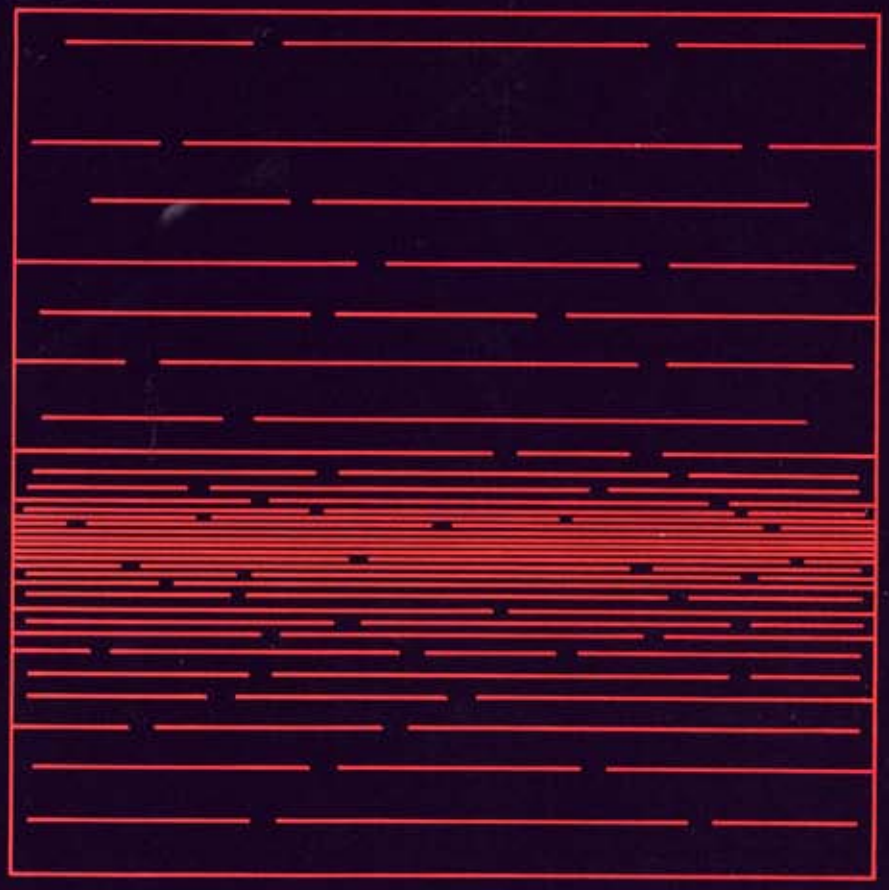
CMHC
Canada Mortgage
and Housing Corporation

SCHL
Société canadienne
d'hypothèques et de logement

LeBreton Flats Development Evaluation 2

Walls and Floors as Sound Barriers

2



Canada

LeBreton Flats Development Evaluation 2

Walls and Floors as Sound Barriers

Aussi disponible en français

Canada Mortgage and Housing Corporation
Société canadienne d'hypothèques et de logement

Honourable Paul Cosgrove
Minister

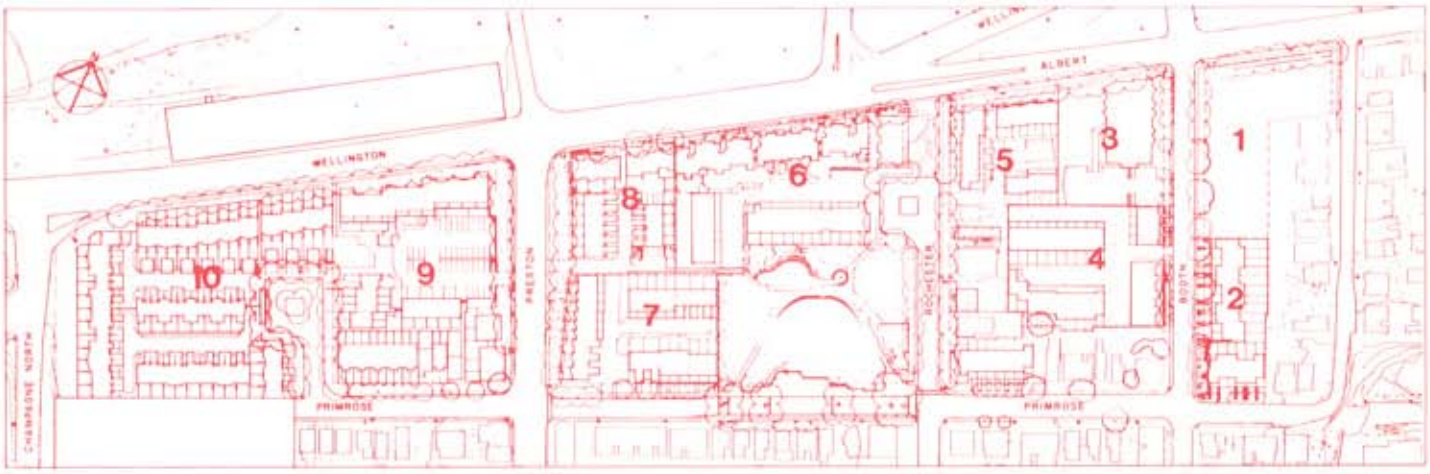
ISBN 0-662-11791-3
Cat. No. NH18-17/2-1981E

Preface

The LeBreton Flats residential community is located in downtown Ottawa, within view of the Ottawa River, just 1 km west of Parliament Hill. Phase 1, consisting of 425 housing units, has been developed by Canada Mortgage and Housing Corporation as an exemplary inner-city community. This development adjoins an existing residential neighborhood on the south and borders Wellington Street, a major traffic artery, on the north. Within its ten development subdivisions, there have been new approaches to construction, energy conservation and overcoming environmental constraints; the results are now under evaluation.

This pamphlet on walls and floors as sound barriers is one in a series describing experiments undertaken at LeBreton Flats. New approaches to energy conservation, snow control, storm water management and recreation facility design are among the subjects discussed in the series.

Each pamphlet will identify a specific problem or need encountered in the LeBreton Flats development, describe its experimental solution in terms of concept, design and performance and offer suggestions for improving the design and adapting it to other sites and conditions.



LeBreton Flats, Ottawa

Map showing the ten housing projects which make up phase 1 of the development.

Introduction

The protection of privacy within individual housing units was a major objective in the design of the Phase 1 development. In a high-density community such as Phase 1 (net density 89 units/ha), sound and noise transmitted through walls and floors is annoying and intrusive. CMHC installed several different types of shared (party) walls and floors in townhouses at LeBreton Flats to determine their effectiveness as sound barriers.

This pamphlet describes the construction of six types of party walls and two different floors and evaluates their sound-reducing capacities.

Principles of design

The common wall or floor/ceiling separations between two housing units must function as a barrier against:

- airborne sound generated over a wide range of frequencies by people, stereo equipment, household machinery, electrical tools and other sources
- vibrational noise produced by a slamming door, impact or blow on the wall or floor.

When sound waves are obstructed by a wall or floor, a part of their energy is transferred to the obstruction, causing it to vibrate. In a homogeneous partition such as solid or hollow-core concrete, plaster, plywood, glass, brick or concrete blocks, both faces vibrate together to transmit the sound from one area to another.

The sound insulation of a single-layer wall or floor can be improved by increasing its weight and thickness, but a lighter and more cost-effective sound barrier is the two-leaf partition, such as the 'double-stud' and gypsum board wall, in which two impervious layers are spaced millimetres apart with minimum structural connection in between. (See Figure (f).) The space, which may be filled with such sound-absorbing materials as fibreglass batts, breaks the transmission path of sound vibrations so that they are unable to travel directly from one side of the wall or floor to the other.

Construction

Careful attention to details is essential to realize the full noise-reduction potential of such two-leaf walls.

Noise can circumvent or penetrate even the best sound barrier separations because of poor construction details or improper installation. Care must be taken when installing studs, joists and subfloors to ensure that noise does not travel through these structural members.

A sound-insulating partition, to be effective, must be virtually airtight. Any unnecessary leaks, such as cracks and pinholes, are paths for sound and will reduce the noise attenuation of the wall or floor.

Methods of installing sound-insulating walls for maximum efficiency are described in the ASTM Standard E336-77.

Evaluating the performance

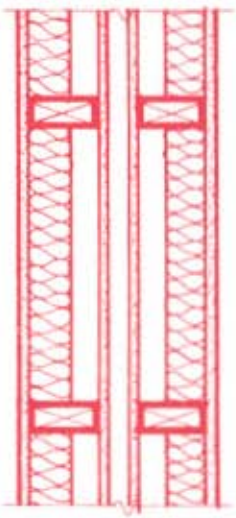
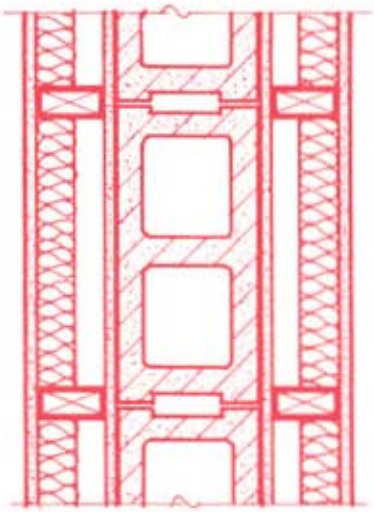
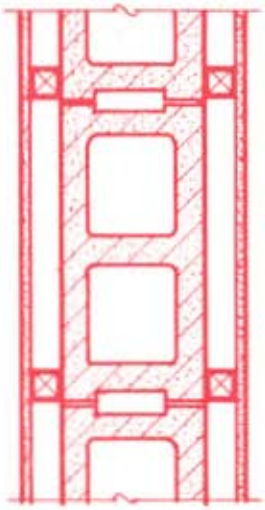
The sound-insulation efficiency of a party wall or floor is determined by how much it reduces wide-ranging frequencies of airborne sound. This reduction is expressed as a Sound Transmission Class (STC) rating, which provides a comparative measure of a construction's potential performance as determined by laboratory testing. The higher the STC rating the better the sound insulating properties. The Canada Building Code specifies a minimum STC of 45 for party walls and floors.

The *actual* noise reduction between two adjacent units is commonly described by a Noise Isolation Class (NIC) rating. NIC ratings should correspond quite closely to STC ratings if the partitions have been properly constructed and there are no other significant sound transmission paths.

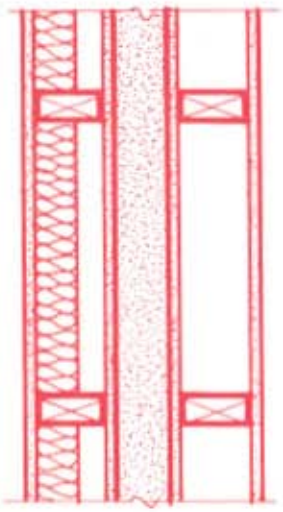
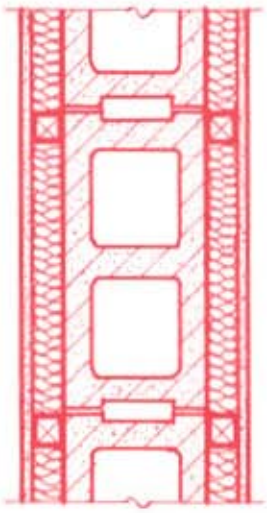
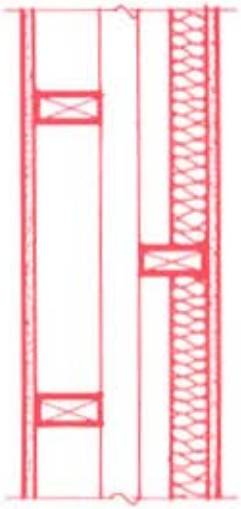
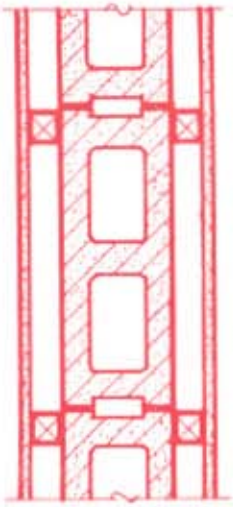
A separation providing a Noise Isolation Class (NIC) of 45 may not sufficiently reduce noise to ensure occupant satisfaction. At sites where the steady background noise (from furnace fans, refrigerators, traffic, etc.) is low, indoor sound transmissions become more noticeable and separation ratings substantially higher than 45 are desirable.

The noise reductions achieved with the party walls and floors in the LeBreton Flats townhouses were determined by the National Research Council of Canada. The measured NIC values are presented in the following tables.

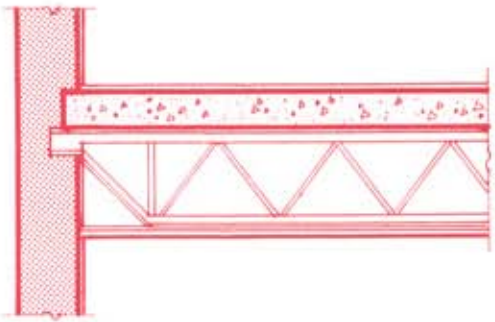
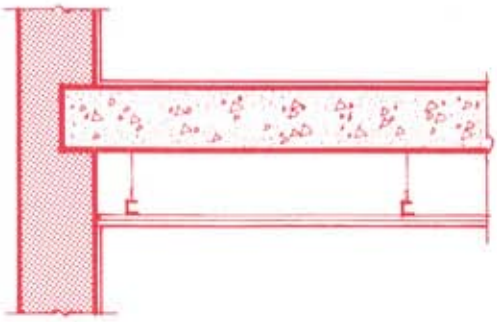
Construction of the party walls and floor/ceiling systems

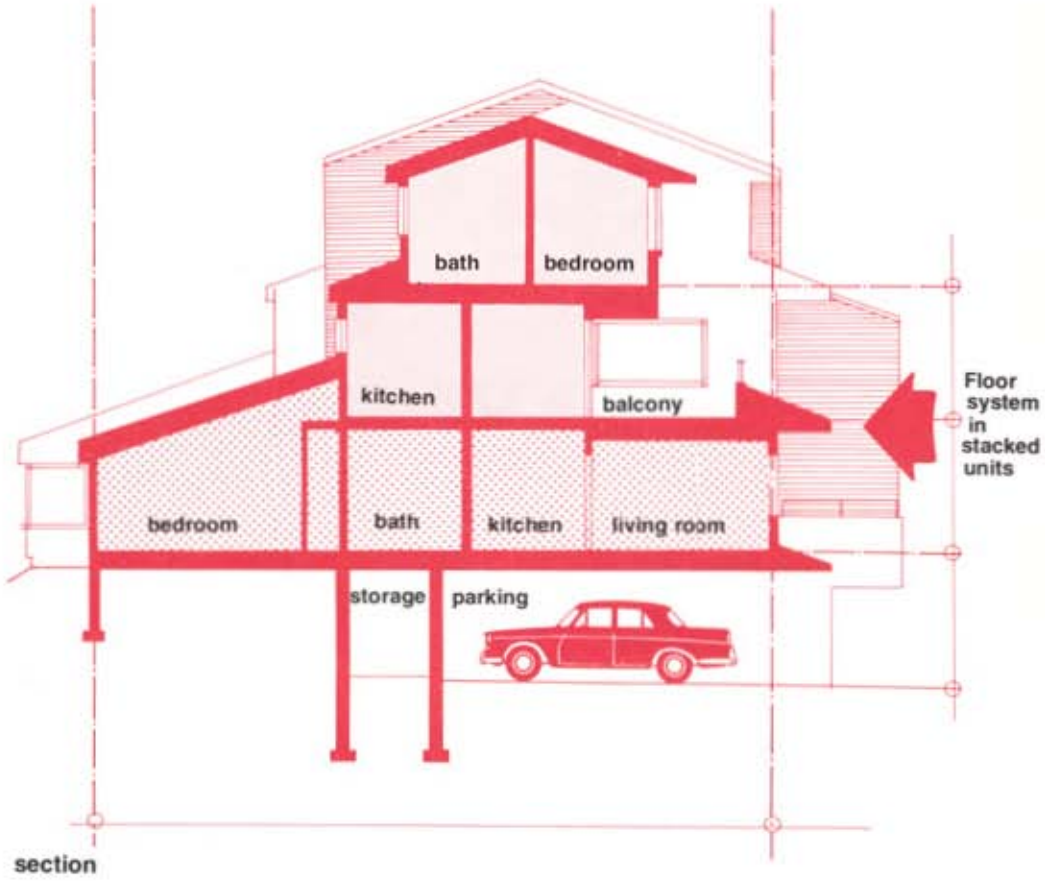
Walls	(a) Double-stud wall with air space	(b) Double-stud wall with concrete block separator	(c) 190 mm concrete block wall with no insulation
			
Materials	16 mm gypsum board 50 mm sound insulation 38 x 89 mm wood studs 12.5 mm gypsum board 25 mm air space 12.5 mm gypsum board 38 x89 mm wood studs 50 mm sound insulation 16 mm gypsum board	16 mm gypsum board 50 mm sound insulation 38 x 89 mm wood studs 12.5 mm gypsum board 190 mm concrete block 12.5 mm gypsum board 38 x 89 mm wood studs 50 mm sound insulation 16 mm gypsum board	12.5 mm gypsum board 38 x 38 mm strapping 190 mm concrete block 38 x 38 mm strapping 12.5 mm gypsum board
Construction	Two standard interior walls, separated by a 25 mm air space. Each component wall is constructed of 38 x 89 mm wood studs nailed at 400 mm centres filled with 50 mm thick mineral fibre acoustical insulation enclosed with 12.5 mm gypsum board on the inside and 16 mm fire grade gypsum wallboard outside.	Two standard interior walls, separated by hollow 190 mm concrete blocks. Each component wall is constructed of 38 x 89 mm wood studs nailed at 400 mm centres filled with 50 mm thick mineral fibre acoustical insulation enclosed with 12.5 mm gypsum board on the inside and 16 mm fire grade gypsum wallboard outside.	Built of hollow 190 mm concrete blocks, strapped with 38 mm lumber for the attachment of 12.5 mm gypsum board both sides.
1981 Cost*	$663.00	$870.00	$503.00
Noise Isolation Class (NIC)	40	70	55
Fire rating (hours)	1	2	2
Thermal Resistance RSI (R)	3.27 (18.63)	3.36 (19.1)	1.17 (6.70)
Comments	Relatively expensive; poor noise reduction; low fire rating.	Very expensive; excellent noise reduction; functions as firewall.	Easy to construct; good noise reduction; efficient firewall; handy for the installation of electric wiring.

*Cost calculated for wall section 2.65 m high, 4.4 m long. Thickness varies.

(d) Composite wall	(e) Concrete block wall with insulation	(f) Double-stud wall with insulation on one side	(g) 140 mm concrete block wall with no insulation
			
16 mm gypsum board 38 x 89 mm wood studs 50 mm sound insulation 12.5 mm plywood 75 mm cementitious sand 12.5 mm plywood 38 x 89 mm wood studs 16 mm gypsum board	12.5 mm gypsum board 38 x 38 mm strapping 50 mm sound insulation 190 mm concrete block 50 mm sound insulation 38 x 38 mm strapping 12.5 mm gypsum board	12.5 mm gypsum board 38 x 89 mm wood studs 50 mm separation 50 mm sound insulation 38 x 89 mm wood studs (staggered) 12.5 mm gypsum board	12.5 mm gypsum board 38 x 38 mm strapping 140 mm concrete block 38 x 38 mm strapping 12.5 mm gypsum board
Experimental wall combination. Two different walls separated by 62.5 mm space filled with cementitious sand. Form ties. One component wall has a 38 x 89 mm stud frame faced with 16 mm gypsum board on the outside and 12.5 mm plywood on the inside. The second wall is similar in construction but is filled with 50 mm thick mineral fibre acoustical insulation.	Constructed of hollow 190 mm cement blocks, strapped with 38 x 38 mm lumber, insulated with 50 mm thick sound absorptive material on both sides and enclosed with 12.5 mm drywall.	Similar in construction to (a) but only one component wall is filled with 50 mm thick sound insulation and no gypsum board on the inside faces.	Constructed of hollow 140 mm concrete blocks, strapped with 38 x 38 mm lumber enclosed both sides with 12.5 mm gypsum board.
$865.00	$653.00	$391.00	$500.00
59	59	53	58
2	2	1	2
2.21 (12.57)	3.16 (17.98)	2.10 (11.96)	1.15 (6.48)
Very expensive; very good noise reduction.	Relatively expensive; efficient; only slightly better than (c) — sound transmission through the strapping; reduces airborne impact noise; excellent fire rating.	Inexpensive; good noise reduction.	Expensive; very reliable and efficient; good noise reduction; excellent fire rating.

Floor Systems

	(a) Concrete over open-web steel joists, drywall ceiling, carpet covered	(b) Poured in place concrete slab, carpet covered
		
Materials	102 mm reinforced concrete slab 250 mm open web steel joist 16 mm firecode drywall	175 mm reinforced concrete slab 12.5 mm drywall
Construction	Carpet on underlay over 102 mm reinforced concrete slab, over open-web steel joists, 16 mm firecode drywall securely fastened to underside. Ceiling finished with heavy stipple coat.	Carpet on underlay over 175 mm reinforced concrete slab; 12.5 mm drywall ceiling finished with heavy stipple coat, supported on furring channels wirec to joists.
1981 Cost (dimensions)	$67.00 per square metre	$67.00 per square metre
Noise Isolation Class (NIC)	55	About 44 (estimate)
Fire rating (hours)	1	1
Comments	Easy to construct; good airborne sound insulation; poor impact sound attenuation. Cost of increased wall height not included.	Barely adequale sound insulation; average fire rating.



Two-leaf partition walls and floor systems can be used in stacked and row units, such as these housing units at LeBreton Flats

Conclusions

The results of sound attenuation testing at LeBreton conform to design and theoretical expectations. Increased weight did improve sound insulation, especially when the weight was distributed between two layers with minimum connections in between.

Gypsum board walls curb sound best when maximum space is left between two exterior layers of gypsum and the structural coupling is kept to a minimum (as, for example, in wall (f)).

The comparatively poor performance of wall (a) is related to the small space between the two layers of gypsum board in the middle of the wall; removing both interior layers would substantially increase the STC.

Fibreglass in a stud cavity has little sound-absorbing value unless structural coupling is minimized, for example, by using double-stud framing or resilient channels.

The noise-reducing capacity of this type of wall may be lessened when the rough framing is done by chain saw — a common practice in the field. Holes cut into the stud wall for built-in cabinets, shelving, etc. also reduce its acoustical performance.

The concrete block wall strapped on both sides may provide better sound reduction over a long period of time, because it is less subject to holes and other damage.

The general principles of sound transmission and attenuation are also borne out by the comparative NIC ratings of the two types of floors.

Because of its solid nature, the reinforced concrete floor (b) transmitted more sound than reinforced concrete over open-web steel joists (a).

Alternative uses

The party wall can be adapted for use in the construction of apartment buildings. Care must be taken to select a wall design that provides the specified fire rating for these applications.

Further reading

Harris, Cyril M.
Handbook of Noise Control, 2nd edition.
New York: McGraw-Hill, 1979.

The American Society for Testing and Materials, Annual Book of ASTM Standards,
Volume 18 *Thermal and Cryogenic Insulating Materials;*
Building Seals and Sealants; Fire Standards; Building Constructions; and Environmental Acoustics.
Standard E336-77. Installation of fixed partitions of light frame type for the purpose of conserving their sound insulation efficiency.
ASTM, 1916 Race Street, Philadelphia, Penn., USA 19103, 1980.

For more information, contact:
Development Evaluation Advisory Services, Canada Mortgage and Housing Corporation, National Office, Montreal Road, Ottawa, Ontario. K1A 0P7
Canada.