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RESEARCH PROJECT ON THE NOISE ISOLATION PROVIDED BY WINDOWS IN RESIDENTIAL PROJECTS

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Executive Summary

The external Research Program of CANADA MORTGAGE AND HOUSING CORPORATION accepted the proposal by MJM ACOUSTICAL CONSULTANTS INC. to conduct a study on the noise isolation provided by windows of residential projects.

The acoustical data presently available on windows is presented as if the glazing composition was the only factor influencing the sound isolation which they provide; sound transmission loss data on fully operable windows is not easily available. One of the objectives of this research project was to fill this void by investigating the sound attenuation properties of the most popular types of standard operable windows currently installed in low and medium cost residential projects: casement windows (2 sashes, one fixed, one operable), horizontal sliding windows (4 operable sashes), and vertical sliding windows (2 operable sashes). Another goal of this study was 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 windows.

A total of eighteen tests were conducted: nine on stand-alone double glazing thermopanes, and nine on different types of double glazing operational windows. Table 1 below contains a summary of the results obtained, expressed in terms of Sound Transmission Class (STC); it also contains useful information about the windows tested such as their type, their weight, their price, etc.

The conclusions of the present study are as follows:

- The Sound Transmission Class (STC) of the nine stand-alone thermopanes tested in this study varied from STC 25 to STC 34. The STC measured on

casement windows, horizontal sliding windows, and double hung sash windows varied from STC 27 to STC 41.

- Sealed thermopanes with a deeper airspace provide a higher STC rating and a higher sound Transmission Loss (TL) for frequencies above the Mass-Air-Mass resonance.
- Doubling the thickness of one of the glass panes composing the double-glazing thermopanes increased the STC by approximately 6 points. Also, for thermopanes constructed with an unbalanced construction (one 3 mm and one 6 mm glass), the coincidence dip in the TL curve is much less pronounced, resulting in better sound isolation at high frequencies. To reduce significantly the coincidence dip however, the mass of one pane must be at least twice the mass of the other pane.
- A study conducted from 1978 to 1981 on the transmission loss of windows by the NRCC1 indicated that factory sealed thermopanes incorporating an aluminum spacer between the panes provided inferior sound transmission loss when compared to glazing of similar composition with no spacer. In the present study 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 stand-alone 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 stand-alone thermopane is 1 point of STC. The reason for those increases have yet to be determined with further research.
- Casement windows built with aluminum, wood, and PVC constructed with identical glazing provided similar sound isolation performance with STC ratings varying by 2 points. The maximum sound transmission class 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. The deeper airspace in the thermopane of the aluminum window is probably responsible for the superior STC rating and partly responsible for the higher 1/3 octave TL values

provided by this window. However, comparing the sound transmission loss curves of the aluminum, PVC and wood windows suggests 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 which offers 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 (thermopane no 6) with the maximum STC rating measured on casement windows (aluminum window no 11), it appears that STC 37 would be the maximum rating which could be obtained from an operable casement window equipped with a 25 mm (1") thick thermopane.
- The aluminum sliding window provides very superior sound isolation when compared to a PVC sliding window (STC 41 vs STC 32). Based on the previously mentioned NRCC study on windows, the STC rating of these two windows should have been in the same range (STC 40). Further research is required to explain the poor performance of the PVC horizontal sliding window.
- The aluminum horizontal sliding window ranked first in terms of acoustical performance, and seventh in terms of price. This window appears particularly well adapted for low cost residential projects located in noisy environments.
- Acousticians and construction professionals must be careful when selecting windows destined for buildings located in noisy environments. They should not rely solely on glazing composition to determine the sound isolation performance of operable windows. They must 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. In addition, 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, the present study indicates that 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 NRCC for a sealed window having the same glazing composition (This is consistent with the predictions of David

Quirt the author of the NRCC study). In the case of PVC sliding windows and in the case of sash windows however, the results of this study indicate that this degradation could be more substantial and reach 8 points of STC.

- This research was a preliminary attempt to determine the effect of glazing size, gaskets, frame and sash composition of operable windows on their sound isolation performance. Further research is required to confirm some of its findings.

References

- Table 1

Measurement Manufacturer	Window description	Type of frame/sash	Thermal glazing composition	Notes	Weight of sample Glazing thickness	STC rating
1 Thermalite	Thermopane installed directly in test opening and sealed at perimeter	No frame	Glass 3 mm Airspace 19 mm Glass 3 mm	Standard thermopane used in Aluminum casement windows (window no 8)	62 lbs 24,5 mm	27
2 Thermalite	Thermopane installed directly in test opening and sealed at perimeter	No frame No sash	Glass 3 mm Airspace 16 mm Glass 3 mm	Standard thermopane used in wood and PVC casement windows (windows no 9 and 10)	62 lbs 21,5 mm	26
3, 3A, 3B Thermalite	Thermopane installed directly in test opening and sealed at perimeter	No frame No sash	Glass 3 mm Airspace 13 mm Glass 3 mm	Standard thermopane used in pine sash windows (window no 16)	62 lbs 19 mm	3 = 26 3A = 25 3B = 25
4 Thermalite	Thermopane installed directly in test opening and sealed at perimeter	No frame No sash	Glass 3 mm Airspace 16 mm Glass 6 mm	Thermopane designed to enhance the acoustical performance of aluminum windows (window no 11)	91 lbs 24,5 mm	33
5 Thermalite	Thermopane installed directly in test opening and sealed at perimeter	No frame No sash	Glass 3 mm Airspace 13 mm Glass 6 mm	Thermopane designed to enhance the acoustical performance of wood or PVC windows (windows no 12 and 13)	91 lbs 22 mm	31
6 Thermalite	Thermopane installed directly in test opening and sealed at perimeter	No frame No sash	Glass 6 mm Airspace 9 mm Glass 8 mm	Thermopane designed to maximize the acoustical performance of aluminum, wood and PVC windows while maintaining a thin airspace between the glass lights	146 lbs 23 mm	34
7 Thermalite	Thermopane installed directly in test opening and sealed at perimeter	No frame No sash	Glass 5 mm Airspace 38 mm Glass 5 mm	Glazing composition destined to a sealed window or to the most economical sliding window (window no 15)	104 lbs 48 mm	32

Measurement Manufacturer	Window description	Type of frame/sash	Thermal glazing composition	Notes	Weight of sample Glazing thickness	STC rating	Net Price
8 Wilton	Casement window; 2 sashes (1 fixed, 1 operable)	Aluminum sash and frame	Glass 3 mm Airspace 19 mm Glass 3 mm	Standard aluminum casement window	103 lbs 25 mm	30	456$
9 Melco	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	334$
10 Polar	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	295$
11 Wilton	Casement window; 2 sashes (1 fixed, 1 operable)	Aluminum sash and frame	Glass 3 mm Airspace 16 mm Glass 6 mm	Superior sound isolating glazing in standard aluminum sash	124 lbs 25 mm	35	514$
12 Melco	Casement window; 2 sashes (1 fixed, 1 operable)	PVC sash; wood frame covered with PVC	Glass 3 mm Airspace 13 mm Glass 6 mm	Superior sound isolating glazing in standard PVC sash	118 lbs 22 mm	33	355$
13 Polar	Casement window; 2 sashes (1 fixed, 1 operable)	Wood sash and frame	Glass 3 mm Airspace 13 mm Glass 6 mm	Superior sound isolating glazing wood sash	112 lbs 22 mm	34	320$
14 Wilton	Sliding window; 4 sashes sliding horizontally	Aluminum sash and frame	Glass 3 mm Airspace 108 mm Glass 3 mm	Standard aluminum sliding window	95 lbs 114 mm	41	268$
15 Robert	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	177$
16 Robert	Sash window; 2 sashes sliding vertically	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	149$

[1] J.D. Quirt: Measurement of Sound Transmission Loss of Windows, Building Research note no 172, National Research Council of Canada, Ottawa, April 1981.