# Leaky Condos

## Why the Technology Didn't Work

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Over the past 10 to 15 years, a multiunit residential building boom has occurred in the coastal areas of British Columbia, particularly in the Lower Mainland. Predictably - as with any building boom - this heightened activity has been accompanied by building performance problems related primarily to a shortage of qualified or experienced people involved in the design, development and construction of these structures. What makes BC's building performance crisis unique is the predominance and systematic nature of moisture-related building enclosure problems.

Poorly performing building envelopes manifested as a variety of symptoms including wood decay, deterioration of finishes and staining of materials -have been experienced by a wide spectrum of developers, residential architects and contractors, with the only common denominator being the technology used. The massive scope of the problem became evident during the numerous public meetings held last spring by the government-appointed Barrett Commission of Inquiry, which was charged with the task of determining the causes of the leaky condo crisis and making recommendations to address it.

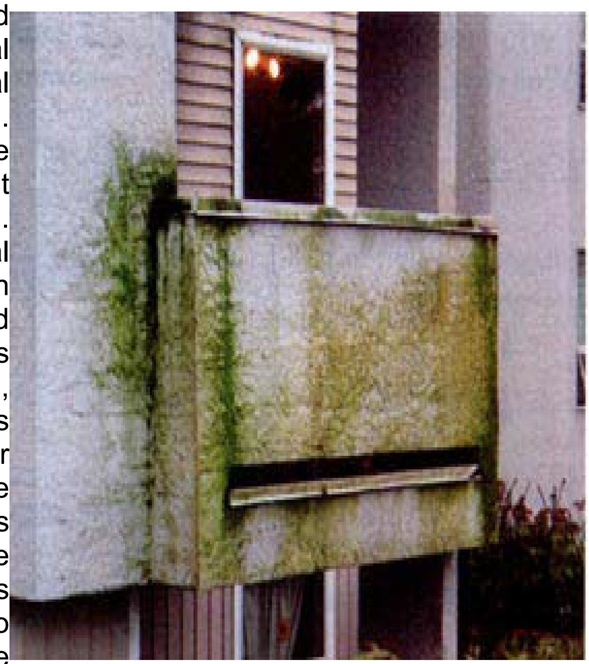
Looking at the problem from a strictly technical standpoint, many people who have been exposed to the leaky condo crisis first hand can readily accept this brief, if oversimplified, explanation: Water Got In ... and Made Things Bad! While clearly this phrase cannot do justice to an extremely complex situation involving a multitude of factors at work in the industry, a closer look at its two components reveals the fundamental physical mechanisms -and basic technology issues - that lie at the root of the leaky condo problem.

### *Water Got In ...*

It has now been firmly established that the problem of structural damage from water leakage is related to exterior moisture getting into walls. In November 1996, the Canada Mortgage and Housing Corporation completed a benchmark study conducted by a team of industry experts to determine the source of the moisture and the cause of building envelope performance problems occurring with greater frequency and severity in the Lower Mainland over the last 10 years. The Survey of Envelope Failures in the Coastal Climate of BC clearly identified water leakage from the exterior as the primary moisture source leading to problems in three- and four-storey wood frame condominiums.

In other words, moisture originating from interior sources - such as condensation of interior moisture due to air leakage or vapour diffusion, or moisture trapped in walls as part of the original construction - were identified as much smaller contributors to the problems. The report does not suggest that any of these less significant moisture sources can be ignored in the design of buildings - only that they are not the primary sources that have led to the leaky condo crisis.

Most of the wall assemblies associated with the problem utilize a face seal strategy to manage the external moisture (rain) that impacts on them. The intent is to stop the water at the exterior face of the wall and prevent it from penetrating further into the wall. The effective performance of a face seal strategy requires that all joints between the wall cladding (stucco, wood and vinyl siding, etc) and other components such as windows, decks, balconies, walkways and saddle connections (where low walls intersect with taller walls) form part of the face seal. The CMHC survey confirmed that water was entering wall assemblies at these interface details - meaning that attempts during the original construction to provide a perfect face seal were unsuccessful.



*Facing page:* Extensive wood decay in the framing and sheathing of walkways and exterior walls illustrates the damage caused by moisture penetration; *left:* extensive green staining on this balcony's stucco cladding is indicative of high moisture content in the wall assembly.

If wetting of face seal walls is relatively rare and drying of rainsoaked materials can occur, these assemblies can function acceptably for many decades. However, the coastal area of BC has one of the wettest climates in North America; during the October to March rainy season, wetting periods are long and drying periods are short. in addition, the location and orientation of buildings on many sites results in more exposure to wind-driven rain. Similarly, the building form (lack of overhangs) can mean that walls are exposed to greater wetting, even on sites with relatively low exposure to wind-driven rain.

One of the major changes in technology that has occurred as a result of the leaky condo crisis is the mandated use of wall assemblies that incorporate a drainage cavity behind the cladding. The addition of the drainage cavity, together with improved details, ensures that far less water gets past the cladding - and if it does, the added air space facilitates better drainage and drying characteristics. This type of wall assembly is commonly referred to as a rainscreen.

The basic differences between the way face seal and rainscreen wall assemblies act to control rain penetration are illustrated in Figures 1 and 2.

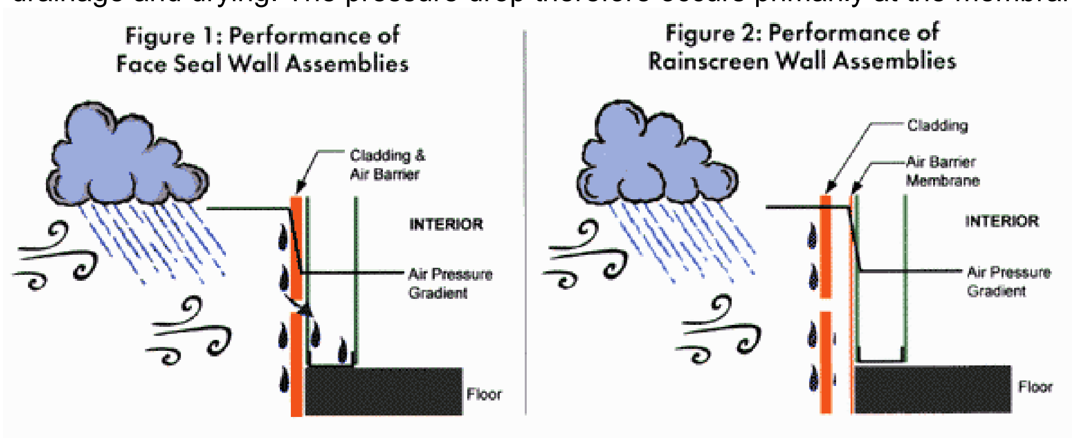
***Face Seal vs Rainscreen Wall Assemblies***

Fundamentally, three things are needed to facilitate water penetration into a building: water, an opening and a driving force. The removal of any one of these factors will eliminate the potential for water penetration. If the wall assemblies in question are not protected by overhangs - and therefore can be assumed to get wet - it is only the holes and the driving force that can be managed, through appropriate wall technology, to control the amount of rain penetration.

The wind will create a pressure difference between indoors and outdoors. in both face seal and rainscreen wall assemblies, this pressure change occurs primarily at the most airtight element in the wall construction, since it provides the greatest resistance to air flow through the wall. This airtight material (or series of materials) is commonly referred to as the air barrier.

In a face seal wall assembly (Figure 1), the air barrier is the exterior surface of the cladding, and thus is the surface at which the pressure drop occurs. This surface is frequently wetted and any imperfections in the face seal surface at wall interfaces (as identified in the CMHC survey and as noted above) will lead to air movement through the holes, and with the wind as the driving force will bring in the water that is readily available on the face of the cladding.

In a rainscreen wall assembly, the air barrier can be established at several locations relative to the interior of the cladding. In Figure 2, it is created by a membrane placed on the exterior surface of the exterior sheathing. The cladding is not airtight and, in fact, now has deliberate holes in it to facilitate drainage and drying. The pressure drop therefore occurs primarily at the membrane.




The fact that there is little or no pressure drop across the cladding means that the driving force is eliminated; therefore, very little moisture is drawn into the cavity behind the cladding. Very little, if any, water is present on the air barrier membrane surface on the other side of the cavity, meaning that the source of water is eliminated. Thus, a minor imperfection in the air barrier usually does not result in water infiltration. In addition, the air barrier exists in a protected environment behind the cladding and therefore is expected to be more durable.

***An Improved (But Not New) Technology***

Interestingly, the rainscreen strategy for controlling water penetration is not a new invention. For example, stucco-clad buildings constructed much earlier in this century typically included a vertical strapped cavity that facilitated drainage and drying. It was, in fact, Canadians who developed and refined the science of how these walls work over 30 years ago.

There are a variety of other reasons that these older buildings worked effectively in controlling moisture penetration. Drainage and deflection of water through the use of overhangs and proper flashing was more prevalent, reducing exposure; facades were generally less complicated, resulting in fewer potential problem details; and walls were generally uninsulated, meaning that the flow of heat improved the drying of wall assemblies.

The use of rainscreen walls rather than face seal walls is not a miracle cure, as recent advertisements from developers would have us believe. Proper management of exposure conditions, along with good detailing, are still critical to the successful performance of the wall assembly, These aspects of the project cannot simply be purchased to improve technology: they require better planning, design skills, coordination of trade work and onsite quality control.

So why was this technology not used where it was needed? The answer is the subject of much of the legal action associated with the leaky condo problem, but the key issues may lie in the overall nature of the residential construction business. The technologies (assemblies, details and construction practices) that were used in houses were gradually applied to increasingly taller (more exposed) and more complicated (more detailed) residential buildings. The walls and windows that perform adequately in houses simply will not perform in a durable manner in higher exposure conditions.

***Are Highrises Next?***

The intense focus on three- and four-storey wood frame condominium buildings in recent years has created an incorrect perception that highrise buildings are immune to similar problems. In many cases, these taller buildings have used the same basic face seal strategy for controlling rain penetration. Their wall and window assemblies are essentially identical to those used in lowrise buildings -except that the wood studs are replaced with steel studs and the exterior sheathing is made of gypsum board instead of wood.

Indeed, it would be surprising if these buildings did not leak. The key difference is the time it takes for the problems to manifest themselves and create a health or safety hazard. it typically takes longer for steel to corrode than for wood to decay; in addition, steel studs in the walls of highrise buildings are not part of the primary structure, as are wood members (studs, floor framing and sheathing) in lowrise buildings.

***...and Made Things Bad***

The right combination of moisture, temperature and a food source will encourage fungal growth and wood decay. This is the most common and serious manifestation of the leaky condo problem for the three- and four- storey wood frame buildings that were the focus of the CMHC survey. Less serious symptoms in this type of building include staining of exterior and interior surfaces and water dripping into suites.

Mould growth on the interior surface of gypsum board resulting from high moisture content in the exterior wall assembly.

In highrise buildings, the problems manifest themselves slightly differently. It is more common to have water appear on the floor inside the suites and wet the carpeting. Within the wall assembly, mould appearing on the gypsum board and corrosion of steel studs and fasteners are the decay mechanisms of primary concern. The ultimate outcome of some of these corrosion problems was seen recently in the collapse of the cladding on a mid-rise building in Burnaby.

Although it was evident from the outcome of the Barrett Inquiry that professional engineers were not considered to be one of the causes of the building envelope problem, they have played and will continue to play a central role in identifying, investigating and remedying it [see article that follows]. With the principles of enclosure design being well understood over 30 years ago, it is the application of these principles that needs to be reinstated in multi-unit residential buildings.

***Have We Turned the Corner?***

Two years ago, the City of Vancouver took the initiative and mandated the use of walls incorporating drained cavities (rainscreen walls) as well as improved detailing and inspection. The CMHC survey, Barrett Inquiry and the incredible media attention on the leaky condo issue have resulted in a greater awareness of the non-technical and technical issues, to the point where the majority of new buildings will incorporate this improved technology.

Additionally, the recent publication of CMHC's Best Practice Guide - Wood Frame Envelopes in the Coastal Climate of British Columbia, and the establishment of the Architectural Institute of BC's Building Envelope Education Program, will go a long way towards increasing professionals' awareness and understanding of the technical issues.

In the meantime, however, professional engineers who specialize in building envelope performance can expect to be kept busy dealing with the legacy of the current failures through the remediation of hundreds of wood frame buildings - and the distinct possibility that many highrise buildings will require significant remediation over the next five to ten years.

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