hepworth acoustics

THE OLIVE PRIMARY SCHOOL
STAGE 4 ACOUSTIC DESIGN REVIEW

On behalf of:

Conlon

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1.0 INTRODUCTION

1.1 Hepworth Acoustics Ltd was commissioned by Conlon to provide a RIBA Stage 4 acoustic design review of the current proposals for the new The Olive Primary School, in Cheetham Hill, Manchester.

1.2 The report covers the following acoustic-related aspects of the development at Stage 4:

- Control of noise transmission between teaching and learning spaces;
- Control of ambient noise within rooms from ingress of external noise and from any mechanical services;
- Control of reverberation time in teaching spaces and corridors; and,
- Externally mounted plant.

1.3 The acoustic performance targets are detailed in Section 2 of the Stage 3 acoustic design review report ref: 'P22-461-R01v1'. The design review and recommendations in this report are based achieving the acoustic design targets based on the current drawings and proposals as referenced through-out this report.

1.4 The various noise units and indices referred to in this report are described in Appendix I. All noise levels mentioned in the text have been rounded to the nearest decibel, as fractions of decibels are imperceptible.

1.5 All recommendations in this report are provided with respect to acoustic performance only and compliance with other requirements (e.g. fire, structural and ventilation) should be checked by others.

2.0 CONTROL OF INTERNAL AMBIENT NOISE LEVELS (IANL)

2.1 The IANL within a space is taken as being the level experienced within the completed, unoccupied, unfurnished space due to the break-in of external noise and any noise from building services. Noise from teaching activities or teaching equipment is excluded.

Building Envelope Proposals

2.2 The resulting IANL within a space is dependent upon two main factors: the noise levels incident upon the building and the sound insulation performance of the building envelope. The various elements of the building envelope determine the overall sound insulation performance which is referred to as the composite sound insulation performance.

Building Envelope Fabric

2.3 Current proposals for the building envelope fabric are shown in drawing numbers '*FS0766-BSA-XX-XX-D-A-3510-*' to '*FS0766-BSA-XX-XX-D-A-3514*'.

2.4 The building will be a formed from a structural metal frame with the fabric of the building envelope made up of brickwork, mineral wool insulation and an internal plasterboard lining.

2.5 The main construction is as follows (internal to external):

- 2No. Layer 12.5mm Plasterboard - 180mm SFS with 180mm slab insulation - 12mm cement board - 100mm Rocksilk Insulation with 50mm air gap - 102mm Brickwork.

Glazing & Ventilation

2.6 We understand that the proposals will be a double-glazing specification with 6mm glass - 16mm cavity - 9.5mm or with 6mm glass - 16mm cavity - 6mm glass within aluminium frames, both capable of achieving at least 28 dB R_w. The proposed glazing system is comfortably capable of achieving the design target.

2.7 Generally, the classrooms will be provided with a hybrid ventilation strategy with a mix of natural ventilation via opening windows together with ventilation units.

2.8 The heating and ventilation proposals for the development are heating via air source heat pumps and ventilation via a 'Natural Ventilation with Heat Recycling' (NVHR) solution. We understand

Monodraught HVR Zero X+ are proposed. The acoustic performance of the NVHR systems is provided below in Table 1.

Table 1: Sound Power Measurements For Monodraught HVR Zero X+ (dB)

Ventilation System	Octave Band (Hz) Sound Power Level dB					
	125	250	500	1k	2k	4k
HVR Zero X+	37	41	40	33	25	19

Roof Construction

2.9 We understand that the proposals for the roof of the building are for a 150mm precast slabs with a nominal 75mm screed and a 200mm *Bauder Total Warm Roof System* (consisting of PIR and waterproof bitumen top layer).

2.10 Based on the proposals above, rain noise targets are anticipated to be comfortably met in line with the BB93 design criteria. However, if the proposals are changed to a lighter-weight roof structure, the roof build-up should be evaluated based on empirical test data (dB L_{IA}) carried out in line with ISO 140-18:2006, from which the internal rain noise levels can then be calculated.

External Ambient Noise Ingress

2.11 The sound insulation performance of the solid elements of the building envelope (i.e. wall and roof) are such that the composite sound insulation performance of the building envelope is determined by primarily the properties of the glazing and ventilation elements.

Calculated Internal Ambient Noise Levels

2.12 Based on the measured ambient noise levels taken at the relevant noise survey location representative of the most exposed elevations, we have carried out noise break-in calculations in line with the BS8233:2014 methodology, taking into account the building envelope proposals including construction and surface areas.

2.13 Based on a NVHR+ system being installed in a single teaching space and double glazing as detailed above, with a typical sound reduction performance of at least 28 dB $R_w + C_{tr}$, and windows closed, the resulting internal noise levels in the new buildings should be well within 35 dB $L_{Aeq,T}$, which is within the lowest (most stringent) internal ambient noise limit for any room type.

2.14 Therefore, standard double glazing will be suitable for this development where no significant external noise from building services or plant is introduced.

Noise From Internal Mechanical & Electrical Equipment

2.15 The resulting internal ambient noise levels in spaces will be due to a combination of external noise ingress and noise from any building services. As such, where rooms will not be significantly affected by external noise ingress (e.g. for rooms without windows), the Mechanical & Electrical (M&E) noise levels can be specified to meet the adopted internal ambient noise level criteria. Where spaces are potentially affected by external noise ingress, some additional headroom must be provided.

2.16 'Noise rating' is a graphical method for assigning a single-number rating to a noise spectrum. It can be used to specify the maximum acceptable level in each octave band of a frequency spectrum, or to assess the acceptability of a noise spectrum for a particular application. The method was originally proposed for use in assessing environmental noise, but it is now used in the UK mainly for describing noise from mechanical ventilation systems in buildings. Whilst there is no direct relationship between NR and dBA values (such as noise levels denoted in terms of $L_{Aeq,T}$), the following approximate relationship applies:

dBA ≈ NR + 6

2.17 On this basis, we therefore recommend that for spaces without windows, M&E noise levels should be controlled to a value no higher than the NR value that is 7 dB below the corresponding adopted internal ambient noise level. For spaces with windows, where external noise ingress will influence the overall internal ambient noise level, M&E noise levels should be controlled to be no higher than the NR value 10 dB below the adopted internal ambient noise level.

2.18 All building service plant and equipment must be appropriately isolated from the building structure to ensure that residual vibration and re-radiated noise is adequately controlled. Necessary measures may include Air Handling Units (AHUs) being mounted on anti-vibration pads with flexible connectors either side of the unit (including roof top AHUs), isolation pads to boilers, open spring or rubber mounts for pump sets with flexible connectors either side of the units.

Noise Ingress from Proposed Externally Mounted Plant

2.19 The M&E consultant/contractor is responsible for ensuring that the criteria for internal noise levels are met with respect to noise from Mechanical & Electrical equipment at the development, including noise from ventilations systems within the space they are serving and plant room noise transmission to adjacent spaces.

2.20 Nevertheless, we have evaluated potential noise from the proposed externally mounted plant with respect to the IANL criteria based on the details provided by the client.

2.21 The proposed external plant is listed below in Table 2.

Table 2: Proposed Externally Mounted Plant (dB)

Description	Number of Units	SPL per Unit @1m
Mitsubishi CAHV R450YA-HPB (ASHP)	6	64
Mitsubishi PUZ-ZM35VKA	1	46

2.22 Based on the six heat pumps and single condenser operating simultaneously, being mounted on the elevation away from learning spaces at the other end of the building, the noise levels from the condensers are predicted to be within the proposed IANL targets, taking into account relevant corrections for the sound insulation performance of the glazing as well as distance attenuation and acoustic screening to high level windows etc.

Recommendations

2.23 Based on our findings of a review of the Stage 4 proposals with respect to controlling internal ambient noise levels at the development, the ventilation proposals are suitable and thermal double glazing with a minimum sound insulation of 28 dB $R_w + C_{tr}$ will be sufficient.

3.0 SOUND INSULATION BETWEEN SPACES

Airborne Sound Insulation of Separating walls

3.1 The minimum required laboratory sound insulation performance values for walls separating teaching spaces and other spaces are detailed in our Stage 3 report (ref: P22-461-R01). Walls which provide these sound insulation performance values (R_w) as a minimum will be required to achieve the sound insulation performance criteria ($D_{n,T,w}$).

3.2 The proposed wall types are detailed in Section K10 of the '*FS0766-BSA-XX-XX-SP-A-7001 Olive Primary - NBS Specification* NBS document.

3.3 Wall types are based on the following British Gypsum constructions:

- NBS K10/127/A/B - GypWall Single Frame - A206015 / MR1 / MR2 (45 dB R_W)
- NBS K10/128/A - GypWall Single Frame - A206142 / MR1 (50 dB R_W)
- NBS K10/129 - GypWall Single Frame - A206231 (56 dB R_W)
- NBS K10/130/A - GypWall Single Frame - A206273 / MR1 (50 dB R_W)
- NBS K10/131 - GypWall Single Frame - A206015 (45 dB R_W)
- NBS K10/134 - GypWall Resilient - Q606040 (60 dB R_W)
- NBS K10/135 - GypWall Twin Frame Braced - A216010 (60 dB R_W)

3.4 The Stage 4 proposals have taken into account the minimum recommended laboratory sound insulation performance specifications provided in our Stage 3 report, and subsequently need no further revisions with respect to sound insulation performance.

Airborne Sound Insulation of Doors in Separating walls

3.5 Doorsets which provide access to teaching spaces will need to provide a minimum sound insulation performance of 30 dB R_w and a minimum sound insulation performance of 35 dB R_w for the Assembly Hall doors and Studio 1 doors.

3.6 Doors should be fitted in accordance with the manufacturer's installation instructions to ensure a good seal is achieved around the full perimeter of the door. The doors will only meet the required sound insulation performance if the door sets are installed with the appropriate edge seals as specified by the manufacturer.

3.7 All internal glazing should be well fitted such that an effective seal is achieved around the perimeter of any window frame and any openings.

3.8 Where any corridor door sets to the teaching spaces will have glazed side lights/side vision panels, the composite sound insulation performance will need to be considered. The composite sound insulation of the corridor walls and glazed areas (including any glazed side panels) will need to achieve at least 40dB R_w,

Foldable Partitions & Roller Shutters

3.9 The foldable partition separating the Assembly Hall and Studio 1 should achieve a performance of not less than 40 dB $D_{nT,w}$. We understand Modern Glide Ltd MG100 - *Moveable Acoustic Wall* is proposed, with a published acoustic performance of between 38 – 58 dB R_w depending on panel thickness.

3.10 It should be noted that the airborne sound insulation specification (in terms of R_w) is always higher than the in-situ airborne sound insulation actually achieved on site. For the avoidance of doubt, a 45 dB R_w wall will not provide an in-situ airborne sound insulation performance of 45 dB $D_{nT,w}$ on site, as the former is an acoustic laboratory test value whereas on-site conditions will reduce the actual airborne sound insulation that is achieved.

3.11 Typically, on-site sound insulation ($D_{nT,w}$) will be around 7 dB below that of the laboratory test value (R_w), but the difference can be higher depending on flanking sound transmission conditions. Therefore, the sound insulation performance recommended for new walls separating teaching and ancillary spaces should be taken as a minimum required performance.

3.12 It is therefore crucial that the appropriate thickness is selected to ensure the performance criteria is achieved.

3.13 The client requires the roller shutter separating the Assembly Hall and Servery to achieve a performance level of 22 dB R_w. We understand Bolton Gate *Fireroll E120 Roller Shutter* is proposed. It is not clear from the client's information whether the selected product is the *Fireroll Acoustic E120 Roller Shutters,* which does have a performance of 22 dB R_w.

3.14 The exact specification should be reviewed to ensure the acoustic version of the E120 model is selected.

Airborne & Impact Sound Insulation Performance of Floors

3.15 The highest requirement for airborne sound insulation for floors is 55 dB $D_{nT,w}$.

3.16 We have calculated the minimum recommended airborne laboratory sound insulation of the floor in order to achieve the required field sound insulation criteria.

3.17 We understand that the proposals are for a 150mm thick hollow core concrete floor with a nominal 75mm depth screed. The proposed ceiling types are detailed in Section K40 of the ''*FS0766-BSA-XX-XX-SP-A-7001 Olive Primary - NBS Specification* document and are as follows:

- Zentia - Ultima+ OP (Class A)
- Zentia - Hydroboard (Class A)
- Zentia - Ultima+ (Class C)
- Zentia - Hygiene (Class A)
- Gyproc - GypCeiling MF 12.5mm Plasterboard

Airborne Floor Sound Insulation Recommendations

3.18 We have calculated that the proposed 75mm screed laid on 220mm hollowcore precast concrete slab will provide suitable airborne sound insulation, taking into account the dimensions of the floor, room volumes, and reverberation times.

Impact Floor Sound Insulation Recommendations

3.19 The proposed concrete floor construction with the underdrawn lay-in grid ceiling by itself will fall short of providing sufficient impact sound insulation without a suitable floor finish at the first-floor level. Drawing number '*FS0766-BSA-XX-01-D-A-2027-Proposed First Floor Plan - Finishes'* shows the proposed floor finishes for the first-floor level.

3.20 The proposals for the majority of the teaching spaces are for JHS - Triumph Loop (denoted as F2 on the drawing), which based on manufacturer data has an impact sound insulation performance of 21 dB ΔL_w. This will provide sufficient additional impact sound insulation performance for the overall floor/ceiling to achieve the criteria.

3.21 The proposals for the other areas are for a mix of Altro Surpema and Altro Pisces (denoted as F2 and F3) which both have an impact sound insulation performance of only 5 dB ΔL_w. In these areas an installing an additional acoustic underlay is proposed with an impact sound insulation performance of 17 dB ΔL_w.

3.22 This will provide sufficient additional impact sound insulation performance for the overall floor/ceiling to achieve the design criteria.

Flanking Sound Transmission

3.23 We have reviewed detailed typical details of the proposed wall constructions in drawings FS0766-BSA-XX-XX-D-A-6520 to FS0766-BSA-XX-XX-D-A-6531. We recommend building the separating walls up to the steel beams and building the defection head in line with the partition manufacturer recommendations as detailed on the drawings. Where necessary, the webbing of the beams should be filled, but not tightly packed/compressed, with mineral wool.

3.24 Generally, the ceiling of adjacent spaces should be broken by the separating wall - i.e. ceilings must be installed after any separating walls and be broken by the walls, such that the suspended ceiling is not common to any adjacent spaces. Walls should be built to full height, from structural floor to soffit.

3.25 The sound insulation performance between spaces on the first-floor level will depend heavily on the junction details between the separating walls and the roof soffit, along with the sound insulation performance of the ceiling.

3.26 Where separating walls are to have a laboratory sound insulation performance of 50 dB R_w or more, depending on the mass of the floor, flanking sound transmission via the continuous floor between the spaces has the potential reduce the sound insulation performance.

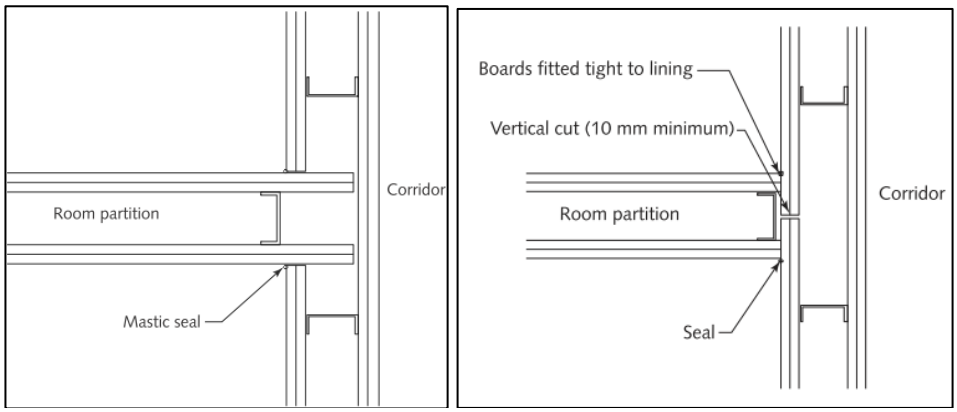
3.27 Based on the current concrete floor proposals, where all separating walls are built down to the structural floor, intersecting floor coverings including any underlays, and the wall/floor junctions are finished and sealed fully in line with manufacturer guidance, then flanking sound transmission via these paths should not have an adverse impact on the performance.

Flanking via Internal Leaf of the External Walls

3.28 Wall linings should not be common to adjacent spaces and should be broken at the junction with external walls, corridor walls and flanking walls, as indicated in Sketch 1 (a) or (b).

Sketch 1 Detail at junction of separating walls and corridor walls

(a) preferred (b) alternative



General Acoustic Detailing

3.29 Any resilient bars should be installed according to the manufacturer's instructions, as the acoustic performance of these can be easily compromised.

3.30 The cavity of external walls must be closed along the line of junctions with separating walls with an appropriate flexible closer, or fully filled with mineral wool.

3.31 Electrical and other sockets in any separating walls should ideally be surface mounted. If not practicable, back boxes/pattresses should be installed fully in line with manufacturers recommendations for the partition specification to ensure that the sound insulation of the wall is not affected.

3.32 Where possible penetrations in separating walls should be avoided as this will reduce the overall sound insulation performance of the wall. However, where holes made for cabling or pipework are unavoidable, they should be very carefully cut/drilled to minimise gaps around the pipes. Alternatively, oversized holes can be closed off with surface-mounted plasterboard pieces following installation of the ducts/pipes etc.

3.33 Any remaining gaps, including any piping sleeves should then be sealed with a suitable intumescent/flexible sealant.

3.34 Soil pipes must be wrapped in mineral wool and encased with two layers of 15mm Gyproc SoundBloc mounted on an independent frame.

4.0 CONTROL OF REVERBERATION

4.1 The broad recommendations provided in our Stage 3 report have generally been taken into account regarding the control of reverberation time and incorporated into current proposals.

4.2 We have reviewed the proposed floor and wall surface finishes for the rooms and calculated the predicted reverberation time based on the following proposals:

- *FS0766-BSA-XX-00-D-A-2017-Proposed Ground Floor Plan* - Finishes Plan
- *FS0766-BSA-XX-01-D-A-2027-Proposed First Floor Plan* - Finishes Plan

4.3 For classrooms and other education areas (construction type CR), Zentia Hygiene in a raft configuration is proposed which is a Class A absorption tile. We understand the desired finish is for an exposed soffit with hanging acoustic rafts. For these spaces, we recommend that at least 60% of the ceiling surface area is covered with the proposed Zentia Hygiene hanging rafts or with an equivalent Class A absorber. This construction will achieve the target reverberation times with taking into account the absorption from the ceiling surface finishes above along with indicative floor surface finishes provided by the architect.

4.4 For the main hall, the entire ceiling should consist of a Class A absorber as can be seen in the current proposals.

4.5 Suitable control of reverberation within circulation spaces can be achieved by covering a surface area equal to the surface area of the floor with a Class C absorber. This is generally done by installing a ceiling tile with Class C acoustic absorption as can be seen in the current proposals.

5.0 SUMMARY & CONCLUSION

5.1 Hepworth Acoustics Ltd was commissioned by Conlon to provide acoustic consultancy services in connection with the design of new school buildings The Olive Primary School in Cheetham Hill, Manchester.

5.2 The noise from external sources, building services, airborne sound insulation between spaces and the control of reverberant noise has been considered.

5.3 Recommendations have been given for the design of the scheme to achieve the adopted acoustic criteria.

Appendix I: Noise Units & Indices

Sound and the decibel

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the pressure values into manageable numbers. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that the human response to sound most closely follows a logarithmic relationship. The dB (decibel) is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (at the threshold of hearing) to 120 dB (at the threshold of pain).

Due to the logarithmic nature of decibels, when two sounds of the same level are combined together, the total sound level is (under normal circumstances) 3 dB higher than each of the individual sound levels e.g. 60 dB plus 60 dB = 63 dB. In terms of perceived 'loudness', a 3 dB(A) variation in sound level is a relatively small (but nevertheless just noticeable) change. An increase in sound level of 10 dB(A) generally corresponds to a doubling of perceived loudness. Likewise, a reduction in sound level of 10 dB(A) generally corresponds to a halving of perceived loudness.

The ear is not equally sensitive to sound at all frequencies. It is less sensitive to sound at low and very high frequencies, compared with the frequencies in between. Therefore, when measuring a sound made up of different frequencies, it is often useful to 'weight' the frequency spectrum appropriately, so that the measurement correlates better with what a person would actually hear. This is usually achieved by using a mathematical filter called the 'A' weighting, which is built into sound level meters. Sound levels measured using the 'A' weighting are denoted dB(A) or dBA.

Frequency and Hertz (Hz)

As well as the loudness of a sound, the frequency content of a sound is also very important. Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or Hertz (Hz). Sometimes large frequency values are written as kiloHertz (kHz), where 1 kHz = 1000 Hz.

Young people with normal hearing can hear frequencies in the range 20 Hz to 20 kHz. However, the upper frequency limit gradually reduces as a person gets older.

Glossary of Relevant Sound & Vibration Terms

When a noise level is constant and does not fluctuate, it can be described adequately by measuring the dB(A) level. However, when the noise level varies with time, the measured dB(A) level will vary as well. In this case, it is therefore not possible to represent the noise with a simple dB(A) value. In order to describe noise where the level is continuously varying, a number of other indices can be used. The various indices used in this report, along with other relevant terms are described below.

D_{n} This is the 'Normalised Level Difference' and is a field measurement of the airborne sound insulation between adjacent spaces. As well as being a field measurement, this term and other D_{n} terms below include on-site conditions other than direct noise transmission through the separating partition (e.g. a wall), which is known as flanking sound transmission.

D_{nT} This is the 'Standardised Level Difference', which is equivalent to the measured D_{n} and corrected to a standardised reverberation time of 0.5s.

$D_{nT,w}$ This the 'Weighted Standardised Level Difference', is a single figure value of D_{nT}, and is the field measurement of airborne sound transmission

$D_{n,e,w}$ This the 'Weighted Element Normalised Level Difference', which is a single figure value quantifying the sound insulation performance of a building element, such as an air vent.

R This is the 'Sound Reduction Index' as measured in a laboratory, which is a measure of the sound insulation properties of a building element (e.g. a wall) in a stated frequency band.

R_{w} This is the 'Weighted Sound Reduction Index' (R_{w}), which is a single figure quantity of R, the laboratory measured Sound Reduction Index.

$\Delta L_{n,w}$ This is the 'Improvement in Weighted Normalised Impact Sound Pressure Level', which is a laboratory value for the improvement in the impact sound insulation provided by a floor treatment, e.g. a soft floor covering. It is the difference between the Weighted Normalised Impact Sound Pressure Level (laboratory value) measured with and without the floor treatment. Also denoted ΔL_{w} in some standards, including ratings to BS EN ISO 717-2:1996.

C_{tr} This is a weighted transport noise spectrum, which can be added to $D_{nT,w}$ or R_{w} in some standards to account for the spectral composition of different sound sources.

RT/T_n The 'Reverberation Time' is the time it takes in seconds for a sound level, typically within an enclosed space, to reduce by 60 dB (T_{60}) after the source of the sound has ceased. However, reverberation time is often measured based on the time it takes for the sound level to decrease by 20 dB (T_{20}) or 30 dB (T_{30}).

α 'Absorption Coefficients' are the fraction of sound energy absorbed by a material. Expressed as a value between 1 for total absorption (i.e. no reflection) and 0 for no absorption (i.e. total reflection) of an incident sound wave. The absorption coefficient varies with frequency and angle of incidence.