Conservation and Restoration of the Spencer Building in Vancouver, British Columbia

By Marcus Dell, PEng and Michael Grummett, PEng

DEFINITIONS

Conservation – The action or process aimed at safeguarding the character-defining elements of a historic place so as to retain its heritage value and extend its physical life.

Restoration – The action or process of accurately revealing, recovering, or representing the state of a historic place, or an individual component, as it appeared at a particular period in its history, while protecting its heritage value.

Conservation may involve preservation, rehabilitation, restoration, or a combination.

PROJECT OVERVIEW

The Spencer Building has played an important role in Vancouver's history, beginning as the flagship department store for David Spencer Limited (Spencer's). From 1925 to 1948, the building was a major retail hub in the downtown core of Vancouver, specializing in ladies' fashion, perfume, and jewelry (*Figure 1*). The tenants have changed over the years, and since 1989, it has housed the downtown campus of Simon Fraser University, a major Canadian educational institution. The Spencer Building is, and will continue to be, a prominent historic structure in the downtown core of Vancouver.

Figure 1 – Spencer Building circa 1930. Photograph courtesy of Vancouver Archives.

The overall goal of the conservation and restoration program was to rehabilitate 90 years' worth of deterioration and destabilization that had occurred to the building enclosure. In addition, the program was intended to improve interior environmental conditions, ensuring the building's prominent position as a gathering place for students, office workers, locals, and tourists. Fortunately, the building ownership group was motivated to invest in the downtown core of Vancouver and this historically significant property.

The street level was completely altered in the late 1970s as a modernization of the building and to facilitate repurposing. Unfortunately, these alterations could not be undone; therefore, the street level was not addressed as part of the conservation and restoration.

The duration from initial identification of exterior performance problems with the building enclosure to completion of the conservation and restoration was approximately four years. The planning and preparation steps took approximately two years, and the site construction work occurred over a two-year period. The intent of this article is to provide a big-picture overview of the complete project, while providing more detailed insight into select aspects and sharing some of the lessons learned.

The project began with a detailed condition assessment of the exterior walls and windows. The exterior walls are clad in a combination of smooth-faced, fired-brick masonry and cast stone, both of which were supported on steel angles at the floor levels. The original windows consisted of steel frames and 20 pieces of single-pane glass, many of which included blemishes or defects from the original manufacturing. Over the years, water penetration into the building enclosure resulted in corrosion of the steel shelf angles, the steel window frames, and the reinforcing steel embedded within the cast stone.

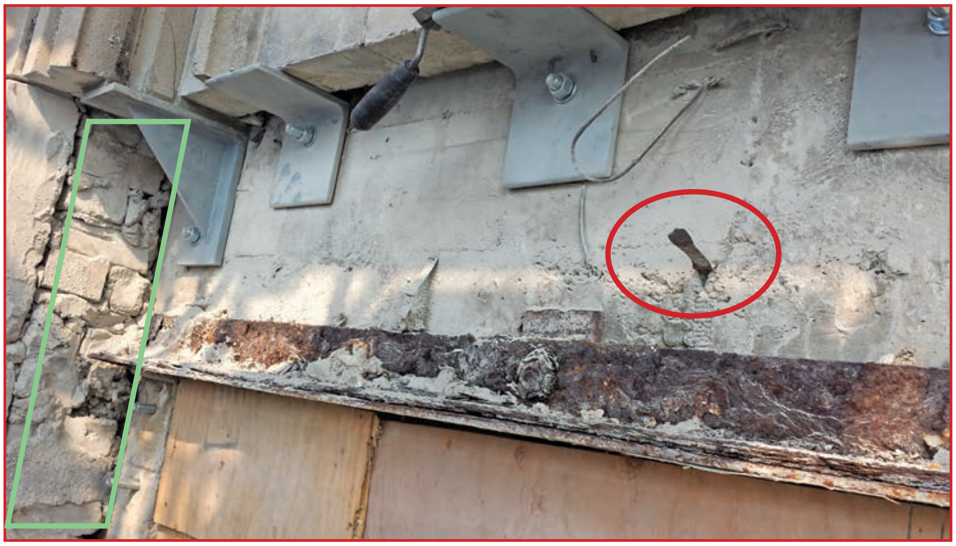


Figure 2 – Severely deteriorated shelf angle. The red circle illustrates one of the original masonry ties used to secure the cast stone to the concrete frame. The green rectangle illustrates the typical masonry rubble installed between the cast stone and the concrete frame. The plywood was used to protect the window during removal of the masonry.

For those not familiar with cast stone, it is a pre-cast architectural concrete material utilizing fine aggregates and cement to achieve durable physical properties and the desired decorative finish. Typically, cast stone units contain steel reinforcing to give the units structural integrity and to aid in lifting during installation.

The Vancouver climate is often referred to as a "temperate rainforest," and as such, the materials on the exterior of buildings (new and old) become saturated with water during the wet season (often November to May). Therefore, the saturated materials are often subjected to freeze-thaw damage when the temperatures dip in the winter months.

In short, the primary cause of the deterioration at the Spencer Building was corrosion of steel components. The corrosion of the shelf angles (*Figure 2*) resulted in large vertical compressive loads within the brick and cast stone because the façade did not include any control joints. These large vertical loads in conjunction with lateral loads (outwards) caused by corrosion of the window frames resulted in overall instability of the masonry cladding and spalling of the brick and cast stone (*Figure 3*). In some

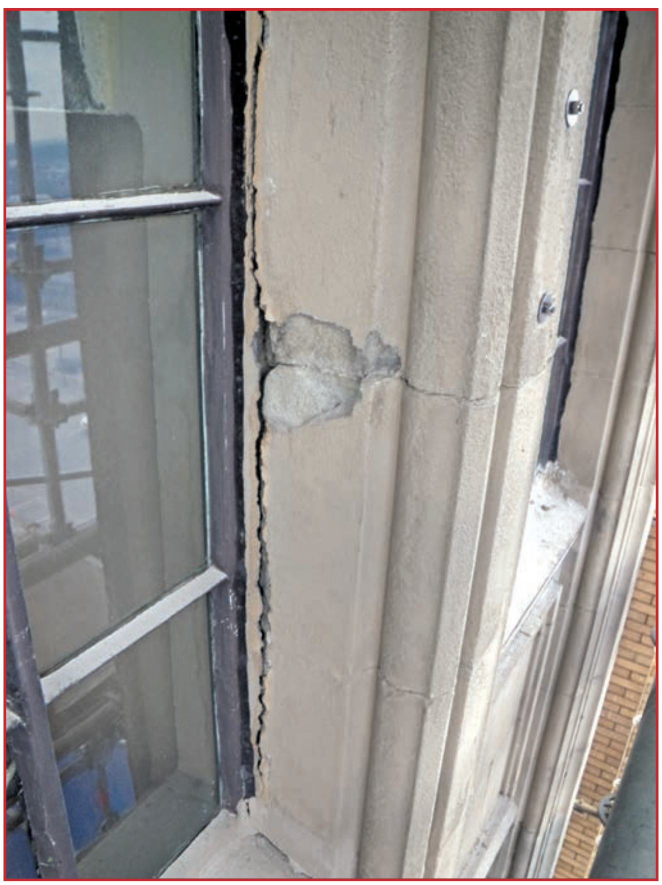


Figure 3 – Damaged cast stone due to corrosion of window frame and significant vertical compressive loads created by corrosion of the shelf angles at the floor levels.

Figure 4 – Damaged cast stone due to corrosion of embedded reinforcing steel.

a building permit on any historic building.

The additional information learned during the trial repair also allowed us to work with the building ownership group to develop an overall conservation and restoration plan. A key component of the plan was understanding the owner's expectations.

In summary, the owner requested a 50-year performance life for all the newly installed major components. These included shelf angles (hot-dipped galvanized) and the stainless steel fasteners used to attach them, as well as new stainless steel masonry ties, new cast stone units, new windows, and flashings.

locations, the cast stone at the window jambs was bowed outward up to 12.5 mm (½ in.) between floor levels. The outward bowing and the significant compressive loads had crushed the inside edge of the cast stone.

In addition, expansive forces caused by the corrosion of the steel within the cast stone damaged the cast stone units themselves (*Figure 4*).

TRIAL REPAIR

A trial repair was recommended to determine whether the proposed restoration could be implemented. For example, it was not known how much cast stone would have to be removed to allow installation of the proposed new high-performance windows. Trial repairs are expensive, but the value of this step in a historical restoration cannot be underestimated. Not only did the trial repair allow for determination of original construction practices, but it also provided the building ownership group and the City of Vancouver Heritage Commission an opportunity to see firsthand the types of problems that needed to be addressed and the aesthetics of the proposed outcome.

The trial repair also allowed us to confirm that the conservation and restoration could be completed with proper consideration of the *Standards and Guidelines for the Conservation of Historic Places in Canada*, published by Parks Canada. This confirmation is a critical step in preparation of a conservation plan—a document that must be developed prior to application for

CONSERVATION AND RESTORATION PROGRAM

The goal of this section is to provide detailed insight into select technical aspects of the building enclosure conservation and

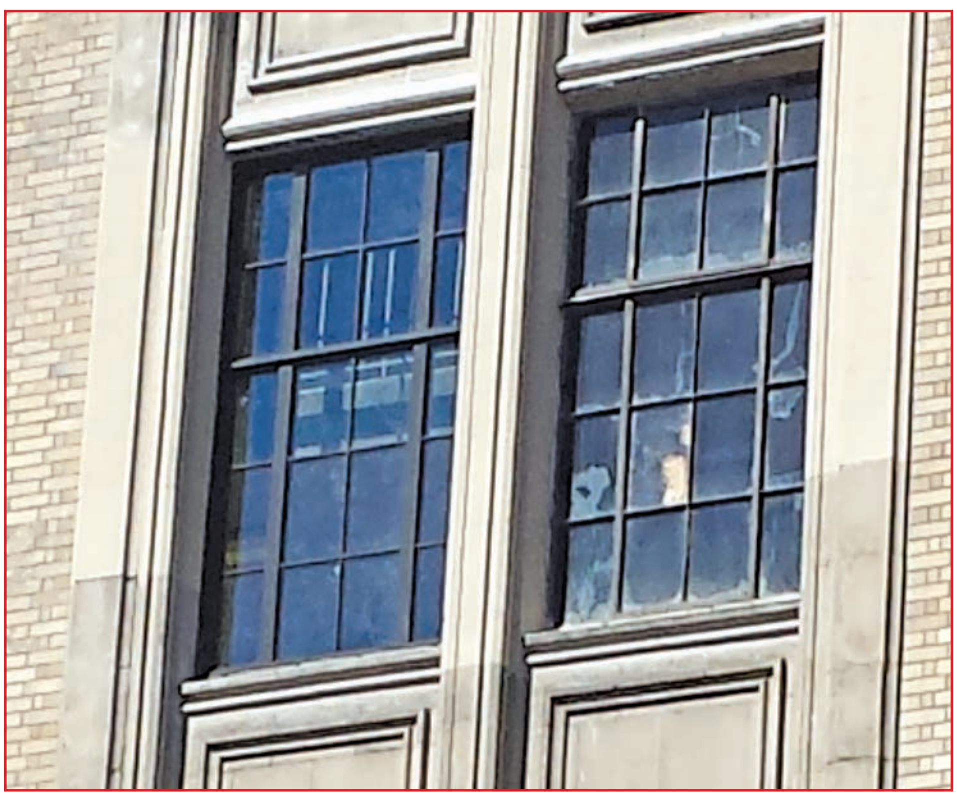
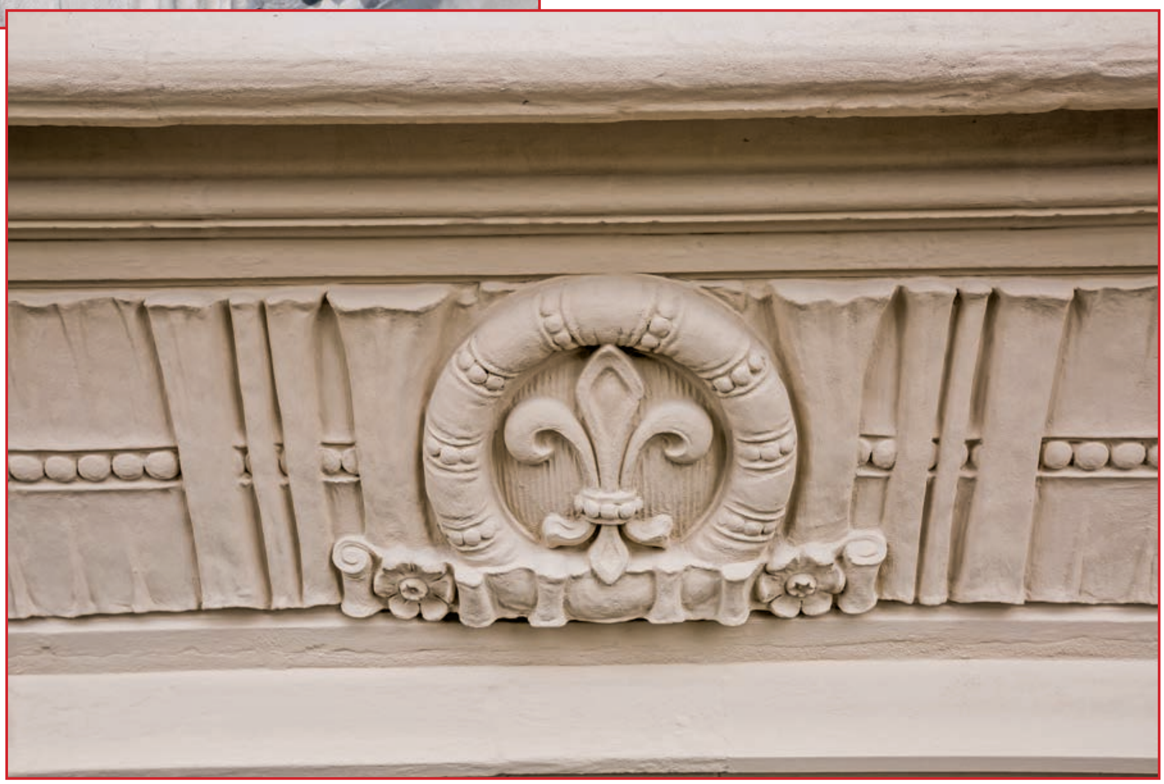


Figure 5 – Photograph of a new window on the left and an original window on the right.

Figure 6A – Condition of cast stone at time of condition assessment.

Figure 6B – Condition of cast stone after restoration.



restoration, and to share some of the lessons learned. The building enclosure for the Spencer Building consists of four primary components, namely: windows, cast stone, brick, and flashings. Insight is provided for each of these components.

Windows

Windows are a challenging component of the building enclosure when implementing a historic conservation and restoration because replacement of the windows often results in a significant impact on the aesthetics of the building.

As noted previously, the original windows consisted of steel frames with 20 pieces of single-pane glass. The original operable vents within the windows had been sealed shut many years ago. As noted above, corrosion of the window frames was damaging the cast stone and causing instability within the masonry. The deterioration of the windows was significant, so they could not be restored in situ. In addition, the original windows had very poor thermal performance. Therefore, it was deemed necessary to replace the original windows with new high-performance units that mirrored the originals.

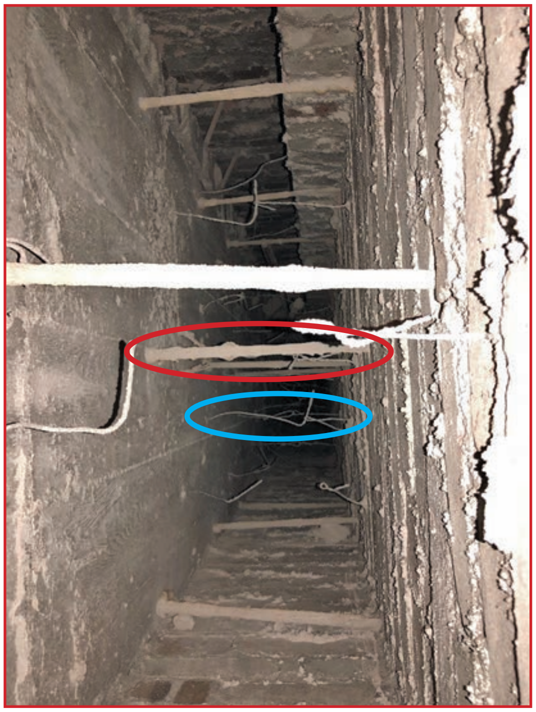
We worked with a local window fabricator to develop a thermally broken window configuration that closely resembled the originals. Muntin bars were placed within the insulating glass units (IGUs), and additional muntin bars were adhered with double-sided tape to the exterior of the IGUs (mechanically fixed at perimeters), resulting in an acceptable aesthetic. Care was taken to ensure that the new muntin bars had the same dimensions (width and projection) as the originals. *Figure 5* illustrates an original and a new window adjacent to each other. During the installation, a continuous moisture and air seal was installed between the concrete frame of the building and the new window frame. A liquid-applied membrane was used for this purpose to accommodate existing irregularities in the concrete.

Cast Stone

To those not familiar with historic buildings, cast stone is often referred to as precast concrete. Even though the two materials are similar, the difference is primarily the size of the aggregate. Specifically, cast stone has much finer aggregate, allowing for the formation of intricate (detailed) surface features (*Figures 6A* and *6B*). Traditionally, cast stone was coated after installation to obtain the desired color. At the time of our

Properties	Testing Requirements	Cure Before Testing	Performance Requirements
Compressive Strength	ASTM C1194 ASTM C1194	7 days 28 days	25 Mpa 45 Mpa
Water/Cement Ratio	ASTM C1194		0.45 max.
Absorption	ASTM C642 - Cold ASTM C642 - Boiling	28 days 28 days	6% max. 10% max.
Air Void Parameters	ASTM C457 - Air content ASTM C457 - Spacing factor ASTM C457 - Specific surface	8-10% 0.23 mm max. 24-48 mm^2/mm^3	
Resistance to Freeze-Thaw	ASTM C666/C666M (Procedure A)	14 days	CPWL< 5% (@300 cycles)

Table 1 – Cast stone performance criteria.



condition assessment, there were multiple coatings on the cast stone. The original cast stone units contained traditional (nongalvanized, noncoated) reinforcing steel. After exposure to the elements for many years, the depth of carbonation of the concrete had reached the reinforcing steel, allowing corrosion of the reinforcing steel to occur (typically, there was two inches of concrete cover over the steel reinforcing in the original cast stone). The expansive forces associated with corrosion of the reinforcing steel caused spalling of the cast stone (*Figure 4*). The combination of corrosion and spalling resulted in damage and loss of structural integrity, and contributed to displacement of the stone.

Considerable effort was required to develop a concrete mix design that resulted in cast stone units that complied with ASTM C1364-10b, *Standard Specification for Architectural Cast Stone*. ASTM C1364 includes a requirement that the cast stone units comply with ASTM C666, *Standard for Resistance to Rapid Freezing and Thawing*, a criterion that was deemed important for resistance to the Vancouver climate. *Table 1* documents the key performance criteria for the cast stone.

Several cast stone samples were manufactured and tested to ensure compliance with all necessary criteria before a final mix design was accepted. Appropriate time

Figure 7 – View down into the cavity between the back of cast stone units and the concrete backup. Clearly visible are the sieves filled with epoxy resin and stainless steel threaded rods (red ellipse). Also visible are the wire ties installed at the time of original construction (blue ellipse).

needs to be allowed for the manufacture and testing of samples; some of the tests can only be performed after 28 days of curing, and then the testing takes several months. Frequent material testing during fabrication ensured that materials remained consistent throughout construction.

Reinforcing was added to each cast stone unit to improve the structural integrity of each unit during installation and in situ. The reinforcing bars used are 304 stainless steel to reduce the risk of corrosion and resultant damage to the cast stone units. Care must be taken to ensure that blades used to cut the stainless steel during manufacturing were purpose-specific, and that they had not previously been used to cut conventional carbon steel (cross contamination can result in corrosion of the stainless steel). Attempts were made to have a minimum of 1½ in. of concrete coverage over the stainless steel reinforcing bars; however, this limit was sometimes reduced due to the need for field "trimming" for installation purposes. The decision to use stainless steel reinforcing was reinforced (pun intended) by the difficulty of ensuring the minimum concrete coverage.

Each of the original cast stone units was visually assessed to determine the need for replacement. It was not possible to perform this assessment until the multiple paint coatings and previous repairs had been removed. To be consistent with proper conservation and restoration principles, only units that were significantly damaged were replaced. Units with minor damage were repaired in situ. Approximately 500,000 pounds (227,000 kg) of cast stone had been replaced by completion of the project.

It was necessary to create a fiberglass mold for each different configuration of cast stone unit to be replaced (there were dozens of different molds required). Fortunately, most of the cast stone units were installed in a repetitive pattern around the building, so it was usually possible to find a unit of each type that was not damaged. The molds were cast on the undamaged units.

Given the mix of original and new cast stone units, there was a need to install a coating to obtain a uniform aesthetic. A coating would also reduce the amount of water absorbed by the cast stone, which in turn would reduce the risk of freeze-thaw damage to the units and the mortar between them.

The two primary performance characteristics required of the new coating were bond to the surface of the cast stone and high vapor permeance. After reviewing several products, a mineral silicate coating manufactured by Keim was selected. Mineral silicate coatings are manufactured primarily from inorganic materials, which are less prone to fading and color change over time than organic materials; they are very vapor-open, and they obtain excellent bond to cementitious surfaces.

The selected mineral silicate coating was installed at the mock-up location and was reviewed after exposure to one winter season. No problems with debonding or color change could be identified.

The mineral silicate coating was applied in a three-step process. One of the steps in the process included the application of a "fine filler," which helped hide some of the surface imperfections in the original cast stone that was kept in place.

Figures 6A and *6B* illustrate a sample of cast stone at the time of original review, and a similar piece after completion of the restoration and conservation. The significant color difference is due primarily to the

Figure 8 – Shelf angles attached to primary frame with anchors set into epoxy resin. Liquid-applied membrane used between shelf angle and concrete back frame.

accumulation of atmospheric dirt on the original uncleaned stone.

In addition to replacement of damaged cast stone units, each unit was attached to the structural frame of the building to reduce the potential for lateral movement. Stainless steel rods, sieves (sometimes called screens), and epoxy resin were used for this purpose. The length of the rods had to be carefully determined to ensure that the rods penetrated all the way through any rubble or voids that were present behind the cast stone. *Figure 7* is a view into a cavity behind a section of cast stone.

Brick

A large portion of the wall areas are clad with fired, smooth-faced clay brick that was manufactured by Clayburn Company of Abbotsford, British Columbia. The Clayburn manufacturing facility was constructed in 1905, immediately adjacent to the clay source on Sumas Mountain, east of Vancouver. Some of the village's buildings associated with the now-closed facility remain as historical structures to this day.

Considerable effort was made to locate a brick with similar color and surface texture. A special-order brick was purchased specifically for the project. The new brick was intermixed with original brick at the time of installation.

At the time of original construction, the brick masonry was supported on shelf angles that were bolted to imbeds in the structural concrete frame at each floor level. The original shelf angles did not have any corrosion protection. The original shelf angles were badly corroded in many locations but were in near-new condition in other locations (*Figure 2*). Where corroded, the expansive forces associated with the oxidization had caused spalling of the brick.

Given the owner's request for a 50-year design service life, and the desire to provide a uniform support condition throughout the building exterior, it was decided that all the shelf angles would be replaced with new hot-dipped, galvanized shelf angles. Consideration was given to the use of stainless steel shelf angles, but the cost increase was deemed excessive. The new shelf angles were attached to the building frame using stainless steel threaded anchors set into epoxy resin (*Figure 8*).

Flashings

The tops of the parapet walls were partially covered in flashings at the time of original construction. Over the years, these flashings had been modified, sealant had been added, and in some places, the original copper flashings had been replaced with painted steel flashings.

Copper flashings were the natural choice for this restoration project. However, the natural patina (surface corrosion) that occurs on the surface of copper can result in discoloration of surfaces onto which it drips.

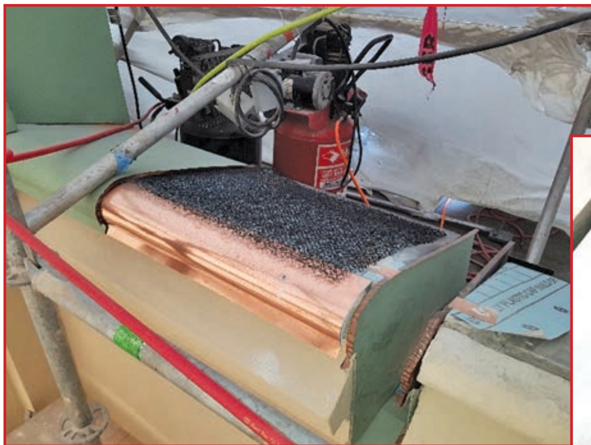


Figure 9A – Pre-patinated copper flashing installation on parapet walls. The wind clip is formed from new copper, and drain mat is installed below the cap flashing to facilitate drainage.

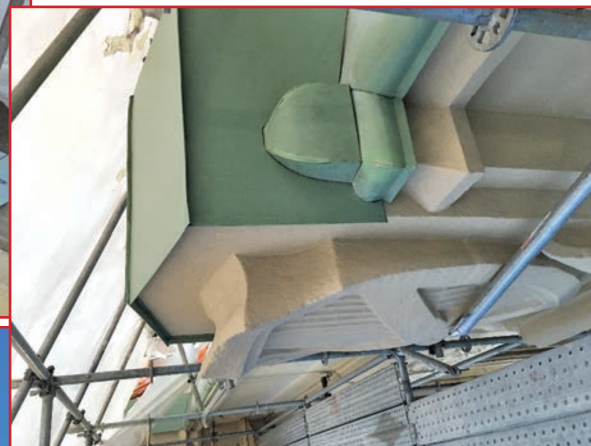


Figure 9B – Pre-patinated copper flashing installation on parapet walls.

Gradually, the risk of staining decreases as the copper weathers. Therefore, pre-patinated (green-color) copper flashings were used (*Figures 9A* and *9B*). A vapor-open drape membrane and a drainage mat were used between the flashings and cast stone parapet blocks to facilitate drying of the cast stone.

The goal of the cap flashing was to protect the top of the wall from water penetration, while having a minimal impact on the aesthetic of the building when viewed from the street level.

CONCLUSIONS

Both the owner and the project team are very pleased with the outcome of the conservation and restoration of the Spencer Building; the project mandate has been fulfilled. A properly implemented conservation and restoration extends the physical life of the existing character-defining elements and helps the building retain its heritage value. As

Figure 10A – Spencer Building circa 1930.

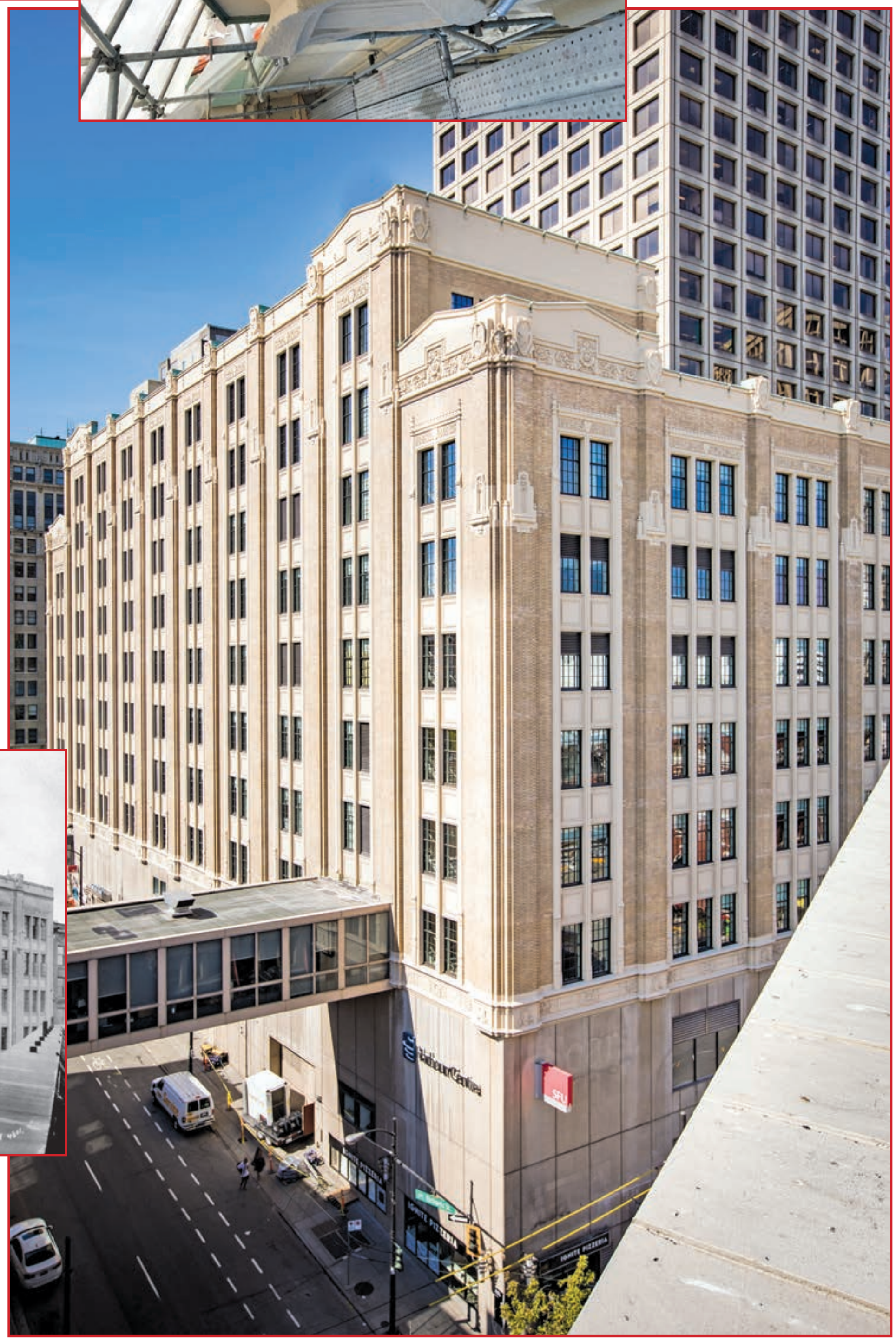


Figure 10B – Spencer Building in 2018 after conservation and restoration.

illustrated in *Figures 10A* and *10B*, this goal was obtained.

Fortunately, the building ownership group was committed to the program, and the building occupants were supportive of the conservation and restoration process because they were directly impacted by the noise during the construction process. Clear communication by the owner and engineering team early in the planning phase resulted in support of the project by the tenants/users of the building.

As a closing caution, do not underestimate the challenges associated with a major restoration project on a historical building. However, once these challenges have been overcome, the results are very rewarding and can contribute significantly to the community and skyline for future generations.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Marcus Dell, PEng, a senior building science specialist with RDH Building Sciences, Inc., combines his academic training with over 30 years of work experience to improve building enclosure performance on buildings throughout North America. Dell is a member of the Editorial Board for RCI Interface. *When not working, Dell spends significant time skiing, climbing, and adventuring in the world's mountain ranges.*


Mike Grummett

Mike Grummett was formally trained as a structural engineer at McMaster University in Hamilton, Ontario. His practical experience as a structural and building science project engineer is markedly useful when considering the common problems associated with heritage buildings. Combining technical experience and heritage appreciation, Mike has been deeply involved in the assessment, planning, repair, and conservation of numerous historically significant buildings in British Columbia.