15th Canadian Masonry Symposium
Ottawa, Canada
June 2-5, 2025

Moving the Impenetrable

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ABSTRACT

The Ottawa City Registry Office was constructed in 1874 following specifications prepared by Kivas Tully, The Provincial Architect and Engineer for Ontario. It is one of several similar structures across the province, used to store the land registers and to provide search and copy services to the public. To serve these important public services, the Offices were built as secure vaults, impenetrable to would-be thieves and neighbourhood fires, which were a common occurrence throughout major cities at the time. In Ottawa, the stone foundation walls extended to bedrock (> 10' deep) with 6" thick stone floor slabs (that protected the Office from potential tunnelling), and the six-wythe brick walls with brick vaulted ceilings protecting the contents from outside fires.

The building eventually became obsolete when the official registry was relocated and the structure cycled through many tenants before it was vacated in 1982. The area around the Office has been developed, leaving the building to stand alone adjacent to the loading docks of a shopping mall. The project aims to redevelop the area with a new residential high-rise, and to accommodate all services and needs of the site, the Heritage Designated building needed to be relocated.

Moving a building that was built as a fortress comes with significant difficulties. Discussion will focus on the process of the relocation, including the unique experience of observing cracking develop as the move progressed over different bearing conditions and the difference between how cracking appeared in restored and unrestored masonry. Also, engineering design related to the installation of the support structure, and the multiple support scenarios before, during and after the move. Further complications due to ongoing work on site will be explored, such as blasting during the move and after while in its temporarily supported scenario.

KEYWORDS

Masonry Conservation, Preservation Engineering, Adaptive Reuse, Building Move, Case Study

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INTRODUCTION

As Ottawa has grown, expanded, and advanced over the past 150 years since being designated the Capital of the Canada, new buildings and roads have been constructed, but there are still relics of this era scattered throughout the modern landscape. These buildings are often overshadowed by the new, and determining how to preserve, and maintain a use for these buildings is a crucial aspect of heritage conservation.

One such building is the Ottawa City Registry Office (CRO), originally constructed in 1874. It was the building where all the land registers were stored and provided search and copy services to the public. As these were the only copies of these important records, the Registry Offices across Ontario were built as a secure vault according to a set of provincial specifications prepared by Kivas Tully, the Provincial Architect and Engineer for Ontario. These buildings were designed to be impenetrable to would-be thieves and neighborhood fires. In Ottawa, the stone foundation walls extended to bedrock (>3m deep) with 150mm thick stone floor slabs (that protected the Office from potential tunnelling), and the six-wythe brick walls with brick vaulted ceilings protecting the contents from outside fires. There are also iron bars embedded within the brick walls of the vault as a further level of protection.

While originally constructed on the main road of Nicholas Street, it was across the street from the courthouse and jail, both of which still exist today as an art gallery and hostel, respectively. The land to the west of the CRO were many warehouses, hotels, and shops as it was steps away from the rail line and Rideau Canal. The CRO eventually became obsolete when the official registry was relocated, and the structure cycled through many tenants before it was vacated in 1982. The area around the CRO has been developed into the Cadillac Fairview (CF) Rideau Centre, leaving the building to stand alone adjacent to the loading docks of the shopping mall. See Figure 1 for the CRO in its original position in 2022.

This current project was driven by CF to redevelop the land around the CRO into a new residential high-rise with main level commercial space, connected to the shopping centre. The project also includes additional underground parking and an upgrade to the existing loading dock. Due to the geometry of the site and the redevelopment, as well as requirements of the loading dock and services and needs of the site, it was determined that the Heritage Designated building needed to be relocated 1.5m west and 17.5m north.

Figure 1: The Ottawa City Registry Office, 70 Nicholas St, Ottawa, ON [2022]

PREPARING FOR THE MOVE

Moving a building that was designed as a fortress comes with significant difficulties. While small and unassuming, with stone foundation walls at approximately every ~600mm supporting 150mm thick stone slabs, the six-wythe brick walls (including two interior walls), and the three-wythe thick brick vaulted ceiling result in a very heavy structure. Abandoned since 1982, the building was also in poor condition. Significant planning needed to be considered to ensure the safety of the building during and after the move.

The Moving Plan

At the project onset, the final location of the building would be above a to-be-constructed parking garage. As the bedrock is high on the site, it was known that the rock would require to be excavated for the parking garage and with schedule playing an important role, this was to be done by blasting. The new underground structure was also intended to extend below the original location of the CRO. To minimize the vibrations that would be transferred to the heritage structure during the excavation work, it was decided to pre-excavate the northern portion of the site (the future location of the CRO), install temporary piles onto which the building would be placed, and temporarily backfill with compacted granular to create the road for moving. This process allowed for the rock excavation to be advanced and simplified the excavation after the move around the piles, as backfill rather than rock. The new parking garage would then be constructed below the heritage structure with a grade-level transfer slab, and concrete foundation walls and columns would make up the difference, building up tight to the underside of the masonry walls to create the final support for the structure.

Masonry Repairs

As much as it is important to design the support structure and moving plan to minimize the change in stress in the masonry, it was also necessary to make sure that the building was in as good condition as possible prior to subjecting it to the move. The interior brick was originally covered in plaster that had cracked and debonded over time, hiding the condition of the masonry behind. The first step was removing all interior finishes and plaster to expose the masonry structure.

Upon removal of the plaster the original brick and soft lime mortar was exposed. There were some areas of cracking, especially at the south-west corner, where settlement had occurred, and above the windows in each of the three rooms. The interior brick walls were repaired with a Type O mortar and salvaged brick. Part of the end-state project includes a large opening in one of the interior walls, so replacement brick was harvested from this area. It was determined to not create the large opening before the move, to maintain the original integrity and redundancy. All cracks were repaired by carefully removing bricks adjacent to the crack and chasing the fracture through the depth of the six-wythe wall. Only cracked bricks were replaced, as the soft mortar allowed for simple salvage and reuse of the original bricks.

In 1874 in Ontario, the mass-manufacturing and transportation of bricks wasn't yet an established industry, so bricks were typically batch-fired locally. This is highlighted in the original bricks by the varying degrees of burnt ranging from soft light red to dark brown for the interior brick, and even the presence of cat and dog footprints in the bricks.

The intention of the interior repairs was to both repair existing cracks as well as strengthen the structure. The intersections of the perpendicular brick walls were repointed, ensuring any tying bricks were replaced and rebonded. The deterioration above the windows was addressed with a combination of dismantle and rebuild and repointing. The dismantle area extended up in each interior room to the connection of the brick vault to the perpendicular walls. This connection was originally completely separate, but as part of the project keys were installed at the very apex of the vault, as a method to further tie the north and south walls to the interior structure. The window arches were also fully repointed with minor resetting required.

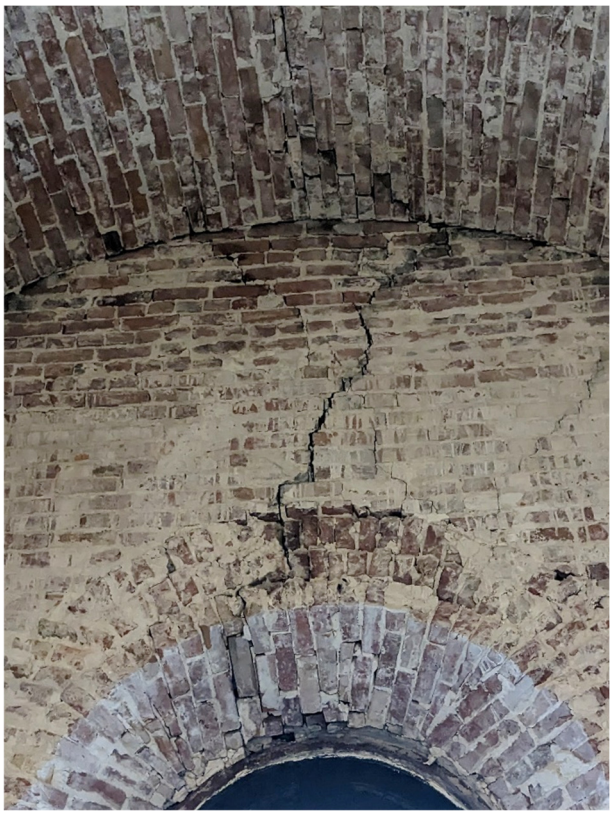

Figure 2a: Condition of the north wall, central room, before repairs [2022]

Figure 2b: Condition of the north wall, central room, after repairs [2022]

Another discovery that was made during the removal of the interior finishes was in a large box under a false floor. The box contained many large carved stone pieces, that were quickly identified as the original chimney that had been dismantled at some point in the building's past. These were relocated offsite for the duration of the move, and were reassembled in a dry-stack mock-up to confirm all the elements were accounted for.

The building was originally built with stone foundation walls down to bedrock. The bedrock slopes in this area, so the foundation varied from approx. 1.2m to >3m. In addition to the foundation walls below the perimeter and partition masonry walls, there are additional foundation walls every ~600mm to support the stone slab floor. The stone slabs were removed, the backfill (construction debris) between the foundation walls was removed, and the interior foundation walls were dismantled. In the future location the building will rest finally on new walls, so the original stone walls weren't required to be salvaged or relocated. In order to create a working surface within and around the CRO, a temporary lean mix concrete slab was poured.

A final reinforcement strategy that was employed is providing additional thrust resistance for the vaults. There are two existing rods which span from one end of the building to the other. It was a concern that during the move existing masonry could shift so additional temporary redundancy to the tension ties was provided with three new steel cables and HSS bearing beams on each gable end.

The Steel Platform

In coordination with the moving contractor lifting plan and track layout, the pile design and layout, and the new transfer slab layout, a steel platform was designed to support the building for all the different support

conditions. Significant consideration was given to how to install the steel platform. The main goal that was repeated frequently by the design team during this process was “to not let the building realize it was moving”.

Five general support conditions were considered for the platform: with blocking to the foundation wall below, the jacking locations, the track locations for the first move to the west, the track locations for the second move to the north, and the pile locations. The platform was designed for deflection control in each of these supporting conditions of a maximum deflection of L/720 to reduce the risk of cracking for the masonry. Refer to Figure 3 for the structural steel plan of the platform.

The main component of the platform is five main girders, running in the east-west direction. Two girders were located approximately 300mm from each side of the north and south perimeter walls. The fifth girder was location at the centre of the building. Secondary steel was installed north-south on top of the girders, running similarly on each side of each of the four north-south masonry walls. The final level of steel were regular needle beams, punching through the masonry walls with a non-shrink grout bed supporting the masonry above.

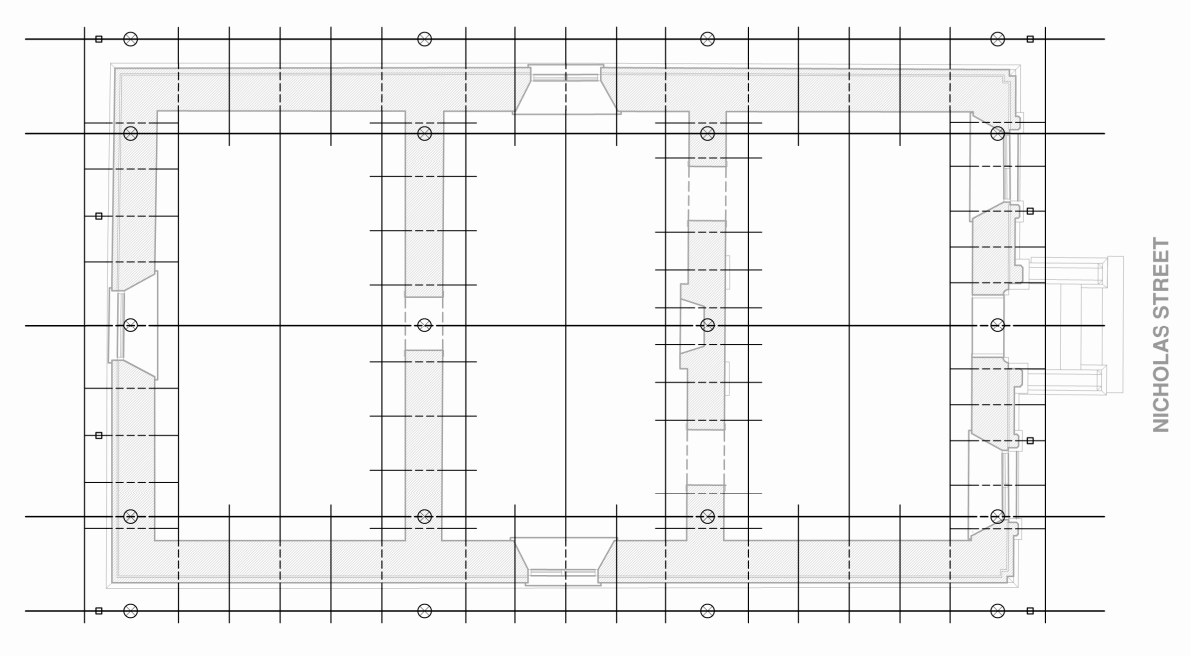

Figure 3: The structural plan of the steel support platform [2022]

The steel was installed sequentially as described above. With the girders and secondary steel beams installed, the building was able to arch over the pockets created to remain sitting on its original foundation. As the needle beams were installed in alternating sequence, similar to an underpinning procedure, the weight of the CRO was slowly transferred to the steel frame. The steel frame at this time was bearing on blocking to the foundation wall below or on piled blocking for the girder ends, see Figure 4.

Figure 4: The steel platform partially installed, bearing on blocking and foundation [2023]

THE MOVE

To separate the building from its foundation, jacks were installed at pre-determined locations below the steel frame and slowly the structure was raised. The mortar joint below the band stone around the perimeter of the structure acted as the tell-tale, once it began to crack it indicated structural separation. At this time the jacks were locked in place to allow the foundation wall to be demolished from below the steel platform, see Figure 5a.

Once the tracks were set the jacks were re-engaged, and the blocking removed to lower the building uniformly onto the tracks, see Figure 5b. The building was moved twice, the smaller 1.5m move to the west took place on Wednesday, July 19, 2023, and the second 17.5m move to the north took place on Saturday, July 22, 2023. After each move the jacks were re-installed and the structure lifted off the tracks. After the first move, the building was temporarily placed on blocking. After the final move, the building was set on temporary piles to allow the parking garage excavation to proceed.

The move was successful, with two main discussion topics: settlement and masonry repairs.

Figure 5a: Platform supported on jacks, foundation walls removed [2023]

Figure 5b: Platform being lowered by jacks onto tracks [2023]

Settlement

As previously described, a concrete mud slab was poured around the original building location to create a working surface following the floor removal and excavation, while the remainder of the moving path was constructed of compacted fill. A path of two 25mm steel plates were set up along the movement route, and the moving tracks laid upon these.

The first day of the move was entirely on top of the concrete slab, while the second day included the transition from the concrete to the compacted fill. It quickly became apparent that the fill experienced minor settlement as the buildings weight compressed it.

The first signs of the additional compaction that was occurring in the fill was cracking in the brick mortar joints. Cracking was occurring at the connection of the north and south masonry walls from the perpendicular walls, and cracking in the vault. The engineers on site quickly identified the cause of the cracking. At this time the first of the five girders had moved onto the fill, resulting in a slight difference in elevation of the two girders holding the north wall, tilting it down slightly to the north. The outward tilting of the north wall correlated with the evidence of the cracking in the connection to the perpendicular walls as well as the separation in the vault as it was being pulled.

The theory was put to the test as the second of the girders transitioned from the concrete to the fill. As expected, the separation of the side walls and vaults closed in slightly, and instead step cracking formed in the north-south walls, on the north side of the windows. The step cracking was reminiscent of typical settlement cracks.

As the third, central girder settled over the transition, the settlement crack shifted to the south. The cracks on the north side of the window mostly closed in and new cracking formed on the south side of the window. The fourth girder further closed in the cracking, and as the final girder transitioned over the change in subgrade material most of the cracks closed, see Figure 6.

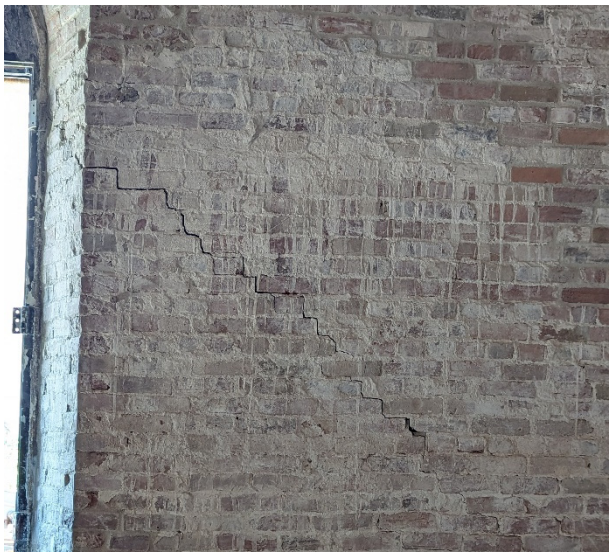

Figure 6a: West wall condition during the move [2023]

Figure 6b: West wall condition after the move [2023]

Masonry Repairs

As previously described, repairs were completed to the masonry before the building was moved. The repairs performed very well during the move, as their efficacy was tested when the building was attempting to shift.

One of the main takeaways was where masonry was dismantled and rebuilt with proper keying this provided an extremely strong connection that remained intact during the move. As demonstrated in Figure 7, the cracking almost always occurred in the original soft mortar, not through the repair mortar. This was especially highlighted where the keys were added at the connection of the vault peaks to the perpendicular wall. The cracking that occurred bypassed the new keys and travelled instead through the original mortar around the repair. This indicates the inherent strength in simple masonry bonding.

Figure 7: Cracking/separation of brick vault from perpendicular walls [2023]

POST-MOVE

After the move, the excavation of the fill below the building proceeded, see Figure 8. Over winter 2023-2024, the excavation was completed, and the new underground structure was built up to receive the CRO. New brick walls were built off of the new transfer slab, between the needle beams, and the needle beams were removed in reverse order of their installation. Building solid brick back up to replace the removed needle beams slowly transferred the weight from the steel platform to the final support structure. The steel platform was completely removed by mid-October 2024.

Figure 8: The CRO on piles during the excavation [2023]

In the meantime, the high-rise construction has also been progressing, see Figure 9, and there are still more changes that the historic structure needs to undertake. Expected to be complete in the spring/summer 2025, the original wood roof will be replaced with a new steel structure to accommodate increased snow loads and meet Building Code non-combustibility requirements, a new door opening will be made in the north-west corner, and the western interior partition wall will have a new large opening. These changes are required due to the changes on the site, and to facilitate the building's new use as a café or similar.

Figure 9: The CRO with the new high-rise under construction [2024]

CONCLUSION

In conclusion, the work over the past few years is only a small part of the life of the Ottawa City Registry Office but is a critical part of keeping this building for the future. The resiliency of masonry was showcased during the moving of the building and is a testament to its ability to adapt. The solid brick walls and vaults which were part of the original impenetrable design will be showcased and exposed for future use. The new steel beams which will be installed to create the openings are intended to be left exposed, without attempting to disguise the intervention.

ACKNOWLEDGEMENTS

Any project requires a significant team working together towards the safe and successful completion of the work. Thank you to:

Owner – Cadillac Fairview

City of Ottawa's Heritage Department

General Contractor – Reliance Construction Group

Superstructure Primary Engineer – Entuitive

Heritage Architect – Barry Padolsky

Architect – Zeidler NEUF

Piling Engineer – WSP Canada

Restoration Contractor – Heritage Grade and Atwill-Morin Ontario

Moving Contractor – DemoPlus and Mammoet