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THE ACOUSTIC DESIGN OF THE UNIVERSITY OF SALFORD PERFORMING ARTS BUILDING

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This paper looks at the acoustic design of the New Adelphi Building at the University of Salford. The building houses, recording studios, music practice rooms, a 350 seat multi-configuration theatre, group rehearsal spaces and teaching accommodation. The building is located in the University of Salford campus near a railway line and existing student accommodation, as such external noise and vibration ingress and noise egress had to be carefully considered in the building envelope design. The acoustic design had to consider the many proposed uses. In order to control noise transfer of loud activities to adjacent spaces, floated box-in-box constructions were used extensively in order to provide high levels of sound insulation. The strategies for controlling external noise ingress and operational noise egress, internal airborne and impact sound insulation, room acoustics are discussed along with details of the mechanical services design.

Keywords: performing arts, theatre, studios, sound insulation, room acoustics

1. Introduction

The New Adelphi Building opened in September 2016 and is a 6 storey performing arts building located in the University Salford’s main campus and replaces the existing Adelphi building. The design of the building started in 2010 and construction started in January 2014. This paper discusses the key acoustic design considerations, which include external noise and vibration ingress, and noise egress via the building envelope, internal airborne and impact sound insulation of floors and partitions, room acoustics in performance and rehearsal spaces, and the mechanical services design.

Figure 1 New Adelphi building, University of Salford (© Tom Bright)

2. Project brief

2.1 Proposed uses

The brief from the University of Salford was to provide 6 recording studios, 2 TV studios, 2 radio studios, 33 music/drama rehearsal spaces, a band room (large rehearsal space to accommodate big band/wind band), a 350 seat theatre, open plan studio space and ancillary accommodation. All design criteria were based on providing professional quality spaces throughout and the scheme is constructed to achieve the BREEAM[1] excellent standard.

2.2 Site plan

The New Adelphi Building is location is shown in Figure 2 (highlighted in blue). The site is located in University of Salford's main campus in Greater Manchester. The A6, a main road between Salford and Manchester city centre, is 130 m south of the site and Salford Crescent railway station is 60 m west of the site (highlighted in orange in Figure 2). The surrounding buildings are all part of the University and mainly comprise teaching accommodation, with the exception of student accommodation (Horlock Court – highlighted in red in Figure 2) which is 70 m to the north of the site. Though these are to be demolished in the coming years and replaced with other University buildings.

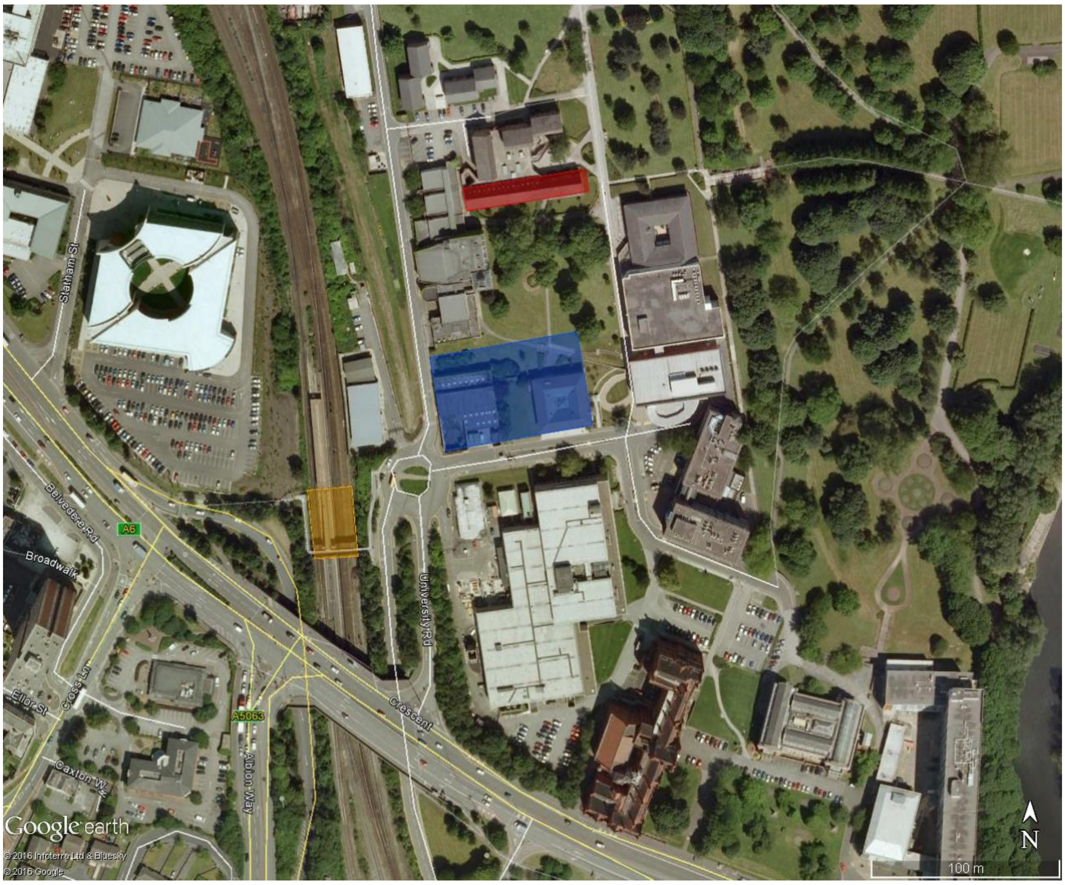

Figure 2 Site plan (courtesy of Google Earth)

3. Building envelope

3.1 Noise ingress/egress

The key considerations of the building envelope are environmental noise ingress, ground-borne vibration ingress/re-radiated noise and activity noise egress from the music/drama spaces.

The recording studios are located in the basement, this allows them operate 24 hours a day and increases the availability to students.

Measurements of music activities (band rehearsals, individual instruments) were carried out in order to assess representative internal activity noise levels. These were then used to calculate the required facade sound insulation performances for music/drama spaces, which was determined by the noise egress requirements, rather than the noise ingress requirements. Depending on the expected activity noise level and the location of noise sensitive buildings relative to the facade, this resulted in specifying a sound insulation performance between R'_w+C_{tr} 50-65 dB to external walls and R'_w+C_{tr} 39-48 dB to external glazing.

The external wall sound insulation performances were achieved using a combination of shear walls/blockwork and independent internal linings. To achieve the external glazing sound insulation requirements to performance/rehearsal spaces, glazing areas were limited to 30% and secondary glazing was used in combination with the curtain walling where performances of $> R'_w+C_{tr}$ 39 dB were required.

The theatre has 2 large doors for stage equipment, scenery and performances that open out onto the courtyard to the north of the building. These were both acoustically rated in order to maintain the overall sound insulation performance of the facade.

A noise survey was carried out early on during the design stages and the external noise levels of L_{Aeq} 53-64 dB were predicted at the facades. For non-performance/rehearsal spaces, this resulted in an overall facade sound insulation performances varying between $R'_{w}+C_{tr}$ 10-31dB, depending on the use of the space and the facade location.

3.2 Ground-borne vibration

Ground-borne vibration from the nearby railway line has also been considered. A vibration survey was carried early on during the design stage in to assess the ground-borne vibration and re-radiated noise in the building. This was a particular concern for the recording studios, which are located at basement level and have a very low internal noise level criteria (NR20). The results of the assessment indicated that the box-in-box constructions proposed to the recording studios would sufficiently reduce the re-radiated noise generated by passing trains. For spaces not formed from a box-in-box construction, which had higher internal noise level criteria (NR25), the re-radiated noise level was assessed to be below the internal noise level criteria.

4. Internal sound insulation

The varied uses within the building and the desire for professional quality spaces led to number of different sound insulation performance requirements. Heavyweight constructions (ie, concrete and blockwork) form spaces that require higher levels of sound insulation; recording studios, performance/rehearsal spaces, ensemble rooms, instrument tuition rooms. These spaces are located in the basement and on the lower floors of the building. The spaces that require less onerous sound insulation performances are located on upper floors and are formed from hollowcore concrete slabs supported from a steel frame.

4.1 Box-in-box constructions

For the music performance and rehearsal spaces the separating floors and partitions were designed to achieve an airborne sound insulation of $D_{nT,w}$ 70 dB to recording studios and ensemble rooms, and $D_{nT,w}$ 65 dB to instrument tuition rooms. In both cases this was achieved by using box-in-box constructions, with differing partition constructions. An example sketch detail showing the principles of the box-in-box construction is shown in Figure 3. The elements of the box-in-box constructions are:

- Floated concrete floors on isolation mounts
- Independent twin-leaf partition constructions – either drywall construction or blockwork and drywall lining with each leaf built from the floated concrete floor to the structural soffit
- Sound insulating ceilings supported on resilient hangers
- Wide air-space double glazing to maintain the overall airborne sound insulation performance
- Mechanical services zone below the sound insulating ceiling and the above sound absorbent ceiling.
- Acoustically rated doors.

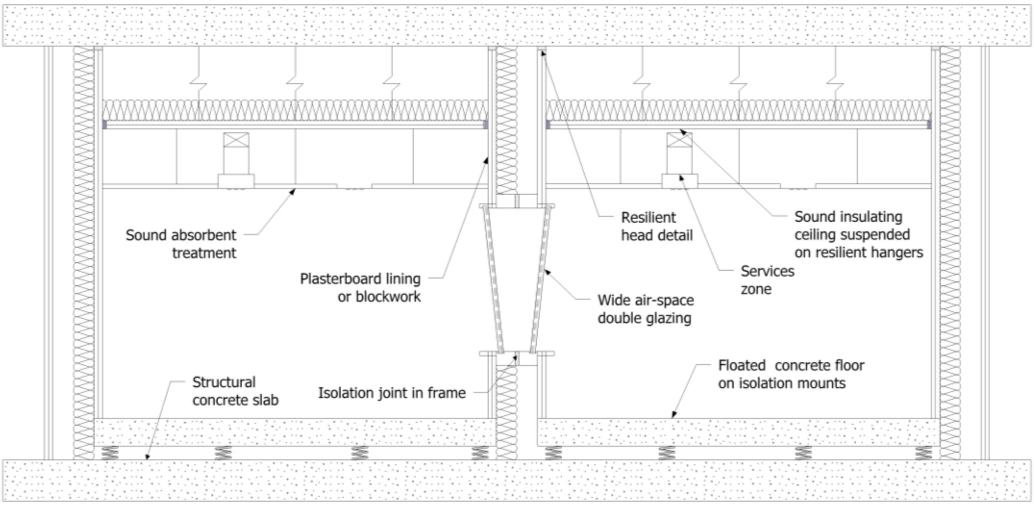

Figure 3 Example sketch detail showing a box-in-box construction

4.2 Upper floors

The upper 3 levels of the building house open-plan studio space, offices and teaching spaces. These areas are similar to a typical office building, with a steel structure, hollowcore concrete slab floors and floor-to-ceiling curtain walling. Internally raised access floors and drywall partitions were used, with the partition being built from the structural floor where higher levels of airborne sound insulation were required (> $D_{nT,w}$ 40 dB).

5. Room acoustics

5.1 Recording studios

For recording studios, the use of irregularly shaped rooms was preferred by the University, so the recording studios utilise variable absorption to allow musicians and sound engineers to tune the studios for the specific requirements of a recording. A maximum reverberation time of T_{mf} 0.6 s was targeted, with a low frequency criterion of 0.8 s in the 125 Hz octave band. These requirements were achieved using a 300 mm deep sound absorbent ceiling, to control bass modes and variable diffusive/sound absorbent wall panelling.

5.2 Music/drama rehearsal spaces

For the ensemble rooms, instrument tuition rooms and the band room the 300 mm deep sound absorbent ceiling were used along with variable wall panels or drapes. This allows musicians to vary the reverberation time in each space depending on the instruments being used.

For the drama rehearsal spaces targeted less onerous reverberation time criterion, though sound absorbent ceiling and wall panels were used to control reverberant noise build-up in the spaces.

5.3 Theatre

The 350 seat theatre is arranged over 3 levels has a number of configurations; proscenium stage (see Figure 4), in the round and arena stage. In order to control reverberation in the space a full sound absorbent soffit is provided along with variable drapes to the side walls (at all levels) and fixed sound absorbent wall panels to the rear walls.

The balustrades to upper levels are solid and angled downward to provide lateral reflections to the stalls audience. Also solid reflectors to underside to technical galleries are used to provide early reflections to upper levels.

Figure 4 Theatre, New Adelphi building (© Tom Bright)

5.4 Atrium

The large central atrium runs the full height of the building (excluding the basement level) and is open to open-plan studio spaces on upper levels. Additionally breakout areas are provided in the atrium (see Figure 5). The key design consideration for the atrium was to control reverberant noise build-up within the space, as such sound absorbent treatment was provided as perforated plasterboard to the balcony/walkway ceilings and as vertically hung baffles the level 3 soffit and above breakout areas.

Figure 5 Atrium, New Adelphi building (© Tom Bright)

The provision of the sound absorbent treatment in the atrium, particularly around the breakout areas, allows the spaces the to be used comfortably by the students for informal study.

6. Building services

Ventilation to the basement level recording studios and control rooms is provided by a fully mechanical system, which is designed to achieve a noise level of NR20 during background ventilation. A purge ventilation mode is provided, which achieves NR35, and can be used when recordings are not taking place. The ventilation ductwork enters the rooms via the room fronts, rather than via any separating floors/partitions.

A similar strategy for background ventilation is provided to the ensemble rooms and the instrument tuition rooms, though purge ventilation, while the room is not in use, is provided via opening windows.

For all other spaces, full mechanical ventilation is provided, with the majority of the building services ventilation plant located on the roof. All of the externally mounted plant items and plant items with external louvres/vents had to achieve the external plant noise limits. These limits are cumulative and were designed to achieve 10 dB below the background noise level at the nearest residential premises (Horlock Court), as per the Local Authority requirements and the guidance contained in BS 4142[2]. Additionally, in order to control noise levels across the campus, limits were set at the facades of non-residential University buildings.

REFERENCES

1 BRE Environmental Assessment Method (BREEAM) New Construction – Non-Domestic Buildings, 2011, *Building Research Establishment (BRE Global)*.

2 BS 4142:1997 Rating industrial noise affecting mixed residential and industrial areas, *British Standards Institute*.