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RESEARCH PROJECT ON NOISE ISOLATION PROVIDED BY EXTERIOR WALLS IN WOOD CONSTRUCTION

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Executive Summary

The external Research Program of CANADA MORTGAGE & HOUSING CORPORATION accepted the proposal by MJM ACOUSTICAL CONSULTANTS INC. to conduct a study on the noise isolation provided by exterior walls in wood construction.

At the time the proposal for this research project was submitted, the acoustical data available on exterior walls was almost inexistent. The main objective of this project was to fill this void by investigating the sound attenuation properties of four exterior walls commonly used in Canadian low cost residential housing.

A total of nine Sound Transmission Loss measurements were conducted on the four exterior walls selected: two walls with 38 mm x 140 mm (2" x 6") studs and two with 38 mm x 89 mm (2" x 4") studs. Five tests were carried on walls with no exterior finishes, and four on walls with PVC cladding. All the wall compositions selected had a thermal insulation factor of RSI 3.5 (R_{20}). In order to establish the effect of varying the stud spacing, one sound transmission loss test was performed on a wall whose studs were spaced 600 mm (24") apart; the rest of the specimens were constructed with studs spaced at 400 mm (16") o.c. which is presently the stud spacing most often used for exterior walls in Canadian construction. The interior finish was the same for all the walls tested: 13 mm (") drywall located on the receiving room side (the large reverberation chamber). The exterior side of the wall was located on the source room side.

The conclusions reached during the present study are as follows:

- Spacing the 38 mm x 140 mm (2" x 6") studs of an exterior wall at 600 mm (24") o.c. wall n° 1 instead of 400 mm (16") o.c. wall n° 2 resulted in an increase

of 6 points of STC and in an increase of 2 points of OITC. The 1/3 rd octave sound transmission loss values of the wall constructed with studs at 600 mm (24") o.c. are generally higher or in the same order that those of the wall constructed with studs at 400 mm (16") o.c. except for frequencies below 80 Hz for which the TL of the wall constructed with studs spaced at 400 mm (16") o.c. are greater.

- Exterior walls framed with 38 mm x 140 mm (2" x 6") studs, are generally constructed with OSB boards or asphalt impregnated wood fibre boards. The wall constructed with asphalt impregnated wood fibre boards instead of OSB boards provided a significantly better sound transmission loss for all frequencies above 125 Hz, even though the surface mass of the wood fibre boards is more than two times less than that of the OSB boards; below 125 Hz the OSB boards provide a slightly superior sound isolation. The difference of only 0 to 2 points between the STC and OITC ratings measured on walls constructed with asphalt impregnated wood fibre board and those measured on walls constructed with OSB boards can be misleading since it suggests that the walls provide similar acoustical performance when in fact, the transmission loss curves indicate that the wall constructed with the wood fibre board is clearly superior to that constructed with OSB boards. The effect of the 3 mm (1/8") airgap that the manufacturer recommends to leave between the OSB boards tested has not been fully investigated during this study and should be investigated further in a subsequent study.
- When using 38 mm x 89 mm (2" x 4") studs the most popular materials used to reach the RSI 3.5 (R_{20}) insulation factor and to provide suitable air barrier are either 38 mm (1 ") thick semi-rigid fibrous insulation covered with a housewrap air barrier, or 38 mm (1 ") extruded polystyrene insulation. The results of the present study suggest that walls constructed with a fibrous insulation covered with a housewrap air barrier provides a sound isolation performance significantly superior to that of walls built with a polystyrene insulation. The STC and OITC ratings measured were 2 to 3 points in favor of the fibrous material.
- In the case of the four types of exterior wall tested in this research, adding a PVC cladding had little or no effect on the transmission loss at low frequency (below 125 Hz). Since the OITC rating is governed mainly by the low frequency sound transmission loss, a variation of only 2 points was noted between the

OITC ratings of the walls tested. The increase of STC rating caused by the addition of a PVC cladding is in the order of 1 to 4 points and is mainly governed by the sound transmission loss measured between 125 and 400 Hz. The PVC cladding provided the greatest sound transmission loss increase when it was installed on wall n° 8 constructed with 38 mm x 89 mm (2" x 4") studs and a semi-rigid 38 mm (1 ") thick fibrous insulation covered with a housewrap air barrier. It was not in the scope of this research project to test several exterior finishes currently used in the Canadien residential construction industry.

- Comparing the results of the sound transmission loss measurements made on the four exterior walls studied in the present research project (walls n° 6 to 9), one notices that:
    - Although there is a variation of only one point in the OITC and 3 points in the STC ratings of the four walls tested with exterior finishes, one cannot conclude that they provide equivalent sound isolation for exterior noise sources having different spectra. In fact, the difference between the sound transmission loss provided at frequencies above 125 Hz by the four walls tested in this study can reach 10 dB.
    - Below 125 Hz, the walls tested provided an equivalent sound isolation. All the walls provided their minimum sound transmission loss at 80 Hz; the transmission loss at that frequency was approximately 12 dB.
    - From 125 to 315 Hz wall n° 6 constructed with 38 mm x 140 mm (2" x 6") studs and asphalt impregnated wood fibre board provided the best sound isolation, followed by wall n° 8 constructed with 38 mm x 89 mm (2" x 4") studs and semi-rigid glass fibre insulation.
    - From 315 Hz and above wall n° 8 provided the best sound isolation followed by wall n° 6.
    - When expressed in terms of STC rating the walls constructed with 38 mm x 89 mm (2" x 4") studs provided a better sound isolation than those constructed with 38 mm x 140 mm (2" x 6") studs; the walls constructed with a PVC cladding ranked as follows starting from that providing the highest sound isolation:
        - Wall n° 8: 38 mm x 89 mm (2"x 4") with semi-rigid fibre insulation
        - Wall n° 6: 38 mm x 140 mm (2"x 6") with asphalt impregnated wood fibre board

    - Wall n° 9: 38 mm x 89 mm (2"x 4") with rigid polystyrene insulation
    - Wall n° 7: 38 mm x 140 mm (2"x 6") with OSB boards
  - An evaluation based on noise spectra collected during a recent noise climate survey made by MJM Acoustical Consultants inc. and the results of the present study suggests that walls n° 6 to 9 should provide enough sound insulation to reduce exterior noise due to road and rail traffic from a $Leq_{(24h)}$ of 60 dB(A) outside to a $Leq_{(24h)}$ = 35 dB(A) inside a home and meet the CMHC noise level criteria not to be exceeded inside bedrooms of residential projects. However, wall compositions no 6 to 9 should not be used in residential sites where the exterior noise due to vehicular or train traffic levels exceeds a $Leq_{(24H)}$ of 60 dB(A).
  - It is now relatively frequent in low cost developments incorporating "new house concepts" to build detached homes separated by a distance of only 4 to 5 feet. With the low frequency output of the contemporary home sound systems, it is probable that the low frequency content of music or films could be transmitted from home to home via exterior walls n° 6 to 9, in residential projects where homes are separated by only a few feet.
  - This research was a preliminary attempt to obtain reliable sound transmission loss data on exterior walls with wood structure destined to low cost housing. Further research is required to confirm some of it findings and to determine ways of improving the acoustical performance of exterior walls of buildings to be constructed in noisy environments.

Acronyms

- **$Leq_{(duration)}$**: Equivalent Sound Pressure Level
  Equivalent sound pressure level integrated over the sampling period or duration indicated between parenthesis. This quantity is useful to compare fluctuating noises; it corresponds to the sound pressure level of a steady state noise whose acoustical energy and duration are the same as the fluctuating noise measured.
- **OSB**: Oriented Strand Board
- **STC**: Sound Transmission Class

- **OITC**: Outdoor-Indoor Transmission Class