



# West Block Parliament Building Rehabilitation

Canadian Consulting Engineering Awards 2020 – Entry Binder

**Ojdrovic + Cooke**

ENGINEERS IN JOINT VENTURE





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### Project Introduction

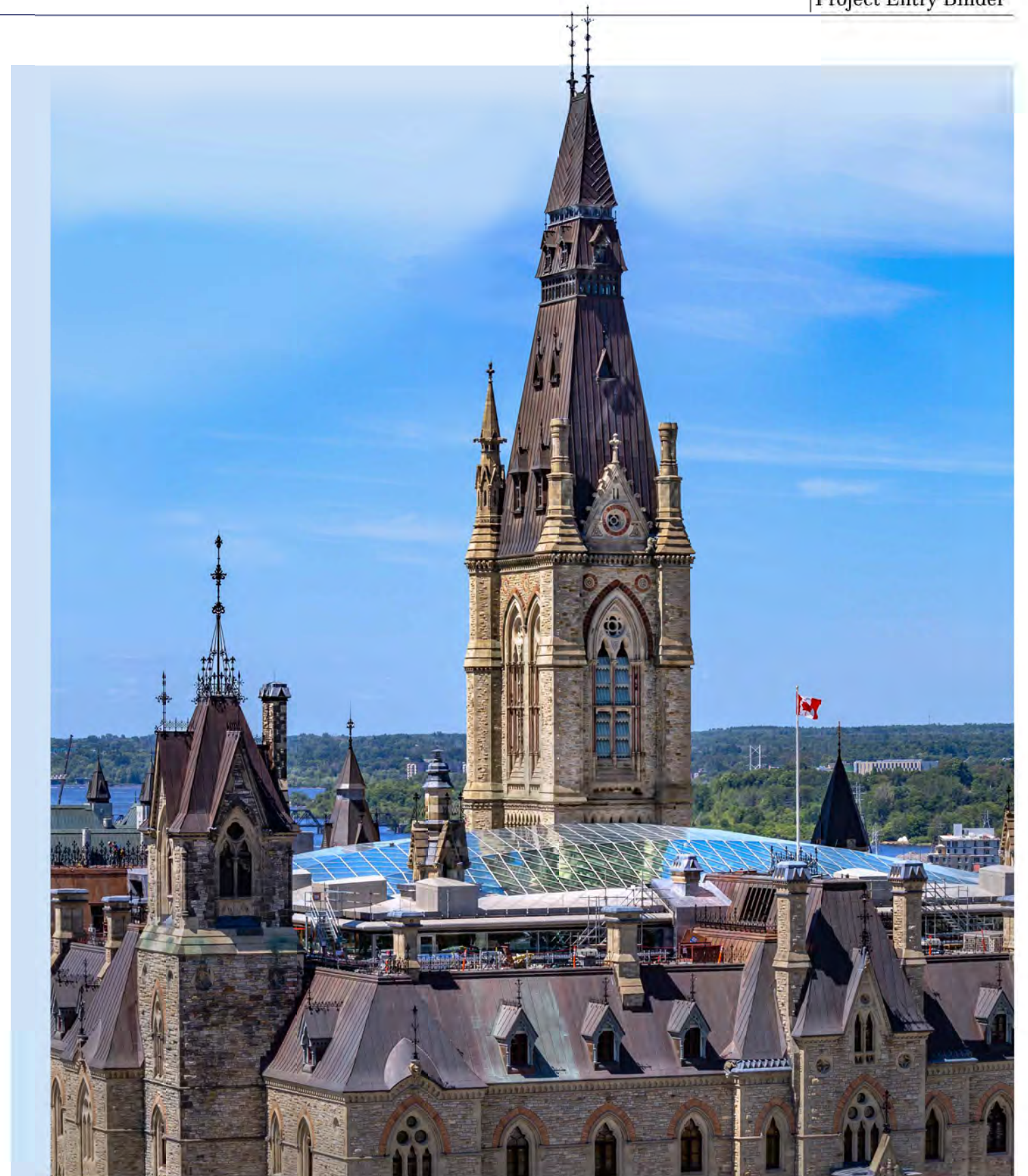
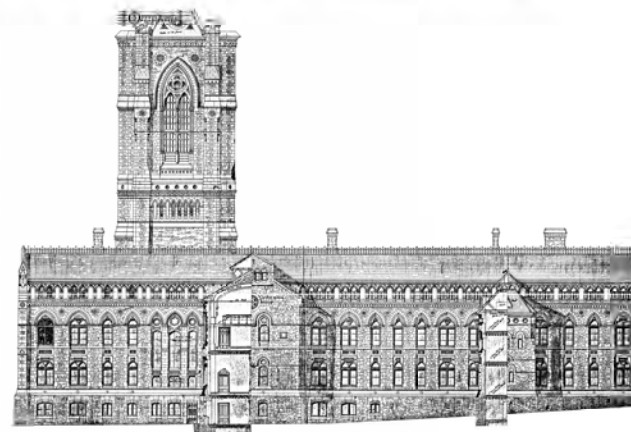
Prominent Ottawa landmark located on the west side of the centre lawn of Parliament Hill, it was constructed in three phases; construction began on the first phase in 1859, and as more space was required to accommodate the federal civil service, two large additions were added to the original structure, developing the site until its last phase was completed in 1909. Major renovations to the interior and exterior of the building were completed in the early 1960s, including the design of Room 200, The Confederation Room, one of the largest ceremonial rooms within the Parliamentary Precinct. Additionally, when the Centre Block was partially destroyed by the great fire in 1916, the West Block became the oldest of the Parliament Buildings on the hill. As a result, the building has been restored and modernized to meet the current needs of the 21st century, all while respecting its historical and cultural significance of the late 19th century.



### Project Summary

The rehabilitation of the Centre Block of Parliament is expected to take at least ten years and to accommodate the interim needs of parliamentarians, many projects across the National Capital Region have been undertaken. The restoration and redevelopment of the West Block Parliament Building in Ottawa was one of the largest heritage building rehabilitation projects in North America, at a cost of \$863M. It included rehabilitation, modification and strengthening of the existing heritage masonry building and construction of several underground and above ground levels within the existing courtyard. The new temporary House of Commons Chamber together with government and opposition lobbies and open space for circulation occupy the courtyard. The Chamber has an "open air" feel because, together with other spaces, it is covered by a glazed roof high above.

The House of Commons now sits within the structural steel forest and under the glazed roof where Parliamentarians and visitors enjoy a view of the restored and seismically strengthened 19<sup>th</sup> century stone masonry building. Ojdrovic + Cooke, Structural Engineers of record, worked to ensure it remain a strong symbol for the people of Canada.



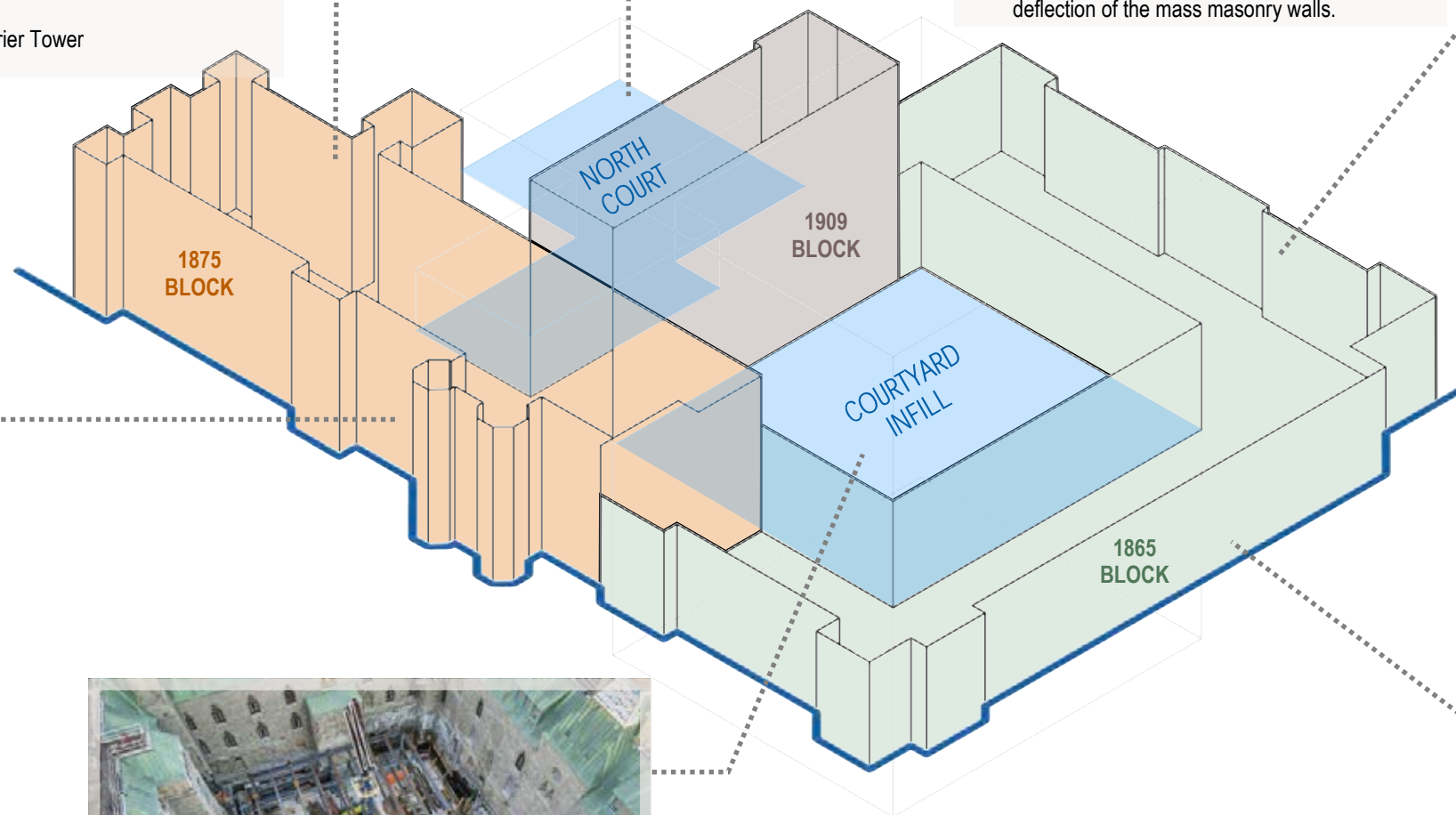


Existing Conditions, Investigation and New Blocks



Masonry Conservation (Exterior):

- Deteriorated masonry below roof eaves on all exterior walls, mostly due to moisture damage. Frost damaged brick and debonded stone. No anchors and few keystones.
- Extensive stone and brick deterioration at chimneys. Over thirty chimneys, all dismantled and rebuilt with seismic anchorage.
- Corroded cramp anchors on Mackenzie Tower pinnacles and chimneys resulting in spalling stone.
- Rebuild of Laurier Tower



Existing Roof Structure Upgrade:

- Upgrade all existing steel trusses to support new mechanical equipment and the mass of acoustic separations.
- Unique, truss-by-truss, upgrades to accommodate new access and existing geometry.
- Designed temporary support of trusses to allow for large scale dismantle of exterior masonry walls.

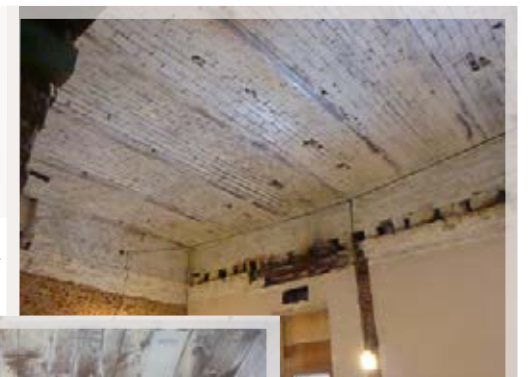


Interior Courtyard:

- Exposed rock before excavation (view photo).
- Courtyard excavation / Courtyard infill; to create new multi-storey basement and new "open air" House of Commons chamber.

Existing Fox/Barrett & Terra Cotta Arch Floors:

- Removal of Fox and Barrett Floors and replaced with new composite steel deck / concrete slabs
- New structural slab over arch slabs on 4<sup>th</sup> floor level. Existing truss tension ties buried in concrete slab.



Terra cotta brick arch floors ▶



◀ Fox & Barrett floors



Existing Masonry Walls:

- Stone Foundations; Investigative Openings exposed waterproofing installed in 1960's and its impact on the masonry, trapping moisture.
- Stone Masonry Exterior; Built in three construction phases, dressed in Nepean Sandstone, Potsdam Sandstone and Berea Sandstone.
- Interior Walls and Structure; Brick masonry terra cotta walls



### Meeting Client's Need

The Client's primary goals are summarised as follows:

- A design that respects and reflects the dignity of the Parliament of Canada.
- A rehabilitation which will respect the heritage character of the building.
- A building that meets the expectations of many stakeholders and the requirement of current building codes.

A thorough understanding of stakeholders' expectations was achieved through a large number of multidisciplinary design team and client meetings, studies and exploration of options. Every major design solution was vetted and peer-reviewed. The level of cooperation between design disciplines was much higher than on a standard project. No effort was spared to restore and bring to life the heritage attributes of the building.

Existing stone masonry walls were rehabilitated with adherence to the principle of minimal intervention while achieving the expected level of seismic resistance through the use of custom grouted steel anchors. Seismically, a hybrid of the existing masonry shear walls along with new shear walls was utilized. The custom anchors were required to ensure appropriate reaction with weaker heritage elements. This hybrid seismic design minimized the amount of new structure that was required to meet code.

Technical solutions developed to allow for deep excavation of courtyard and passages under the existing building allowed for efficient communication within the building for occupants and visitors. New space provided for new content, such as committee rooms, communication hubs, restaurant, visitors paths and services, etc.

A monumental new courtyard structure gave new meaning to the dignity of the House of Commons.



### Masonry Innovative Approach & Resources

The Heritage stone building underwent a seismic upgrade to meet the requirements of National Building Code. The interventions were kept to a minimum by carefully including existing masonry (stone and brick) as lateral resisting elements and complementing them with only two new concrete shear walls and two concrete block elevator shafts. University of Calgary performed testing of large masonry panels which simulated the exterior walls of the building in order to determine material property parameters for the analysis of existing walls.

The exterior masonry was rehabilitated and upgraded to modern Code requirements using the latest technology in compatible masonry anchor design. This was carefully balanced with conservation principles to ensure minimal intervention into the Heritage Building.



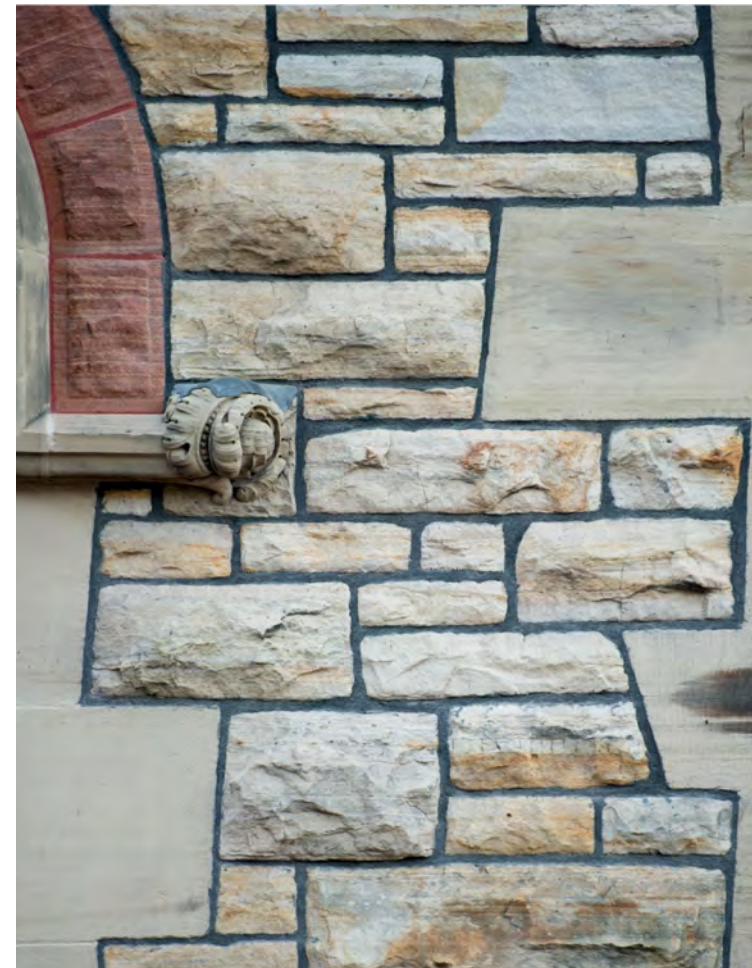
▲ Grouted anchors were used to reinforce masonry wall for seismic forces.

### Environmental Benefits

The most environmentally friendly method of construction is recycling of existing structure. The West Block project saved as much as possible of the original materials. A minimum intervention approach in the masonry scope of work led to the reuse of existing stone units to minimize production of new elements. Extensive research and study went into the selection of mortars to ensure the most durable solution in each unique condition. This will contribute to the longevity of the mortar and reduce deterioration that leads to avoidable replacement in the future. Copper roofing was salvaged from various parts and reused within the protected interior courtyard roofs.

During the renovation of the building in 1960, asbestos based thermal insulation was used within the attic space. Asbestos is today considered an extreme environmental concern and health hazard and all efforts were made to remove as much as possible of asbestos containing materials. In seldom cases where it was not possible to remove it, remaining traces of asbestos were encapsulated to ensure the protection of future occupants.

Mechanical engineers, experts in solar effects, lighting consultants and others contributed to the design of the glazed roof pillow. Structural analysis of the courtyard roof supported other disciplines' efforts to provide energy efficient building. Optimization of steel structure lead to reduction of structural steel used in construction while maintaining the safety and adherence to the building code intent. Several systems were assessed in order to reduce the steel quantity.







▲ Excavation Under Existing North Wing Building Above

▼ North Court - Underground Structure



### Complexity

The material properties of the Heritage Building were largely unknown and varied due to the heterogeneous nature of masonry, the varying degree of deterioration, the numerous previous interventions, and the differing ages of structures. Understanding the existing construction and properties was paramount to an accurate seismic analysis.

Survey of existing roof structure had to be done in asbestos filled attic space. A review of a single instance of each typical truss was available for evaluation. This resulted in many unforeseen conditions, but the owner facilitated a collaborative process with the contractors to modify design details as information became available. As timing was essential, dedicated engineers from the consultant team and the steel fabricator's team worked together on site to expedite the review and design.

The courtyard structure had three levels of complexity:

- *Architectural* – The steel is completely exposed thus unifying the architectural vision of Gothic arches with structural needs. Every structural detail had to respect the architect's vision.
- *Analytical* – The engineer's response to the unusual steel structure was a rigorous structural and seismic analysis to confirm its conformance with the intent of the National Building Code. A three-dimensional analytical model of the courtyard roof structure and the 17-metre-tall steel frame below, partially embedded in rock, was created.
- *Construction* - Daily collaboration with steel supplier continued throughout the construction. Attention was paid to the fabrication and connection details to ensure that the structure would achieve the desired response. Throughout the construction, the structure was re-analyzed to reflect actual as-built conditions.

### Innovative Approach to Structural Design

The layout of the structural system is defined by the footprint of the House of Commons Chamber located in the center of the courtyard. Two double rows of five structural columns enclose the Chamber. The assembly of welded plates, which compose the shaft of the columns and branches, resemble the fluting of stone columns of Gothic structures and create the lines extending visually into the branches that open up to distribute the support points. The branch tips support a three-dimensional space truss that forms the overall shape of the roof and ceiling, both glazed to provide natural light within the Chamber.

The ornamental steel structure within the courtyard was developed architecturally first, with the exposed structural steel frame becoming the main architectural feature. A complex finite element "study of model analogues" proved that the proposed structure demonstrates a level of safety and performance in accordance with the requirements of the National Building Code.



### Social and/or Economic Benefits

Parliament Hill in Ottawa is one of the most recognized symbols of Canada, and the principal attraction to many tourists visiting the National Capital Region. Once the House of Commons moved to the West Block "open air" chamber in early 2019, the experience to visitors has changed. The path from the new Visitors Welcome Centre leads through masterful underground North Court of the West Block into the restored heritage building.

The public galleries of the House of Commons Chambers are becoming a new tourist attraction. The visitor has a view of traditional interior of the House of Commons floor with original furniture and contemporary design of everything above. The view extends above the cantilevered gallery to reveal surrounding heritage stone walls of the courtyard, copper mansard roofs, and blue Canadian sky. From the edge of the gallery, the visitors are able to peek into the parliamentarian's working offices, creating a new and unique experience.

One of the largest restoration projects in Canada contributed directly to the local and national economy. At any time during the construction, several hundred tradespeople and product suppliers contributed to the success of this project. New curriculums were developed in local colleges and universities to educate both architects and engineers, and trades, from masons, to woodworkers, to copper roofers, etc., to benefit future restoration projects throughout Canada.

Rehabilitating the Heritage Building and introducing a remarkable contemporary addition has expanded the existing landmark which will continue to contribute to the living story of Parliament Hill and Canada.

