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"Leaky Condos" are Building Envelope Failures

A cautionary tale of what happens when the entire construction and development system breaks down.

by Richard Kadulski

Technical construction issues are not often at the top of main stream local and national media coverage, but building envelope failures in BC have recently gained that kind of profile. Mention "leaky condos" and construction horror tales emerge. Drive around Greater Vancouver, and you'll see tarp-covered buildings everywhere.

Much of the media coverage is a repetition of technical myths reported as if they were the absolute truth. We must correct the misconceptions, and also hope that members of our industry learn a lesson from the Vancouver situation. This is a cautionary tale, as problems seem to happen anywhere there's a construction boom. Only the 'details vary from place to place. Similar problems have happened in other areas, including Nova Scotia and the eastern seaboard of the USA.

Many explanations have been advanced for the current situation and a search is on for the guilty party on which to pin all the blame.

A key factor is the high level of construction activity that has encouraged unqualified participants and lowered levels of professional enforcement of existing building standards. Also, too many in our industry rely on someone else's inspections to spot incorrect application of materials and even simple quality control inspections.

The "Leaky Condo" Problem

The problem is envelope failures in new construction, mostly in the Greater Vancouver area. Water problems are happening despite the Building Code's clear and explicit regulations that buildings must not leak. These problems include water penetration, damage to cladding systems and decay of structural components. The problems are most pronounced in new low-rise (3 - 4 storey) multi-family wood frame projects, where the units are marketed as self-owned dwellings (condominiums).

The most common cladding material subject to failure is stucco, although problems have been noted with other siding products. Because of long wet periods, limited drying potential in this climate, and the construction details used, water leaks through the exterior envelope and rot sets in, leading to structural failure. Moisture eventually seeps inside the dwelling, enhancing indoor fungal growth. The poor indoor air quality will eventually create health problems for the dwelling's inhabitants.

A survey by Canada Mortgage and Housing Corporation (CMHC) found that the main source of moisture was exterior water finding its way into the walls. It is not interior moisture or construction moisture finding its way out.

Water enters at junction details: mainly at windows, the perimeter of decks, balconies and walkways, and at post locations. The cause seems to be incorrect detailing or construction of the building envelope to avoid water entry rather than poor materials or inadequate maintenance. After all, stucco has been used successfully in Vancouver for the last 90 years or more. *(Findings of the CMHC study were summarized in Solplan Review No.72, January 1997.)*

Building Science

Three conditions must be present simultaneously for a water problem to occur in a wall:

1. there must be water on the wall,
2. there must be a hole through which the water can enter, and
3. a driving force must be acting that will move the water.

That is why the Building Code requires that the wall assembly must keep out rain water, wind, and water vapour. The assembly must also let water vapour out if it has gotten in, and keep heat in during winter and out in summer.

To control the movement of air and moisture through the building envelope, the code clearly identifies the need for an *air barrier* and a *vapour barrier*, both of which affect building performance and durability. The difference between the two is often misunderstood.

Vapour Barriers

A *vapour barrier* controls the movement of moisture through the pores of a material by slowing the rate of vapour transmission. Effective vapour barrier materials have a low permeance to water vapour. Vapour barriers must always be on

the warm side of the wall. Materials on the cold side of the vapour barrier must always be more permeable to water vapour than on the warm interior side. Vapour barriers provide protection against *interior* moisture sources.

Air Barriers

An *air barrier* stops the movement of air under pressure through the wall. It does not have to meet the vapour barrier requirements for vapour permeability. Air leakage across the building envelope is the major factor that affects envelope performance and damages the building.

Air movement in and out of the building takes place through holes and gaps in the construction. When warm air leaks out of the building, it carries moisture outward with it. Research has shown that air movement through the building envelope will move 100 times the amount of moisture that diffuses through building materials. This moisture can damage the structure as it condenses on cold surfaces.

The driving force for air movement is created by a difference in pressures. Wind creates significant pressure differences that will push or pull air through any leakage points in the envelope.

In cold weather, stack effect causes air to be drawn into the lower parts of the building, where it replaces warm air leaving through the upper portions of the building. The bigger the temperature difference between inside and outside, the more powerful the stack action to move the air. Multi-family dwellings usually have pressurized hallways that effectively pressurize each individual dwelling, creating forces that drive warm, moist air into the envelope.

The Source of the Problem

There has been much speculation about possible causes of the problem:

Building Code

The Building Code has been blamed for not being suitable for the climate. However, the intent of the code is clear. It states that buildings must not leak, and that the building be designed for the location in which it is found. The West Coast climate, although mild, is one of the most technically challenging climates for construction. Long, cool, wet periods at times with driving rain alternate with very short dry periods, reducing the length of time available for construction assemblies to dry.

The Building Code establishes a minimum set of construction standards. It is not intended to be a textbook on building design, nor does it set out quality criteria. This is an important distinction, as often there are misunderstandings about the intent of the regulations. Code provisions set out enforceable standards. Quality, being open to subjective interpretation, is not readily enforceable.

Part 9 of the code ("Housing and Small Buildings"), which applies to houses and small buildings, is prescriptive. Many multi-family projects are built under the provision of this section. Part 9 regulations offer explicit design and installation instructions for most materials and assemblies in use today. For buildings that do not fall under the scope of Part 9, the prescriptive requirements for envelope components can be still used as a guide.

Part 5 of the code ("Wind, Water and Vapour Protection"), which applies to larger structures, sets out performance objectives. The requirements are flexible and allow many alternative ways of meeting the code objectives.

Suggestions have been made that the code be modified to make the requirements more responsive to the regional climate. This implies a prescriptive code. Such a change could actually be counter productive as it will reduce the flexibility of action as new ways of assembling materials are refined.

Material Failure

The problems are happening despite the use of good materials that meet code requirements.

Exterior cladding materials must shed rain and provide a weathering surface to protect the interior parts of the wall, including the sheathing and sheathing paper. Historically, many natural exterior finish materials have been used successfully: wood siding, brick, stucco, metal. Traditionally, only a few materials have been used in any one region so designers and tradespeople learned how to use them successfully. Recently, there has been increased use of a wider range of new products such as vinyl siding and exterior insulated finish systems (EIFS - commonly called "synthetic stucco"). These new products have been developed to provide more finish options, to improve durability, to address specific market and economic needs, or for aesthetic reasons.

The BC Building Code requires that materials used for exterior cladding meet standards that apply to the product, and that these materials be installed to perform as intended. Any product applied incorrectly will cause problems. Part 9 of the code, which applies to houses and small buildings, has clear, prescriptive requirements for the design and installation of exterior claddings, vapour barriers, thermal insulation, sheathing papers, flashings and fastening devices. The requirements are readily verifiable if appropriate inspections and field reviews are carried out during construction.

Energy Conservation

Suggestions have been made that increased insulation and air sealing for energy conservation have contributed to the problem.

Using insulation to retain heat and make a home more comfortable has increased in the last fifty years. By keeping the heat in, the insulation has kept heat out of wall cavities, so the cooler temperatures may make these assemblies more prone to condensation if moisture is allowed to get into the wall. Due to lower heat flow, the materials are less able to dry out. All evidence, however, is that the source of the moisture causing problems in BC is not interior-generated or construction moisture, but exterior, weather-driven moisture.

Relying on interior heat loss to dry out water that has leaked into the building is not an appropriate solution to the problem.

Polyethylene Vapour Barriers

Many are blaming the use of polyethylene vapour barriers for trapping moisture in the walls, not allowing the walls to "breathe." The widespread use of poly was only implemented in the mid 1980s because of code changes. The vapour barrier will retard moisture migration through the wall. However, the source of the moisture causing the problems is exterior moisture that enters the envelope, and not interior moisture.

Removing the low permeance vapour barrier but maintaining an airtight envelope may work in many cases, but it still requires a very good external moisture barrier to keep the water out of the envelope in the first place.

If exterior moisture penetrating the cladding were to be allowed to dry to the interior, the walls and insulation would always be wet, and the question could well become one of why bother having any walls at all. In a wet tropical climate all you need is a good roof over your head and breezy walls, but not a cold wet climate. There is simply too much water to allow it to dry inside!

Design Issues

Some building designs are less suitable for use in a wet climate. The trend in the last fifty years to universal designs, oblivious to location and climate, is simply irresponsible. Most buildings being built today could be anywhere. Look at real estate marketing brochures and you see images of Arizona, Mexico, England, France, etc. regardless if the project is in Vancouver, Edmonton or Ottawa. A design suitable for the Arizona desert is just not right for a wet West Coast climate.

Fashion setting developers twelve years ago loudly proclaimed their inspiration was Arizona, California or Italian Mediterranean design. Today this has come back to haunt them.

Workmanship

There is much evidence that poor workmanship has also contributed to problems. The best materials, if poorly used and installed incorrectly, will not perform as intended. Trades qualifications are important, but so is adequate supervision to ensure the work has been done adequately. Both have sadly been lacking in Vancouver recently.

Greed

Boom times tend to flush out all manner of people with dollar signs in their eyes. Their less than scrupulous activities, hidden behind numbered companies, take advantage of high demand. These situations are not unique to Vancouver, as they seem to happen in all areas experiencing a construction boom.

Developer profit and marketing fees far exceed fees paid to design and technical professionals who will build the project and retain legal responsibility.

A shift in market place dynamics has changed the way projects are developed. In the past, most multi-family projects were rentals, so ownership remained with a single owner who had an interest in durability and low maintenance. Today individuals own their suite, so the developer's focus is on style and image marketing to sell units as quickly as possible, rather than long term building performance.

The Guilty Parties

Fingers are being pointed in all directions. A provincial commission of enquiry has been established with the express objective to determine who should be held accountable. The following is our analysis of the roles the various players in the industry and their part in the present situation.

Developers

Developers initiate projects. Style conscious developers may impose design visions not suitable for the climate. A bottom line with high margins is the most important consideration.

Behind numbered shell companies, created for a single project, there is no individual and no assets to go after if something does go wrong eighteen months after project completion.

Contractors

The front line people who actually put the materials together. Competitive pressures mean that a lot of work gets done on a piece-work basis and quality control suffers. Limited availability of skilled trades people in boom times does not help either. At present, there are no licensing or certification requirements for contractors in B.C., nor are there any third party warranty requirements.

Realty Marketers

Sales people may be competent to close a deal, but generally have limited technical knowledge. They stress fashion elements, ignoring technical merit, creating a situation where extra square footage of marble will be stressed rather than a more compact but better designed and built unit.

Planning Officials

Planning restrictions have encouraged inappropriate design. In some municipalities, areas under roof overhangs were counted as square footage. As a result many buildings were built with no overhangs that could offer protection to walls. Sometimes there was insistence on flat roofs to reduce others' views when pitched roofs were part of the initial design. (Sloped roofs shed water.)

In other municipalities, exterior walkways used as corridors were not counted in total square footage, leading to designs with exterior walkways - extra details that, when done incorrectly, are sources of leakage. Another zoning requirement is that exterior walls "step in" to minimize the building's impact on adjacent properties. This results in a series of flat roof areas, often used as decks for the upper floor, but which are difficult to waterproof and drain.

Architects

Architects have ultimate design responsibility. Too often they cave in to client demands or create designs inappropriate for the climate. They often do not receive the mandate to properly develop their designs, but to prepare just enough drawings to obtain the necessary permits. Full professional services, including adequate site reviews are often not performed these days.

It is a sad fact that building science is not a strong suit in architect's training. Most are more interested in Design than in careful attention to the technical details essential to execute any design. Complex, articulated designs ask for problems to happen. They work only if immaculate attention is given to detail - yet too often the appropriate detail is not provided.

The Architectural Institute of BC (AIBC) has belatedly taken a role in developing a building envelope education curriculum that will cover building science, best practice guides for rain penetration control, inspections and testing, and the professional's roles and responsibilities.

CMHC is developing a "Best Practice Manual" for building construction types found on the West Coast. This document will contain appropriate sample details, and is slated to be ready later this year.

Building Inspectors

The objective of building code regulations is to mandate basic structural and life safety. In most jurisdictions this means building envelopes are not on the inspection list. The drive to deregulate and downsize means that, as budgets are reduced, building officials often do cursory, audit inspections and rely on other professionals to certify compliance with codes and regulations.

The City of Vancouver now mandates rain screen design for some cladding types, more explicit detailing of plans at the building permit stage, and certification by a third party building envelope professional.

Financial Community

A large portion of any new development must be presold before financing is provided so that unrealistic budgets may be set and locked-in before full construction details are finalized. This increases pressures to cut corners if other costs increase as the project progresses.

Mortgage lenders and appraisers generally lack a building science background and do not give adequate weight to technical issues. Stylistic marketability concerns are given more value than construction quality.

Home Buyers

Consumers are aggrieved parties, having to cope with remedial work when things go wrong. Although it is not fair to expect them to know how a building is built, nor to know all the questions to ask, most do not do the research they do when shopping for an automobile or even household electronics. Even as the issue was gaining public awareness, many were not having independent pre-purchase inspections done, only to regret it soon after moving in.

Home owners have generally bought into the marketing hype focusing on style, finishes and the expectation of getting the extra few square feet of space, at the expense of inherent construction quality.

The Solution

There is no single guilty party. Rather it is a breakdown of the entire development process. We are aware that a house-is-a-system, the whole being greater than the sum of the individual parts. However, we seem to have forgotten that the same applies to not only to multi-family projects, but to the process as well. An implied expectation has developed that someone else is going to look at our work and will get us out of trouble if a problem emerges.

The question has been asked "What happens in Seattle, which has the same climate, similar construction practices and design approaches?" The answer may lie in a different legal structure. Americans are very litigious, so each trade tends to pay more attention to their individual jobs. Builders are liable and must guarantee their product for 4 years (water penetration is considered a structural failure). Further, the construction activity has not been as frenzied as it has been in Vancouver over the past decade and there are higher entry requirements for contractors. At the highest levels of the development management team there is an understanding that sound construction principles must be followed.

There has to be more responsibility demanded of builders and developers. This may mean tighter more powerful third party warranties, more rigorous quality assurance procedures, and contractor qualification.

There is no single guilty party. Rather it is a breakdown of the entire development process.

Taking quick, prescriptive action on a single material type will not solve the more fundamental issues in our industry. What is needed is a comprehensive approach that addresses the many issues facing all participants. More emphasis must be placed on quality assurance during construction, including inspections for conformance with current standards.

It may not be easy, but creative marketing may be needed to undo the unrealistic expectations that have been generated over the past generation. This means down playing expectations, emphasizing the importance of quality behind the surface, and explaining just why emphasis on certain design features may be wrong. ☼

Adieu, Godfather

Loyal Solplan Review readers who read everything, including the fine print copyright statements (we're surprised how many do), may have noted occasional references to the Godfather. This was our lighthearted way of referring to your editor's brother, John Kadulski, who was not only our accountant, but also business mentor. Especially in the 1970s when we started with the Solplan Series of solar energy applications books, the "Godfather's" advice and support were invaluable.

It is with sadness that we must bid adieu to the Godfather, who passed away at the beginning of May after a short illness. He will be missed.