COMPLEXITIES OF CURTAIN WALL FLANKING TRANSMISSION - A CASE STUDY

Kelly Kruger *[1], **Robert Ogle**†[1]
[1]Building Science Engineering, Edmonton, Alberta, Canada

1 Introduction

Aluminum and glass curtain wall construction is very common in modern commercial buildings. The continuous external façade can lead to significant limitations on the sound isolation between adjacent rooms, separated either laterally or vertically. Flanking transmission of curtain wall systems is very difficult to predict at the design stage of a project. Manufacturers do not routinely measure this parameter. The scarcity of data is partly due to a lack of laboratories that have the necessary specialized test environment. Generic flanking transmission loss data is of little value because of the large variation in curtain wall assemblies. Designers are often left with best guess approximations based on previous experience. These factors also make it difficult to significantly improve flanking transmission of an existing curtain wall installation.

The authors were recently involved in the acoustic commissioning of a university building where the sound isolation between floors was considered to be critical. A Noise Isolation Class of NIC 55 - 60 was required in order to allow music practice rooms to be located directly below conventional lecture rooms. Adequate acoustic isolation should have been achieved if the sound transmission was entirely determined by the 200 mm thick, post-tensioned concrete floor that separates the classrooms. The initial sound isolation, NIC 42, was found to be well below expectations, as shown on Figure 1.

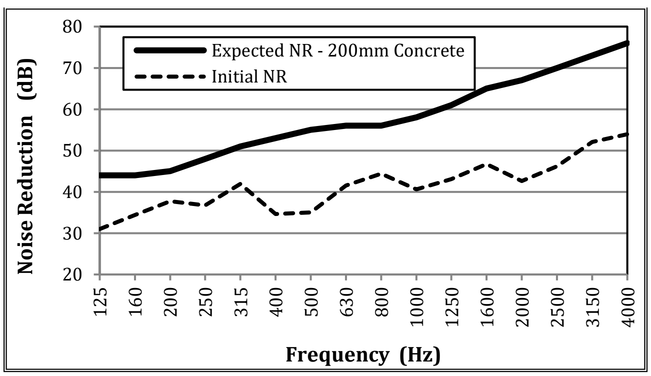

Figure 1: Expected vs measured noise reduction

It was evident that there was significant flanking occurring at or near the building façade, made up of a unitized curtain wall assembly. Due to the complexity of the junction between the curtain wall and the floor structure, several potential flanking paths were identified. It was possible to alter each flanking path individually so that the incremental improvement of each step could be quantified. Figure 2 shows a photo of the curtain wall and the construction detail at the intersection of the curtain wall with the floor.

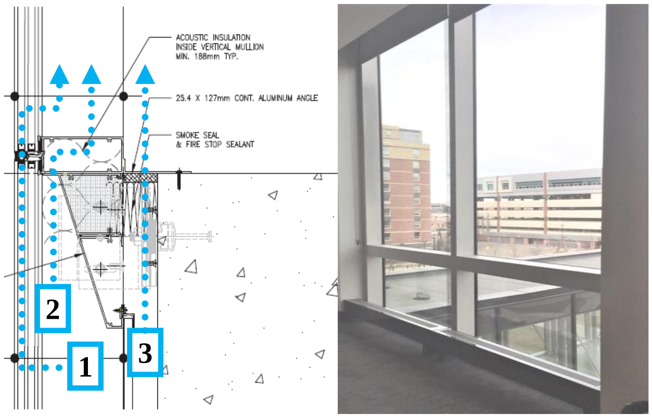

Figure 2: Curtain Wall Flanking Paths.

Flanking can occur along several paths. Path 1 shows the transmission from the glazing on the lower floor level through the spacer and into the glazing on the upper floor. Path 2 shows the transmission directly through the horizontal mullion. Path 3 shows the transmission through the gap between the curtain wall and the floor slab.

2 Method

A series of sound isolation tests were conducted between floors. The receiving room measurement positions were located approximately 2 m from the curtain wall due to the large influence of curtain wall flanking. Also, the receiving room had numerous desks located very near the curtain wall and so the receiver locations are indicative of the worst case sound isolation experienced by the room occupants.

3 Results and discussion

An inspection of the curtain wall/floor junction revealed that the fire stop had not been fully installed (Flanking Path 3). This left a significant opening at the edge of the floor slab that was only blocked by carpeting. It was assumed that this gap was the most significant flanking path. It was therefore dealt with first by inserting two layers of fire resistant, mass loaded joint filler, with mineral wool inserted between layers. Treating Flanking Path 3 provided a modest improvement to NIC 46.

Next, vibratory velocity measurements were taken on the various components of the curtain wall. Measurements were taken on the horizontal mullions, vertical mullions and glazing for both the lower and upper sections of the curtain wall. The sound power radiated by each component was calculated by accounting for the exposed surface area.

* kelly@bse.ab.ca
† Robert.ogle@bse.ab.ca.
‡

Overall the glazing was the most significant contributor, although the contribution from the lower horizontal mullion was comparable in a few high frequency bands, most notably above 500 Hz. The contribution from the vertical mullions was generally much less significant throughout the frequency range. The vibration measurements also revealed that there was substantially less sound power radiated from the upper section of the curtain wall compared to the lower section.

To verify that the sound power radiated from the horizontal mullion was significant, at least in some of the higher frequency bands, the bottom mullion was clad with a mass loaded vinyl (MLV) sheet with a surface density of 15 kg/m^2. This provided an improvement in noise reduction of up to 6 dB in the frequency range identified by the vibration analysis. The mass on the mullion was increased further by applying a layer of 16 mm drywall on top of the MLV. This did not provide an additional improvement in sound isolation.

The remaining and now most significant flanking path was along the glazing, Path 1. The vibration analysis indicated that the glass in the lower section of the curtain wall radiates approximately 10-15 dB more sound power than the larger upper section of glazing. This prompted the idea of adding an additional glass panel on the inside of the lower section of curtain wall. As proof of concept, a temporary drywall panel was installed at this location. The improvement in noise reduction that was provided by the drywall panel was promising. However, it was recognized that because the new inner glass panel would be manually glazed in the field some air leakage from the room interior into the cavity between the new glass panel and the existing insulating glass (IG) unit might occur. Since the presence of the new glass panel would reduce air and heat flow to the inside surface of the IG unit, the surface temperature would be reduced. Therefore there was a concern that condensation might occur under certain environmental conditions.

In order to confirm if condensation would be problematic, temperature probes were used to monitor the glass temperature of both a typical existing IG unit, and an adjacent unit covered using gypsum board of roughly the same insulation value as the proposed inner glass panel. Data loggers were also used to measure the interior and exterior relative humidity (RH) for a period from December 20th 2018 to January 10th 2019. During this time, a minimum glass temperature of 6.5° C and a maximum dew point temperature of 0.2° C were measured (not concurrently) and are shown on Figure 3. Maximum interior RH levels during both occupied and unoccupied classroom times were found to be less than 25%. Using the collected data, a “worst case scenario” of a -30° C exterior temperature with interior conditions of 25° C and 25% RH was evaluated. In this scenario the dew point of the interior air was 3.6° C and the minimum glass temperature was 5° C. Therefore under these design conditions, condensation would not occur.

Given these findings we concluded that the introduction of the interior glass panels would not result in condensation problems.

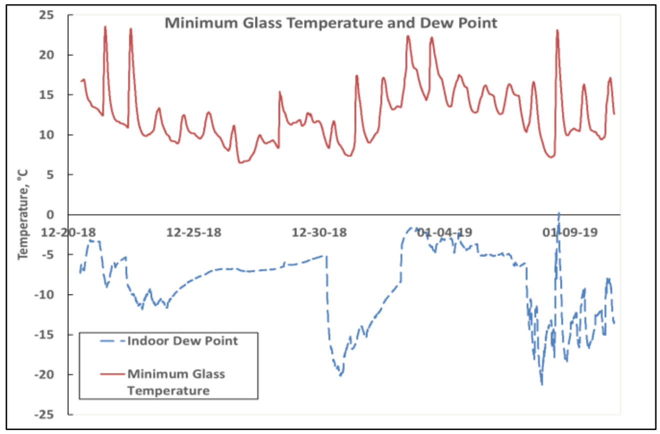

Figure 3: Minimum insulated glass temperature vs. dew point

Finally, a new glass panel was installed to cover the entire lower section of the curtain wall, thereby reducing the contribution of the last major flanking path. The lower mullions were clad with a layer of MLV that incorporated a sound absorptive foam layer exposed to the cavity between the curtain wall and the new glass panel. A significant improvement in sound isolation (NIC 57) was achieved.

4 Conclusion

Figure 4 summarizes the improvement that occurred after each step of mitigating the flanking through the various paths. Some flanking from the curtain wall is still evident but any further modifications to the existing construction are no longer thought to be practical.

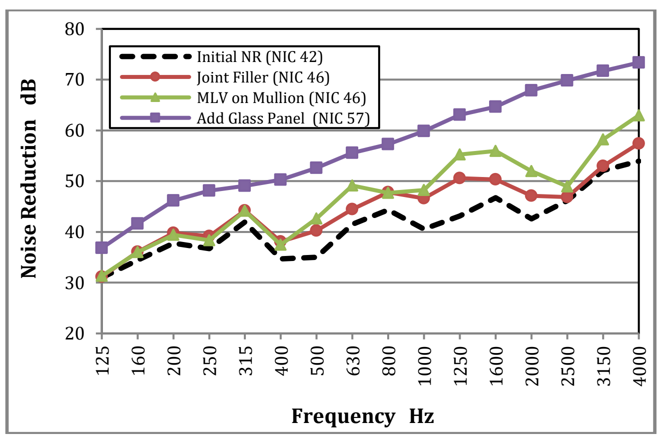

Figure 4: Improvement due to treatment of Flanking Paths

Acknowledgments

The authors would like to thank Mr. Frank Salopek of MacEwan University for his considerable assistance throughout the investigation and for his many key suggestions on implementing practical solutions.