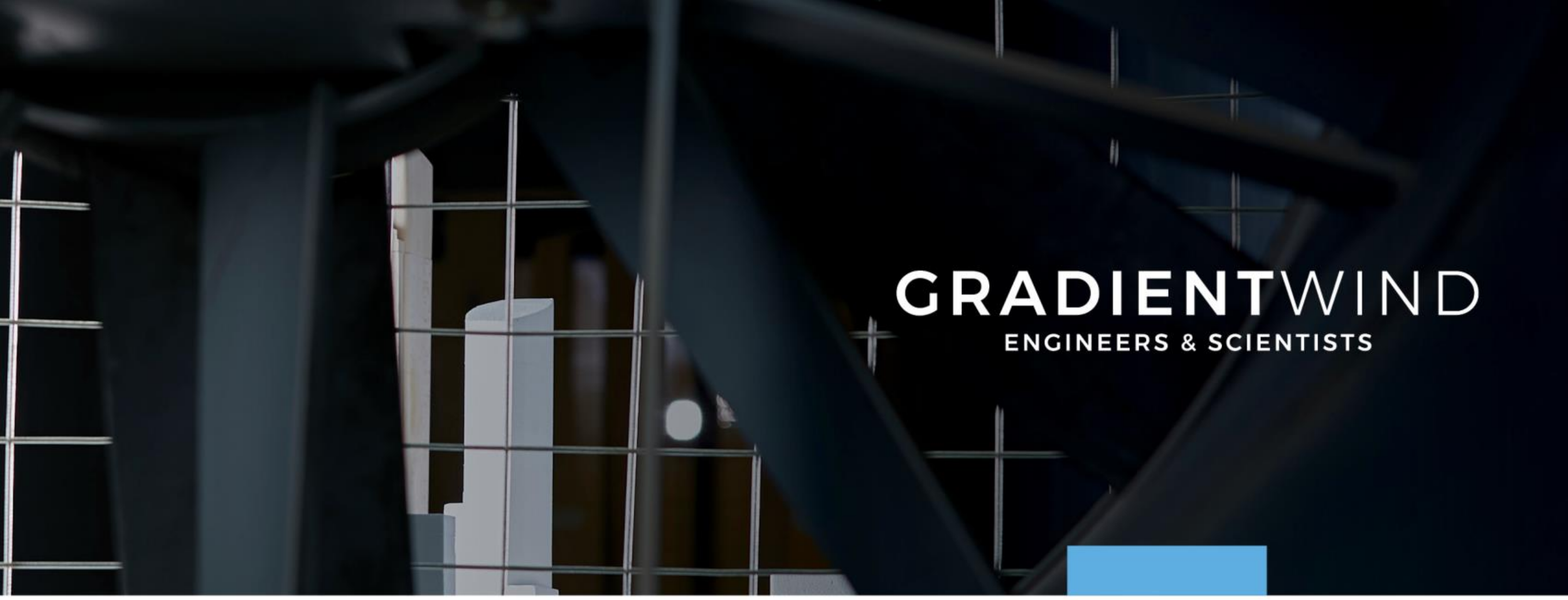
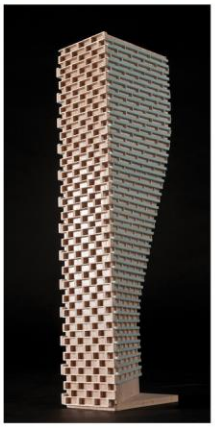


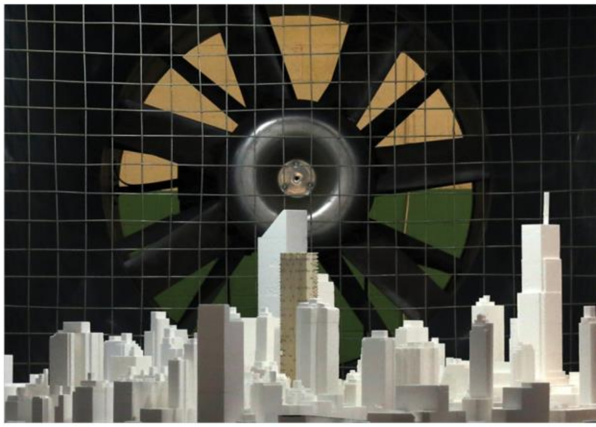
GRADIENTWIND
ENGINEERS & SCIENTISTS

BUILDING ACOUSTICS

770 Brookfield Road
Ottawa, Ontario

REPORT: GW14-122-Building Acoustics





June 17, 2020

PREPARED FOR
Dan Henhoeffer
Hobin Architecture Incorporated
63 Pamilla Street
Ottawa, ON
K1S 3K7

PREPARED BY
Michael Lafortune, C.E.T., Environmental Scientist
Joshua Foster, P.Eng., Principal

EXECUTIVE SUMMARY

This report summarizes recommendations related to indoor acoustics and vibration control for a proposed student apartment development located at 770 Brookfield Road in Ottawa, Ontario. The focus of this building acoustics assessment is a proposed student apartment development consisting of several mid-rise blocks. The assessment involves separate consideration of both occupant noise and mechanical noise for indoor acoustic design. Our work is based on architectural drawings provided by Hobin Architecture Inc., dated April 12, 2019, as well as mechanical drawings provided by Smith + Andersen, dated February 24, 2020.

Gradient Wind has reviewed the acoustical requirements for the 770 Brookfield Road development. This report provides a summary of recommendations to meet client specified acoustical requirements, Ontario Building Code (2012) requirements, and industry guidelines, as well as other industry standard acoustic parameters outlined by ASHRAE for common areas and residential spaces. The overall conclusions from our review are as follows:

(i) Wall construction requirements to achieve the best in-situ performance of acoustic assemblies are outlined in Section 3.2.

(ii) Sound transfer through plumbing, duct runs, or fire protection systems will be controlled by following the requirements of Section 3.4.

(iii) Noise from mechanical equipment will be controlled to appropriate Noise Criteria levels using mitigation measures such as silencers and acoustic lining, as per the requirements of Section 4.

(iv) Vibration from mechanical equipment will be controlled as per the recommendations outlined in Section 5.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Hobin Architecture Incorporated to undertake a building acoustics assessment of a proposed student apartment development located at 770 Brookfield Road in Ottawa, Ontario. This report summarizes recommendations related to indoor acoustics and vibration control. Indoor acoustics design is considered separately in two categories: occupant noise and mechanical noise. Our assessment is based on architectural drawings provided by Hobin Architecture Incorporated, dated April 12, 2019, as well as mechanical drawings provided by Smith + Andersen, dated February 24, 2020.

2. TERMS OF REFERENCE

The focus of this building acoustics assessment is a proposed student apartment development consisting of several mid-rise blocks. The development is located southwest of the Brookfield Road & Robson Road intersection. Block A, C and B, D are nine and six-storeys in height respectively, containing residential space only. Block E1 and E2 are two-storeys in height, containing retail and amenity space. The development will be completed in two phases, with Block A, B and E1 completed first, and the remaining blocks following. The site will contain one floor of underground parking, and mechanical penthouses atop each residential block.

The major mechanical equipment serving the building includes Make-up Air Units (MAU), Heat Pumps, Energy Recovery Ventilators (ERV), and various Exhaust Fans. The MAUs are located on the roof and within the mechanical penthouse. The ERVs serve common areas on the ground floor. Individual fan coil units are located in each suite. Boilers, reservoirs and other mechanical equipment are located in the mechanical penthouse, parking levels and roof. The building is also expected to be serviced by an emergency generator.

The building structure is comprised of poured reinforced concrete while exterior walls are comprised of steel studs and gypsum board with cladding. Interior partitions are constructed from steel stud and gypsum wallboard between units.

3. OCCUPANT NOISE CONTROL

Occupant noise control is achieved through the selection of suitable vertical and horizontal separations between suites. As such, separations are selected with consideration given to minimum requirements of the Ontario Building Code (OBC 2012), as well as specific acoustic behaviour of demising walls and floors. The OBC requires a minimum sound transmission class (STC)[1] rating of 50 between adjacent suites, as well as between suites and corridors. The OBC requires STC 55 between suites and elevators or garbage shafts. STC ratings represent laboratory conditions for an ideal partition installed in a perfectly isolated test chamber. As-built partitions in the field are expected to have somewhat lower values, referred to as Apparent Sound Transmission Class (ASTC), of 3 to 5 points due to unavoidable flanking transmission. As such, a prudent design will select partitions with STC ratings at least 5 points higher than required by code to account for flanking paths of sound transmission in real buildings. Based on the foregoing, GWE has reviewed the architectural plans and has determined that the STC of most relevant partitions exceeds the OBC requirements.

Partition STC ratings have been determined by comparison of similar assemblies based on published test data from laboratories such as the National Research Council of Canada (NRC) or by estimates using the software program INSUL by Marshal Day Acoustics. Improvements to each partition, to achieve OBC criteria and good engineering practice, are indicated in **bold** text.

<u>1 Hour Partition Wall (SP1a):</u>

- Two layers of 16 mm Type X gypsum wall board
- 92 mm steel studs @ 600 mm O.C. w/ 89 mm batt insulation
- 32 mm air space
- 92 mm steel studs @ 600 mm O.C. w/ 89 mm batt insulation
- Two layers of 16 mm Type X gypsum wall board

STC rating 64 (TL-93-302)

[1] Sound Transmission Class is a single number rating of walls or floors determined in the laboratory according to ASTM Standard E90 to attenuate sound from one space to another. The corresponding number for the same as-built partition in the field is referred to as the Apparent Sound Transmission Class (ASTC) determined according to ASTM E336.

Partition Wall Slab:

- 290 mm concrete

INSUL STC rating 60+

Stairwell Wall Slab:

- 300 mm concrete

INSUL STC rating 60+

Elevator Wall Slab:

- 350 mm concrete

INSUL STC rating 65+

1 Hour Corridor Wall (SP2):

- One layer of 16 mm Type X gypsum wall board
- 92 mm steel studs @ 600 mm O.C. w/ 89 mm batt insulation
- Two layers of 16 mm Type X gypsum wall board

STC rating 54 (TL-92-368)

1 Hour Shaft Wall (SP3):

- One layer of 25 mm shaftliner panel
- 64 mm CH studs @ 610 mm O.C. w/ batt insulation in cavity
- **Resilient channel @ 610 mm O.C.**
- Two layers of 16 mm Type X gypsum wall board

STC rating 50 (RAL 437362 1976)

Typical Floor Slab:

- Finished flooring (hardwood / tile)
- **4 mm rubber or felt acoustic underlayment**
- 225 mm concrete slab

INSUL STC rating 55+, IIC 50

Mechanical Room Floor Slab:

- 375 mm concrete slab

INSUL STC rating 65+

3.1 Reverberation Control

Room acoustics of large spaces such as the fitness rooms and lobbies can be affected by the room finishes. Hard surfaces on the walls, ceiling, and floor can produce a reverberant (live) room where sound generated inside the space takes longer to decay. Longer reverberation times can lead to sound level build-up and acoustical discomfort. To control reverberation inside these rooms, it is recommended that an acoustic ceiling with a minimum noise reduction coefficient (NRC) of 0.7 covers up to 70% of the ceiling area in each room.

3.2 Construction of Acoustic Partitions

In order to achieve the required STC ratings for partitions, and for general construction guidelines, the construction of acoustic partitions should incorporate the following features and practices:

(i) All partitions are to be constructed slab to slab with no gaps in the walls.

(ii) All light-gauge steel studs used in acoustically rated partitions shall be 25-gauge non-load bearing unless otherwise specified. Partition walls using heavier gauge studs have inferior acoustic performance and should be avoided unless specifically called for.

(iii) All top, bottom and end-wall metal tracks will be installed onto solid surfaces with two beads of acoustic caulking or a foam gasket squeezed between the track and the surface.

(iv) Gypsum wallboards will be installed with joints in the vertical position continuously supported onto steel studs.

(v) Where two or more layers of gypsum boards are installed on one side of partitions, the joints shall be staggered by one stud space.

(vi) Door frames at corridor partitions shall be heavy gauge steel filled with acoustic material, and sized so that the layers of gypsum board can be fitted behind the frame (i.e. providing a minimum 6 mm overlap between the frame and gypsum board).

(vii) All gaps along edges, at architectural elements crossing partition walls, around electrical conduit and so on shall be caulked with acoustic sealant.

(viii) Electrical outlets in STC rated partition walls shall be offset by not less than one stud space in the lateral direction, fully sealed with acoustic caulking and surrounded by batt insulation.

(ix) All acoustic partitions shall be fully filled side-to-side and top-to-bottom with batt insulation.

(x) The detail of the demising walls at the exterior wall should consider extending the gypsum board along the demising wall into the stud cavity of the exterior wall to minimize flanking transmission around the ends of the demising wall.

(xi) Electrical cables passing through rated partitions shall be passed neatly through the wall and fully sealed. If cable trays are used, the trays must be stopped and restarted at rated partitions with cables passed through a sealed conduit.

(xii) Stud tracks shall be sealed with two beads of acoustic caulking on all sides of the partition.

3.3 Requirements for Doors

Doors are typically the weakest link for an acoustic partition and can significantly affect the total performance of the wall depending on the area ratio of wall to door. ASTC Standard Test Method E336 provides a method to establish the ASTC of a uniform partition, and a separate method to determine the Noise Isolation Class (NIC) for partitions with other elements such as doors. Sound transfer across the doors separating dwellings from corridors is not anticipated to be a concern, due to the relative quietness of the corridors during most times of the day. In most multi-tenant high-rise buildings, the corridors are pressurized and some air leakage around the doors is required. With this consideration, standard suite doors will be sufficient.

3.4 Plumbing Noise, Duct Runs, Cable Runs and Fire Protection

With respect to plumbing noise and duct runs, as they affect STC ratings:

(i) Pipes carrying intermittent liquid flow, such as rainwater leaders and sanitary drainage, must be carefully covered to avoid noise transfer to suites. Where pipes pass beside noise-sensitive rooms such as living rooms or sleeping quarters, it is recommended that pipe elbows be wrapped with a minimum of 25 mm acoustic insulation batts, covered with loaded vinyl sheathing or equivalent. The pipe wrap should extend 1000 mm on either side of the elbow. Examples of pipe wrap include AcoustiTech Acoustidrain, Kinetics Model KNM-100ALQ. An alternative would be to provide two layers of 16 mm Type X gypsum board on the plumbing wall and wrap the pipe with 90 mm of batt insulation.

(ii) Sprinkler piping need not be wrapped, as there is no flow under normal operation.

(iii) Penetrations for mechanical piping or conduits passing through acoustic rated partitions shall be neatly cut. The remaining gap, not more than 16 mm wide, shall be sealed with acoustical caulking and filled with mineral wool.

(iv) Where vertically supported at floor levels, storm and sanitary piping larger than 25 mm in diameter shall have 12 mm rubber pads installed between support brackets and the concrete slab.

(v) Where ductwork passes through acoustically rated partitions, the opening shall be as small as possible and finished with acoustical sealant and mineral wool in the gap as a minimum.

(vi) Electrical cables passing through acoustically rated partitions shall pass neatly through a conduit in the wall and be fully sealed.

3.5 Impact Noise

Complaints relating to impact noise between floors in multi-level buildings often arise due to walking on hard surfaces with hard-soled shoes. Impact noise is rated according to Impact Isolation Class (IIC) but has no code-specified limits in Canada. However, the National Research Council of Canada (NRC) provides guidelines that IIC 50 should be targeted for acceptable acoustic performance. Bare concrete covered with ceramic tile provides approximately IIC 25. Bare concrete covered with carpet produces IIC greater than 50. Therefore, it is recommended to use an elastomeric underlayment under hard finished flooring surfaces such as hardwood, which will greatly improve the IIC rating of the floor. Suitable products for this purpose include Pro Acoustik, SonoBase+, AcoustiTech or equivalent.

The floor covering for the fitness room shall be specified to be a minimum 9-mm rubber flooring, such as Mondo Sport Impact or equivalent. This will provide sufficient impact isolation for fitness and cardio activities.

4. MECHANICAL NOISE

Sources of mechanical noise in the building include:

(i) Make-up Air Unit
(ii) ERV Units
(iii) In-Suite Heat Pumps
(iv) Exhaust Fans
(v) Emergency Generator

The building is also serviced by an elevator, which can produce noise and vibrations. Noise from the elevator is primarily controlled by the high STC rating of the elevator shaft walls, which must meet STC 55 according to OBC 2012. The poured concrete walls around the elevator shaft are sufficient to meet this requirement. The most significant source of noise is from air moving equipment, which has the potential to create noise near the source, as well as at greater distances by way of noise propagation inside ducts.

Mechanical noise in occupied buildings arises from several sources, which include air moving equipment and plumbing noise. The operation of air moving equipment represents one of the principal sources of noise that influences the entire building. Noise from air moving equipment and other mechanical sources is controlled with reference to Noise Criteria (NC) curves, according to room type and function. The NC is a single value measure which represents a family of curves that relate acceptable noise levels in decibels as a function of frequency. According to ASHRAE guidelines, the target NC levels for bedrooms and living rooms are NC 30, while kitchens and utility spaces are NC 35. NC levels 30 and 35 correspond approximately to 40 decibels (dBA) and 45 dBA, respectively. According to National Research Council of Canada research publications, bedroom noise levels should not exceed 40 dBA. Kitchens, bathrooms and non-sensitive spaces can have higher levels of ambient noise. Targeted NC levels for various occupied rooms are found in Table 1.

TABLE 1: TARGETED NC LEVELS FOR VARIOUS SPACES

Room Type	Recommended NC Level
Bedrooms and living rooms in suites	30
Bathrooms, kitchens and utility spaces in suites	35
Retail, residential lobby, corridor and common spaces	40

4.1 Mechanical Equipment

MAKE-UP AIR UNIT

The building is serviced by four main make-up air units located in the mechanical penthouse and on the roof, identified as MUA-A.01, MUA-A.02, MUA-B.01, MUA-B.02. These units have a supply air duct for the corridor and common spaces that are routed down vertical shafts and branched off at each level, transmitting noise through duct propagation. Provided these units are equipped with the specified silencers, noise levels will fall below the indoor noise level criteria. Minimum silencer insertion loss values are listed in Table 2 below. Final MUA and silencer selections should be provided to Gradient Wind for review.

TABLE 2: MUA SILENCER INSERTION LOSS VALUES

Unit Tag	Minimum Insertion Loss Value (dB)							
	60 Hz	120 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
MUA-A.01	14	24	24	30	34	32	30	28
MUA-A.02	15	26	27	32	37	35	31	29
MUA-B.01	12	22	22	28	32	30	28	26
MUA-B.02	12	22	22	28	32	30	28	26

ERV UNITS

A number of ERV units are located on the ground floor and in the mechanical penthouse, servicing common spaces. These units also have the ability to transmit noise through duct propagation, however, they are generally quieter than the MUAs. At the time of writing, sound power data for these units was unavailable. Typically noise from these units is mitigated with the use of internal acoustic duct lining. Gradient wind will review the internal duct lining requirements once sound data is available.

IN-SUITE HEAT PUMPS

Air handling in the residential dwelling units, as well as within common areas, is provided by heat pump units. The vertical in-suite units are housed within closed cabinets, and supply air to the bedrooms and living space through a duct and diffuser. These also contain a return grille with the capacity to transmit radiated noise. The vertical units shall contain an acoustically lined plenum at the supply side, and an acoustic grille at the front panel for return air. To further reduce noise transmitted into the suites on the supply side, it is recommended that supply ducts for VHP-B-E be internally lined with acoustic lining up to the first diffuser or for the first 1 m of ducting. These noise control measures are sufficient to mitigate noise and no additional measures are required.

EXHAUST FANS

The building contains a number of exhaust fans found in the parking levels, penthouse, roof, and ground floor, which serve non-noise sensitive spaces. As such, they have been considered insignificant sources of noise. The bathroom and kitchen exhaust fans in each suite are small and as such have been considered to be insignificant.

EMERGENCY GENERATOR

The building is expected to be serviced by a single emergency generator. The generator should be located favourably located away from noise-sensitive spaces. The mechanical room concrete slab will be sufficient to attenuate noise to the suites below the mechanical penthouse. Gradient Wind will review generator shop drawing submittals to ensure that appropriate treatment of the generator is provided. Silencers on the air intake, radiator air exhaust and combustion stack will be required.

5. VIBRATION CONTROL

The primary sources of building vibrations are from reciprocating and rotating mechanical equipment, including pumps, air handling equipment and fans. In order to ensure a comfortable living environment, mechanical equipment in the building will require the following minimum isolation:

(i) The Make-up Air Units on the roof shall be supported on spring isolators having a minimum rated deflection of 50 mm (2”). The springs can be supported directly on the floor/roof deck.

(ii) ERV units shall be supported on spring isolators having a minimum rated deflection of 25 mm (1”). The springs can be supported directly on the floor or suspended from the floor slab.

(iii) The standby power generator shall be supported on spring isolators having a minimum rated deflection of 50 mm (2”). The springs will be supplied with a rubber/neoprene pad on the base. The springs can be supported directly on the floor.

(iv) Inline pumps greater than 3.7 kW (5 horsepower) located in the mechanical penthouse shall be supported on spring isolators or hangers having a minimum rated deflection of 38 mm (1.5”). Pumps can be isolated individually or grouped together on to an inertia base. Pumps less than 3.7 kW shall be supported on rubber/neoprene pads, such as Vibro-Acoustic Isolators model N or equal.

(v) Boilers, domestic hot water heaters and expansion tanks located in the mechanical penthouse, and parking level mechanical rooms shall be supported on 25 mm NSN pads. It is sufficient for these items to be supported directly on the floor slab.

(vi) The in-suite heat pumps shall be supported on rubber/neoprene mounts, such as Vibro-Acoustic Isolators model RD or equal, supported directly on the floor slab.

(vii) Piping that crosses floor levels shall have riser clamps supported on minimum 9 mm rubber/neoprene pads, such as Vibro-Acoustic Isolators model N or equal.

(viii) Small stand-alone fans and rotating equipment shall be isolated on minimum 9 mm rubber/neoprene pads, such as Vibro-Acoustic Isolators model N or equal, supported directly on the floor slab.

(ix) Large condensing units shall be supported by restrained spring isolators having a minimum deflection of 38 mm.

These recommendations are preliminary and are subject to change once more details of the equipment are known. Any seismic restraints (designed by others) shall not interfere with the free movement of the equipment, shout-circuiting the vibration isolators.

6. CONCLUSIONS AND RECOMMENDATIONS

Gradient Wind has reviewed the acoustical requirements for the 770 Brookfield Road development. This report provides a summary of recommendations to meet client specified acoustical requirements, Ontario Building Code (2012) requirements, and industry guidelines, as well as other industry standard acoustic parameters outlined by ASHRAE for common areas and residential spaces. The overall conclusions from our review are as follows:

(i) Wall construction requirements to achieve the best in-situ performance of acoustic assemblies are outlined in Section 3.2.

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(iv) Vibration from mechanical equipment will be controlled as per the recommendations outlined in Section 5.

This concludes our acoustics assessment and report. If you have any questions or wish to discuss our findings, please advise us. In the interim, we thank you for the opportunity to be of service.

Sincerely,

Gradient Wind Engineering Inc.

Michael Lafortune
Environmental Scientist

Joshua Foster, P.Eng.
Principal

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