Research & Development Highlights

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Air Tightness, Air Movement and Indoor Air Quality in Atlantic Region High-Rise Apartment Buildings

Introduction

Based on the findings of previous CMIHC investigations in low-rise housing and high-rise office buildings, there is reason to suspect that high-rise apartment buildings may have ventilation, air quality, and moisture problems due to air leakage.

High-rise apartments rely heavily on air leakage for fresh air, and as a result are much leakier and less energy efficient than detached housing. Most apartmentbuildings only provide ventilation air to corridors and common areas. Comfort-related complaints regarding temperature fluctuations and smells are common, and suggest potential problems with air quality and uncontrolled air movement within the buildings. Air leakage can also lead to moisture-related problems such as corrosion of metal framing elements and brick ties, or mould growth in wall cavities. Unplanned air leakage is suspected to be widespread in apartment buildings across the country. However, little is known about actual air change rates, pollution levels, or the incidence of air leakage through exterior walls. A survey of high-rise apartment buildings is therefore required to confirm or disclaim suspicions of these problems.

Canada Mortgage and Housing Corporation (CMHC) commissioned one such study in the Atlantic Region. Testing was conducted on buildings located in St. John's, Newfoundland.

Test Program

Two buildings were tested: a seven-storey building with 51 apartments (Building 1), and a six-storey building with 65 apartments (Building 2).

The consultants began by collecting information which could be helpful in identifying possible pollutants, locating their sources, assessing the effectiveness of the ventilation systems, and defining the severity of any problems experienced. They did this by reviewing building plans and complaint records, inspecting different areas of the building, and interviewing occupants, managers, and others. A survey of the occupants in both buildings revealed only minor problems, with most complaints relating to air infiltration problems. Once this was completed, the buildings were assessed to determine the required testing.

Three types of tests were performed on the selected buildings:

(a) Airtightness

One of the primary objectives for the testing was to determine the airtighiness of the buildings. This was determined by measuring the airtightness values for each floor of each building.

(b) Air Movement

Air flow patterns for the building were studied by conducting tracer gas tests. A specified volume of tracer gas was released and air samples were taken at different locations throughout the building over a three-hourperiod. These samples were then analyzed for changing concentrations of tracer gas.

(c) Air Quality

Each building was tested for various pollutants whose presence was suggested during the information-collecting phase of the project. These included carbon monoxide, carbon dioxide, excessive humidity, formaldehyde, particulates, volatile organic compounds, radon, biological contamination, ozone and asbestos.

Findings

Testing in both buildings revealed air leakage rates that were higher than Canadian and international standards for air leakage. Building 1 was substantially leakier than Building 2.

Most of the air movement in Building 1 was the result of stack effect, influenced by outside weather conditions, which caused air to travel up through the building through garbage chutes, stairwells and elevator shafts. Most air movement in the tighter Building 2 was due to occupant activity.

Because of its greater airtightoess, Building 2 had higher levels of carbon dioxide, radon and relative humidity than Building 1. However, all contaminant levels were within recommended guidelines, except for total suspended particulate levels in smokers' apartments.

Air change rates in the apartments tested were much higher than expected. Design calculations used to determine heater sizing assume a maximum rate of *1.5* air changes per hour. Measured rates were as much as *6.5* times this value. This high rate may be a result of the testing procedure, which did not require all potential sources of air inifitration to be completely sealed. However, even when all air leakage sources were meticulously sealed, air change rates were high.

General Discussion

International standards for air leakage rates for apartment units are in the neighbourhood of one air change per hour at 50 Pa. In order to achieve this, further studies are required to determine leakage rates from individual apartments.

As buildings become tighter, equal effort will need to be directed at maintaining adequate mechanical ventilation to apartment units. Ventilation systems are basic in both the buildings examined in this study with ventilation requirements handled by the openable windows. First-cost considerations are the prime concern of the developer and not items which pay over the life of the project. Improvements in energy efficiency through the reduction of air inifitration and the subsequent need for mechanical ventilation to replace the need for openable windows will not be the norm in building construction in the near future unless developers are forced by regulatory means to meet energy-consumption targets.

The buildings examined in this study demonstrate that significant energy wastage is occurring. Air infiltration contributes to as much as 40 percent of the total energy consumed in building construction, and the buildings examined in this study are exceeding this value. It is reasonable to state that the buildings examined are wasting energy and contributing to environmental problems such as global warming.

While testing revealed no evidence of internal moisture damage, the high air infiltration rates could contribute to the potential for water damage in the exterior walls.

The testing methodology used for this project requires refinement to become more practical.

Air infiltration methods fail to emphasize the importance of sealing any and all potential sites for air infiltration into the test area. Quality control of this effect is extremely cumbersome and plays havoc with the budgeted time for the field analysis, but it is a vital part of the success of the study.

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- Conduct further air tightness testing on both buildings.
- Both buildings were very leaky when compared to international standards. Further testing is required in both buildings to identify primary leakage areas.
- Create a large building data base.
- A larger data base is required if general assumptions about buildings in Atlantic Canada are to be drawn from this study. The two buildings compared here, although very similar to each other, are not typical of the construction style in the St. John's area. More studies of different types need to be conducted before general assumptions can be made.
- Assess influence of parking garage.
- Further air quality testing of the units adjacent to the parking garage is required to assess the impact of the parking garage on air quality.
- Establish more meticulous airtightness testing procedures.
- All mechanical systems should be sealed when testing external walls. Tests should also be conducted to determine the flow rates associated with the individual building components.

See also: *Air Tightness, Air Movement and Indoor Air Quality in British Columbia High-Rise Apartment Buildings* (90-232).

Air Tightness, Air Movement and Indoor Air Quality in Quebec High-Rise Apartment Buildings (9 1-205).

Project Manager: Jacques Rousseau

Research Report: Field Investigation Survey of Air Tightness, Air Movement and Indoor Air Quality in High-Rise Apartment Buildings: Atlantic Region

Research Consultant: BFL Consultants Limited

A full report on this research project is available from the Canadian Housing Information Centre at the address below.

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