

NOISE REDUCTION OF A STANDARD CURTAIN WALL CONSIDERING OPENING FOR NATURAL VENTILATION

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1. INTRODUCTION

The growing interest in natural or hybrid ventilation systems makes a challenge for good integration of openings in building façades. In a noisy environment, there is an important limitation for the use of direct openings with common building envelopes. As a part of a research project dedicated to this problem, it is possible to evaluate the impact of a curtain wall before testing several double-skin configurations. Experimental measurements made in laboratory conditions lead to the estimation of usual noise reduction and sound transmission class. Moreover, the airflow capacity can be assessed as a function of the aperture. Analyzing those parameters together should give useful information for the design of passive ventilation with a significant airflow when acoustical performance is an important issue.

1.1. Global research project

The actual study is a part of an on going project managed by the *Groupe de recherche en ambiances physiques* (GRAP) at the school of architecture of Université Laval in Quebec City. As explained, there is an interest to get air exchange through building façades without letting noise to penetrate inside. Those parameters are directly linked to the comfort of occupants by perception of physical ambiances, as for thermal environment, air quality, lighting, and sound. Acoustical treatment of building openings is complex, as many construction elements and phenomena must be considered. De Salis et al. [1] have made a remarkable review of most possibilities in relation with natural ventilation.

On the other hand, actual practice in architectural conception and design shows a need for better description of dynamic performances that involve various variables. Consequently, this long-term research points towards achieving a comparative analysis of different constructions regarding acoustics and the use of natural ventilation. After previous reports about windows [2] or a prototype for hidden silencer, this paper focuses on curtain wall. It should be followed by further try-out with multiple configurations of double skin envelopes.

1.2. Curtain wall sample

The proposed sample of insulated curtain wall is based on standard construction that includes an aluminium structure and windows. Chosen assembly consists in a self-standing frame divided in nine windows, three of them

being operable. As it is generally the case, the overall thickness of sealed units is 25 mm (1 inch), having two glasses of 6 mm and a gap of 12 mm. Figure 1 details dimensions of the sample built in the laboratory, which represents a total transmission area of 12.7 m².

2. EXPERIMENTS

2.1. Testing facility and sample installation

Both reverberating chambers of the acoustical laboratory of Université Laval were used to achieve all data acquisitions. The first room of 200 m³ is separated from the second of 60 m³ by an opening of 7.9 m² (2.63 x 3.00 m). However, it must be noticed that the curtain wall was installed to fulfill dimensions of the smaller room. To be able to move the curtain wall in the future, the main structure was put into a 2x8 in. wood frame. Junctions with laboratory walls were carefully caulked with acoustical sealant, and neoprene compression joints were added to all sides.

2.2. Testing method

For noise insulation tests, an omni-directional loudspeaker was used in the source chamber. Measurements were made with a pink noise generator, in accordance with ASTM E90 [3]. Acquisitions of sound pressure levels and reverberation times were recorded on a real time acoustic analyzer. Those values were processed afterward to calculate transmission loss and sound transmission class index, following ASTM E413 [4].

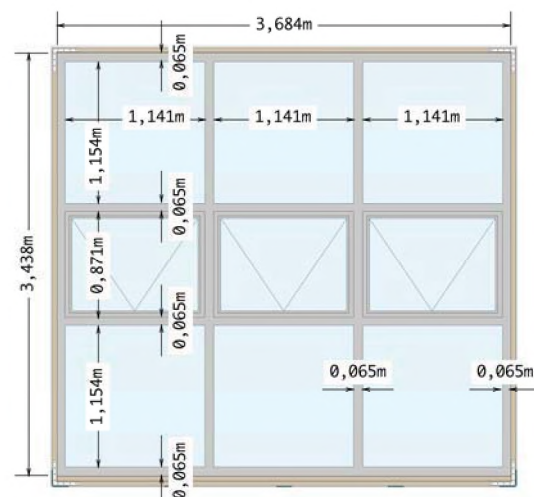


Figure 1. Dimensions of tested curtain wall.

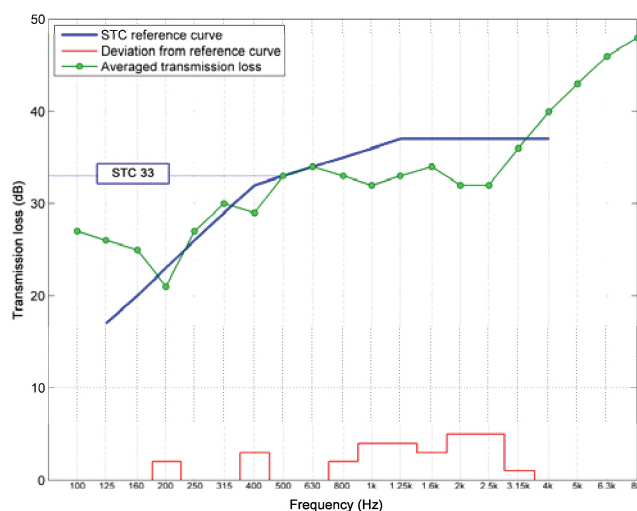


Figure 2. STC calculation for tested curtain wall with 6/12/6 mm sealed units and closed windows.

3. RESULTS

3.1. Sound insulation of closed and half-opened wall

Firstly, evaluation of the sound insulation procured by the façade sample has been tested with all windows closed. Sound pressure levels were noted and averaged in both rooms to get the noise reduction. Reverberation time measurements made in the receiving room then allowed the calculation of normalized insulation values, which has lead to a global sound transmission class of 33. Graph of fig. 2 shows the spectrum of observed transmission loss and determination of STC. That result follows expected performance for that kind of windows.

Even if the sample is equipped with three operable windows, experiments were accomplished by opening the middle unit only. As joining both rooms with the aperture can modify sound absorption, discussed results concern only direct noise reduction. Using A-weighting for sound pressure levels, this analysis might reflect occupant's perception. Figure 3 gives the averaged interpolation of noise reduction as a function of the opening ratio, 100% being maximum position of this particular model of window. Observations reveal that sound insulation drop of around 7 dB(A) when we start to half-open the aperture. Then, the decrease is fairly constant down to a noise reduction of 13 dB(A).

3.2. Airflow observations

The first test made about ventilation was to check maximal free running capacities. That consists in measuring airflow with a small deferential pressure through the façade. With a constant difference of 3 Pa, it seems possible to supply an airflow over 200 litres per second with an opening ratio higher than 10%. It means that a half-opened window with a light wind could improve the air exchange rate and still offers 20 to 25 dB(A) of noise reduction.

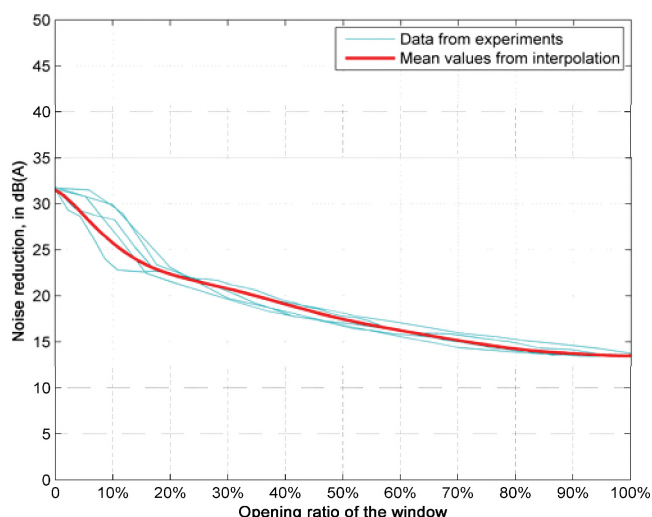


Figure 3. Noise reduction for the curtain wall depending on the opening ratio of one operable window.

4. CONCLUSIONS

The present research project aims to verify the relationship between acoustic insulation and airflow capacities for building façades. This particular study reports first results related to performances of a common curtain wall. In addition to known benefits, curtains walls can help to protect rooms from outside noise. When all windows are closed, the sound transmission class depends mostly on the glass thickness, with values generally over 30. If openings are used for natural ventilation, those tests show noise reduction in the range of 13 to 32 dB(A).

The next step will be to consider double skin assemblies as solutions to provide a good fresh air inlet with a lower annoyance caused by noise transmission.

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ACKNOWLEDGEMENTS

This research would have not been feasible without the contribution of A. & D. Prévost inc. and Les Miroirs St-Antoine inc. concerning the sample of curtain wall and windows. Authors also acknowledge the help of M. Leroux (GRAP) during installation and tests, along with J-G. Migneron for his support.