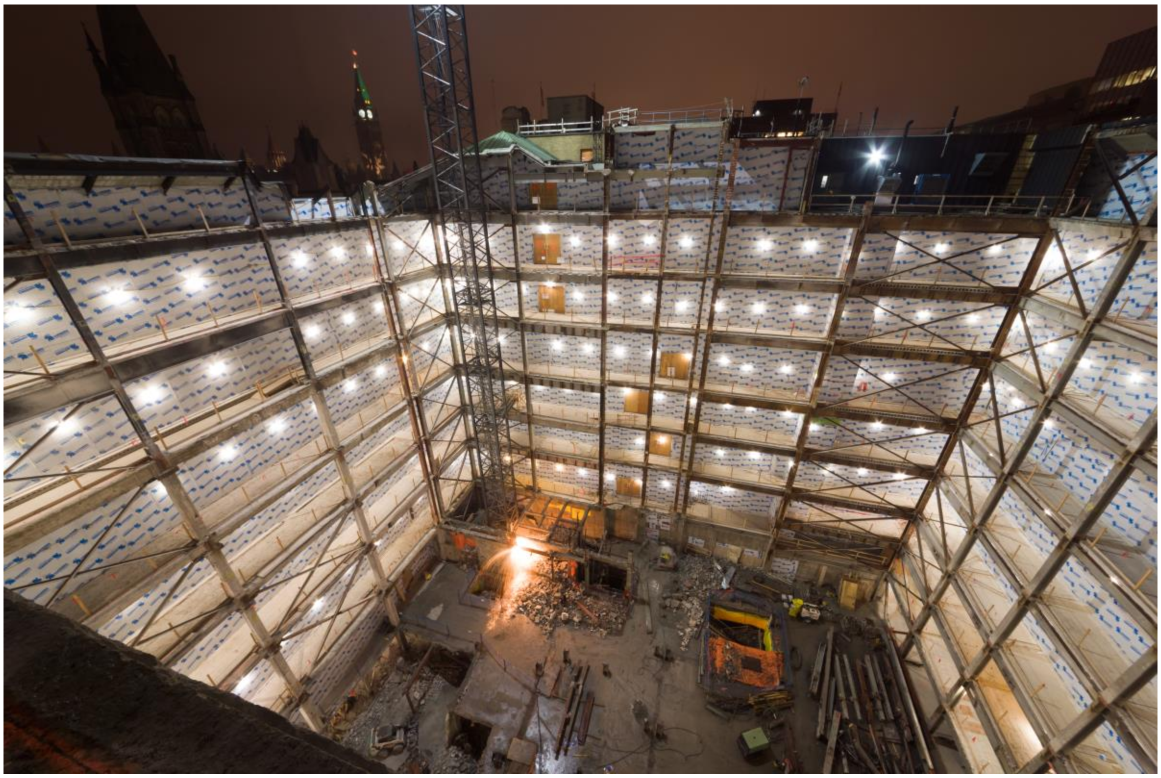
180 Wellington
Abatement, Demolition, Seismic Upgrade

Project Entry Binder



Adjeleian Allen Rubeli Limited

Consulting Engineers

April 23, 2015

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1.1 Project Summary

The Wellington building consists of a 7 story (above grade) structure, complete with two subgrade levels, located between Wellington Street and Sparks Street, to the east of Bank Street in Ottawa, Ontario. The existing building is designated as a Recognized Heritage building by the Federal Heritage Building Review Office (FHBRO). The existing building was constructed in two phases, where the first was constructed in 1925-27 and the second in 1958-59.

Figure 1: 1926 Original Photograph

Figure 2: 1959 Structural Addition

The 1958-59 construction consisted of two independent buildings, an addition to the 1925-27 structure as well as a vertical 2 story addition to the original 1925-27 building. The two 1958-59 structures and the modified 1925-27 structure were isolated from one another through the use of structural expansion joints.

The 180 Wellington project is part of the Long Term Vision and Plan (LTVP) for the Parliamentary Precinct. More specifically, the Wellington building has been designated as a swing space for the Senate and House of Commons over the next 10 to 20 years to accommodate the 25 year LTVP on Parliament Hill where the West Block, East Block and Center Block will be rehabilitated. The Wellington building has a direct line of site to Parliament Hill.

Figure 3: View of Parliament Hill, 1925

Adjeleian Allen Rubeli Limited (AAR) completed the project not only as the structural engineer of record, but also undertook the roles of heritage structural engineer as well as demolition structural engineer. The multiple roles undertaken by AAR's office allowed for a well-coordinated project and streamlined approach to the various structural challenges encountered during the design and construction phases.

2.1 Innovation

As described in the project title, the scope of work addressed three principle issues.

1. Abatement: The existing building was constructed and fit-up during a time of widespread use of asbestos containing materials as well as other hazardous materials. As part of the rehabilitation plan, the removal of all asbestos from the building was intended. In inaccessible areas such as enclosed heritage protected spaces, the asbestos materials were encapsulated to protect future users against possible concerns.

Figure 4: Abatement Enclosure

2. Demolition: The scope included structural removals to suit the central zone of demolition at the center of the building to allow for the new reinforced concrete core to be constructed. The structural demolition of the central zone represented approximately 38% of the building footprint.

Figure 5: View of Demolition

3. Seismic Upgrade: The structural upgrade of the building had a primary goal of increasing the lateral force resisting capacity of the existing structure to 100% of the 2005 National Building Code of Canada (NBCC) requirements. This element will be discuss further in the following sections.

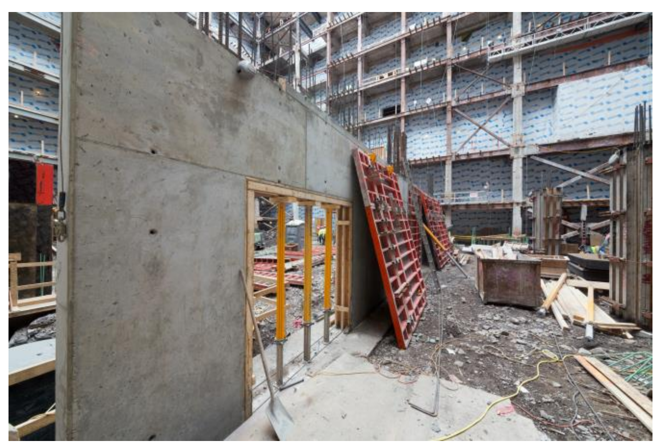

Figure 6: New Shear Wall System

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Beyond the scope of the Abatement, Demolition, Seismic Upgrade, future phases of the Wellington project include the base building fit-up, which will see the reinstatement of the building finishes and building services for future occupancy.

In addition to meeting 100% of the 2005 NBCC seismic requirements, other programming elements had to be incorporated into the structural design to ensure a fully functional building. Such considerations included large column free areas as well as the protection of heritage designated and heritage character defining elements.

Heritage protection was at the forefront of the structural design coordination effort as there is no flexibility in safeguarding the heritage elements during the demolition and reconstruction related to the structural design. Any damage or impact to the heritage elements, both interior and exterior, was defined as unacceptable. In order to address the risk to the heritage elements, vibration monitors were installed on various heritage elements throughout the building and were relocated as the demolition progressed to fully understand and control the impact of the demolition and construction activities. In addition to a controlled vibration monitoring system, the development of a coordinated sequence of demolition between the consultants and contractors was key to protection of heritage elements. In some instances, major demolition of the central zone of demolition was located within 1m of critical heritage elements such as the mosaic vestibule, arguably the most defining heritage element of the existing building.

Figure 7: Mosaic Vestibule

The NBCC in effect at the time of the structural design was the 2005 edition. The building structure is bearing on rock below grade and based on the geotechnical investigations and testing, the site class was defined as a Class A. In consideration of meeting 100% of the 2005 NBCC seismic requirements and AAR's knowledge and involvement in the development of the 2010 NBCC, AAR proposed the use of new code requirements not yet in effect to further increase the seismic performance of the building. Based on the NBCC 2005, the values of f_a and f_v used in the determination of seismic loads are limited by a class A rock. However, the NBCC 2010 introduced a further reduction to the values of f_a and f_v based on the in-situ measured shear wave velocity of the rock. This use of proposed code changes allowed for a more cost effective and efficient structural design, reducing cost and schedule for the client.

As the original building structure consisted of three structurally independent structures separated by expansion joints, each separate structure would require a seismic upgrade to the 2005 NBCC per the project requirements. In the interest of producing a cost effective structural design, options were developed and compared to analyze the difference between seismic upgrades to three individual and smaller structures and a seismic upgrade of one larger structure. The result of the analysis was to create a combined structural system taking advantage of the larger building footprint and structurally connect all three building structures into one final structure meeting the seismic requirements of the 2005 NBCC.

To further complement the development of the structurally connected structure and the demolition of the central zone, the temporary structure had approximately 38% of its footprint and structure removed, creating a temporary stability concern that was addressed. All three independent structures were structurally connected across the expansion joints using both temporary and permanent means.

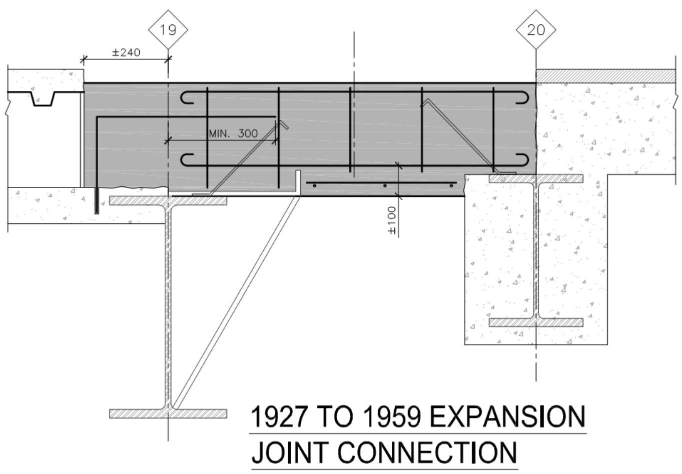

Figure 8: Expansion Joint Connection

Figure 9: Aerial View of Central Zone

In addition to the connection at the existing expansion joints, temporary and permanent horizontal diagonal bracing was installed on the buildings existing floor structures to reinforce the existing floor diaphragm to ensure the proper transfer of diaphragm loads to the lateral force resisting system. As 38% of the existing structure was being removed, the lateral force resisting system was significantly compromised and a new temporary system was implemented consisting of vertical structural steel brace frames in the four corners of the central zone of demolition from the foundation level up to the roof structure. Both temporary and permanent interventions provided a stable structural solution that allowed for the major demolition work to proceed safely until the final structural solution of reinforced concrete shear walls was constructed.

Where the existing building's floor diaphragm consisted of reinforced concrete slabs, these elements were reinforced in the temporary condition only. Where the existing building's floor diaphragm consisted of hollow core precast concrete slabs, AAR's analysis concluded that the diaphragm required reinforcing in the permanent condition to adequately distribute the lateral loads to the new reinforced concrete shear wall system.

Figure 10: Permanent Horizontal Bracing

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2.2 Complexity

As the majority of the building is existing and spanning over different eras of construction standards in the nation's capital, a clear understanding of the existing building's structural components was vital to the successful delivery of this project. Although existing building drawings were available for portions of the existing building structure, very little was available related to the 1925-27 structure.

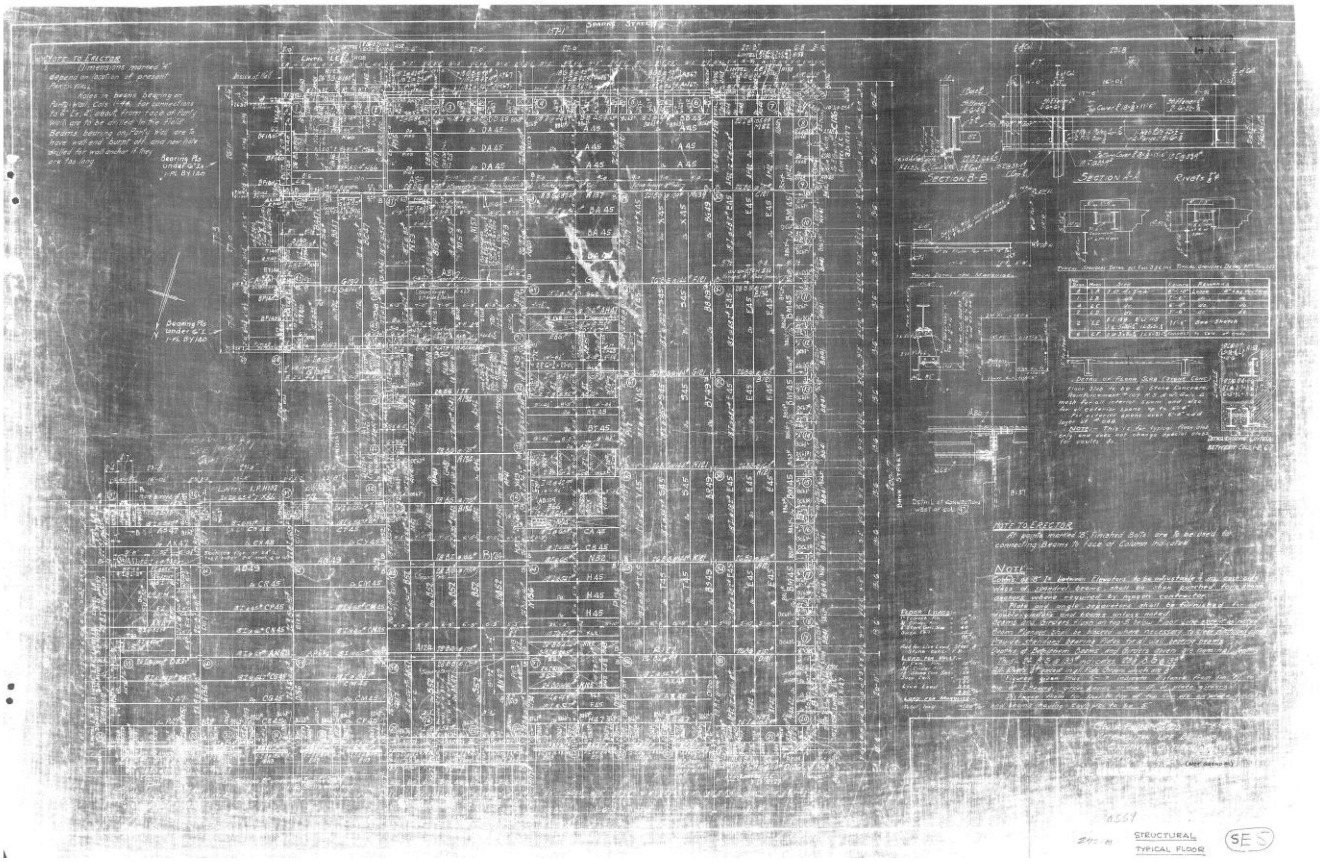

Figure 11: Original Structural Drawing from 1925, Partially Legible

As the building was occupied and fully fit up during the design stages, access to the building's structure for investigation was limited, and further hindered by the presence of asbestos within the finished ceiling spaces. In order to mitigate the client's risk, an exploratory opening plan was developed to better understand the existing structure's conditions and construction details.

Further to the central zone of demolition, which allowed for the construction of a new reinforced concrete structure including a shear wall system, additional shear walls were introduced outside the central zone of demolition to balance and optimize the structural design. Each structural intervention introducing new structural elements to the existing building structure includes the development of structural connections to accommodate the imposed loads such as gravity loads and seismic loads.

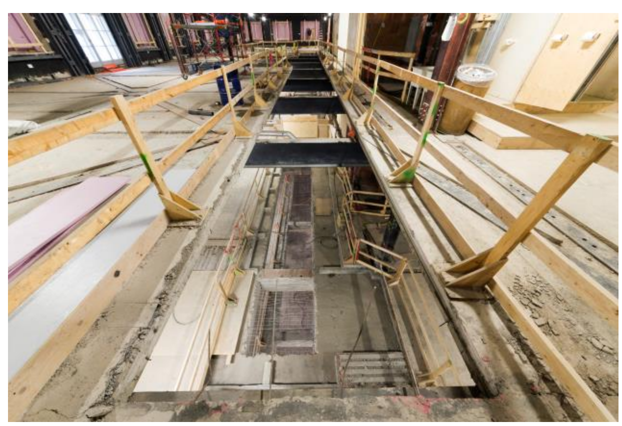

Figure 12: Shear Wall Slab Openings in 1927 Structure

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At the perimeter of the central zone, the new reinforced concrete structure is connected at each level by means of lateral "toothed" tie ins to ensure the transfer of shear forces due to lateral loads. The integration of the 1925-27, 1958-59 and new structures was at the forefront of the structural design to ensure that the structure acts as a single structural system while maintaining its character and heritage value.

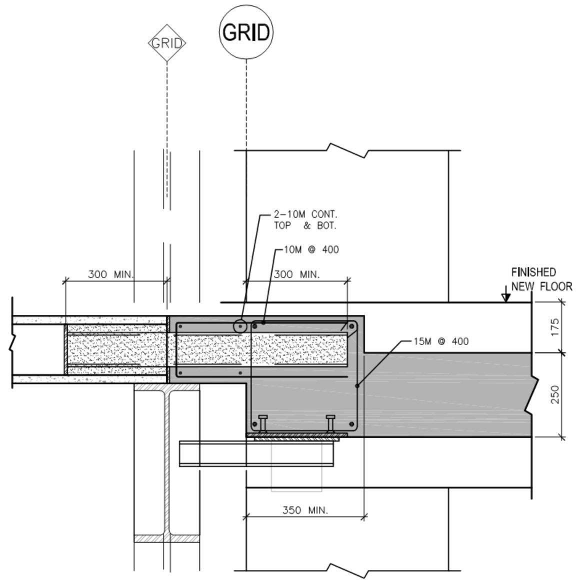
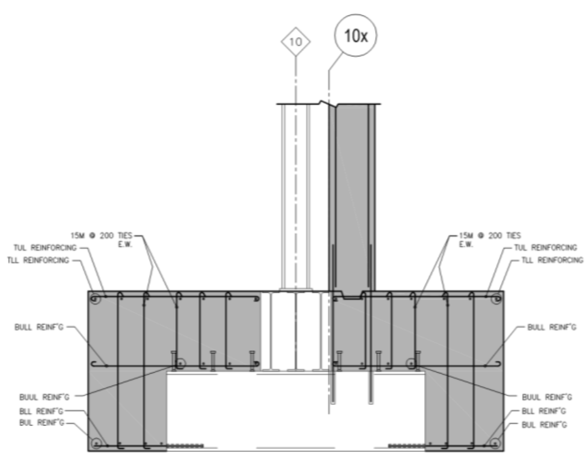


Figure 13: Lateral Seismic Ties

The new reinforced concrete structure within the central zone extended down to existing bedrock at the 2nd basement level. Additional excavation was required at the new elevator cores and protection of the adjacent existing footings was required to ensure bearing stability. At the perimeter of the central zone, the new reinforced concrete columns required reinforced concrete pad footings, with a bearing size exceeding that available without impacting the original footings. For the 1927 structure, the original footings consisted of steel grillage in both orthogonal directions. In order to develop an efficient design and meeting the user requirements, new combined footings were designed to incorporate the existing steel footings.



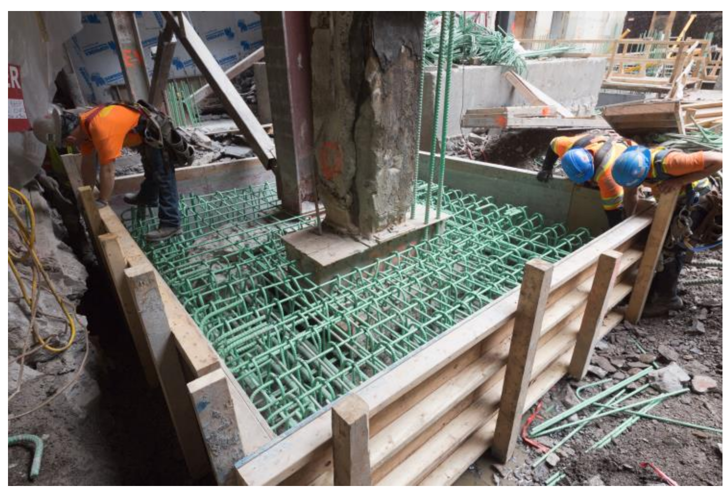


Figure 14: Design of Combined Footing **Figure 15: In-situ construction of Combined Footing**

Within the constraints of developing large column free areas, headroom was also a strong consideration and restriction. Security considerations restricted the future mechanical and electrical services generally to the corridors increasing the congestion and risk of interferences. Creating long span elements with relatively shallow depths to accommodate large concentrations of mechanical and electrical services posed interesting challenges requiring innovative structural solutions. To further increase the complexity of mechanical and electrical coordination, the majority of the mechanical and electrical design was only scheduled to be completed in future phases of the project. Therefore consultant coordination and requirement forecasting was essential to developing a functioning and cost effective structural design.

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2.3 Social and/or Economic Benefits

As part of the Parliamentary Precinct LTVP, this project is at the center of the 25 year rehabilitation and revitalization of Parliament Hill. This project enhances Canadian heritage, conveys Canadian democracy as well as parliamentary functions and operations. The Wellington building has been part of the downtown Ottawa core since the 1920s and this project intends to reflect its historic place within the City of Ottawa.

As a building with an intended use as a federal government building with particular relationships with the Senate and the House of Commons, this project serves the democratic process of Canada and each Canadian citizen is in some way an end-user of this building.

The abatement, demolition and seismic upgrade portion of the Wellington Building project composes 52 million of a 425 million multi-phase project. Beyond the Wellington Building project, the LTVP plans on investing 4 to 5 billion into the downtown core over the 25 year plan. This project and all related are producing many years of work over all facets of the construction industry and public sectors.

The heritage protection and significance of the Wellington Building is a strong foundation upon which the project design and intent was developed. As a basis of not only the structural design, but all project requirements, the heritage considerations were inherent to the successful completion of the project while maintaining the historic and heritage values of the building as part of the Parliamentary Precinct.

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2.4 Environmental Benefits

The project was designed within the Green globes system, creating a building that is based on contemporary sustainable design principles. Where possible, demolished materials were recycled, including structural steel and concrete and recycled resources were used in the production of new structural materials. Although the scope of work included the demolition of the central zone, all structural interventions were intended to minimize the impact on the existing structure and maintain, where possible, the existing elements, structural and otherwise.

Existing interior marble cladding was removed where structural interventions were required with the intent of reinstallation in future phases to reduce the necessity for new stone. Heritage considerations required a flexibility in the structural design to minimize new materials and re-use the existing structure in order to maximize the heritage preservation and in consequence environmental conservancy. The removal of designated substances including asbestos containing materials creates a future safe and healthy working environment for the building occupants and all materials were disposed of through environmentally friendly methods.

The structural design within the new reinforced concrete central core incorporated an allowance for a future cistern to hold grey water for use in the building functions.

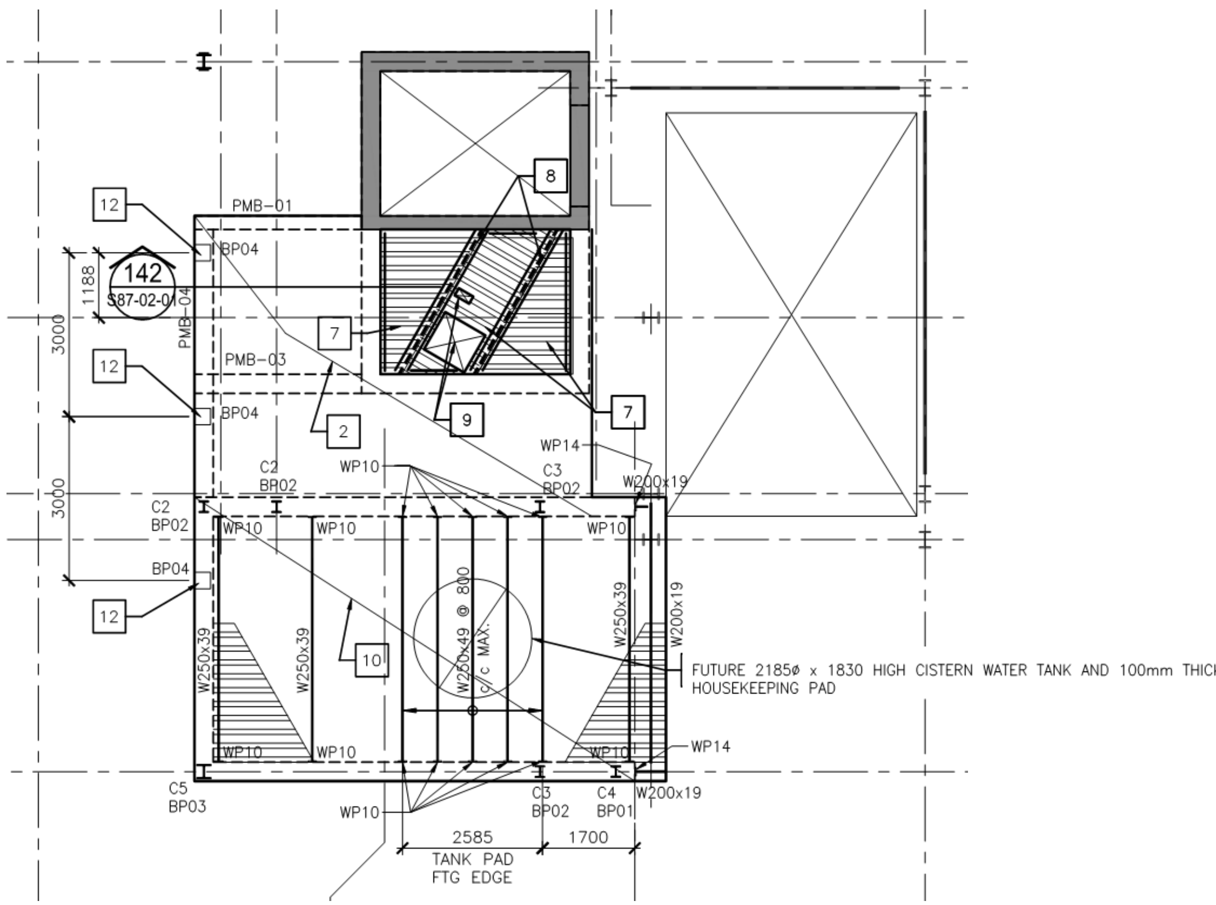

Figure 16: Water Cistern at Penthouse

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2.5 Meeting Client's Needs

The existing building has seen many changes throughout its history, including changes since it came under PWGSC ownership in 1973. In order to fully revitalize the building for its intended use as a swing space for the Senate and House of Commons, the demolition of existing building architectural finishes as well as mechanical and electrical building services was incorporated into the scope of work. The demolition scope was further expanded to include structural removals to suit the central zone of demolition at the center of the building to allow for the new reinforced concrete core to be constructed.

Within the existing building's column grid system and generally low headroom, large column free areas were not possible without significant structural interventions. The large column free areas were intended to develop the multi-purpose committee rooms to be used by the Senate and House of Commons. Various structural options were considered during the schematic design phase including Structural Steel Moment Frames, Structural Steel Brace Frames and Reinforced Concrete Shear Walls. Based on the user requirements and preliminary design analysis, Reinforced Concrete Shear Walls were considered to be the most cost effective solution to meet the client's requirements.

The structural solutions presented and implemented to produce the column free zones, large atrium spaces, protection of heritage elements, while meeting the seismic requirements of the 2005 NBCC provide the end user a functional space meeting their project requirements.

The Abatement, Demolition, Seismic Upgrade phase of the LTVP was completed within schedule and allowed for the transition between the Abatement, Demolition, Seismic Upgrade phase under a lump sum contract with PCL Constructors Canada acting as general contractor to the next phase of the project awarded under a construction management arrangement.

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