Example penetration details

7.2 Penetrations in Separating Floors

No service penetrations should be made through separating floors, i.e. between dwellings or flats with the exception of services runs for bathrooms or kitchen facilities. Where these occur, these should be boxed in with two layers of plasterboard with a mass per unit area of at least 10kg/m^2 and include insulation within the boxing and should appropriately fire stopped.

7.3 Waste Water Pipes

Rain water and other water based services must be boxed in using two layers of plasterboard with a mass per unit area of at least 10kg/m^2 and filled with mineral wool, as shown in Figure 12 below. To avoid sound flanking through the services, the gaps around the pipe should also be sealed as best as possible prior to the boxing being installed. This may be done using a fire collar as required by other disciplines.

Bends within pipe work should be as gradual as possible and sudden 90^0 angles will create additional unwanted noise and should therefore be avoided where possible.

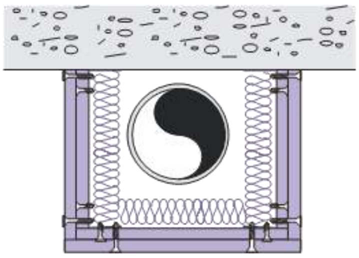


Figure 12: Waste water pipe detail

7.4 Recessed Sockets and Switches

Wherever possible, recessing sockets or switches in party walls should be avoided as this presents the risk of degrading the partition to below sound insulation performance requirements. Where this is unavoidable then the following guidance should be followed.

7.4.1 Proposed Design

It is seen that there will be recessed sockets in separating walls within this development. In general recessed sockets are seen to be staggered by 300mm which is considered to be suitable. to ensure that the sound insulation performance of separating walls is not compromised sockets are to be used and is seen to be a suitable design approach.

It is however understood that there will be back to back multiple sockets between living spaces. MACH Acoustics advise that as it is not possible to stagger the sockets a plasterboard lining is provided to one side of the partition as a minimum as shown in Figure 12 below.

Figure 12 shows a plasterboard backing has been provided to onside of the wall only, with the sockets on the opposite side of the wall utilising putty pads. This detail is suggested due to the number of un-staggered sockets within this wall.

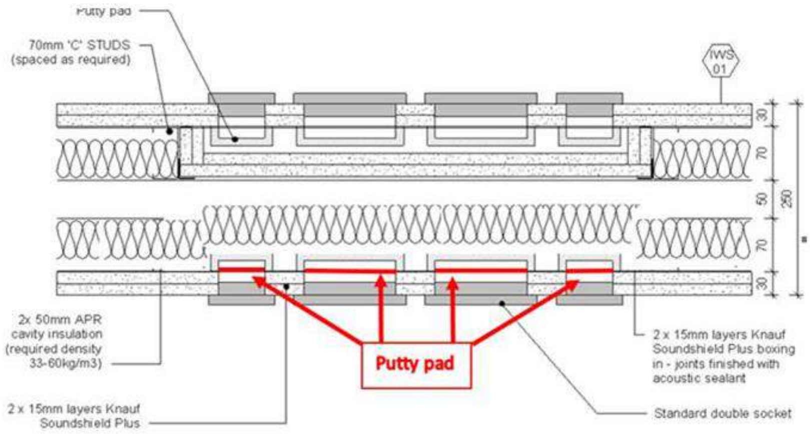


Figure 13: Suggested un-staggered sockets detail

Some alternative socket details are provided within the following sections.

7.4.2 Plasterboard Backing

The following figure illustrates the Robust Details guidance with regards to recessed sockets.

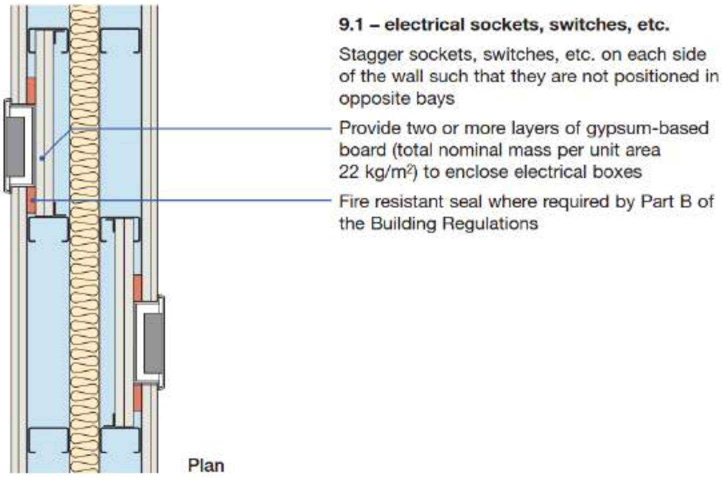


Figure 14: RSD guidance on recessed sockets

7.4.3 Back Boxes

An alternative to plasterboard backing is to use a proprietary acoustic back box behind the socket. If this is the preferred option, MACH Acoustics must review any proposed products and the manufacturer's installation guidance should always be followed. Figure 15 provides an image of a typical acoustic back box.

Figure 15: Typical acoustics back box

7.5 Ventilation Ducts

All mechanical ventilation systems must carefully have designed by the M&E engineer such that the sound insulation and internal noise levels requirements are achieved. All services should therefore be sufficiently isolated such to minimise re-radiated airborne noise. There must also be no perceptible vibration within residential areas.

7.6 Riser Shafts

MACH Acoustics suggest that the riser shafts within this development are designed such to provide an appropriate level of sound insulation for the services contained within such that noise breakout into adjacent areas in of a suitable level. Following a review of the floor plans it is seen that riser shafts are located within corridors and are separated from dwellings by the separating walls shown in Table 5 previously. This is considered to be a suitbale detail.

7.7 Toilet Pods

The inclusion of toilets must not compromise the sound insulation between dwellings or rooms for residential purpose. Following a review of the drawings it is seen that toilet pods do not form part of the separating wall between dwellings. The separating wall is therefore seen to be continuous between toilet pods and adjacent dwellings. This is considered to be a suitable design no further detail review is considered necessary.

7.8 Lifts

The design of mechanical systems such as lifts is seen to the responsibility of others and therefore not of MACH Acoustics, however lifts do present the potential for intrusive noise and perceived vibration to dwellings and therefore some guidance on the control noise and vibration from lifts has been provided.

Noise and vibration can result from a wide range of different parts of the lift. The negative impact of noise can be in the form of sound quality, sleeping conditions and enjoyment of the dwellings. There are often challenges in identifying the transmission path (airborne / structure borne) and how the transmission paths can be mitigated to reduce the noise and vibration without affecting other parts and requirements of the lift. Lifts are complex elements of plant, clearly spanning over multiple floors. As such, rather than specifying noise and vibration requirements and measures for each part of the lift, the conditions below have been provided and are seen to apply to the lift as a whole.

Subjectively, no noise or perceived vibration should be detectable from lifts or any part of the lifts within dwellings. Inaudibility within dwellings is defined as lift noise levels less than NR25, measured within 1 and 1.5 meters from a surface assumed to be the main noise source.

In the case where the perceived noise is intermittent or tonal, noise levels will need to achieve NR15. Noise levels ($L_{Aeq,30\ seconds}$) within lobbies shall not exceed 55 dBA and 70 dB L_{AMax}, at 2m from the lift doors or any other parts of the lifts.

Subjectively, the opening and closing of doors or any other moving parts of the lift within the lobbies should not contain tonal noise, scrapping noise or any other transient/intermittent type noise.

Airborne Sound Insulation - The above targets are based on ensuring a maximum lift noise level within dwellings. These levels will be a function of the sound reduction provided by the building fabric, and the level of sound produced by the lift itself. The proposed constructions are seen to provide good levels of sound reduction ≈50 dB D_w, however if the noise from the lifts is not suitably controlled, noise levels within dwellings may exceed those given above. Since lift noise levels are dependent upon the selected plant, the proposed design, type and insulation, it is seen that the lift manufacturers/contractors are responsible for achieving the levels given above.

Vibration Isolation - Interaction of rails and lift Car Guides are a potential source of vibration and subsequent noise. It is therefore recommended that the rails should be fastened to the building at the edge of the floor slab. The floor slab edges are inherently stiffer than the shaft walls and will limit the transmission of the rail/guide interactions from generating structure borne noise in adjacent spaces. It is clearly fundamental to ensure that the cars run smoothly up and down the rails.

Again, it is seen to be the responsibility of the lift manufacturer/contractor to ensure that lifts are installed and isolated correctly.

Elevator Doors - The operation of elevator doors can generate significant sound levels. This can be the result of typical door operations or may be caused by misalignments or improper installation. The elevator installer should repair any door noise issues.

Audible Signals - Audible signals to announce their arrival at a floor are required to be adjusted and modified to ensure reasonable sound levels at nearby locations.

Motor Room and Motor Roomless Lifts - The noise criteria above applies to the building as a whole. It is therefore important to ensure that all elements of plant forming the lift, meet to the above conditions.

7.9 Plant Rooms

Noise within plant rooms has the potential to have an impact upon the residents of this development. It is therefore critical that the sound insulation performance of the elements separating the plant rooms from the residential areas is sufficient that noise from the mechanical services does not contribute to noise within the adjacent dwellings.

A review of the sound insualtion between non residential areas of development will be provided within a separate report.

7.9.1 Vibration

Attention shall be given to the installation of all plant and equipment to ensure there is no transmission of excessive tactile and audible frequency vibration to the adjacent areas, due to the operation of machinery or equipment and / or its connecting pipe work, duct work or conduits. Anti-vibration mounts should be used for all rotating plant equipment or where there is a potential for vibration.

8.0 CONTROL OF REVERBERATION WITHIN COMMON PARTS OFTHE BUILDING

The objective of acoustic treatment in corridors is to absorb sound so that it does not interfere with the adjacent rooms. ADE (Regulation E4) does not nominate a reverberation time target for corridors but instead recommends that the amount of additional absorption should be calculated as shown the following methods.

- Method A: Corridors should include 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 with the additional absorption. For stairwells, calculate the combined area of the stair treads, upper surface of the intermediate landings, upper surface of landings (excluding ground floor) and ceiling area of the top floor. Either, cover at least an area equal to this calculated area with Class D absorber, or cover an area equal to at least 50% of this calculated area with C Class absorber or better.

- Method B: This comprises of calculating the total acoustic absorption within the common spaces, which allows for the acoustic absorption from carpeted floors and other similar acoustically absorptive surfaces. For corridors a minimum of 0.25m^2 of total absorption per cubic metre of the volume is required.

8.1 Demonstrating Compliance

ADE states that *'Requirement E3 only applies to corridors, stairwells, hallways and entrance halls which give access to the flat or room for residential purposes.'*

As mentioned in Section 1 of this report, it is seen that there are corridors, hallways or entrance halls and which provide direct access to residential dwellings. These are therefore required to meet the requirements of Regulation E4 of the building regulations and will be addressed in a separate report.

It is however seen that stairwells within this development will be separated by a fire door and therefore do not provide direct access to residential dwellings.

Guidance provided on the governments planning portal resource for England and Wales comments that:

The purpose of this Requirement is to protect residents from noise produced in reverberant common areas.
The Requirement only applies to "corridors, stairwells, hallways, and entrance halls which give access to the flat or room for residential purposes". To comply with this, it is recommended that absorbent treatment should normally be applied only to common areas onto which dwellings open directly.

Where separating walls, without doors or windows, are adjacent to common areas it would not normally be necessary to treat the common areas, assuming normal usage. Other situations are dealt with in paragraph 0.8 of Approved Document E (2003).

It is therefore considered that stairwells within this development are not required to meet the requirements of Regulation E4.

9.0 FAÇADE ASSESSMENT

A noise break-in assessment and an assessment of the the sound reduction provided by the various façade elements has previously been addressed in the Design Note Façade Assessment – Residential R1 31/03/2016.

This assessment provided a full review of the proposed wall and façade specifications such to ensure that the internal noise requirements for this scheme are achieved.

In order to achieve the internal noise requirements it is seen that the following façade elements are proposed.

Element	Configuration	Sound Reduction R (dB) per Octave Band (Hz)						Rw (C;Ctr)
		125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	
Glazing	SGG Planilux 6 (12) SGG Stadip Protect 44-2	26.0	24.8	33.4	42.3	40.3	49.5	37 (-1;-4)
Wall	External cladding Cladding	20	34	43	48	53	54	51 (-1;-5)

Table 12: Sound reduction façade elements

Table 13 below provides the performance specification for the proposed trickle ventilator.

Element	Configuration	Weighted Element Normalised Level Difference Dne						Dne,w
		125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	
Ventilator	PryAcoust 2500AE	40.7	38.8	35.8	42.3	43.9	45.1	41

Table 13: Sound reduction façade elements

Based upon the specifications shown in Table 12 and 13 it is considered that the internal noise level requirements outlined within the planning conditions for this scheme will be achieved.

APPENDIX A – GLOSSARY OF ACOUSTICS TERMINOLOGY

dB	Decibel. The unit of sound level.
dBA	A-weighted decibel. The A-weighting approximates the response of the human ear.
$D_{nT,w}$	Weighted standardized level difference. A single number rating of the sound level difference between two rooms. $D_{nT,w}$ is typically used to measure the on-site sound insulation performance of a building element such as a wall, floor or ceiling.
Flanking	Transmission of sound energy through paths adjacent to the building element being considered. For example, sound may be transmitted around a wall by travelling up into the ceiling space and then down into the adjacent room.
Frequency	Sound can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. Sound is generally described over the frequency range from 63Hz to 4000Hz (4kHz). This is roughly equal to the range of frequencies on a piano.
Impact sound	Sound produced by an object impacting directly on a building structure, such as footfall noise or chairs scrapping on a floor.
L_{Aeq}	The equivalent continuous sound level. This is commonly referred to as the average noise level and is measured in dBA.
L_{A90}	The noise level exceeded for 90% of the measurement period, measured in dBA. This is commonly referred to as the background noise level.
$L'_{nT,w}$	Weighted, standardized impact sound pressure level. A single number rating of the impact sound insulation of a floor/ceiling when impacted on by a standard 'tapper' machine. $L'_{nT,w}$ is measured on site. The lower the $L'_{nT,w}$, the better the acoustic performance.
$L_{n,w}$	Weighted normalised impact sound pressure level. A single number rating of the sound insulation of a floor.
NR	Noise Rating. A single number rating which is based on the sound level in the octave bands 31.5Hz – 8kHz inclusive, generally used to assess noise from mechanical services in buildings.
Octave band	Sound, which can occur over a range of frequencies, may be divided into octave bands for analysis. The audible frequency range is generally divided into 7 octave bands. The octave band frequencies are 63Hz, 125Hz, 250Hz, 1kHz, 2kHz and 4kHz.
Reverberation time (T60)	Reverberation time is used for assessing the acoustic qualities of a space. T60 is measured in seconds (s) and describes how quickly sound decays within a space.
Mid-frequency reverberation time (T_{mf})	The mid frequency reverberation time is the arithmetic average of the reverberation times for the 500Hz, 1Khz and 2Khz octave bands for standard classrooms and the arithmetic average of the reverberation times between 125Hz and 4Khz octave bands.
R_w	Weighted sound reduction index. A single number rating of the sound insulation performance of a specific building element. Rw is measured in a laboratory. Rw is commonly used by manufacturers to describe the sound insulation performance of building elements such as plasterboard and concrete.
Sound absorption	When sound hits a surface, some of the sound energy is absorbed by the surface material. 'Sound absorption' refers to ability of a material to absorb sound.
Sound insulation	When sound hits a surface, some of the sound energy travels through the material. 'Sound insulation' refers to ability of a material to stop sound travelling through it.
Structure-borne transmission	Transmission of sound energy as vibrations inside the structure of a building.

APPENDIX B – BUILDING REGULATIONS – APPROVED DOCUMENT PART E PERFORMANCE STANDARDS

The residential areas within this development are covered by the requirements of the Building Regulations 2000 Approved Document E (ADE).

Approved Document E requires that acoustics performance standards areachieved when refurbishing or developing a new building. The regulations relating to acoustics are listed below:

- Regulation E1 – Protection against sound from other parts of the building and adjoining buildings.
- Regulation E2 – Protection against sound within a dwelling house or flat.
- Regulation E3 – Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes

B.1 Regulation E1 – Protection against sound from other parts of the building and adjoining buildings

Regulation (E1) states:

> *"Dwelling-houses, flats and rooms for residential purposes, shall be designed and constructed in such a way that they provide reasonable resistance to sound from other parts of the same building and from adjoining buildings."*

Section 0, clause 0.1 of ADE states that the normal way of satisfying the regulation, is to provide separating floors and walls which comply with the performance standards set out in Table 0.1a and Table 0.1b of Approved Document E (ADE) 2003.

Section 0, clause 0.1 of ADE states that the normal way of satisfying the regulation, is to provide separating floors and walls which comply with the performance standards set out in Table 1a and Table 1b of Approved Document E (ADE) 2003. The standards for dwelling-houses and flats are set out within Table 1a and the performance standards for rooms for residential purposes are set out within Table 1b.

Table 1a: Dwelling-houses and flats – performance standards separating walls, separating floors, and stairs that have a separating function.		
	Airborne sound insulation $D_{nT,w}+C_{tr}$ dB (Minimum Values)	Impact sound insulation $L'_{nT,w}$ dB (Maximum Values)
Purpose built Dwelling-houses and flats		
Walls	45	-
Floors and Stairs	45	62
Dwelling-houses and flats formed by a material change of use		
Walls	43	-
Floors and Stairs	43	64

Table 1a: ADE 2003 performance standards for dwelling-houses and flats

Table 1b: Rooms for residential purposes – performance standards separating walls, separating floors, and stairs that have a separating function.		
	Airborne sound insulation $D_{nT,w}+C_{tr}$ dB (Minimum Values)	Impact sound insulation $L'_{nT,w}$ dB (Maximum Values)
Purpose built rooms for residential purposes		
Walls	43	-
Floors and Stairs	45	62
Rooms for residential purposes formed by a material change of use		
Walls	43	-
Floors	43	64

Table 14b: ADE2003 performance standards for rooms for residential purposes

B.2 Regulation E2 – Protection against sound within a dwelling-house etc

Regulation (E2) states:

"Dwelling-houses, flats and rooms for residential purposes shall be designed and constructed in such a way that-

- *a. Internal walls between a bedroom or a room containing a water closet, and other rooms; and*
- *b. Internal floors provide reasonable resistance to sound."*

Section 0, clause 0.9 of ADE 2003, states that the normal way of satisfying the requirement E2 will be to use constructions for new internal walls and floors that provides the laboratory sound insulation values set out in Table 0.2. Table 15 below shows the performance standards for internal wall within the development.

Table 2: Laboratory values for new internal walls and floors within: Dwelling-houses, flats and rooms for residential purposes, whether purpose built of formed by material change of use.		
		Airborne sound insulation R_w dB (Minimum Values)
Walls		40
Floors and Stairs		40

Table 15: ADE 2003 performance standards for internal walls

It is stated in the requirements statement in ADE 2003 that the requirement E2 does not apply to:

"(a) an internal wall which contains a door
(b) an internal wall which separates an en-suite toilet from the associated bedroom."

B.3 Regulation E3 – Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes

Regulation (E3) states:

> *"The common internal parts of buildings which contain flats or rooms for residential purposesshall be designed and constructed in such a way as to prevent more reverberation around the common parts than is reasonable."*

Requirement E3 only applies to corridors, stairwells, hallways and entrance halls which give access to the flat or room for residential purposes.

Section 0, clause 0.11 of ADE 2003 states that the normal way of satisfying the regulation is to comply with the requirements set out in Section 7 of ADE 2003. ADE Section 7 provides two design approaches, which are as follows:

B.3.1 Method A

Corridors and hallways should be provided with acoustically absorptive ceiling tiles to ISO 11654, Class C or better, to an area equal to the floor area. In practice, most typical ceiling tiles on a nominal 100mm suspension system meet this.

For stairwells, an area of Class C tiles equal to 50% of the area of the following should be provided:
- stair treads
- upper surface of the intermediate landings
- upper surface of the landings
- ceiling area

It is also permissible to install an area of Class D tiles equal to 100% of the above area.

B.3.2 Method B

This comprises the calculation of total acoustic absorption within the common spaces, which allows for the acoustic absorption from carpeted floors and other similar acoustically absorptive surfaces.

This method is only recommended for corridors and hallways.

APPENDIX C – SOUND INSULATION CACULATIONS

Separating Walls

Table 16 below provides a summary of the airborne sound insulation requirements for separating walls within the residential areas of this development.

Room ID	Area of Separating Element (m)	Floor Area (m^2)	Room Volume (m^3)	Requirement $D_{nt,w}$+C_{tr} (dB)	Construction & Flanking Correction (dB)	Requirement R_w + C_{tr} (dB)
S_06 Living	10	31	79	50	5	51
E_01 Bed		10	26	50	5	56
S_03 Living	15	30	77	50	5	53
H_02 Living		34	86	50	5	52
B_12 Living	13	29	74	50	5	53
F_06 Bed		13	32	50	5	56
F_06 Bed	11	12	30	50	5	56
I_03 Living		35	89	50	5	51
F_08 Bed	11	12	30	50	5	56
F_10 Bed		12	30	50	5	56
F_10 Bed	13	12	31	50	5	56
S_11 Living		30	77	50	5	52
AFF G_01 Bed	13	11	27	50	5	57
AFF D_01 Living		27	68	50	5	53

Table 16: Sound insulation calculations - separating walls

Separating floors - Airborne Sound Insulation

Table 17 below provides a summary of the airborne sound insulation requirements for separating floors within the residential areas of this development.

Room ID	Area of Separating Element (m)	Floor Area (m^2)	Room Volume (m^3)	Requirement $D_{nt,w}+C_{tr}$ (dB)	Construction & Flanking Correction (dB)	Requirement $R_w + C_{tr}$ (dB)
G_01 Bed	12	12	31	50	5	56
G_02 Bed		12	31	50	5	56
G_01 Living	38	38	97	50	5	56
G_02 Living		38	97	50	5	56
S_02 Bed	12	12	31	50	5	56
S_01 Bed		12	31	50	5	56
S_02 Living	30	30	75	50	5	56
S-01 Living		30	75	50	5	56
AFF G_01 Bed	10	10	26	50	5	56
AFF C_01 Living		25	63	50	5	52
AFF G_01 Bed	12	12	31	50	5	56
AFF E_01 Bed		14	35	50	5	55

Table 17: Sound insulation calculations – separating floors - airborne

Separating Floors – Impact Sound Insualtion

Table 18 provides a summary of the impact sound insulation requirements for separating floors within the residential areas of this development.

Receiving Room	Floor Area (m^2)	Floor to Ceiling Height (m)	Volume of Receiving Room (m^3)	Requirement $L'_{nt,w}$ (dB)	Flanking Correction (dB)	Requirement Ln,w (dB)
A - New Apartment	33	2.5	83	57	5	56.2
B - G_04 Bed	12	2.5	30	57	5	51.8
C - G_01 Living	38	2.5	97	57	5	56.9
D - S_01 Bed	12	2.5	31	57	5	52.0
E - S_01 Living	30	2.5	75	57	5	55.8
F - AFF G_01 Bed	11	2.5	27	57	5	51.3
G - AFF C_01 Living	25	2.5	63	57	5	55.0
H - H_04 Living	34	2.5	87	57	5	56.4

Table 18: Sound insulation calculations – separating floors - impact