
Building Science in the Restoration of a Heritage Building

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ABSTRACT

The Hotel Georgia is a Vancouver landmark. The 12-story building opened in 1927 and since then has hosted royalty and scoundrels—and a host of famous entertainers. The hotel is registered as a protected heritage property by the City of Vancouver. It is currently undergoing a major renovation with the intent of reopening as a five-star hotel.

The concrete-framed building is clad with a brick veneer and precast elements over backup walls of laid-up terra-cotta blocks. The brick is supported on shelf angles and tied back with irregularly spaced strap anchors (in a severe seismic zone!). Most windows were wood-framed, double-hung units.

The team overseeing the renovation of the building envelope had to consider many issues, including

- *providing seismic competence,*
- *addressing brick displacement caused by corrosion jacking at shelf angles,*
- *providing thermal and acoustic comfort appropriate for a five-star hotel,*
- *providing appropriate protection against water penetration in Vancouver's maritime climate,*
- *maintaining heritage character and fabric, and*
- *controlling costs.*

Key features of the renewal design included

- *installation of structural framing inside the existing walls and tying the brick through the terra-cotta block to the frame;*
- *replacement of about a quarter of the shelf angles without wholesale brick removal;*
- *use of spray-applied urethane foam to the inside of the existing wall to control the flow of heat, air, vapor, and moisture;*
- *replacement of guest room windows with wood-framed, double-glazed, single-hung operators; and*
- *restoration of lower floor wood-framed windows.*

This paper highlights how building science and logic drove design decisions.

INTRODUCTION

Vancouver is a young city with very few large buildings more than 80 years old. The Hotel Georgia has been a major and colorful part of Vancouver's history since it was designed by R.T. Garrow and John Graham and constructed in 1927 (Rossiter 1998). It is now registered as a protected heritage

property by the City of Vancouver. When this historic downtown hotel was slated for major refurbishment, it was of major interest to building professionals and heritage groups alike.

The renovation was enabled by some interesting development concepts. The renovation of the hotel was packaged with the development of an attached high-rise tower that provides

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additional amenity spaces for the hotel and luxury condominium suites. The city and developer negotiated a relaxation of height and density restrictions for the tower with commitments to restore the hotel, preserving key heritage features of the enclosure and specific interior elements. The end result is that the 1927 hotel is being renovated and upgraded to house a five-star hotel and the attached 49-story “point tower” will provide 156 luxury condominiums for sale (Figure 1). The renovations include the following:

1. Provision of a seismic upgrade of the primary structure, including the addition of concrete shear walls.
2. Gutting of interior partitions on the residential floors to provide larger luxury guest room suites.
3. Repair and retention of the original brick and “cast stone” cladding, including seismic restraint.
4. Replacement of residential floor windows with new wood-framed, double-glazed units that replicate the original double-hung wood windows. This includes replacement of three floors of recently installed aluminum windows with the wooden windows.
5. Restoration and retention of many of the windows on the second floor, which houses the ballrooms and other function rooms.
6. Replacement of storefront entrance glazing that has been installed on the ground floor with systems that look more historically appropriate.

7. Restoration of interior finishes of lower floor function rooms that have been deemed to have heritage significance.
8. Provision of rooftop and terrace amenities including planted areas, bathing and decorative pools, patio decks, and a hot tub/spa.
9. Creation of an eight-story underground parking area.
10. Installation of a ground-source heat pump system.
11. Creation of new and updated amenity spaces, including restaurants, bars, and kitchens.

This paper focuses on the decision-making process and the design of the walls and windows of the project. The authors acted as the Building Envelope Professionals for the project. This role is a requirement of the Vancouver Building Bylaw (VBBL), which requires that a Building Envelope Professional undertake a design review and an “enhanced field review” and provide letters of assurance that the components and assemblies of the project substantially comply with the requirements of Part 5 of the VBBL and with the plans and specifications accepted by the city on application for building permit. The Building Envelope Professional is therefore part of the design team but has responsibilities to the authority having jurisdiction.



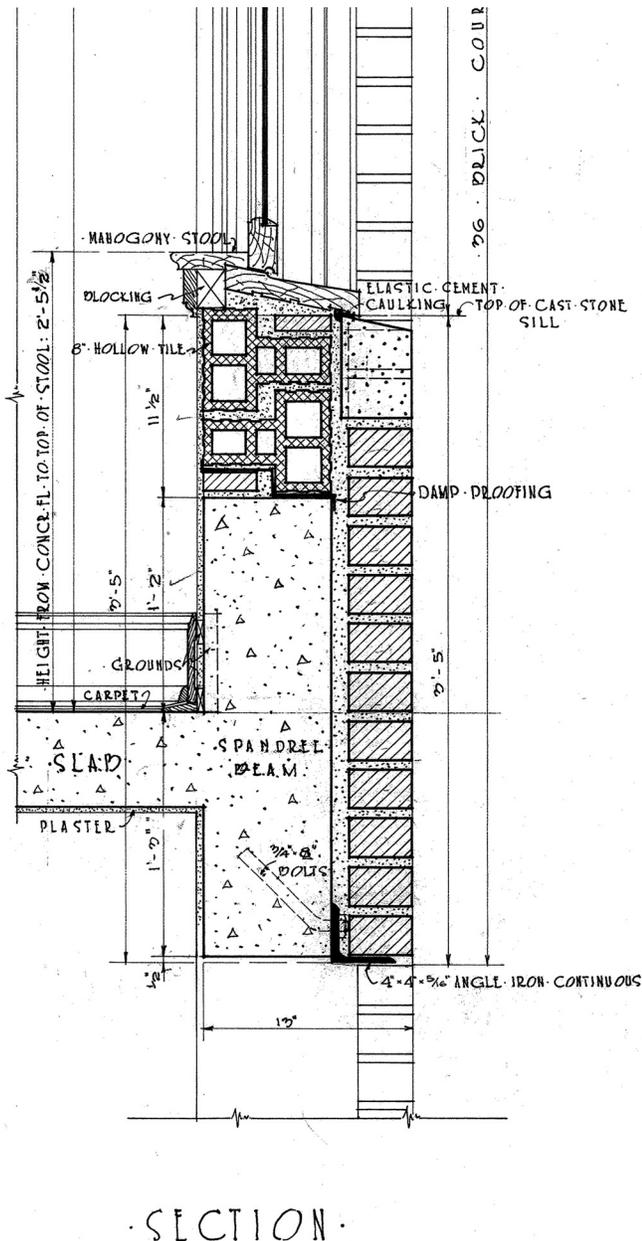
HOTEL GEORGIA

801 WEST GEORGIA STREET
VANCOUVER, BC

Figure 1 Rendering of hotel and associated condominium tower.

EXISTING CONSTRUCTION

The 1927 construction of the Hotel Georgia provided two basement levels, two function levels, and ten residential floors. The primary structure consists of poured concrete columns and slabs. The seismic upgrade carried out as part of the current project included the addition of full-height concrete shear walls, some of which were located on exterior walls. As shown in Figure 2, the slab edge detail included a perimeter beam that extends both above and below the slab. The space between the beams is filled with terra-cotta blocks or wood-framed, double-hung windows. The plaster finish is rendered directly to the interior face of the terra-cotta and concrete.



SECTION

Figure 2 Section through slab edge.

The exterior cladding is a locally produced buff-colored Claybank brick with trim elements and window sills of what Garrow called “cast stone,” a sand/cement mix with some reinforcing steel that looks like sandstone (Photo 1). These materials have been used on a number of Vancouver buildings of similar vintage.

The cast stone elements include coping (parapet wall caps), ledges/moldings/bands (mainly at the twelfth floor plate), parapet walls, finials at parapet corners, spindles at parapets, window jambs and transom panels at the twelfth floor, corners at the twelfth floor and lower floors, facing and ornamentation at the street level at the bottom three floors facing Georgia Street and Howe Street, and all window sills. At some point in the building’s history, the cast stone elements were painted with an undetermined coating.

The brick and concrete cladding elements are supported on shelf angles that are cast into the perimeter beams at window head level.

The original windows on the residential floors are one-over-one, weight-balanced, double-hung units of high quality wood (probably old growth Douglas fir). See Photo 2 and Figure 3 for typical window detail. On four of the residential floors, the original sashes had been removed and aluminum-framed, double-glazed windows had been installed into the original wood frame. We were informed that these windows were installed to meet airline standards for crew accommodation



Photo 1 South facade of Hotel Georgia Vancouver.

with respect to sound control. Single-glazed windows and downtown traffic noise had been judged to be a poor mix for high-level accommodation standards.

On the lower two floors, where many of the significant heritage interiors were located, the remaining original windows were also generally wood-framed, single-glazed units but were of different formats, including large, multi-light, fixed, and casement sash units.

The decorative roof parapet was an important heritage feature of the building. It was fabricated from cast stone and incorporates features including railings with open spindles, cast-in decorative elements, and projecting finials at the corners. The roof itself was a conventional built-up roof. There was a late addition to the building located on the roof, a framed structure that had housed a radio station. This element was slated for removal.

ENCLOSURE CONDITION

Several condition evaluation activities were commissioned as part of the renovation design process, including the following:

1. A visual, non-intrusive review of the envelope was undertaken early in the design process.
2. A condition review of each original window was undertaken to identify what repairs were required to the sash, frame, and masonry surrounding each window.

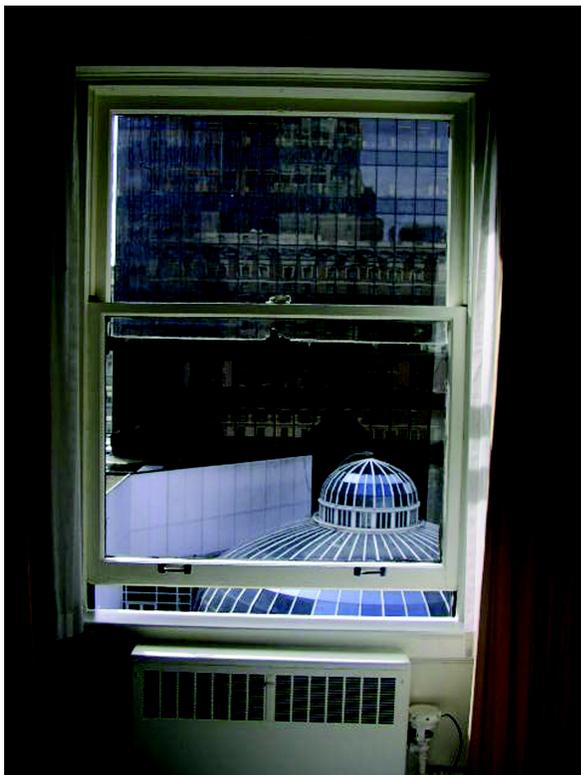


Photo 2 Typical window in suite.

3. A testing company was engaged to identify brick ties and to make some limited test openings to evaluate the condition of shelf angles.
4. In areas where shear walls were to be installed, brick was removed. These locations effectively provided large-scale test openings where the exact construction of the walls could be determined.

Masonry

Key findings regarding the masonry construction were as follows.

Contrary to what was indicated in the drawings, the collar joint between the face brick and backup was not filled with mortar. Neither was it a free-draining cavity. The gap between the brick and backup wall was partially obstructed by mortar droppings, but the face brick was not reliably bonded to the backup wall (see Photo 3). There were irregularly spaced, galvanized, corrugated brick ties between bricks and the terra-cotta blocks. The only tie between the brick and the concrete perimeter beams or columns were irregularly spaced wires

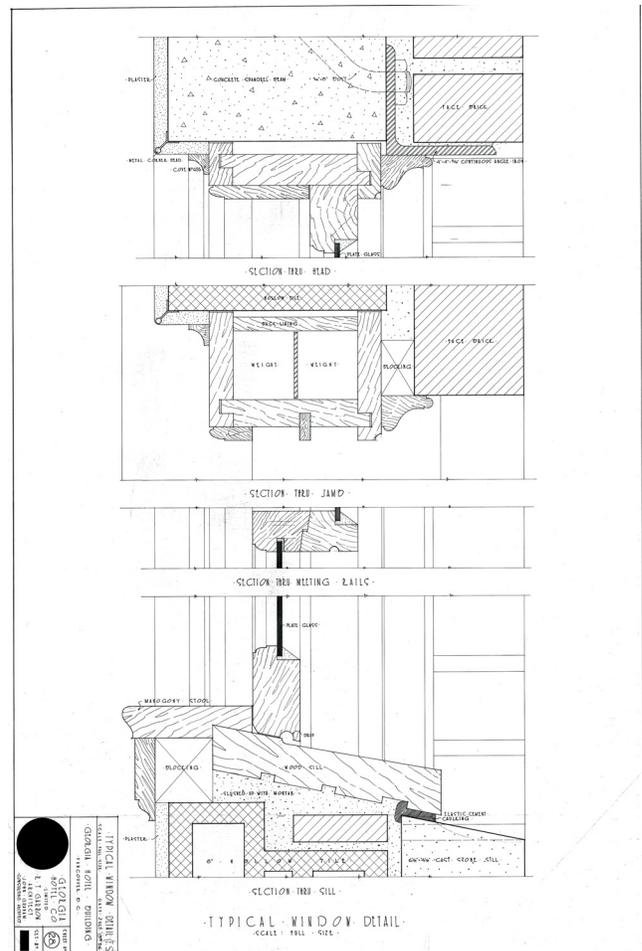


Figure 3 Window installation detail from historic drawings.

that were probably originally used as form ties (see Photo 4). Considering that the terra-cotta is too brittle to assume it would remain in place under seismic forces and displacements, the structural engineer was of the opinion that upgrading retention of the brick against lateral forces was necessary for a high seismic zone such as Vancouver.

The brick was generally in good condition. Mortar condition was generally good except where excessive moisture ingress or absorption was occurring. There was some mortar joint erosion and moss growth.

At upper floors there was masonry damage and displacement of the brick and cast stone elements due to corrosion of the shelf angles. This was generally limited to the tenth, eleventh, and twelfth floors and the elevator machinery penthouse. We found some upper-floor panels of brick “bowing” outwards due to shelf angle corrosion jacking. The extent of displace-

ment due to corrosion jacking was remarkable in places on upper floors (see Photos 5 and 6). At lower floors, the shelf angles still had the original paint. We attribute the variations primarily to dramatic differences in time and extent of wetting of the brick due to rain impact that results from wind-driven rain patterns around tall buildings (Inculet and Surry 1995). Moisture accumulation due to exfiltration of indoor air during cold conditions may also have played a role. We note that the latter mechanism could be minimized during the renovation but the former was an environmental condition that could not be changed.

The terra-cotta block in areas that were exposed proved to be relatively roughly laid with chipped blocks and open joints on the outer face. It certainly was not watertight. There were tarred felt flashings at the base of the terra-cotta (visible in Photo 3).



Photo 3 Wall with face brick removed.



Photo 4 Wire “ties” found at perimeter beam.

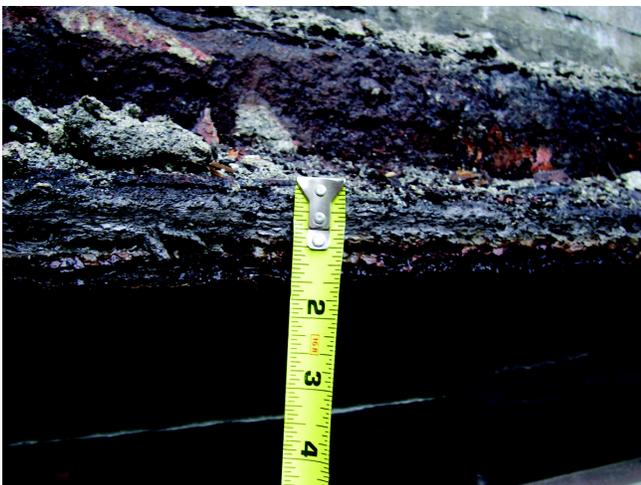


Photo 5 Shelf angle corrosion, horizontal leg.



Photo 6 Shelf angle corrosion, vertical leg.

The cast stone elements at the lower floors were in good condition but required some localized repairs. More repair was required at the upper floors, where the cast stone has cracked due to corrosion of reinforcing steel. This was particularly problematic at the parapet. Many of the spindles of the parapet railing were cracked and damaged (see Photo 7). The finials required cleaning, some relatively minor repairs, and seismic restraints. Again, the pattern of degradation matched typical wetting patterns. Many of the cast stone window sills and some jambs were cracked, with their reinforcing steel corroding and expanding (see Photo 8). Our window survey indicated that approximately 18% of the concrete sills required replacement and approximately 48% required refinishing of the concrete sill coating.

Windows

Table 1 is presented as a summary of the window condition review. This table outlines repairs required if the windows were to be restored and reused. All windows needed refinishing and resetting of glazing. Typical repairs that required significant carpentry included

1. repair or replacement of rotted elements of lower sash,
2. replacement or Dutchman repair of rotted wood window sills,
3. Dutchman repair of the lower portions of rotted wooden jamb elements, and
4. hardware repair or replacement.



Photo 7 Degraded cast stone spindle of parapet wall.

The joinery used in the window made the required repairs possible. We judged that the windows could be brought to a state that provided their historic performance levels.

Roofs

With respect to roofs, records indicated that the roof membranes were replaced in 1985–1986 with a liquid-applied system that was topped with a single ply of mopped Styrene-Butadiene-Styrene sheet in 1995–1996. The roofs appeared to be well maintained. Cutting through the roofing membranes would be part of the major renovation, so the roofing membranes would be replaced in any case.

DESIGN PRINCIPLES

Early in the design development phase, we produced a document outlining design assumptions and guidance for the rehabilitation of the heritage building enclosure. This was an output of the investigations described previously, discussions with the design development team, and engineering judgment and analysis. The intent was to have all parties in the design and construction team working from the same assumptions. The following is a slightly compacted version of the document.

General

1. The envelope of the Hotel Georgia project has operated successfully, without systemic problems, for eighty years in Vancouver's climate, with an indoor environment consistent with residential/hotel occupancy without humidification or modern standard ventilation.
2. In the future, the consequences and benefits of design decisions made today regarding the Hotel Georgia will accrue to a single relatively sophisticated agency (unlike a condo). The building will be operated by an agency with the knowledge and resources to maintain the building.



Photo 8 Failure of cast stone window sill due to corrosion at reinforcing.

Table 1. Historical Window Condition Summary

	Type A	Type B	Type C	Type D	Type E	Type F	Type G	Type H	Type J	Type K
Window Total/Type	249	11	14	70	20	12	6	19	16	0
Repair Needed										
Frame										
Repair trim	16	0	0	2	0	1	0	0	0	0
Replace trim	0	0	0	0	0	1	0	0	0	0
Repair jamb(s)	17	1	0	0	4	3	0	1	4	0
Repair/replace sill	59	0	1	18	10	6	0	1	5	0
Replace sill	46	0	0	0	0	0	0	0	0	0
Sash (Lower)										
Adjust operation	74	5	7	2	8	10	0	1	0	0
Repair rail/style	78	0	2	1	8	7	0	4	2	0
Repair/install limiter	2	0	9	0	15	0	0	0	0	0
Install handle(s)	8	0	4	0	4	2	0	0	0	0
Replace/repair chain	2	0	1	0	0	1	0	0	0	0
Repair latch	111	0	3	1	6	6	0	0	0	0
Install latch	30	0	0	0	4	2	0	0	0	0
Exterior Rough Openings										
Repair head	71	0	3	3	0	3	0	3	6	0
Repair steel lintel	57	0	2	2	2	0	0	1	5	0
Repair right jamb	63	0	2	4	1	0	0	2	3	0
Repair left jamb	64	1	2	3	1	2	0	6	3	0
Refinish sill coating	119	0	8	41	6	5	0	10	5	0
Replace concrete sill	59	0	1	7	2	0	0	0	0	0
Total repairs/type	876	7	45	84	71	49	0	29	33	0
Other	3	11	2	19	3	5	0	0	1	0

Legend:

Type A = Suite wooden windows
 Type B = Suite wooden windows
 Type C = Suite steel windows
 Type D = Suite replacement windows

Type E = Picture (ballroom) windows
 Type F = Office windows
 Type G = Commercial display windows
 Type H = Stairwell windows

Type J = Roof-level windows (levels 13 and 14)
 Type K = False exterior windows

Note: All windows to be refinished and re-glazed.

3. Preservation of the historic fabric of the building is a priority.
4. The indoor environment will not change substantially in a negative direction with the new use. The building will remain as residential/hotel occupancy, humidification is not being considered, ventilation systems will be brought to modern standards, and occupancy will generally be lower. These changes will reduce the probability of periods of high humidity.

Opaque Walls

1. The walls operate as mass masonry walls with respect to rain penetration control. Most precipitation is shed off the face brick and mortar joints; some is absorbed and held

2. until it can be dried back to the outside. The void space inboard of the brick is compromised by mortar droppings and there are no drain or vent holes.
2. Control of air leakage is inherent in the wall assembly as a whole rather than as a result of a single-designed plane of airtightness. It is debatable whether the plaster or the brick is the most airtight layer.
3. The multiple layers of oil-based paint on the plaster have provided sufficient vapor diffusion control for the construction and environment that the building has been exposed to.
4. The existing walls are uninsulated. This can allow the interior surfaces to be colder than is typically accepted in modern buildings (for comfort more than resistance to

condensation in historic environments) but has the advantage of allowing heat to flow to the outer parts of the wall to promote drying to the outside.

Windows

1. The existing windows are single glazed and heat has been provided under the windows.
2. The extent of damage to interior finishes shows that condensation on the windows has occurred but has not been excessive. The condition of the windows was governed by deterioration caused by precipitation.

Design Decisions

1. The windows and frames will be replaced with wood-framed, single-hung windows that replicate existing windows. The new windows will include insulated glazing units (IGUs) and modern weatherstripping details (see the following for more detailed discussion). This will improve thermal performance, condensation resistance; air leakage resistance, and acoustic performance. With less accidental air change there is more reliance on ventilation to provide needed air change and humidity control.
2. In general, the existing brick will be maintained. Tieback against seismic forces will be accomplished by retrofit ties installed either to existing concrete from the outside or to new interior structures from the inside. Some shelf angles will be replaced using methods that limit brick removal.
3. For the masonry walls, we will renew and continue to rely on the historic operating principles with respect to water penetration. No attempt will be made to create a drained cavity. Work will include
 - a. repointing degraded mortar joints to limit inward water migration and air leakage through brick,
 - b. renewing flashing and drip details, and
 - c. keeping existing terra-cotta blocks where possible.
4. We propose to apply a limited thickness of medium-density spray-applied foam insulation on the interior surface of the existing walls to provide
 - a. a controlled amount of insulation to keep interior surfaces warm but allow significant heat to escape to help dry mass walls,
 - b. an airtight layer to counteract disturbances to interior finishes and terra-cotta,
 - c. a level of vapor diffusion resistance at least as good as the existing layers of paint, and
 - d. a waterproof layer to further resist inward water migration.
5. Where brick will be removed for other reasons (i.e., adding shear walls), we will typically conform to modern drained cavity wall construction.
6. Waterproofing of the roof will follow a consistent approach using inverted roof assemblies. All roof areas would be waterproofed with a membrane adhered to the

slab with insulation above. The ballast could be gravel, pavers, a planted area (with a root barrier), or a pool. With any pool, the pool shell would be made waterproof by some method, the structure would be waterproofed by the membrane previously noted, and the space between would be drained.

Deciding what to do with the windows was the subject of particular analysis, considering

1. their physical condition,
2. the performance and durability in the environment that they have been exposed to,
3. the performance expectation in the envisioned application,
4. the retention of heritage character-defining appearance,
5. the preservation/retention of historic fabric, and
6. the expected life and extent of future repairs when refurbished vs. the expected life when replaced with replicated or new window systems.

The owner was committed to retaining and restoring the original wooden windows on the first and second floor (about 7% [and the most significant] of the window openings) and replacing the modern windows that had been installed on floors 4, 5, 6, and 12 with windows that replicated the originals (about 20% of openings).

The existing windows generally were in good enough condition that one could consider the options listed below in order of the level of intervention.

1. **Repair the existing windows, retaining as much as possible of the existing wood and glass.** This would require removal of the sash for refinishing and resetting of the single glazing, repairing rotted wood (mostly bottom rails), and replacing weatherstripping. The frames would be stripped in situ, degraded wood (mostly on sills) would be replaced or repaired with epoxy, and the frame would be filled and refinished.

This approach follows the “least intervention approach” and preserves the maximum heritage fabric. However, it retains the limited performance of the existing, single-glazed windows with respect to acoustic separation, thermal performance, and condensation resistance.
2. **Repair the existing windows but upgrade the glass to laminated glass.** This requires the same work as Option 1, but the existing glass would be replaced with laminated glass to provide a limited improvement in acoustic separation and security without requiring modification of the sash. The incremental benefit would be minor, so this option was given little consideration.
3. **Repair the existing windows but upgrade the glass to an IGU.** In addition to the work defined in Option 1, the sash would have the glazing pocket routed out to accept an IGU. The glazing unit would be heavier than the exist-

ing glass, requiring opening of the weight pockets to adjust the counterweights.

IGUs would provide improved acoustic separation and modern performance with respect to thermal performance and condensation resistance.

In our opinion this option was practical with the one-over-one (suite) windows. There would be a limited change to sight lines and the appearance of the frame sections because of the removed material. It is less practical on the multi-light windows on the lower two floors because too much of the muntin bars would have to be removed.

4. **Repair the existing windows' retaining glass and add a second layer of glazing with a new sash or glazing layer.** The second glazing layer could be outboard of the existing (as in a storm window) or inside. The second glazing layer must be removable for cleaning and should allow window operation. Adding an interior casement operating sash or a second vertical sliding sash are options we had used on past projects. These change sight lines and appearance significantly but provide thermal and acoustic performance, similar to Options 4 or 5.
5. **Replicate existing sash to match material and appearance of original sash using IGUs and install into existing restored frames.** It is easier and less costly to fabricate new sashes than to modify them as in Option 3 or even, perhaps, refinish them as in Options 1 or 2.

This approach does not retain the historic fabric in the sash, but the new sash could be fabricated to be virtually indistinguishable from the existing in terms of material and appearance, at least for one-over-one windows. In multi-light windows, the profile of the muntins must be modified from that of the existing windows.

It is not inconsistent with heritage concepts to treat sash as wear items that need to be replaced when required. The newly fabricated sash would have modern standard performance and should have a longer life than a refurbished sash. The life of the refurbished frames could be the limiting feature.

6. **Replicate existing sash and frames to match material and appearance of original windows but use IGUs.** In this option no fabric is retained, but the sash and frames can be fabricated to match existing material and appearance. This is an extension of Option 5 but effectively resets the lifetime clock of the windows back to zero. With appropriate and regular maintenance, 50 years of service can be expected.
7. **Replace existing windows with new "low-maintenance" windows.** This assumes removal of the existing wood sashes and frames and replacing them with new windows that have an appearance similar to the existing but use "modern" materials. The windows can be selected to provide the desired performance characteristics and to have low ongoing maintenance costs. There are windows with these characteristics that have an appearance similar to that of the existing windows, but they will not be identical.

For the windows on the first and second floors it was decided to apply Option 1 because these windows were recognized to be of high importance to the heritage character of the building. Modifying the existing multi-light sash to accept double glazing or reconstructing the windows with a new sash to accept double glazing was ruled out because doing so would impact the appearance of the windows.

For the remaining original suite windows, we suggested to the owner that the best method of meeting performance, heritage, and cost priorities is to install replicated wood sashes whether or not the frames are replaced (Option 5 or 6). The one-over-one style of window makes it possible to fabricate sashes that carry IGUs for sound and thermal control but are virtually indistinguishable from existing sashes. The end result would be windows that are nearly identical to the existing windows but have performance characteristics appropriate for an upscale hotel.

However, there are long-term operational advantages to replacing the existing frames. Even with the required major effort and cost to restore the existing window frames, future renewal efforts and costs will be higher than they would be if we used new material. Providing new, undeteriorated material for the frames would provide a significantly longer period of time that the heritage appearance of the windows would be maintained without significant future repair and replacement.

Ultimately the decision was made to replace the windows with high-quality, single-hung wooden windows that matched the appearance of the existing units but were not actual replicas.

IMPLEMENTATION

Walls

The challenge with the exterior walls was to provide the desired hydrothermal performance, weather resistance, and resistance to seismic forces while retaining the original brick and cast stone. The team explored a number of design approaches to provide the necessary support of the brick against lateral loads and frame displacement during seismic events. It was desired to anchor the brick in its existing location. Where the brick was out of plane, no attempt would be made to straighten it because that would cause additional cracking. We considered installation of reinforced masonry or shotcrete walls inboard of the brick, with or without removal of the terra-cotta block backup wall. However, minimizing added weight was a priority. This drove a decision to construct a structural, steel-stud frame inboard of the existing wall and to tie the brick back by drilling through the terra-cotta and installing 6 mm stainless-steel all-thread rods from the new frame into the face brick from inside. The rods were epoxied into the brick and bolted to the frame. Photos 9 and 10 show the system used. The frame and tie pattern defined by the structural engineers were studs at 300 mm and vertical spacing at 450 mm. The installers were requested to drill through the wall at a slight downward angle from inside to outside to have gravity help limit inward water migration. In the area where

the brick was outside the perimeter beam or concrete backup walls, commercially available retrofit expansion ties were installed from the exterior, through the mortar joints of the brick and into the concrete backup.

Given that the terra-cotta block would now be even less continuous, it became critical to provide an airtight and watertight assembly inside the block layer. This was done by using

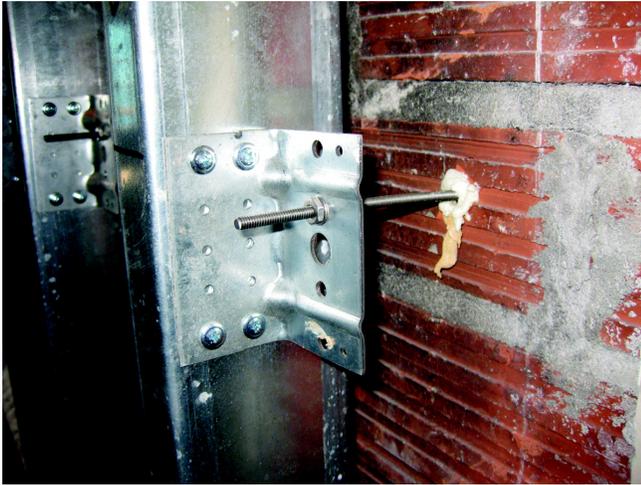


Photo 9 Brick tie installed through terra-cotta backup wall.



Photo 10 Structural frame supporting brick ties.

the properties of medium-density closed-cell polyurethane foam insulation (ccSPUF). The new stud wall was anchored to the slab above and below and stood off the inside face of the originals wall by about 25 mm. At about 50 mm, ccSPUF was applied to the inside face of the wall. This expanded behind the steel-stud frame and around the threaded rods, providing a continuous layer of waterproof, airtight, vapor-resistant insulation (see Photo 11). The foam engaged the studs, providing a structure strong enough to resist wind loads even if adhesion to the original wall was compromised. This was considered relevant because not all of the original plaster was removed during demolition. Long-term adhesion of the foam to plaster on the cold side of the insulation could not be assumed.

It was recognized that the addition of insulation would reduce heat flow to the masonry elements of the wall and that this could reduce drying potential. The consequences of this were considered and judged to be acceptable. In Vancouver's mild climate, freeze/thaw degradation is very limited, and the exterior elements of the building were all moisture tolerant. We also noted that brick at the parapet walls, which had never received the benefit of interior heat, was in good condition, showing no evidence of freeze/thaw damage. It was, however, decided to be cautious about how much insulation to add. A 50 mm thickness was selected considering the desire to have a continuous layer outboard of the studs while engaging the studs for structural support of the foam. The level of insulation would be more than adequate keep interior surfaces warm for both comfort and condensation resistance. Energy savings were not a major driver in the decision but were a serendipitous benefit.

Windows

The windows selected for this project were not reproductions of the originals. They were high-quality, commercially available, single-hung, IGU-glazed, wooden windows with cosmetic modifications to better match the millwork of the



Photo 11 Insulation applied to exterior walls.

originals. Two significant differences are that the windows are counterbalanced by a spring system rather than weights and that they are fabricated with a weatherstripping system. The units are capable of meeting modern standards for air and water leakage.

Significant attention was paid to preparing the openings for the new windows. The original windows were mortared in, so they were probably installed concurrently with the brick and terra-cotta block. As can be seen in Photo 12, the masonry around the window was rough and open. The windows were located in a plane that bridged the terra-cotta block and the brick. Any water that leaked through the window frame or at the wall/window joint was generally restricted to these moisture-tolerant materials. The new windows were installed in the same plane, but we decided that all reasonable measures should be taken to minimize water entry as far inboard as the terra-cotta, particularly considering that the insulation would reduce the drying capacity of the masonry elements. The installation detail also had to address the fact that without weight pockets, the new window assemblies were narrower than the historic windows.

The rough openings of the windows were prepared by parging the sills and jambs on the openings to fill the cavities in the terra-cotta. At the sill, the parge coat was formed with a slope to the outside. The sill was waterproofed with a liquid-applied urethane waterproofing that extended approximately 6 in. up the jambs. The window was installed in the opening



Photo 12 Condition of window rough opening prior to purging.

using strap anchors back to the new structural, stud frame wall, and the window was sealed into the wall assembly using urethane sealant and ccSPUF (see Figure 4 and Photos 13 and 14).

Masonry Repair

Replacement of the corroded, steel shelf angles with new galvanized steel angles was required on the top three floors, at the penthouse, and at limited locations at lower levels; thus, some brick removal was involved in sections. In general this was limited to two to three courses of brick by installing the shelf angle in sections and anchoring the sections back to the concrete perimeter beams using drilled-in expansion anchors. At locations where the shelf angles were replaced, a liquid urethane waterproofing membrane was installed to direct any incidental moisture away to the exterior (see Photo 15). The exterior masonry repair included replacement of damaged, cast stone window sills and all the spindles of the parapet balustrade. Repointing was carried out where necessary.

Heritage Parapets

The roof parapet walls, consisting of cast stone blocks, spindles, and copings, were upgraded by casting a new concrete wall at the interior. Structural tie backs were used to secure the existing parapet wall to the new concrete wall (see Figure 5). To preserve the appearance of the existing cast stone copings, a liquid urethane membrane was installed over the entire parapet wall (existing and new concrete parapet).

Since most of the parapet spindles were in disrepair, it was decided that all spindles would be removed and replaced. A waterproofing detail (liquid urethane membrane) similar to that of the parapet wall was implemented at the spindle locations.

The finials located at the corners of the parapet walls were removed and taken off site for cleaning and minor repairs. To seismically attach a finial, a core hole was made through the center and was reinforced with steel and filled with concrete.

CONCLUSION

Any restoration of a historic building requires balancing many factors, including providing a use for the building that ensures its value as a useful entity, preserving the historic features and fabric, correcting the causes and consequences of historic performance problems, and providing the performance required for its continued use.

In the best projects, there should be a balance of input and opinions from experts championing heritage preservation, building performance, and economic viability. Intervention decisions involve compromise but cannot be driven by one point of view. We would put forward the Hotel Georgia project as one where an appropriate method and balance was achieved.

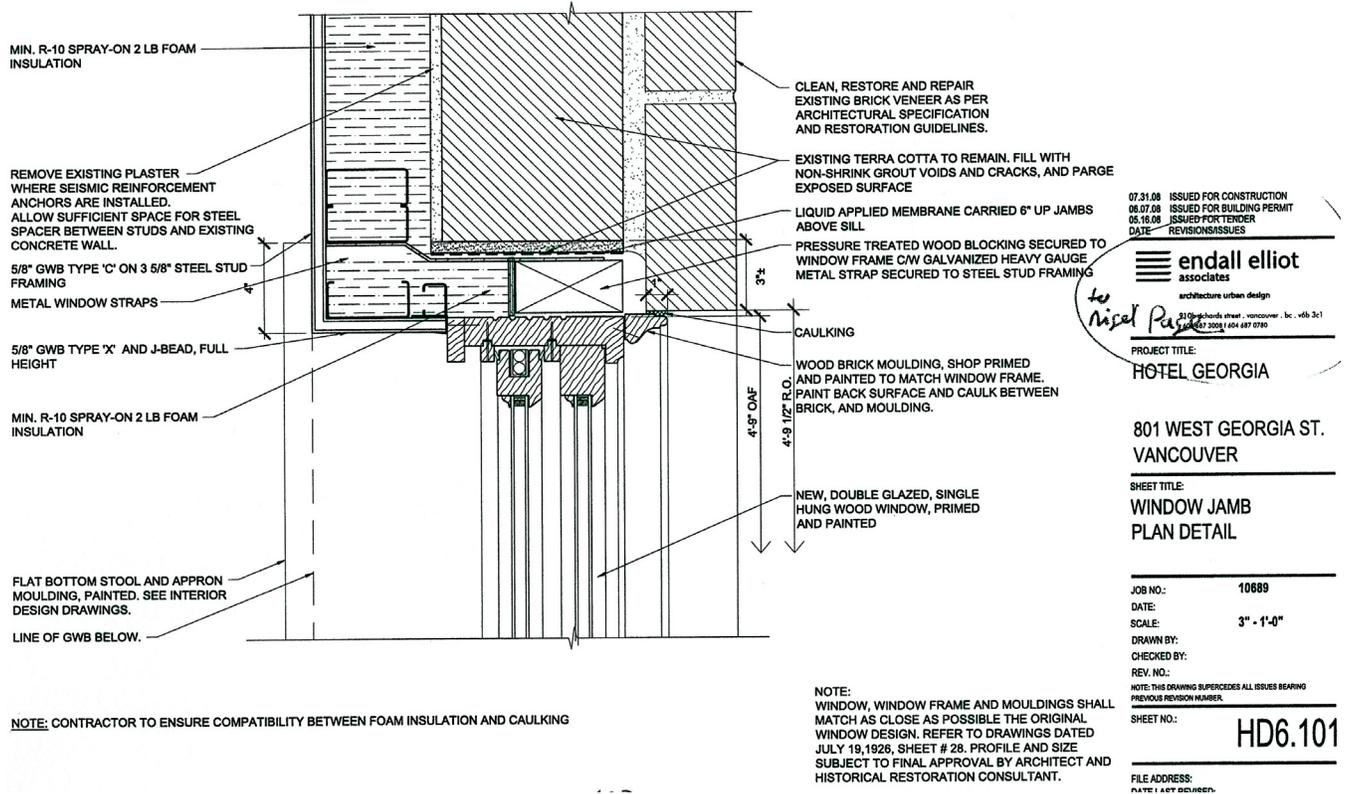


Figure 4 Window installation detail—head.



Photo 13 Waterproofed window opening.



Photo 14 Window attachment and sealing.



Photo 15 New shelf angle with liquid applied "flashing."

ACKNOWLEDGMENTS

Project Credits

1. Developer: Hotel Georgia Development Ltd.
2. Development Managers: Delta Land Development
3. Construction Managers: Scott Construction Group
4. Architects: Endall Elliot Associates Architecture and Design
5. Heritage Consultant: Robert Lemon, Architect Inc.
6. Structural Engineers: Glotman Simpson Consulting Engineers
7. Building Envelope Consultants: Morrison Hershfield Ltd.

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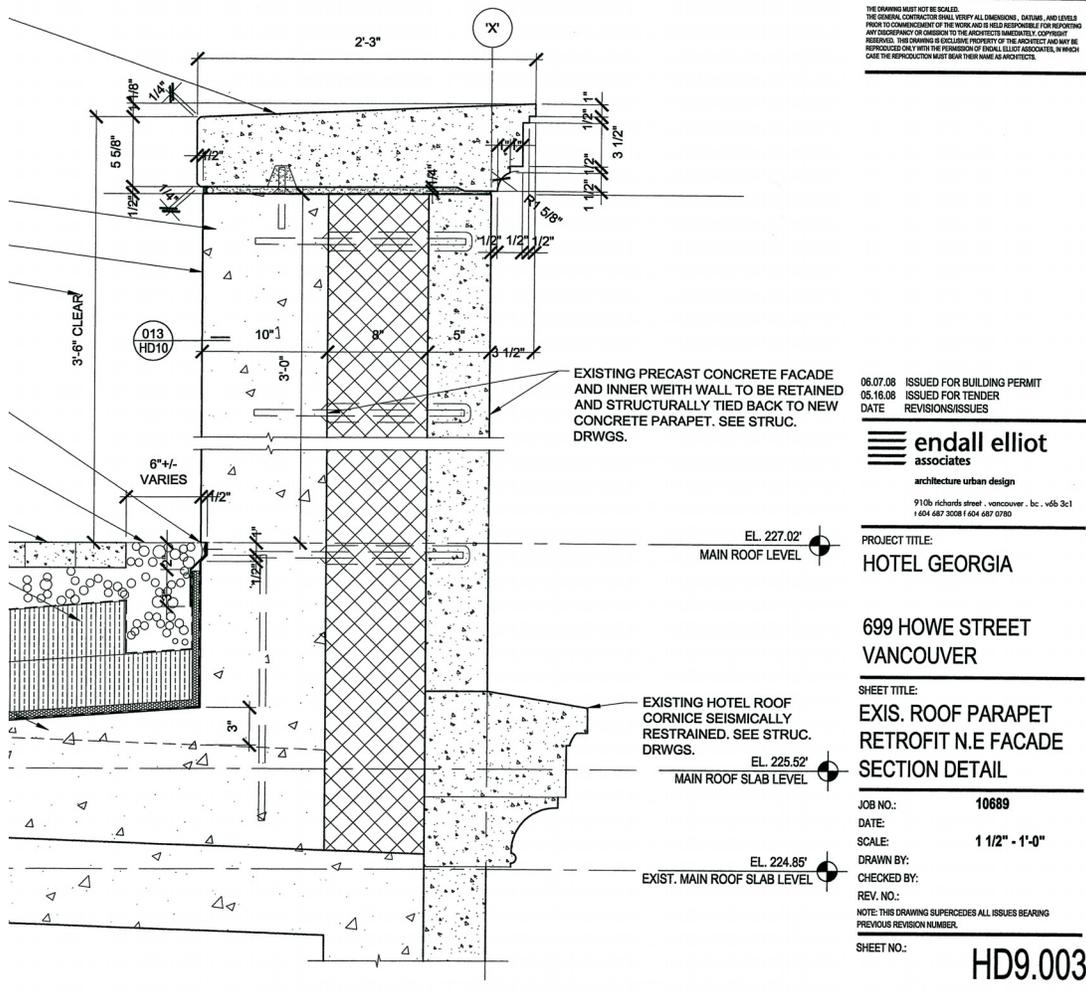


Figure 5 Parapet reinforcement detail.