Noise Isolation Provided by Windows in Residential Projects

Introduction

The most popular types of standard operable windows currently installed in low and medium cost residential projects are casement windows (two sashes: one fixed, one operable); horizontal sliding windows (four operable sashes); and vertical sliding windows (two operable sashes).

Until relatively recently, acoustical data about windows typically assumed that the composition of the glazing was the primary factor that would influence the windows' sound transmission properties. The data did not address the possibility that sound transmission could be influenced by other window characteristics, particularly those associated with the various types of operable windows.

As part of the CMHC External Research Program, the present study was initiated to address this apparent information gap. The project objectives were as follows:

- to investigate the sound attenuation properties of the most popular types of operable windows
- to investigate ways to improve the acoustical performance of casement windows by modifying the composition of the thermopanes, while maintaining the standard sash thickness of this type of window.

Research Program

The following factors were considered during the selection of the thermopanes and windows tested:

- type of window (casement, sliding or sash, physical characteristics, and cost)
- size of window (all measured 1200 mm X 1600 mm, a standard size in new residential construction)
- method of installation inside the test opening
- composition of the glazing unit (type of glazing; width of airspace between panes; thickness of the glass; type of spacer)

A total of 18 sound tests were conducted: nine on stand-alone, factory sealed double-glazing thermopanes, and nine on different types of operable windows. The stand-alone units were tested individually without being inserted in sashes or frames; their thermopanes had the same glazing composition as those of the operable windows tested.

Results

Following the testing, the window units were assigned Sound Transmission Class (STC) and Transmission Loss (TL) values, to indicate their acoustic capabilities. (Note: The higher the STC rating, the better the sound isolation properties of the window.)

Cette publication est aussi disponible en français sous le titre : *Pouvoir insonorisant des fenêtres dans les ensembles résidentiels*

The research report's key results are presented below (and summarized in Figure 1):

- The STC of the nine standalone thermopanes tested ranged between STC 25 and STC 34. The STC measured on the operable windows ranged between STC 27 and STC 41.
- Sealed thermopanes with a deeper airspace provide a higher STC rating and higher TL for frequencies above the MASS-AIR-MASS resonance.
- Doubling the thickness of one of the glass panes composing the doubleglazing thermopanes increased the STC by approximately 6 points.
- Three factory-sealed thermopanes constructed with spacers made of different materials (aluminum, PVC, and aluminum/neoprene) were tested and were found to provide equivalent STC and TL.
- The STC rating of 1200 mm x 1600 mm casement windows was approximately 3 points higher than the STC rating measured on 1200 mm x 1600 mm standalone thermopanes with same glazing composition, sealed in the test opening. In the case of the double hung sash window, the increase in performance compared to the standalone thermopane is 1 point of STC. The reason for those increases required further research.
- Casement windows built with aluminum, wood, and PVC and constructed with identical glazing provided similar sound isolation performance with STC ratings varying by 2 points. The maximum STC measured on casement windows was achieved by an aluminum window (STC 35) equipped with a double-glazed thermopane composed of one 3 mm glass and one 6 mm glass with a 16 mm airspace, followed by the wood (STC 34) and PVC (STC 33) thermopane windows with panes of equal thickness separated by a 13 mm airspace instead of 16 mm.
- Researchers noted that the deeper airspace in the thermopane of the aluminum window was probably responsible for the superior STC rating and partly responsible for its higher transmission losses.
- Comparisons between aluminum, PVC, and wood windows suggested that the seals and the sash composition of the aluminum window could also be responsible for the better sound isolation performance of this window at mid- and high frequencies.
- The casement window that offered the best ratio cost/sound isolation is the wood window followed by the PVC window and, in last position, the aluminum window.
- Combining the maximum STC rating obtained on a stand-alone thermopane measured in the present study with the maximum STC rating measured on casement windows, it appeared that STC 37 would be the maximum rating that could be obtained from an operable casement window equipped with a 25 mm thick thermopane.
- The aluminum sliding window provided superior sound isolation when compared to a PVC sliding window.
- The aluminum horizontal sliding window ranked first in terms of acoustical performance, and seventh in terms of price.

Implication for the Housing Industry

The researchers noted several key findings and recommendations that have implications for the housing industry:

- Acousticians and construction professionals should be careful when selecting windows destined for buildings located in noisy environments. For example:
  - They should not rely solely on glazing composition to determine the sound isolation performance of operable windows.
  - They should be aware that factory-sealed thermopanes can have a significantly lower sound transmission loss than that published for glazing samples of apparently identical composition but whose perimeter is not factory sealed using a standard aluminum spacer.

Figure 1: Summary of Key Results

Window Type	Type of frame/sash	Thermal glazing composition	Notes	Weight/ Thickness	STC
Stand-Alone Non-Operable Windows					
Thermopane installed directly in test opening and sealed at perimeter	No frame; no sash (not operable)	Glass 3 mm; Airspace 19 mm; Glass 3 mm	Standard thermopane used in aluminum casement windows	62 lbs 24.5 mm	27
		Glass 3 mm; Airspace 16 mm; Glass 3 mm	Standard thermopane used in wood and PVC casement windows	62 lbs 21.5 mm	26
		Glass 3 mm; Airspace 13 mm; Glass 3 mm	Standard thermopane used in pine sash windows	62 lbs. 19 mm	26, 25, 25
		Glass 3 mm; Airspace 16 mm; Glass 6 mm	Designed to enhance the acoustical performance of aluminum	91 lbs 24.5 mm	33
		Glass 3 mm; Airspace 13 mm; Glass 6 mm	Designed to maximize the acoustical performance of wood or PVC windows	91 lbs 22 mm	31
		Glass 6 mm; Airspace 9 mm; Glass 8 mm	Designed to maximize acoustical performance of aluminum, wood, PVC windows while maintaining a thin airspace between the glass lights	146 lbs 23 mm	34
		Glass 5 mm; Airspace 38 mm; Glass 5 mm	Glazing composition designed for a sealed window or for the most economical sliding window	104 lbs 48 mm	32
Operable Windows					
Casement window, 2 sashes (1 fixed 1 operable)	Aluminum sash and frame	Glass 3 mm ; Airspace 19 mm; Glass 3 mm	Standard aluminium casement window	103 lbs 25 mm	30
Casement window, 2 sashes (1 fixed 1 operable)	PVC sash; wood frame covered with PVC	Glass 3 mm; Airspace 16 mm; Glass 3 mm	Standard PVC casement window	98 lbs 22 mm	28
Casement window, 2 sashes (1 fixed 1 operable)	Wood sash and frame	Glass 3 mm; Airspace 16 mm; Glass 3 mm	Standard wood casement window	92 lbs 22 mm	29
Casement window, 2 sashes (1 fixed 1 operable)	Aluminum sash and frame	Glass 3 mm; Airspace 16 mm; Glass 3 mm	Superior sound isolating glazing in standard aluminum sash	124 lbs 25 mm	35
Casement window, 2 sashes (1 fixed 1 operable)	PVC sash; wood frame covered with PVC	Glass 3 mm; Airspace 13 mm; Glass 3 mm	Superior sound isolating glazing in standard PVC sash	118 lbs 22 mm	33
Casement window, 2 sashes (1 fixed 1 operable)	Wood sash and frame	Glass 3 mm; Airspace 13 mm; Glass 3 mm	Superior sound isolating glazing wood sash	112 lbs 22 mm	34
Sliding window, 4 sashes sliding horizontally	Aluminum sash and frame	Glass 3mm ; Airspace 108 mm; Glass 3 mm	Standard aluminum sliding window	95 lbs 114 mm	41
Sliding window, 4 sashes sliding horizontally	Sash and frame made out of vinyl covered pine	Glass 5 mm ; Airspace 34 mm; Glass 5 mm	The most economical 4 sash sliding windows	120 lbs 44 mm	32
Sliding window, 4 sashes sliding horizontally	Sash and frame made out of vinyl covered pine	Glass 3 mm; Airspace 13 mm; Glass 3 mm	The most economical window	90 lbs 19 mm	27

- The sound isolation efficiency of the gaskets at the perimeter of operable window sashes seems to vary substantially with the type of window considered.

- For casement windows and aluminum sliding windows, a degradation of approximately 3 points of STC could exist between the acoustical performance of an operable casement window and the data published by the National Research Council of Canada for a sealed window having the same glazing composition. In the case of PVC sliding windows and sash windows, however, the results of this study indicated that this degradation could be more substantial and reach 8 points of STC.

- The aluminum horizontal sliding window ranked first in terms of acoustical performance, and seventh in terms of cost (that is, only two of the nine operable windows tested were less expensive). Consequently, this window appeared particularly well-suited for low-cost residential projects located in noisy environments. Other factors such as durability, thermal resistance and air leakage would also have to be evaluated.

Finally, the research report notes that this research was a preliminary attempt to examine the effect of glazing size, gaskets, frame and sash composition of operable windows on their sound isolation performance. Further research would be required to confirm the findings.

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Research Report: *Noise Isolation Provided By Windows in Residential Projects, 1997*

Research Consultant: *Michel Morin, MJM Acoustics Inc.*

A full report on this research project is available from the Canadian Housing Information Centre at the address below.

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