INNOVATIVE BUILDINGS

Grandin Green: Pioneering Innovation in an Multi-Unit Residential Building

Figure 1: Southwest Elevation Grandin Green Building

Description

The Grandin Green is a 15 storey multi-unit residential building (MURB) constructed in 1999-2000 in Edmonton, Alberta. The building was one of the first MURBs constructed in Canada to incorporate many innovations designed to reduce energy and water consumption and to enhance the indoor environment. Additionally, it was the first MURB designed in accordance with Natural Resources Canada's innovative Commercial Building Incentive Program (CBIP) that requires buildings to have an annual energy consumption that is 25 per cent less than the Model National Building Code for Buildings.

Description of Project

Name: Grandin Green

Location: Edmonton, Alberta (5400 heating degree days below 18°C)

Management: Grandin Green Strata Title Housing Cooperative Ltd.

Developer: The Communitas Group Ltd.

Architect: GKO Architects

Building Envelope Consultant: Building Science Engineering Ltd.

Year of Completion: 2001

Type of Construction: New, non-combustible

Setting: Urban

Total Building Area: 8,465 m^2 (plus 2,897 m^2 below grade heated parking garage)

Floors Above Grade: 15

Building Use: Residential, strata cooperative

Design Occupancy: 55 suites, social and fitness amenity space

Certification: NRCan's Commercial Building Incentive Program (CBIP)

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The building also incorporated an exterior insulation finish (EIFS) system that was designed and constructed using many of the principles provided by Canada Mortgage and Housing Corporation's (CMHC) Best Practice Guide for Exterior Insulation Finish Systems. A building envelope consultant was retained by CMHC to support the developer in the design, installation and commissioning of the building envelope system.

After 5 years of operation, CMHC invited the Board of Directors of the Grandin Green building to participate in a review of actual energy consumption to determine the extent to which the project realized its original energy efficiency targets. With the active support of the Board of Directors, CMHC engaged an energy consultant to conduct the review.

General

The layout of the building is generally consistent from floor to floor with four suites per level. There are two sizes of suites and three general configurations – one bedroom plus den, and two bedroom plus den or three bedrooms. Expansive balconies are a key feature. Community facilities include a party room, library, exercise room, guest suite, offices, and washrooms. Ownership of the building is organized as a Strata Title Housing Co-operative. Occupancy consists almost exclusively of middle-to-senior age singles and couples, many of whom are retirees. Lifestyles vary considerably, and many of the residents travel extensively, leaving the suites vacant in their absence.

Site

The Grandin Green is an urban intensification project. The building was constructed on land formerly used for single family houses. The location, on the north side of the North Saskatchewan River, provides immediate access to the downtown core of Edmonton while also providing access to recreational opportunities the North Saskatchewan River Valley offers. The building was oriented to provide all suites with a view of the river valley to the south and access to passive solar gains.

Building Envelope

The wall system is an exterior insulation finish system with a nominal RSI value is 2.71 (R15). Conventional MURBs constructed at the time typically had wall RSI values of 1.76 (R10).

The system was designed and constructed using the principles advocated by CMHC's Exterior Insulation Finish System Best Practice Guide. Generally, the wall system is an acrylic stucco system adhered to 90 mm of rigid polystyrene insulation. The insulation is mechanically fastened through an air barrier system and exterior grade gypsum board to steel studs. No insulation was installed within the steel stud cavities. This arrangement helps to protect the supporting structure and air/vapour barrier systems and to prevent interstitial condensation within the wall system.

The major window system is a VisionWall™ system that consists of a low E window unit with two suspended film layers placed between the glazings. The nominal published RSI value is 1.17 (R6.6). This system was chosen to allow a relatively high amount of window area in each suite to take advantage of the view, natural light and solar gains. The relatively few windows installed in the east, north and west elevations are double pane, low-E units with fibreglass frames.

The flat roof system was insulated with 100 mm RSI 3.5 (R20) of polystyrene insulation.

A building envelope commissioning plan was established to ensure that the wall system was properly designed and installed and to minimize the possibility of air leakage and vapour diffusion. Wall sections were constructed and tested during construction to assess quality and to provide feedback to the construction team.

Space Conditioning

Space heating is provided in the individual suites by fan-coils that provide heated air to the apartment via high-wall interior grilles. The fan-coils are located in utility rooms provided in each suite. No perimeter heat was installed due to the high thermal performance of the building envelope system. Hot water is provided to the fan-coils from a central, mid-efficiency, natural gas-fired boiler.

Many suites have natural gas fireplaces which, while mostly used for aesthetic reasons, also contribute to space heating.

Air conditioning was not provided for the suites as it was hoped that the thermal performance of the windows, high thermal mass of the concrete structure and mechanical ventilation would alleviate the need. However, many owners have since installed air conditioning in their suites to maintain comfort conditions in the summer.

The corridor air supply is cooled during the summer months. Air conditioning is also provided in the ground floor lobby area and the recreational/social areas on the top floor.

The common areas and parking garage are heated via the central gas-fired boiler.

Domestic Hot Water

Hot water is supplied to the suites by four, mid-efficiency, natural gas-fired boilers. Two boilers in the basement serve the suites in the lower half of the building while the other two boilers are located in the penthouse to serve the suites in the top half of the building.

Ventilation

The Grandin Green building is one of the few MURBs in Canada to provide in-suite ventilation systems. Each suite is equipped with a heat recovery ventilator (HRV) that provides fresh air to each room of the apartment while simultaneously providing bathroom and kitchen exhaust (Figure 2). The HRVs deliver tempered outdoor air to the return air plenum of the fan-coils where it is mixed with return air and then distributed to all rooms of the suite by the forced air distribution system. The HRVs in the end suites are ducted laterally through the exterior walls. The HRVs in the center units receive outdoor air from a central vertical plenum connected to an outdoor air handler located in the penthouse as only the exhaust air could be ducted laterally to the exterior due to space limitations.

This approach has many advantages over conventional systems:

- Continuous mechanical supply of fresh air to all rooms
- Continuous mechanical exhaust to control odours and relative humidity
- Heat recovery from exhaust air to help temper outdoor air
- Controllable by occupants
- Can be shut off as required (vacation, regular unoccupied hours)
- Central corridor air system can be down-sized
- Suites can be sealed from one another and common corridors.

The corridors are ventilated by a conventional corridor air ventilation system. As the suites are independently ventilated (and the corridor to suite doors are gasketed to prevent the transfer of corridor air to the suites), the capacity of the corridor air system was reduced. This saved on capital costs and also reduces operating costs associated with the delivery of tempered air to the corridor areas.

Common Area Lighting

The building management has taken steps to reduce common area electricity consumption by replacing corridor lighting with low watt fluorescent fixtures or compact fluorescent bulbs. Exit lights have been replaced with light emitting diode (LED) fixtures.

Motion sensors have been installed in many locations such as the common corridors, parking garage and service/storage rooms to control lighting.

Figure 2: In-suite HRV coupled to Forced Air Heating System

Water Fixtures and Appliances

All suites are equipped with 6 litre toilets, Energy Star™ horizontal axis laundry washing machines, low flow shower heads and faucet fixtures.

Energy Consumption Performance

The Grandin Green building was designed to consume 25 per cent less energy than it otherwise would have had it been constructed to the requirements of the MNECB. To assess the extent to which this design objective was achieved in practice, an energy analysis was conducted. This involved the development of an energy simulation model for the building, reconciling the model using three years of utility billing and weather data, estimating total annual building energy consumption and energy end-use points, and, identifying whether or not additional energy efficiency opportunities existed. Utility bills for the common natural gas and electricity meters as well as the electricity bills from 35 of the 55 suites were used in the analysis.

Finally, the building's annual energy consumption was compared to the energy consumption of conventional MURBs as well as the energy consumption of other innovative MURBs that have been constructed in Canada over the past few years.

Annual Energy Consumption

Based on three years of utility information, the total annual energy consumption for the building was 195 ekWh/m^2. Figure 3 depicts the annual energy consumption by end-use. Space heating and domestic hot water represented approximately 67 per cent of the total annual energy use.

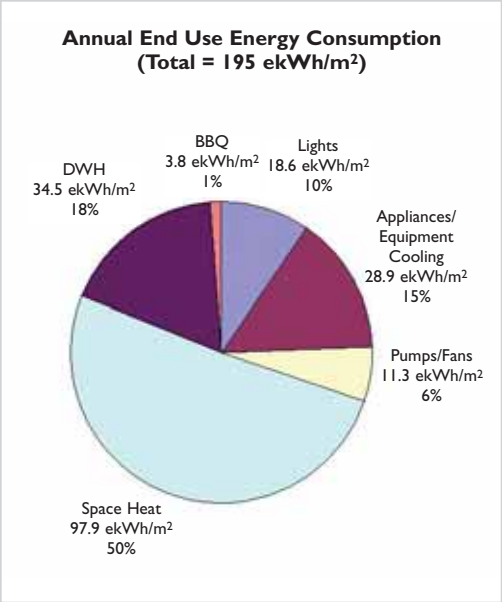

Figure 3: Annual Energy Consumption by End-Use

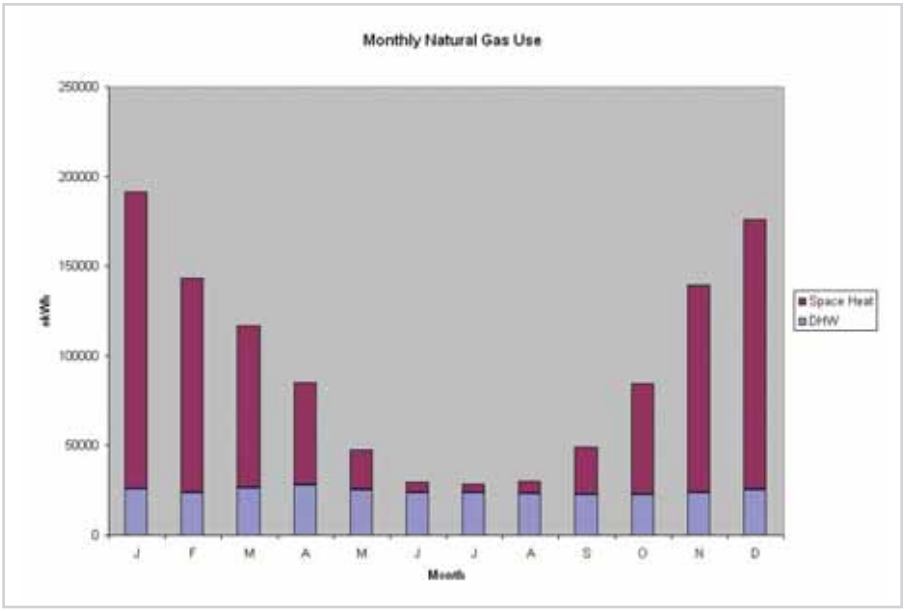

Figure 4: Monthly Natural Gas Consumption

Figure 4 shows the monthly natural gas consumption for space heating and domestic hot water and Figure 5 shows the monthly in-suite and common area electricity consumption. Natural gas consumption varies in a predictable seasonal manner. Electricity consumption shows an increasing trend over the summer months due, in part, to the cooling of corridor air. In-suite electricity consumption exceeds common area consumption on an annual basis by approximately 25 per cent.

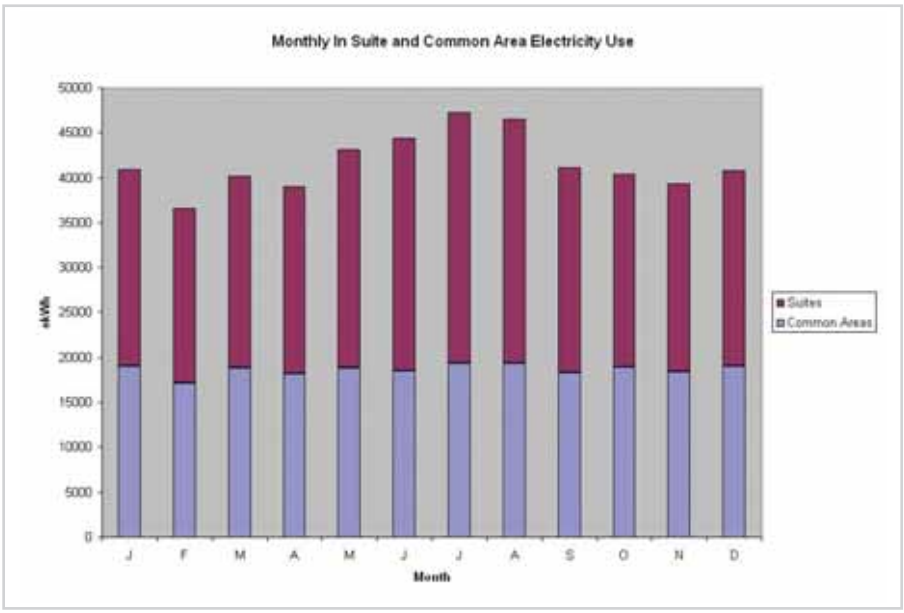

Figure 5: Monthly Electrical Consumption

Table 1 compares the total annual normalized energy consumption with the original CBIP target, other conventional MURBs and three other innovative MURBs for which energy consumption data is available.

Building	Location (Heating degree-days-DD)	Normalized Total Annual Energy Consumption (floor area only) ekWh/m²	Normalized Total Annual Energy Consumption (floor area and degree-days) ekWh/m²/DD	Annual Water Consumption m³/suite
Grandin Green (CBIP)	Edmonton, Alberta (5400)	195	0.036	114
Governors Road (CBIP)	Dundas, Ontario (3600)	137	0.038	85
Almon Street (CBIP)	Halifax, Nova Scotia (4100)	158	0.039	171
Conservation Co-op	Ottawa, Ontario (4600)	186	0.040	141
Typical MURB*	All locations	278	n/a	216
* average consumption figures from CMHC database of 88 MURBs from across Canada (various ages, sizes, occupancies)				

Table 1: Total Annual Normalized Energy Consumption Comparisons

While Grandin Green has the highest total annual energy consumption per m² floor area amongst the CBIP buildings constructed to date, this is to be expected as winter conditions in Edmonton are by far the most severe. When energy consumption is normalized by heated floor area and heating degree-days, the Grandin Green building has the lowest normalized energy consumption of the buildings reported to date.

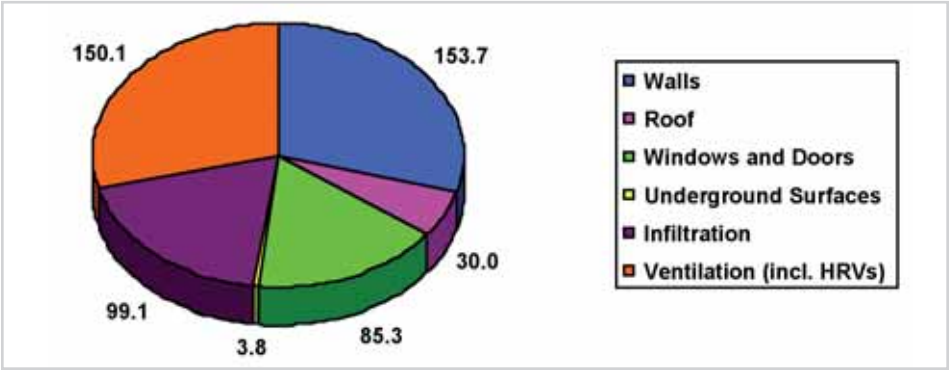

Figure 6: Peak Heating Loads (kW)

Heat Loss Components

Figure 6 shows where energy is consumed to offset peak space heating loads. The primary space heating loads are the walls, windows, infiltration and ventilation.

Actual Annual Energy Consumption vs. Original CBIP Targets

Actual energy use was found to be higher than the CBIP projections with an annual variance of 11.4 per cent and 27.4 per cent for electricity and natural gas respectively. However, the variances are attributable to the heated parking garage, in-suite gas fireplaces, in-suite air conditioning, and higher "plug" loads that were not factored into the original CBIP energy projection. When the estimated energy consumption associated with the parking garage and other uses are deducted from the total energy consumption of the building, the adjusted total energy consumption aligns closely with the CBIP target. This speaks well of the continuing energy efficiency performance of the building and the capability of the CBIP initiative to generate meaningful predictions and energy efficient buildings.

Water Consumption

Total annual water consumption was 6,292 m³ or 114 m³ per suite per year. This compares favourably with the annual water consumption of the other CBIP, and non-CBIP buildings shown in Table 1. The difference in

consumption is likely due to the demographics of the buildings. The Conservation Co-op is mostly occupied by families and it is well established that families consume more water per household than senior and one or two person households. Governor's Road is occupied by retirees who are known to consume the least water per household. Water consumption for the building is further reduced as many of the residents are away for the winter months.

Future Energy Efficiency Opportunities

While the Grandin Green is a well maintained, well operated, energy efficient MURB, opportunities will arise, primarily during regular repair and replacement schedules, which could reduce energy consumption:

- Replacing the domestic hot water boilers with condensing boilers
- Reduce/optimize ventilation airflow to corridors
- Controls for in-suite HRVs to limit use during non-occupied hours
- Eventual replacement of fan-coils and HRVs with units equipped with brushless DC motors
- Studying opportunities to reduce parking garage air temperature.

Financing Innovation

The incremental costs associated with the many innovations embodied in the building were financed through a "green" loan of approximately $20,000 per suite. The monthly interest charges per suite for the green loan are offset by the monthly energy savings.

Summary

The Grandin Green building is successful in meeting its energy efficiency targets set out by Natural Resources Canada's CBIP initiative. The building is not only energy (and water) efficient, its space heating and ventilation systems serve to provide a comfortable, well-ventilated, indoor environment. The development team was able to deploy many technical innovations in the design and construction of the building that were not common at the time it was constructed. As a result, the building is one of the first multi-unit residential buildings in Canada to set, and achieve, higher levels of performance. The residents continue to benefit from this early investment today.

Acknowledgements

CMHC would like to thank the Board of Directors and the residents of the Grandin Green building for their support, cooperation and input to this study.

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