INCREASING SOUND ISOLATION OF WINDOW WITH ADD-ON SYSTEMS & VARIOUS INSULATING GLASS UNIT CONFIGURATIONS

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1 Introduction

Windows represent the most significant weak noise isolation component of the building envelope. Although it is more efficient and cost effective to incorporate acoustical consideration during the design and construction process, remedial work to the window may be required to improve the acoustic comfort in existing residential buildings. In situation where the need to increase transmission loss of the existing windows is required, commercially available add-on systems can be incorporated to either the exterior or interior side of the windows to increase sound isolation. This research evaluates the potential improvement of incorporating five different types of add-on systems to a typical residential window to reduce outdoor traffic noise into the interior space.

The five add-on systems can be subcategorized by installation location: exterior and interior. Exterior add-on systems include an exterior roller shutter and an exterior shutter. Where it is not desirable or feasible to alter the building's exterior aesthetic, especially in multi-unit residence or at heritage or historic buildings, interior add-on systems may be required as alternative solutions. Interior add-on systems investigated include a high-density closed-cell (HDCC) foam window plug, a mass loaded vinyl curtain, and an interior acrylic glazed window.

2 Methodology

Sound intensity measurements were conducted to determine the in-situ sound insulation of the window assembly plus the add-on systems. All sound transmission measurements were made in accordance with ISO 15186-2 "Acoustics – Measurement of Sound Insulation in Buildings and of Building Elements Using Sound Intensity – Part 2 Field Measurements". Measurements were made between 100 to 5000 Hz at one-third octave intervals.

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To study the potential acoustic benefits of add-on systems on windows, baseline measurements of the installed window with various IGU configurations were conducted. The thicknesses of the double and triple glazing used in the tests are as follow: 4(22)6L, 4(16)4 and 6L(11)5(11)6L. The value between parentheses denotes the depth of air-filled glazing space and the thickness of the glass panes, in mm. The type of glass used in the tests is clear float glass. The letter "L" is used to represent laminated safety glass.

A base tilt-and-turn window with unplasticised Polyvinyl Chloride (uPVC) frame was mounted in a high-mass wood-framed wall panel. The window was installed as per a typical residential window installation with sealed joints around the window perimeters. The high-mass wall panel was 82" high and 70" width. The window rough opening was 48" high, 36" wide and 7" deep. The window sill was at a height of 20" above the floor of the testing facility.

3 Results & Discussion

A total of fifteen field sound transmission loss tests were conducted, including three baseline IGU window tests. The interior storm window was tested at depth of 3" and 6" from the interior face of glazing.

The baseline IGU window test results are consistent with trends from published transmission loss data. As expected, when comparing between the two double-pane IGUs, the 4(22)6L IGU exhibits consistently higher transmission loss across all frequencies. The triple glazed IGU has acoustic advantages over the 4(16)4 IGU above 160 Hz. However, the triple pane has almost identical transmission loss data to the 4(22)6L IGU, only showing marginal benefits around 200 to 315 Hz and above 3.15 kHz. Thus, the add-on systems window was studied only on the two double-paned IGU configurations.

3.1 Exterior Add-on Systems

In the case of 4(22)6L IGU, the two exterior add-on systems transmission loss curves are almost identical,

providing increase of sound transmission loss at 700 Hz and above. The resonance effect is emphasized more with the exterior shutters than with the exterior roller shutters at 125 Hz. Above 1000 Hz, the exterior roller shutters exhibit slightly higher sound transmission loss by 5 dB.

In the case of 4(16)4 IGU, the exterior shutter shows higher overall performance than the exterior roller shutters. The difference is most prominent at the frequency range from 200 to 800 Hz. At 250 Hz, the exterior shutters illustrate higher sound transmission loss of 15 dB than the exterior roller shutters. At higher frequencies, the exterior shutters demonstrate slightly enhanced acoustic performance.

3.2 Interior Add-on Systems

In the case of 4(22)6L IGU, the vinyl curtain provides the highest acoustic performance when compared amongst the rest of the interior add-on systems. The vinyl curtain and interior storm window have similar transmission loss characteristics across all frequencies. The HDCC foam has the least sound insulation benefits and shows a pronounce resonance dip at 125 Hz. All three interior systems provide enhanced acoustic performance beyond 1.25k Hz.

In the case of 4(16)4 IGU, the interior storm window offers the highest overall acoustic performance when compared to the remainder of the interior systems. While the vinyl curtain is comparable to the interior storm window at 125 to 400 Hz, the HDCC foam is comparable to the interior storm window at 1.25 kHz and above.

In general, when add-on systems are installed on either side of the double pane windows, the entire assembly may be considered a triple pane IGU system with an additional air chamber created. Mass-air-mass-air-mass resonance may be found at low frequencies. Exception should be given to the HDCC foam; since the HDCC foam is non-rigid and is installed directly against the window, the air layer is not created.

4 Conclusions

An upward transmission loss trend is clear for all add-on systems against the baseline IGUs. Acoustic benefits of add-on systems are most significant on the low acoustic performance double pane IGU with similar glass thickness, as shown in Figure 1. Exterior shutters have better acoustic performance than exterior roller shutters. Interior storm window provides appreciable noise reduction when compared amongst other interior add-on systems.

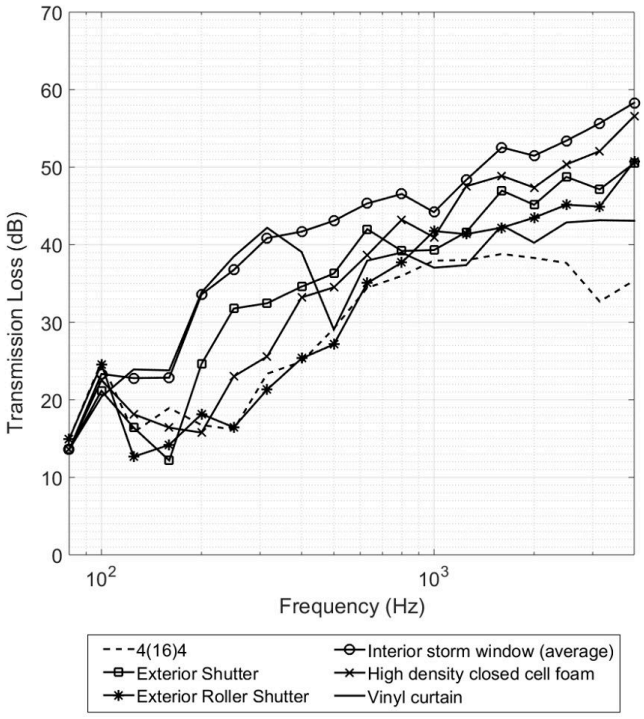

Figure 1: Sound transmission loss data for exterior and interior add-on systems against double pane 4(16)4 IGU

The STC and OITC ratings do not adequately numerate the performance of add-on systems, especially when noise reduction is dependent on the source spectrum and that traffic noise is low frequencies dominant.

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