AIIC Testing of Various Roof Terrace Assemblies and Evaluating the Need for Additional Mitigation

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1 Introduction

Common amenity and private rooftop terraces, overtop of other residential spaces, are common in mid and high-rise multi-family buildings. As these multi-family residences continue to be constructed, it is becoming more apparent that noise from footfalls and other objects impacting the structure can cause significant annoyance. The Ontario Building Code (OBC) has no requirements with respect to impact sound isolation, and there is limited laboratory or field test data available for the Impact Insulation Class (IIC) ratings for rooftop terrace assemblies.

This paper presents the results of the Apparent Impact Insulation Class (AIIC) field tests done on various rooftop assemblies in concrete multi-family buildings. This research aims to contribute field test data to the existing body of knowledge on typical roof terrace assemblies and help determine if or when additional mitigation is beneficial. The test results provide an indication of the acoustical performance of typical terrace assemblies that are used. The findings point to the benefit of exploring and conducting further testing of other assemblies with different floor finishes, supports, and underlayments.

2 Background

2.1 Impact Sound Isolation – Floor Systems

Structure-borne noise generated from activities such as footfalls or dragging furniture across a floor can be a significant cause of noise complaints. IIC ratings indicate a floor boundary's resistance to structure-borne noise transfer. The higher the IIC rating, the better the floor boundary will be at insulating impact noise.

The main components that make up a rooftop terrace are the floor finish and supports/underlayment. In concrete multi-family buildings, the floor finish is typically modular concrete pavers.

2.2 Building Code Requirements

The Ontario Building Code (OBC) has no requirements with respect to impact sound isolation. Appendix A, Volume 2 of the OBC does provide some information about impact noise: "Footstep and other impacts can cause severe annoyance in multi-family residences" [1]. However, Appendix A of the OBC is for information only, and is not part of the OBC requirements.

3 Method

Field tests to determine AIIC ratings were completed on two different roof terrace assemblies in concrete multi-family buildings. The test procedure involved the generation of floor impact noise using a standardized tapping source, adhering to the specifications of ASTM E1007-21. Sound levels were measured in the receiver space below the tapping machine using a calibrated sound level meter. The microphone was moved through each receiver space using a "slow sweep" technique to obtain the space-time sound energy average.

The roof terrace assemblies selected for testing were typical configurations used in concrete multi-family buildings. The different configurations that were tested were constructed on two different sites. In both tests, the assemblies were constructed on top of 200 mm thick cast-in-place concrete slabs.

The construction for the roof terrace assembly for Assembly A is:

- 50 mm thick 600 mm x 600 mm concrete pavers
- 50 mm thick extruded polystyrene rigid insulation paver supports (2 layers of 25 mm thick pieces)
- 50 mm thick extruded polystyrene rigid insulation (2 layers of 25 mm thick sheets)
- Roof membrane

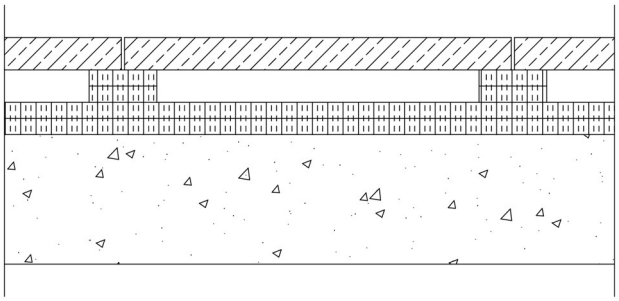

Figure 1: Roof terrace for Assembly A

The construction for Assembly B is:

- 50 mm thick 600 mm x 600 mm concrete pavers
- 100 mm thick bedding (gravel) substrate
- 100 mm thick extruded polystyrene rigid insulation
- Roof membrane

4 Results

Assembly A achieved a rating of AIIC 76, and Assembly B achieved a rating of AIIC 74. The normalized impact sound pressure level and AIIC curves for Assembly A and B are shown as Figures 3 and 4, respectively.

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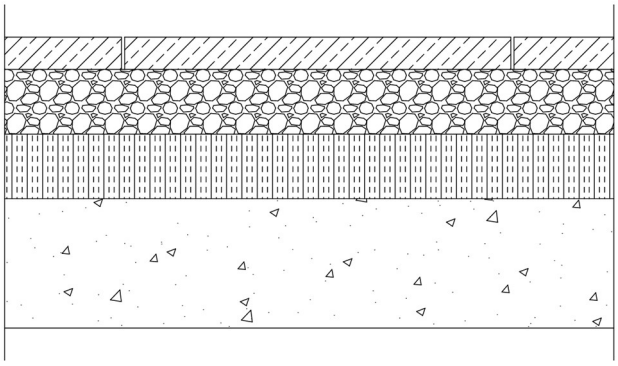

Figure 2: Roof terrace for Assembly B

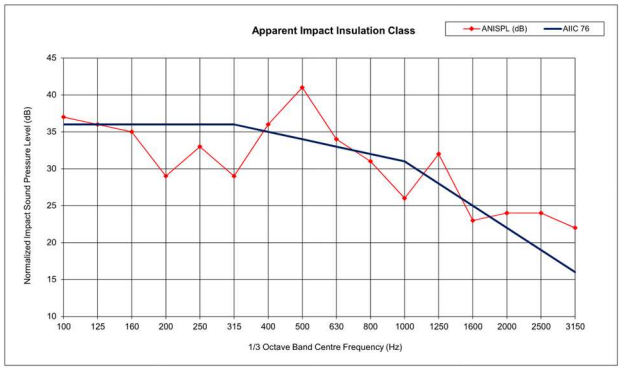

Figure 3: Measured impact sound pressure level for Assembly A

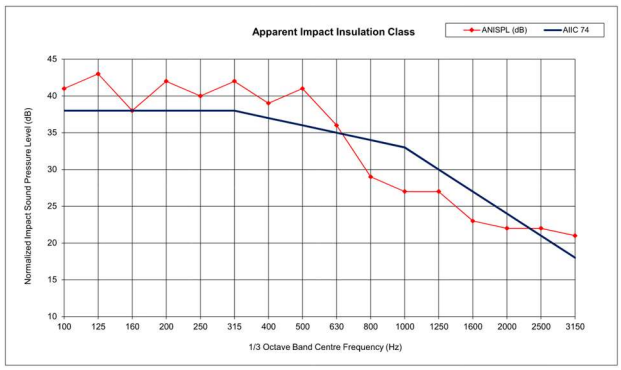

Figure 4: Measured impact sound pressure level for Assembly B

Subjectively, the tapping machine was observed to have a faint tapping noise that was barely audible in both receiver spaces below.

5 Discussion

Figure 3 shows that the overall AIIC rating of Assembly A is limited by the "8 dB" rule at the 500 Hz octave band, whereas in Figure 4 the overall AIIC rating of Assembly B is limited by the "sum of 32 dB" rule at the low and mid frequency bands (particularly between 100 to 630 Hz).

Field AIIC testing has a number of limitations, including the quality of construction and the differences between the buildings and receiver spaces. Variability between the material size, air space depth, and uniformity of substrate thickness, may also affect the performance of these as-built assemblies.

Due to the limited available opportunities to test these outdoor terrace assemblies, the conditions of the tests did not fully conform to the test standard due to the receiver room volumes being less than 40 m^3. This limitation should be considered when interpreting the results.

Based on the test results, typical roof terrace assemblies that include concrete pavers and extruded polystyrene rigid insulation appear to provide adequate impact sound isolation. However, this only applies to concrete structures, whereas the results would be different with wood structures which have a propensity to exacerbate low frequency sound.

Therefore, in general, additional mitigation measures to improve the impact sound isolation performance of these assemblies may not be necessary but may still be needed in cases where higher isolation is desirable.

The building industry would benefit if further research was conducted for these types of assemblies, and by exploring the use of different types of floor finishes and supports. It would be beneficial to examine if and/or how the performance of typical assemblies can be improved with the use of different underlayments between the floor finish and supports, and between the supports and the building structure.

Laboratory test data can establish the IIC ratings of typical assemblies that are used in these types of buildings, and examine how the variability of air space, and material size and depth can influence the IIC performance.

6 Conclusion

The AIIC test results presented in this paper indicate that typical roof terrace assemblies that include concrete pavers and extruded polystyrene rigid insulation in the assembly are sufficient in providing adequate impact sound isolation. Further independent laboratory and field testing should be explored to confirm how variables within these assemblies influence the acoustical performance of these assemblies. Further research of the impact sound isolation of different types of floor finishes, supports, and underlayments should also be explored.

References

[1] *Appendix A,* 2012 Building Code Compendium Volume 2, 2022.