

MAINTENANCE MATTERS



Repairing and Replacing Window Wall Systems

Windows, specifically window wall systems on multi-unit residential buildings, are one of the costliest building envelope components in high-rise complexes in B.C. Here, building owners can learn options for major retrofits or renewals, what needs to be considered, and how building and window age affect those options. Helped by an experienced design and construction team, renewing window wall systems can extend the overall lifespan of a building by another 20 to 50 years.

This bulletin covers the main differences in window wall systems, their expected service life, typical maintenance and repair strategies, when to consider replacement, and different renewal options. It also provides details about how the replacement of a window wall system is normally undertaken and the special considerations that should be discussed along the way.

High-rise residential buildings in British Columbia often have a lot of glass. Since the 1980s, their windows have grown in number and in size to the point where they span from floor to ceiling and are the building envelope main cladding system. This system is known as a “window wall system”.

This evolution has come from advances in window technology, desire for more views, and ease of construction. Window wall systems are durable and robust, but, as with all building envelope elements, they require maintenance and repairs over their lifetime until eventual replacement is needed.

Maintenance Matters

This series of bulletins and companion videos is designed to provide practical information on maintaining residential buildings. Produced by BC Housing, this bulletin was prepared by Morrison Hershfield in collaboration with the Condominium Home Owners Association (CHOA).

What Issues Can Window Wall Systems Experience?

Building envelope assessments conducted by industry experts on multi-unit residential buildings (MURB) have revealed common traits in the window wall system design, installation, and modes of failure.

Common durability problems

In the lifetime of a building, maintenance is required to keep systems such as plumbing, heating, and roofing in good working order until replacement. This also applies to window wall systems. With regular maintenance, these systems may last between 20 and 50 years. The range is wide because many factors influence the system’s service life:

| | |
|---------------------|--|
| Climate | Multi-unit residential buildings naturally have higher exposure to rain due to their height and limited protection from overhangs. Rain, coupled with wind, can particularly challenge the window wall system’s ability to manage moisture, because it creates a pressure difference across the system that allows the rainwater in and overwhelms its drainage ability. Although interior and northern B.C. may not have as much rainfall, they have colder temperatures in the winter. Cold climates, coupled with indoor humidity, can make condensation a frequent issue, especially on window wall systems that have poor thermal performance. In extreme cases condensation can present itself as frost. Whether moisture comes from rain penetration or condensation, its resulting damage to interior finishes and the building’s structural elements may be the primary reason for a window wall system replacement. |
| Materials | Window wall systems have many components, including the aluminum frame, insulating glass units (IGUs), gaskets, sealants, weatherstripping, hardware, coatings, screws, insulation, flashings, and rough opening waterproofing. Premature failure of some components can be addressed through ongoing maintenance, such as adjusting hardware to keep vents and doors functioning properly. Replacement of larger, more costly components may also be worthwhile if the rest of the system is still performing well. For example, failed IGUs can be replaced after 25 years while the frames stay in place for a 50-year period. Components that are difficult to access may mean the whole system must be replaced. For example, if the internal screws at the mitred joints have corroded and are no longer sound, you may need to remove the entire window wall frame to access the screws. Once the building owner has already assumed the cost of removing a window wall frame from its rough opening, trying to refurbish the old frame may be expensive or too risky, so replacement is a better option. |
| Construction | Window wall systems can have features in their construction that lead to shortened life expectancy, such as sealant at mitred joints in the frame. Coupled with poor drainage capacity, these systems are more easily overwhelmed with water entry. |
| Installation | Failures of the window wall system, due to a lack of or poor waterproofing membrane installation into the rough openings, can often contaminate the walls below with repeated exposure to water. This may lead to premature deterioration of the wall components such as sheathing, fasteners and studs prematurely, and cause mould to grow on interior finishes. The exterior wall may need to be renewed at the same time as the window wall system replacement. |
| Other | There may be other valid reasons to replace a window wall system: <ul style="list-style-type: none"> • High energy consumption and occupant discomfort, usually when the window wall system has non-thermally broken frames or allows air leakage. • Poor acoustical performance between suites, between rooms within a suite, and between inside and outside space. • Improper fire-safing detail at the floor slab level, which is required to limit the spread of fire from one suite to another. |

How Can You Fix Your Window Wall System?

A window wall system that's not showing any of the previously listed issues may have useful service life remaining, as long as there is ongoing maintenance. However, a window wall system with systemic and chronic failures that have led to significant deterioration of the adjacent walls clearly needs replacement as part of a larger repair program, including all other building envelope components. If a window wall's condition falls between these two scenarios, it can be more difficult to decide whether to replace or refurbish, and when to undertake the work. Ask these questions to help determine your solution:

> Does the window wall system pose any life safety risks?

If the structural integrity of the window wall system and its attachment back to the building's primary structure is affected, you must take immediate action to ensure the safety of inhabitants and the general public. If necessary, take temporary measures to re-establish a safe system while a permanent solution is developed. Window wall frames that can't withstand environmental loads usually can't be refurbished in a cost-effective or practical way, so must typically be replaced. If the risk relates to the anchoring of the window wall, consult an engineer to develop

an upgraded anchoring design to reuse the existing window wall system.

> Does the window wall system leak water?

You can address occasional leaks with targeted repairs if the source is easily identified, such as a failed sealant at the interior surface of the frame. Leaks affecting the wall or floor below indicate improper waterproofing of the rough opening, so the window wall system will need to be removed to conduct repairs. This work would also include new waterproofing details in the rough opening. Systemic and frequent leaks may point to a construction flaw in the system itself that may be difficult to correct, such as poor drainage.

> Is it worth fixing the existing window wall system or buying a new one?

Every time a window wall system is manipulated there is added stress on the seals and glass, so frames can distort. These risks need to be weighed against the cost of purchasing new ones, how much life remains in the window wall system after refurbishment, and the coordination with other renewals that may be needed such as cladding next to the window wall systems. New systems look quite different from 1990s window wall systems, so extending the life of the existing system on one elevation until all elevations need replacement may be worthwhile.



Gap in shrunken thermal break



Corroded screws in stud wall beneath window

› Is fire-safing required?

Refurbishments must include a review of the fire-safing to make sure it meets the current requirements of the BC Building Code. Replacement of the fire-safing is a potential requirement and is an additional cost.

› Is the window wall system affected by more than one problem?

Addressing several issues under a refurbishment program may be possible but cost prohibitive. For example, if structural problems or water leakage are also coupled with poor acoustical performance, peeling paint finish on the frame, many failed IGUs, or significant heat loss, then a new window wall system is the best solution.

What to Expect When Replacing a Window Wall System

Replacing a window wall system is a major building envelope project. Building owners should know what to expect when faced with this renewal work:

› Different look

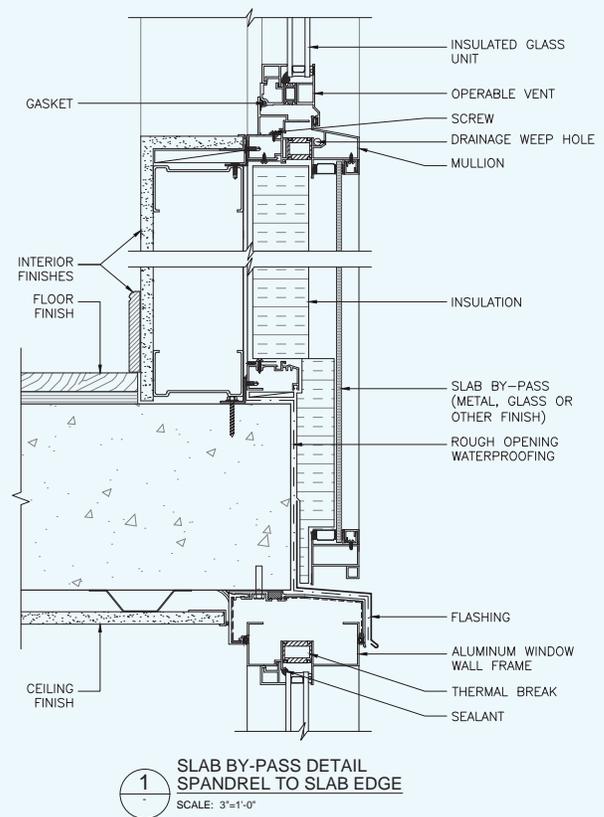
Today's window wall frames are thicker than the earlier versions, which has a visual impact due to the smaller glass surface area. Additional mullions may be needed structurally to meet Building Code requirements, which further reduces the amount of glass. The glass itself may have a different tint or colour due to the many coatings available to help with energy conservation.

› Partial replacement

Because today's window wall system looks quite different, that contrast would be even more evident if only some window wall sections are replaced on a building. Plan where to start and stop the window wall system replacement with a registered professional.

What Are the Components of a Window Wall?

The drawing below shows the slab by-pass panel, which is a unique detail to the modern window wall system. The by-pass panel is an opaque part of the window wall that clads the front edge of the slab and is integral with the window unit sitting on the floor level above. The by-pass panel can have different finishes (for example, metal, glass or terracotta), and incorporates insulation and an air vapour and watertight plane at the inside face of the frame. Moisture management is key to good performance of the window wall: the frame has drainage weep holes that connect each compartment and direct water out at each floor level. The installation of the window wall relies on waterproofing membrane that lines the rough opening. This waterproofing also moves water out of the building and protects the interior finishes and adjacent wall, roof and soffit structures from leaks.



› Other upgrades

Elements like fireplace flues, duct vents, electrical outlets, lights, and sprinkler heads that penetrate through the window wall system may also require upgrading to new Building Code standards. Different frame depths of the new window wall system may also mean penetrations need to be extended or shortened to fit with the new alignment.

› Tie-ins to adjacent systems

The edges of the window wall system must tie into the adjacent wall, roof, and floor assemblies to make sure there is continuation of the building envelope. Tie-ins must be properly designed with the right details and materials, which means that, in most cases, some partial removal of the adjacent assembly will be required.

› Interior finishes

Similar to the tie-ins, interior finishes such as drywall and wood trims will be disturbed during this work, and may not be reinstalled the same way depending on alignment. Blinds and curtains may no longer fit and will need to be adjusted or replaced.

› Major disturbance to occupants

Different trades people will need access to the interior of suites for window wall system replacement over several weeks. Occupants should expect noise and dust as part of the work. There is also a short time when the suite will be open to the outside when the old window wall system is replaced by the new system. Temporary weather protection should be the contractor's responsibility.

› Exterior access

Access from the outside will also be needed, which can temporarily affect occupants' privacy. Scaffolding with safety netting or hoarding, swing stage, or a mast climbing work platform can block views and sunlight.

› Safety

Safety must be maintained during the course of construction, both for occupants and workers. Handling large window wall units can be challenging, so the area of work should be off limits to the public. Occupants should also stay clear of the work area inside their suites. Safe work procedures should be supplied by the contractor to the strata or building owners so everyone always understands the safety requirements.

› Cost

Pricing can vary depending on the scope of the project, the new window wall system, and the options being selected. The frame finish, type of IGU, type of door, acoustical rating, and insect screens can all add up, so consider these choices when evaluating the cost of the system itself.

› Maintenance

It may be advantageous to undertake other maintenance items at the same time as the window wall work while access to the whole facade is available, such as painting or caulking renewals.

How Do You Select a New Window Wall System?

There are overarching Building Code requirements that may influence which window wall products are suitable. These include resistance to air leakage, water penetration, wind or seismic loads, and minimum thermal and condensation resistance performance. There may also be additional requirements set by the strata as improvements to the existing system, such as acoustical ratings. Design professionals must determine these requirements for the building, and window wall manufacturers must demonstrate compliance with these requirements.



Fireplace vent penetration through a spandrel panel

Once code requirements are satisfied, the strata will be presented with several options:

- › **Frame finish:** Aluminum window wall frame coatings can differ in terms of durability, i.e. their ability to maintain their colour and gloss over time, to withstand abrasion, and are specified as meeting one of three American Architectural Manufacturers Association (AAMA) testing standards: AAMA 2603, 2604, and 2605. AAMA 2603 coatings are best suited for interior applications, because they have less colour retention and are less expensive. AAMA 2604 coatings fit in the intermediate category, with good colour and gloss retention and are suitable for high-traffic areas and low-rise exposure. AAMA 2605 coatings perform best in colour and gloss retention, are most expensive, and should be used in high exposure buildings, especially in proximity to salt water or high humidity.
- › **Glass:** IGUs are usually double glazed, though triple glazed is gaining more popularity. If thermal performance is a key factor for the building owners, triple glazed IGUs are a good but more costly option. Other technologies exist, such as suspended film IGUs, but you should discuss their durability with the registered professional. There are a variety of coatings and coloured tints that can affect how the building looks from the exterior and how clear the view is from the interior of the suites. Samples of IGUs should be

compared with the different coatings and tints in different environments such as artificial and natural lighting, cloudy and sunny days, day and night, or from close up and far away. If the building is close to an airport or busy roadway, it is important to rate acoustically the window wall system as a whole rather than just the glass.

- › **Spandrel treatment:** The opaque sections of window wall systems (spandrel panels) are an important architectural expression for the building. Spandrel claddings can be obscure glass, metal panel, composite stone panels, terracotta, or cementitious panels. Registered professionals can provide renderings of the building to help when deciding on the desired look. Evaluate the life expectancy, maintenance requirements, and cost of each one, and verify with the potential window wall manufacturer that they are feasible within their system.
- › **Operable sections and mullion configurations:** A new window wall system offers a chance to change the configuration of the vertical and horizontal mullions, and add or relocate operable vents and doors, which may also have different maintenance requirements. The more mullions or operable vents in a window wall, the costlier and less thermally effective will be the system. The building owners should also decide if they want insect screens for the vents or doors.



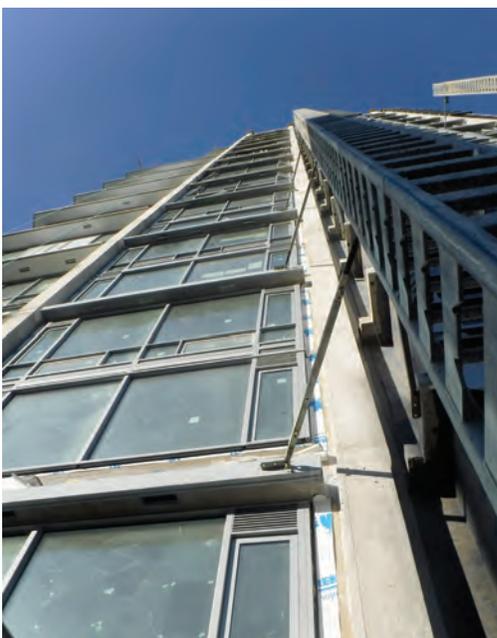
Metal spandrel panels

What Could the Cost Be?

Performance requirements for the building will have an impact on cost, as will options selected by the building owners as noted above. If there is a construction boom, the demand for a window wall system may cause limited supply since it is a popular system for new construction projects. The value of the Canadian dollar and market pricing for materials like aluminum can also impact cost. It is important for all products to be properly vetted and demonstrate performance before seriously considering them for a replacement project. With all these variables, today's new window wall system can vary in cost between \$55 and \$80 per sq. ft. for a straightforward system, and above \$100 per sq. ft. for specialty ones.

What's Needed During Construction?

› **Construction team:** A general contractor or construction manager should manage the tendering process and site installation and is responsible for maintaining safety on site for occupants and workers alike. The glazing contractor would work under the direction of the general contractor or construction



Mast climbing platform for exterior access

manager. Transitions to the adjacent assemblies mean that walls, roofs, and at-grade waterproofing may be impacted to allow for proper installation of the window wall and continuity of the overall building envelope assemblies. Other trades separate from the glazing installers will be required to conduct this work, and should be considered as part of the project's scope and cost.

- › **Access and weather protection:** Window wall system replacement would require access from both the interior and the exterior of the building. Normally the building's elevator can be used to move equipment and window sections. Exterior access can be provided with a combination of scaffolding, swing stage, boom lifts, and mast-climbing platforms. Check that the building's existing roof anchors' certification is valid if accessing the elevations from the roof down. The access equipment and anchoring add to the overall project costs. Weather protection is important to keep the work going during inclement weather, and ensure the interior of the suite, surrounding walls, and new work stays dry and warm.
- › **Permit fees:** You need the proper building permit from the authority having jurisdiction, which has associated fees. Architectural alterations to the building, such as adding canopies to protect new doors from wind-driven rain, may require additional permit fees.

How Does a Registered Professional Help?

The current BC Building Code states that a window wall system replacement or retrofit project is considered an alteration to an existing building and requires the involvement of a coordinating registered professional. This can be either an architect registered with the Architectural Institute of British Columbia (AIBC) or an engineer registered with Engineers and Geoscientists British Columbia (EGBC). Once the building owners decide to address their window wall system, it's time to hire a registered professional. Here's what to expect:

- › **Assessment:** Identifying the issues affecting the window wall system is critical for shaping the scope of the project. A site investigation could include visual inspection, exploratory openings, and off-site testing. The registered professional will present a summary report of findings and recommendations for repair or replacement.
- › **Design:** Once the scope is determined with the building owners or strata, the registered professional leads the project design. Should other consultants be needed for the project (such as a mechanical engineer, structural engineer, or elevator consultant), the registered professional would coordinate them. The design package will include specifications and a drawing of plans, sections, elevations, and details. As the design progresses, the professional will provide budget estimates to help the strata make project funding decisions.
- › **Rendering:** As part of the design, architectural renderings of the building will show the impact of the window wall system on the look of the building. This will help the owners visualize the project and make decisions regarding colours, frame configurations, and materials. The rendering may also be needed for the municipality's permit application process.
- › **Permits:** Significant changes to the building's look may need a development permit from the municipality's urban planning department. If that's not the case, the design package will go to the municipality for a building permit application. The registered professional must also submit signed and sealed letters of assurance.
- › **Tendering:** Often done concurrently with the building permit application, the design package will be issued for tendering to a group of contractors. The contractors are often invited to bid by the strata. The registered professional will help formalize the contractual agreements between the strata and the contractor.
- › **Construction administration:** Once the building



Waterproofing at the edge of the floor at the by-pass panel area

permit is delivered the design package will be issued for construction. Construction will start on the building, starting with mobilization, demolition, and installation. The contractor or construction manager develops a construction schedule and coordinates the work on site between trades.

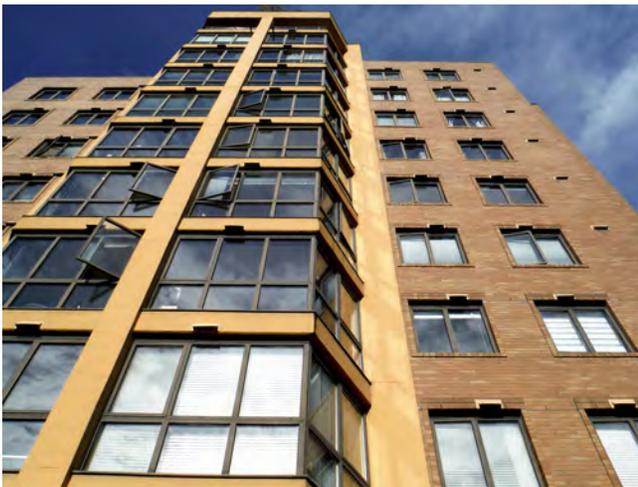
When using a general contractor, the registered professional provides construction administration services, including answering requests for information, issuing change notices, change orders, and site instructions with the strata's approval, and reviewing the contractor's monthly progress claims.

- › **Shop drawings:** The glazing contractor will supply signed and sealed shop drawings of the window wall system. The registered professional will review these drawings to make sure they meet the BC Building Code and the project's design requirements.
- › **Site review:** The registered professional must conduct periodic site visits during construction to review the contractor's work for compliance with the project documents. Site review is key for the registered professional to be in the position to sign and seal the letters of assurance at the end of the project.

- › **Field testing:** It is recommended to conduct water penetration resistance testing of the installed window wall system on site to verify that the system and its installation details are performing as expected when subjected to a simulated wind-driven rain event.
- › **Maintenance manual:** Owners may ask the registered professional to provide a maintenance program for the new window wall system.

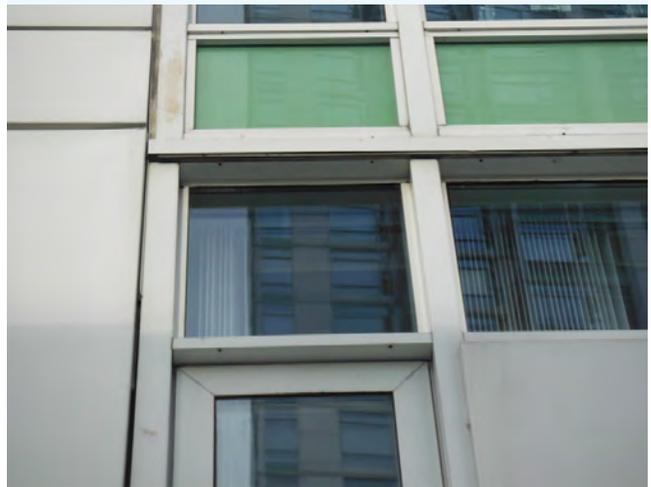
What Happens When Construction is Complete?

It's best to coordinate post-construction reviews of the new window wall system. The same or a different registered professional should perform these reviews and provide a report to the strata. Getting feedback from the owners about the general function of the system and confirmation that the appropriate maintenance is carried out is key to the durability of the system. Always update the depreciation report after a major renovation to account for the changed condition of the building envelope assemblies and their impact on the funding models.



More information:

1. Fenestration Association of BC, www.fen-bc.org
2. *Guide to Managing Renewals Projects in Multi-Unit Residential Buildings*, available at www.bchousing.org
3. Refer to your building's maintenance manual



Action Plan Tips – The Window Wall System

- Conduct annual maintenance and inspection on the window wall system and transitions to adjacent walls, roofs, and podium, including adjusting operable vents, doors, and windows.
- Annually monitor the interior finishes and the window wall system itself for active water leaks, condensation issues, significant air leakage, or fogged or damaged glass.
- Maintain records of the inspections, maintenance programs, renewals and all warranty and service documents. A website or central record system for the property owner provides a valuable location for the records and history of decision making and events.
- Conduct targeted repairs as needed under the direction of a qualified and insured contractor and consultant. Request all repairs be documented and reported in writing.
- Avoid duplication of work and cost. If the scope of work is extensive, consult with a certified professional on options available to correct the problem or renew the affected areas.
- Once the need for a window wall system retrofit or replacement is confirmed, engage a registered professional as the prime consultant to coordinate the project.
- Review credentials, insurance coverage, and past project work of potential registered professionals before selecting your consultants. A legal review of the consulting and construction agreement is recommended before proceeding.
- Work with the registered professional to determine the scope and design of the window wall system and related work.
- Set up project funding and approvals. Remember to include engineering services, construction costs, building permits, legal support, and contingencies.
- Issue design for tender for contractors and sub-contractors to perform the work, with the assistance and guidance from a registered professional and construction manager.
- Maintain and update a depreciation report to plan for the costs, scheduling of annual maintenance, inspections, and long-term funding of the window wall system.
- Conduct post-construction reviews and maintenance to maximize the expected service life of the window wall system.

Notice to Readers

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The regulations under the *Homeowner Protection Act* contain specific provisions requiring owners to mitigate and restrict damage to their homes and permitting warranty providers to exclude coverage for damage caused or made worse by negligent or improper maintenance. These apply to both new and building envelope renovated homes covered by home warranty insurance. Failure to carry out proper maintenance or carrying out improper maintenance either yourself or through qualified or unqualified personnel may negatively affect your warranty coverage. It is important for the property owner to read and review their warranty documents to understand how to file any claims and correspondence in the proper written form directly with the warranty company. Refer to your home warranty insurance documentation or contact your warranty insurance provider for more information.



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