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RESTORATION OF HERITAGE BRICK CLOCK TOWER

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ABSTRACT

This paper is a case study of the restoration of a clock tower in Huntsville, Ontario. The tower was constructed out of multi-wythe clay brick masonry walls and wood floor and roof framing. The clock tower is the focal point of the Town Hall in downtown Huntsville. The clock was originally part of the centre tower of the 1873 Union Station in Toronto, Ontario [1]. This paper explores the intricacies of a heritage restoration project from a structural engineering perspective. The original scope of work was to replace four windows, reinforce the existing wood floor of the clock tower and reinstate the waterproofing at the podium level of the clock tower. Tacoma Engineers (Tacoma) was not involved in the original scope of work. During construction, the contractor uncovered significant deterioration within the multi-wythe clay brick exterior walls. Tacoma was retained at the request of the original Engineer of Record to provide expertise about the condition of the brick. The new scope of work included: demolition of the deteriorated brick walls, reconstruction of the tower walls one corner at a time, replacement of the steel roof, and recladding of the tower exterior walls. With any heritage restoration project it is critical to address the cause of the deterioration and then provide solutions that will mitigate further structural damage. Restoration work on this project was in conformance with the guiding principles of the Ontario Heritage Trust. Working closely with the Town of Huntsville's Heritage Committee were able to successfully restore the clock tower structure in a manner that will preserve this heritage landmark for many years to come.

KEYWORDS: *heritage, restoration, brick masonry, case study*

BACKGROUND

The Town of Huntsville is home to roughly 20,000 people and is located two hours north of Toronto in the Muskoka Region of Ontario [2]. The Town Hall is the only Classical Revival style administration building in the Muskoka Region [3]. The two-storey, multi-wythe brick masonry building is a landmark within the Town. The structural systems consisted of load-bearing brick masonry exterior walls with a combination of wood stud framing, hollow clay tile and brick

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masonry walls used in the interior. The focus of this paper is the unique eight-sided clock tower that is home to a 4-sided clock that was moved from Union Station in Toronto to the Town Hall in 1927 [1]. The tower and clock mechanism are shown in Figure 1. The two-level clock tower consisted of two wood floors and roof framing supported on multi-wythe brick masonry walls. The square lower level of the clock tower was at the same framing elevation as the main roof. The eight-sided upper level of the tower was supported on the lower level. The lower level and upper level of the tower had the approximate plan dimensions of 4900mm x 4900mm and 3950mm x 3950mm, respectively. The tower extended above the main roof structure approximately 8250mm. The roof of the clock tower consisted of an eight-sided, stainless steel, standing seem roof. The exterior of the wood stud walls of the upper tower were sheathed with painted wood panels. The lower level of the tower consisted of multi-wythe brick masonry walls.

Figure 1: Huntsville Town Hall (left), Clock Mechanism (right)

ORIGINAL SCOPE OF WORK - PHASE I

The town of Huntsville originally retained a structural engineering consultant in September 2011 to prepare a repair scope of work to address the damaged wood floor framing supporting the clock tower motor and gear mechanism (refer to Figure 1). Tacoma was not involved in the project at this time. The repair work was intended to address the main source of water infiltration which was originally thought to be the flat roof on which the eight-sided tower structure was supported. The original scope of repair work included: reinforcement of upper tower floor joists, replacement of windows in lower level, replacement of lintels above windows in the lower level, and water-proofing of flat podium level of the clock tower structure. Heritage Restoration Inc. from Toronto,

Ontario was retained by the Town of Huntsville to complete the repair work. Refer to Figure 2 for a photo of the original condition of the clock tower.

Figure 2: Existing Condition of the Clock Tower (August 19, 2013)

Significant Brick Deterioration Uncovered – August 19, 2013

Construction of the original repair scope started in the Spring of 2013. The clock mechanism was removed and the floor framing below the clock mechanism was reinforced. Construction halted when the contractor removed the interior plaster wall sheathing in order to remove one of the old windows. Significant deterioration of the multi-wythe masonry wall construction was noted (refer to Figure 3). The General Contractor asked the Engineer of Record if Tacoma could be brought in to review the condition of the brick walls, given our knowledge of heritage masonry buildings. The Engineer of Record did not object. Tacoma first attended the site on August 19, 2013 to review the condition of the brick walls. The deterioration of the inner-wythe was severe. Mortar loss and spalling was extensive in the area exposed. The softer inner-wythe of the brick wall was in very poor condition and the structural integrity of the wall was in question. Tacoma recommended that the remaining interior finishes be removed from the lower level to facilitate a more complete assessment of the masonry conditions. Since the repair work to the floor framing had been completed, it was decided that Tacoma would take over as Engineer of Record for the project. The restoration efforts were put on hold until a detailed assessment of the brick could be completed. Shoring of the tower floor framing was to remain in place until a revised repair scope could be established.

Figure 3: Severe Brick Deterioration (August 19, 2013)

All Interior Finishes Removed – September 17, 2013

Since the initial site visit Tacoma had been in regular contact with the Town of Huntsville and the General Contractor about the proposed addition of structural brick repair to the project. Tacoma was back on site on September 17, 2013 to complete a detailed assessment of the brick walls. The deterioration noted previously was found to be prevalent throughout the exposed structure. The damage to the brick masonry was most severe at the two load bearing walls (refer to Figure 4). The interior wythe of the two-wythe wall was no longer significantly contributing to the structural integrity of the walls. Damage was noted to be most extensive at the top of the masonry wall and the condition improved nearer to the main roof of the building. It was decided that the condition of the brick masonry walls posed a life safety risk and the repair of the brick walls was required to be completed immediately. The structural repair of the brick masonry was added to the scope of the project at this time.

Figure 4: Brick Deterioration (September 17, 2013)

ADDITIONAL SCOPE OF WORK – PHASE II

The Town of Huntsville continued to emphasize the important of maintaining the heritage characteristics of the structure throughout any repair or restoration efforts. The Municipal Heritage Committee had asked that the repair scope preserve as much of the original building as possible. As previously stated, the observed deterioration the brick masonry was most severe on the two load-bearing sides of the structure so it was decided to completely rebuild those sides of the tower structure. The two non-load bearing sides would be locally repaired and the inner wythe would be reconstructed. Repair drawings were issued for construction September 23, 2013. Refer to Figure 5 for the extent of brick repair work. There were two main concerns with the proposed remedial work: finding suitable replacement material and the sequence of brick removal and replacement.

It was decided that the existing brick used in the exterior wythe was still in good condition and that it could be cleaned and re-used in the reconstruction of the brick walls. The contractor was then able to find a suitable brick to match the size, material properties, and style of the exterior wythe. This approach of blending the existing brick from the exterior wythe and the new brick was approved by the Municipal Heritage Committee.

The sequence of construction was challenging. It was decided that the best way to proceed was to work on one side and one corner of the building at a time while leaving the rest of the structure intact. A series of interior wood stud walls were constructed within the lower level of the tower

that transferred the weight of the tower above to the lower tower floor. The shoring walls were sheathed with plywood to provide additional lateral rigidity to the building during construction.

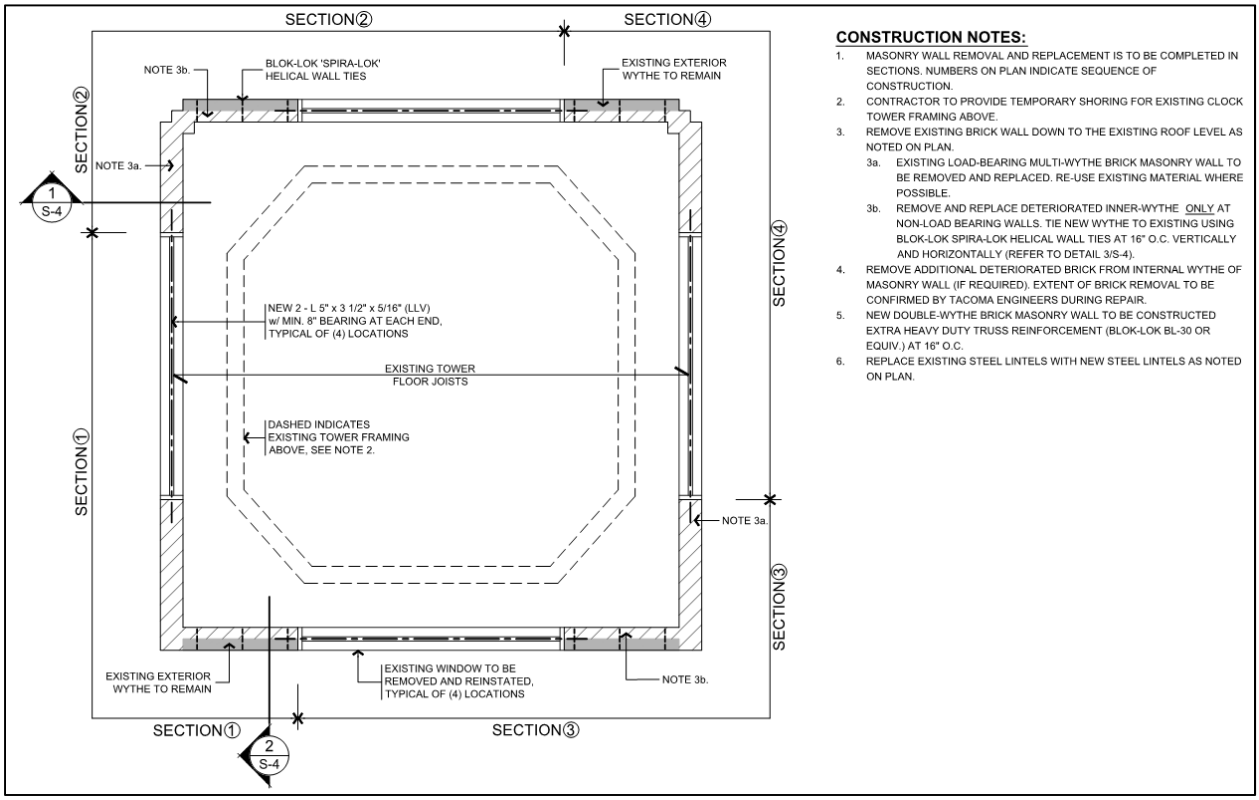

Figure 5: Original Scope of Brick Repair Work (September 23, 2013)

Construction Review – November 7, 2013

To complete the repair to brick masonry as noted in Figure 5, scaffolding was constructed around the tower. The scaffolding allowed for a more detailed review of the exterior masonry wall facing the street (north side of the building). Our construction review on November 7, 2013 uncovered that the exterior brick and mortar joints on the north wall were in similarly poor condition to the two load-bearing walls. Another unique finding on this date was that two of the four walls were noted to have a full extra course of brick within the walls. The variation in mortar joint thickness around the tower can be seen in Figure 6.

REVISIONS TO BRICK REPAIR WORK – PHASE II (MODIFIED)

The anomalies uncovered on November 7, 2013 and the advanced state of deterioration on the north side of the building prompted a change to the repair approach. The scope of brick repair work was modified to include the full removal and replacement of the multi-wythe brick masonry on all four sides of the tower. Drawings were revised and re-issued for construction on November 8, 2013. Refer to Figure 7 for the revised scope of repair work. The weather was now cold enough that the cold-weather masonry construction practices were required to be followed.

Figure 6: Condition of Masonry Wall as Observed on November 7, 2013

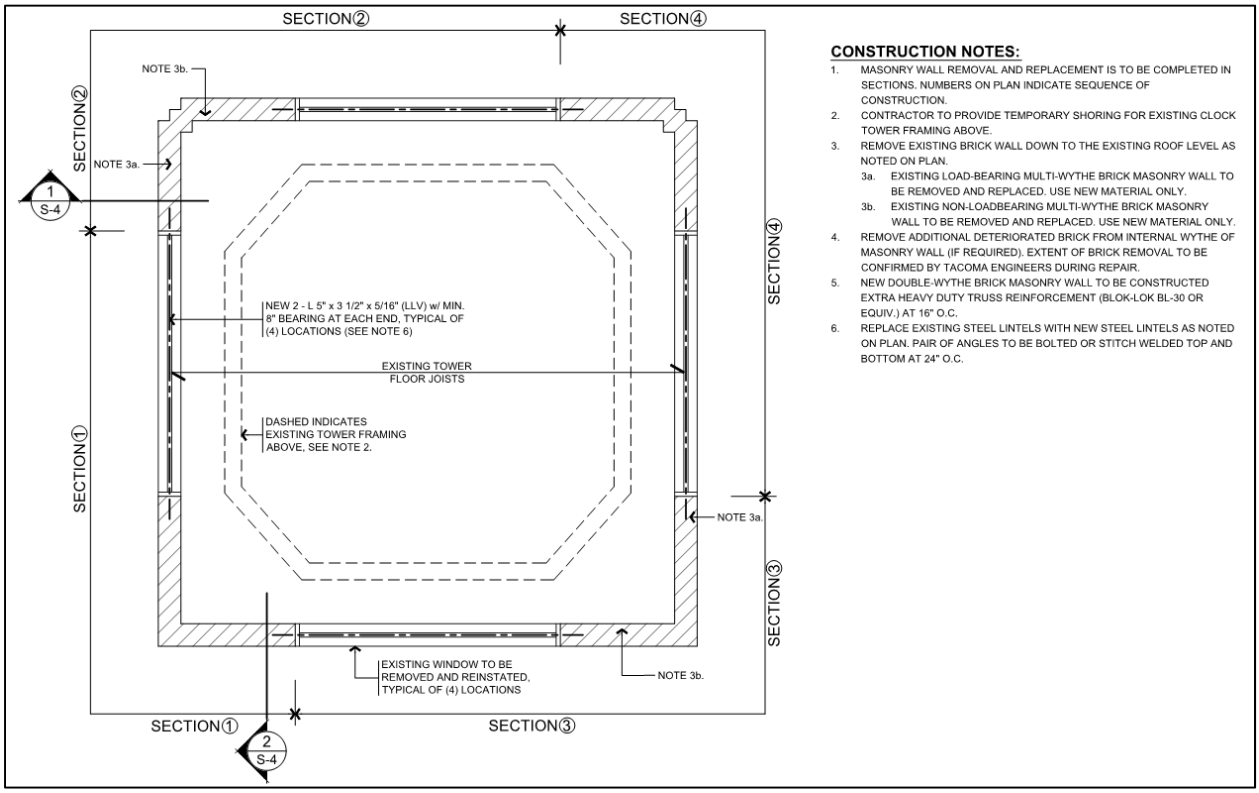

Figure 7: Revised Scope of Brick Repair Work (November 8, 2013)

Construction Review – November 18, 2013

The masonry contractor completing the brick replacement asked Tacoma to attend the site on November 18, 2013 to review additional sources of active water infiltration. It was raining during the construction review. Significant water infiltration from the tower roof was noted. A review of the flashing and roof drainage system during the rain event highlighted the flaws of the existing

systems. The gutter at the eave of the tower roof was inadequately sized, the downspout was not connected, the flashing between the wood panels of the eight-sided tower walls and the flat podium roof was ineffective, and the roof hatch was poorly sealed (refer to Figure 8).

Figure 8: Tower During Construction (November 18, 2013)

Construction Review – November 27, 2013

On November 27, 2013 Tacoma met with the Town of Huntsville and Heritage Restoration Inc. to discuss water infiltration issues. The deterioration of the clock tower roofing, access hatch, flashing and wood wall siding were all noted to be in poor condition and deemed inadequate to effectively prevent water infiltration (refer to Figure 9). Up until this point the additional scope of repair work had been approved on an emergency basis as the uncovered structural damage was deemed to be a life safety risk. Tacoma discussed the importance of addressing the cause of the observed structural damage and about how the active water infiltration from the upper tower structure had largely contributed to the damage to the wood floor framing and the brick masonry. The Town of Huntsville asked Tacoma and Heritage Restoration Inc. for a recommendation to address the issues of water infiltration while maintaining the heritage features of the clock tower façade.

Figure 9: Sources of Water Infiltration

Review – December 4, 2013

On December 4, 2013 Tacoma and Heritage Restoration Inc. met with the Town Council and Mayor to discuss options to address the issue of active water infiltration through the tower roof and exterior wood cladding and to propose changes to the scope of work.

It was recommended that in addition to the structural repair to brick masonry walls, a comprehensive waterproofing system be provided for the clock tower structure. It was crucial to the Town of Huntsville and the Municipal Heritage Committee that any modifications to the clock tower replicate the detail of the existing. The proposed modifications to the scope included: removal of existing rotted material and replacement/ consolidation as required, install new waterproofing membrane over the exterior surface, repair of exterior wood sheathing of clock tower, re-cladding with copper and lead-coated copper to match existing profiles, replace standing seam steel roofing with lead-coated copper standing seam, and add a code compliant lightning protection system. The proposed system would be essentially maintenance-free (no painting, etc.). The additional expense required to complete the waterproofing work was estimated to increase the total cost of construction from $107,000 to $230,000.

ADDITIONAL WATERPROOFING – PHASE III

The Town of Huntsville decided that they wanted to proceed with the comprehensive waterproofing of the tower structure. The revised scope is shown in Figure 10. The Municipal Heritage Committee agreed that the use of copper and lead-coated copper would be a more durable exterior finish than the existing wood sheathing and would be better for the overall sustainability of the building. The copper and lead-coated copper were to be hand crafted to match the exact profile of the existing clock faces and wood cladding (refer to Figure 11). New eave gutters and downspouts were added as part of the waterproofing work.

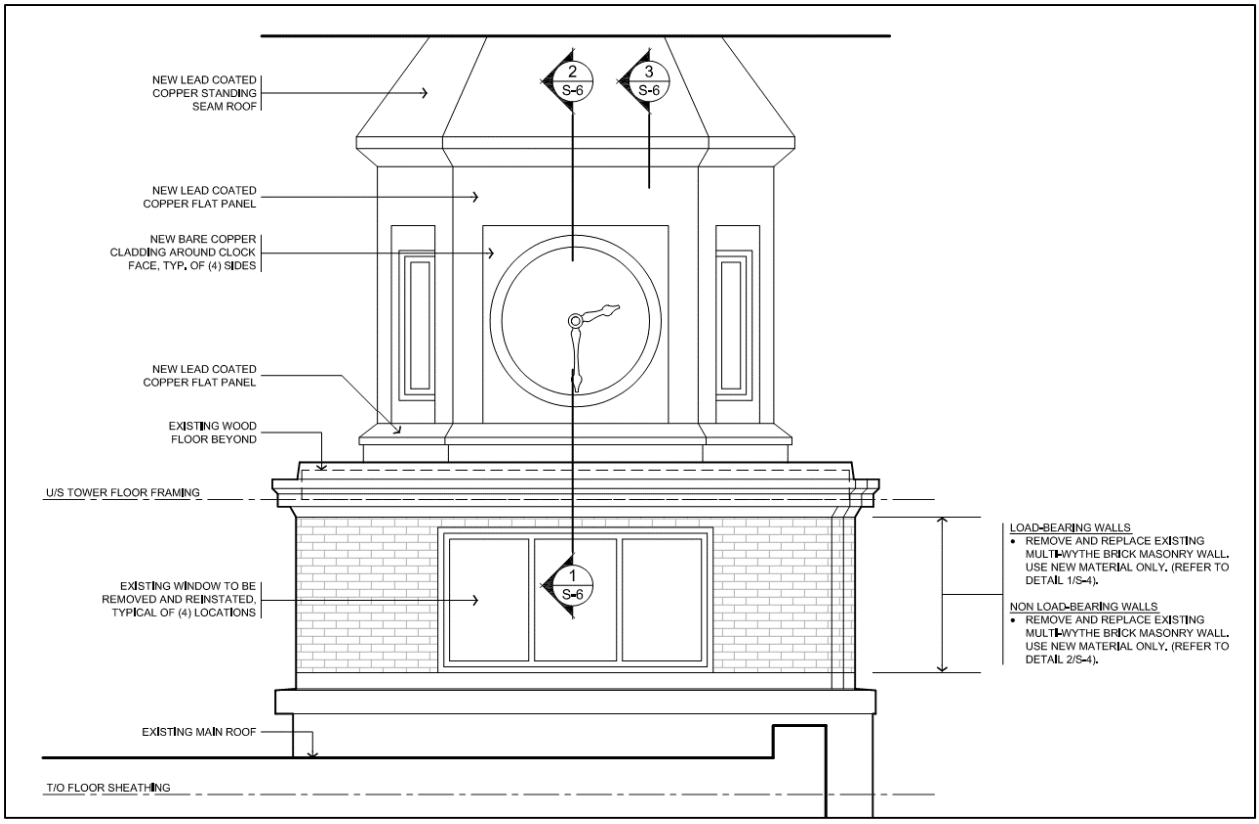

Figure 10: New Lead Coated Copper Siding and Roofing

Figure 11: Copper Re-Cladding Underway (left), Tower Re-Cladding Complete (right)

CONCLUSION

The total construction time was approximately one year. The final construction cost was approximately $230,000. The total repair work included: reinforcement of the floor framing, re-construction of multi-wythe brick tower walls, repair and replacement of rotten wood sheathing, installation of waterproof membrane, the addition of new copper and lead-coated copper cladding, replacement of steel standing-seam roof, flashing and gutters with lead coated copper, and installation of a lightning protection system. The end result was a beautifully restored clock tower that matched the detail and profile of the original tower structure.

Figure 12: Original (left), Restored (right)

ACKNOWLEDGEMENTS

A successful heritage restoration project requires collaboration between all parties. The flexibility and ability to focus on long-term sustainability by Brian Crozier of the Town of Huntsville, The Municipal Heritage Committee, Heritage Restoration Inc., and Mike Babineau of Ultimate Construction Inc. were all critical to the success of this project.

REFERENCES

[1] Filey, M. (2013). "Union Station then & then" *The Sunday Sun – September 15, 2013*, Toronto, Ontario, Canada.

[2] Statistics Canada (2011). "Huntsville Census Profile". *2011 Census Data.*

[3] The Corporation of the Town of Huntsville. *By-Law Number 85-66*. "A By-Law to Designate the Property known Municipally as the Huntsville Town Hall, 37 Main Street East, Huntsville, as being of Architectural and Historical value or interest."