Session Track: Special Topics
Session Code: CS11a

Paper: Conserving the Modern

Presented by
Sharon Vattay , PhD, C.A.H.P.
City of Hamilton
Hamilton, ON Canada

Speaker(s) Biography

Abstract
This paper will consider the challenges of conserving the recent past by looking at a case study of the Hamilton City Hall, 1957-60. This modernist structure is an excellent example of International Style architecture and one of only a few modern City Halls to remain in Canada (along with the City Halls in Ottawa and Toronto). While the north and south elevations of the eight-storey building are glass curtain walls, it is the east and west facades that provide the distinctive character of the building. These walls, along with other building features such as the separate Council Chamber and podium fascia, are clad in Georgia Golden Vein Marble.

Currently, this City Hall building is undergoing renovations and the key-defining feature of the marble cladding is threatened with removal. Some believe that the material is past its prime and, in fact, popular perception is that the marble is in danger of falling off of the building. This fear is not totally unfounded. Five months before the opening of the building in October 1960, two of the 2 ¼ inch thick marble slabs (2 x 3 feet) fell to the ground. Similar mishaps took place in 1963 and again in 1969. Within 10 years of its construction, the building was subject to a $10,000 exploratory program to check the cause of deterioration of the marble slabs. This was followed by a judicial inquiry, which was held in 1972.

The 465-page judicial inquiry report was primarily devoted to a review of evidence related to the marble curtain wall fasteners or anchors indeed the report concluded that the marble itself was sound. The judicial inquiry report found that the manganese bronze anchors, which were used to affix the marble slabs to the city hall s exterior walls, were defective and were not made in accordance with the specifications of the then city architect, Stanley Roscoe, who designed the building. The inquiry findings showed that the design of the method of supporting and retaining the vertical wall marble cladding was suitable as was the material (manganese bronze). However, it was the production of the fasteners that was to blame for the failures.

This paper will discuss how the understanding of modernist construction systems is key to addressing current conservation strategies and will consider the experimental nature of mid-century masonry curtain walls, in an attempt to uncover not only the problems but also possible solutions.7

Session Track: Special Topics
Session Code: CS11b

Paper: Mechanical Anchor Strength in Stone Masonry

Presented by
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Speaker(s) Biography
Kelly Streeter, P.E., began her career studying structural engineering for her bachelor of Science Degree at Cornell University. She first teamed with Vertical Access during her undergraduate tenure and quickly became fascinated with historic buildings of New England. Kelly's exposure to historic structures broadened during her employment with Robert Silman Associates, P.C. where worked on the adaptive reuse of the Yonkers Trolley Barn and the restoration of Frank Lloyd Wright's Taliesin. During this time, she also attended the RESTORE program in New York City.

Kelly returned to academia to apply for her Masters Degree in structural engineering at the University of Colorado at Boulder. Her graduate thesis "Ultrasonic Attenuation Tomography of Concrete Structures" was spurred by her need to better quantify the hidden conditions of structures encountered in her ongoing work with Vertical Access. Kelly conceived, developed and implemented the entire experimental portion of her research program, from specimen casting though ultrasonic data acquisition to proprietary computational analysis to interpret both the pulse velocity and attenuation characteristics. She then discovered how to take advantage of a commercial geological tomography application to create intuitive images of her underlying results. An abbreviated thesis (available at http://monel.sketchy.net/~kelly/EM_2003.pdf)
documents the success of the project.

Kelly gained crucial experience in experimental methods and data acquisition during her employment with Atkinson-Noland & Associates of Boulder, CO developing and challenging hypotheses, preparing specimens, selecting and applying transducers, and completing compressive tests on historic brick.

More recently, Kelly has created and implemented a pilot study to investigate the characteristics of ultrasonic pulse travel in delaminated Guastavino tile vaults (see http://monel.sketchy.net/~kelly/Guastavino.pdf). The promising results have led Kelly to pursue additional funding to further the research.

Abstract
Presentation Title: Mechanical Anchor Strength in Stone Masonry

Funding for this project was awarded to Vertical Access LLC and the Association of Preservation Technology International (APTI) by the National Center for Preservation Technology and Training (NCPTT) under grant number MT-2210-06-NC-02.

Mechanical anchor systems, such as Powers Power Stud and Powers Wedge Bolts are commonly used in historic masonry materials such as limestone and sandstone despite the lack of design values for this type of base material. Scaffolding lateral supports, signage installations and telecommunication mounting systems all use these mechanical fasteners in natural stone materials.

The current lack of codes, guidelines or recommendations for pull-out and shear values of these anchors in historic masonry materials leaves the design community to improvise the design and specification of these bolts. Guidelines available are most relevant to concrete and brick masonry. Although field-testing is employed for some projects, more commonly an arbitrary reduction of the ultimate yield values is used when designing these elements for use in natural stone. The creation of a standard or empirical design equation for these values is arduous because, unlike concrete and concrete masonry units, historic building stone units are not manufactured

in a controlled environment, and their physical properties such as density and compressive strength vary from quarry to quarry and within quarry strata.

The primary inspiration for this project is the dearth of applicable field research in mechanical expansion and thread-type anchors in historic masonry. The research that has been published on mechanical anchors is focused primarily on their performance in concrete and concrete masonry units (CMU) as opposed to limestone, sandstone, and other historic masonry. A literature review of studies on the performance of post-installed concrete anchors, published in 1998, references over 50 studies on this topic [Cheok and Phan 1998]. Testing results and guidelines are also available for evaluating mechanical anchors in brick substrates [Brown and Borchelt 2000] and [BIA 1986].

Technical information available only specifies the use of the anchors in concrete, structural lightweight concrete or grout-filled concrete block. Although a short section on stone as a base material is included in the expanded Architects and Engineers manual, tables for allowable and ultimate loads in stone masonry along with masonry specific installation instructions are non-existent, recommending a testing program be completed because of the wide variability of stone strength [Powers Fasteners 2005]. This reference also mentions that very large factors of safety (up to 10:1) may be used for factors such as questionable base material.

The first task of the study was to confirm the authors suspicions that the engineering community is in the habit of using conservative design values when specifying anchor installations in stone base materials. This was accomplished using an online survey that was distributed to the preservation engineering community. A simple design problem was presented asking for the specification of design values for a theoretical installation.

The lab portion of the research was designed as a screening experiment. Screening experiments evaluate a reasonably large number of variables in order to determine which factors influence the response, in this case the ultimate strength of the anchor installations.

The primary (controlled) variables examined in this study are
1) type of stone
2) orientation of bedding plane
3) type of anchor
4) type of test

The secondary (or measured) variables are
1) pulse velocity (all units),
2) Schmidt hammer readings (all units)
3) compression tests (limited units).
4) failure mode (all units)

Each of the secondary variables is evaluated for their ability to predict the ultimate strength of the anchor installation and recommendations for future research are presented.7

Session Track: Special Topics
Session Code: CS11c

Paper: Leaks, Lions and a Labour of Love: Using Sustainable Technology to Restore a Toronto Landmark

Presented by
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Speaker(s) Biography
Sarah Gray, P.Eng., is a Project Manager and Shareholder at Halsall Associates in Toronto, Ontario Canada, and assists building owners with repairing heritage structures and contemporary buildings. She is currently a member of APT, ASTM E06-24 (Building Performance, Heritage Sub-Committee), and the Canadian Association of Heritage Professionals. Sarah was an appointed member of the Toronto Preservation Board in 2005-2006. Sarah holds a bachelor's degree in civil engineering from the University of Cincinnati, and a master's degree in historic preservation from the University of Pennsylvania.

Jia Shin, LEED AP, is a Technical Staff team member at Halsall Associates in Toronto, Ontario Canada. Jia s project experience includes heritage restoration, structural design and sustainable design integration.

Abstract
Constructed in 1930, the Commerce Court North (CCN) building in downtown Toronto is a popular city landmark and was the tallest building in the British Commonwealth until the early1960s. By the 1990s, air and water leakage, steel corrosion and stone deterioration had taken their toll on the exterior façade of this 34-story Beaux-Arts office tower. The building s owners and property management enlisted structural engineers, building science specialists and heritage consultants to assess exterior repair options and implement selected approaches.

Test openings in the stone facade indicated that stone cracks and spalls were primarily caused by corrosion of underlying steel anchors and supports. In addition, cracking and displacement of several parapets and the 32nd floor arches were due to thermal movements. The project team decided that wholesale replacement of the stone cladding and supporting steel was not practical due to cost, site logistics and disruption to office tenants. Therefore, the owner chose to retain as much of the original façade as possible and authorized a phased program of local cladding repairs.

The repair objectives at CCN were to address localized deterioration, restore structural stability and increase water/air tightness. Restoration methods included pinning cracked stones, using colour-matched stone repair mortar to fill small spalls, inserting dutchman at larger stone spalls, and installing colour-matched sealants at movement cracks. Displaced parapets were dismantled, reinforced and rebuilt. Stone arches and ornamental lion heads at the 32nd floor were dismantled, repaired and rebuilt.

The localized cladding repair approach addressed the visible stone skin and some embedded steel elements. Unfortunately, limited repair budgets did not allow for repairing 100% of the steel. Therefore, a trial installation of cathodic protection (CP) was implemented at several corroded shelf angles. CP technology is intended to control or even stop corrosion by connecting the steel electrically to thin titanium anodes embedded in the exterior mortar joints. Based on the success of the trial installation, project engineers expect that stopping steel corrosion will limit stone deterioration, which will reduce the magnitude of future cladding repairs.

Prior to addressing corrosion at the monumental ground floor steel windows, the client and design team discussed at length whether to locally repair or fully replace the windows. While replacing the windows would have provided the opportunity to increase energy performance, restoring the windows would reduce

transportation and material manufacturing costs associated with new replacement windows. As sustainability initiatives are important to the building owners and their investors, the team elected to restore the existing windows. Low-e glazing replaced the original glass, and a 3-part zinc/epoxy/urethane paint system was applied to the original steel frames.

As the exterior repairs reach completion in 2008, the client, designers and contractors look back on repairs completed at CCN over the past 10 years. Old world stone repair methods and newer technologies have been combined to capture the existing structure s embodied energy while maintaining the heritage value of the building s appearance. This presentation provides an overview of the repair technologies and how the implemented approach will impact the future maintenance of this Canadian landmark.7