BRITISH COLUMBIA POWER COMMISSION BUILDING
780 BLANSHARD STREET – REHABILITATION & ADDITION

SEISMIC UPGRADE & HERITAGE IMPACT ASSESSMENT

780 Blanshard Street, Victoria, BC

Prepared for:
Reliance Properties
111 Water Street, Suite 305
Vancouver, BC V6B 1A7

Prepared by:
RJC Engineers
645 Tyee Road, Suite 220
Victoria BC V9A 6X5

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1.0 INTRODUCTION

Read Jones Christoffersen Ltd (RJC) was engaged by Reliance Properties to provide structural consulting services for the seismic evaluation and heritage assessment of the existing Power Commission Building at 780 Blanshard Street in Victoria. This report discusses the feasibility of rehabilitating the existing building and summarizes the design parameters and proposed seismic upgrade to add density, including the proposed 20-storey concrete tower within the existing historical structure.

1.1 DOCUMENTS REVIEWED

The following drawings were available for review:

- Survey Plans (prepared by Proper Measure, four sheets, dated May 5, 2020).
- Original architectural drawings (18 sheets, date, and author are illegible, although the architect for the building was reportedly Henry Whitaker).
- Structural drawings for the 2016 renovation (set of five sheets, date and author illegible).

The following historical assessment was completed during the coordinated assessment:

- Conservation Plan (completed in May 2022 by Community Design strategies).

1.2 DESCRIPTION OF THE EXISTING STRUCTURE

The existing building is situated in Victoria's Downtown Neighbourhood and was reportedly constructed circa 1949 featuring Art Deco style architecture. The building assisted in shaping BC's power industry through its service for the BC Power Commission as its headquarters and later other provincial ministries. In addition to its historical use, the building's distinctive Art Deco style architectural design led to its registered heritage status with the City of Victoria; however, the building is not designated.

The existing building is four-storeys, with the bottom two storeys partially below grade due to the sloping site. The existing building is entirely constructed from cast-in-place, conventionally-reinforced concrete and is generally repetitive and regular, owing to its Art Deco style. Foundations reportedly bear on rock, although no design bearing value was stated on the existing drawings.

1.3 DESCRIPTION OF THE PROPOSED PROJECT SCHEME

The proposed project aims to develop a 20-storey concrete tower within the existing building while conserving its historical structure and finishing. The proposed project plans to benefit the existing building and community in the following ways:

- The existing structure will be upgraded to meet full seismic and gravity compliance with the National Building Code of Canada (NBCC) 2020, which will be adopted in when the province executes compliance to the British Columbia Building Code (BCBC) 2023 for new and existing primary and secondary structural elements.
- The proposed structure offers more population density in the downtown core area on the site of a historical building.
- The existing structural gravity and the seismic system will be integrated into new construction to form a hybrid system with no seismic gaps that work together as one building.
- New seismic shear walls will be designed to support new and existing elements.
- The proposed development will conserve cultural memories of the existing building and its identity within the community.
- The proposed development will retain the heritage value of the existing building and many primary and secondary character-defining elements, making it appealing to the public.
- The construction approach intends to preserve existing materials, features, and space while limiting temporary exterior bracing that would otherwise be required during construction.
- Repair or replacement of deteriorated existing features will be completed.
- The project intends to offer a mix of commercial and residential use. This includes but is not limited to hotel suites, lounges, kitchens, and shared amenity spaces with the availability of residential one-bedroom, and two-bedroom suites in the tower, as shown in **Figure 2.**

Figure 1 – North East View Architectural Rendering of the Proposed Project

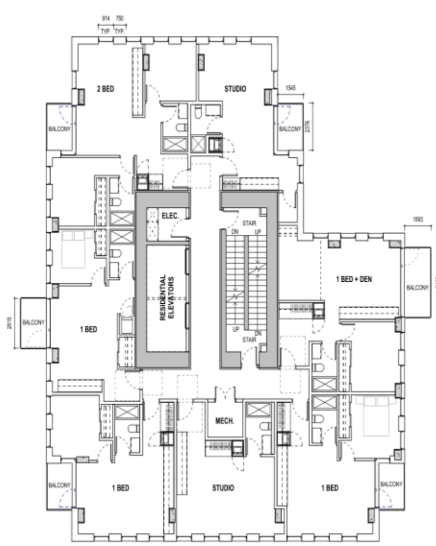

Figure 2 - Preliminary Proposed Tower Layout

1.4 STRUCTURAL TESTING

No structural testing has been performed for this phase of the project. Before advancing the design further, the following structural testing has been recommended to be completed by qualified agencies, with direction from RJC:

- X-ray of the walls to ascertain specific key reinforcing details.
- Compression testing of extracted cores of concrete.
- Tensile testing of extracted reinforcement.
- Insitu concrete testing and sounding.
- Bearing capacity review of the existing footings.

1.5 REGIONAL TECTONIC SETTING AND SEISMICITY

Despite not having experienced a genuinely damaging earthquake in its history, Victoria has one of the highest seismic hazards in Canada – *there is approximately a 25% chance of a destructive quake affecting Victoria in the next 50 years and over 40% chance in the next 100 years*[1].

Southwestern British Columbia is situated near plate boundaries in a complex tectonic setting. The Cascadia subduction zone (CSZ) extends from northern Vancouver Island to northern California; ocean ridges between the Juan de Fuca and Pacific plates push relatively young ocean crust towards the North American plate, where it is forced below the more prominent continental plate. As a result, Vancouver Island is compressed and uplifted, moving in a general Northeast direction. Measurements indicate that Victoria is moving at a rate of about 5mm/yr due to compressive strains. This process is essentially responsible for the entirety of Vancouver Island's seismicity. Transform faults are also present in the North and South of the CSZ in the form of Queen Charlotte and San Andreas, respectively. **Figure 3** illustrates the tectonic setting of the region.

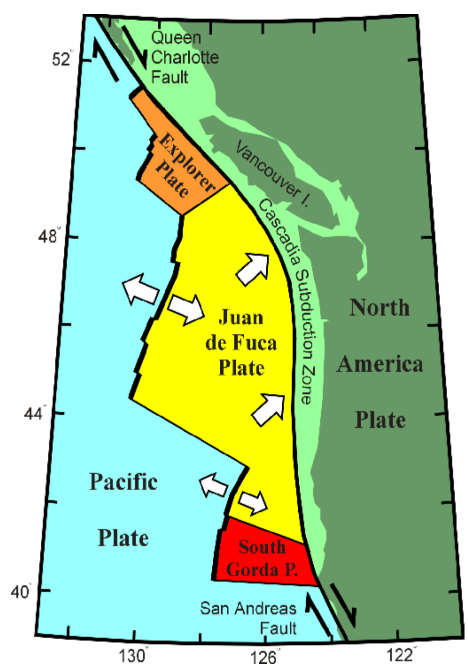

Figure 3 - Tectonic Setting of the Cascadia Subduction Zone

Source: http://commons.bcit.ca/civil/students/earthquakes/unit1_02.htm

[1]Modified from Onur, T.; Seeman, M; Halchuk, S.; Adams, J. (2008). “Probabilities of significant earthquake shaking in communities across Canada.” 14th World Conference on Earthquake Engineering

Earthquakes can be classified into three general types: crustal (shallow), subcrustal (deep), and subduction (interplate). All are discussed below. Due to the aforementioned tectonic setting, Victoria is subject to hazards from all three types. **Figure 4** illustrates the region's seismic history in terms of crustal, subcrustal, and subduction earthquakes.

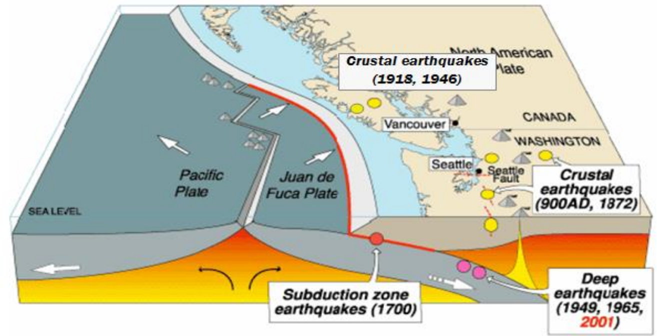

Figure 4 - Recent Seismic History of the Pacific Northwest

Source: http://www.quaketrip.com/wp-content/uploads/2011/01/CascadiaSubductionZone2.jpg

Crustal Earthquakes

Crustal earthquakes are generated as compressive stresses within the crust of the North American plate are relieved on individual faults. They occur at depths up to 10 or 15km in the earth's surface (i.e., the crust). Historical examples of crustal earthquakes in the region include Vancouver Island's 1918 and 1946 earthquakes (see **Figure 4**). The 1946 earthquake, which measured M7.3 and occurred near Courtenay, BC, remains the most damaging earthquake recorded in Western Canada.

Subcrustal (Deep) Earthquakes

Subcrustal earthquakes are not as well understood but are thought to be primarily due to the bending of the Juan de Fuca plate as it is subducted deep below the North American plate. These earthquakes contribute significantly to Victoria's seismic hazard as they occur at a higher rate than crustal earthquakes and yield more considerable ground shaking at a given site for the same distance and magnitude. The last sizeable subcrustal earthquake in Puget Sound was the Nisqually earthquake of 2001, measuring M6.8 and occurring near Olympia, Washington. Other significant events occurred in Puget Sound in 1949 and 1965 (*see* **Figure** 4).

Subduction Earthquakes

Subduction earthquakes are generated at the locked plate interface, with one being pushed (subducted) under the other. Because they occur at the interface, their depth is shallow, and because the locked areas are significant, a tremendous amount of energy can be released: it is why subduction zones can produce the largest earthquakes. The Cascadia Subduction Zone is thought to be capable of producing ~M9 events; the last such "megaquake" occurred in 1700 (see **Figure 4**). Based on paleoseismic evidence, their mean recurrence interval is about 400 to 500 years.

1.6 SITE SEISMIC HAZARD

Seismic forces have increased in recent editions of the BC Building code and are thus far higher than seismic design loads for the existing building constructed in 1949. This is partly due to new observations and data on the recurrence rate of subduction events in the CSZ. The building code currently in effect is the 2018 BC Building Code (BCBC 2018), and is based on the 2015 National Building Code of Canada (NBCC 2015). A significant further increase will occur in the next edition of the BCBC set to come in effect at the end of 2023 (which will be based on the prescribed seismic loads from NBCC 2020). **Figure 5** shows the design spectra for NBCC 2010, 2015, and 2020 for Site Class A. Percentage of weight is the amount of building mass accelerated during the quake due to the hazard provided by the different codes. The greater the weight percentage, the higher the seismic force the structure must be designed to resist. As illustrated, seismic design requirements have and are increasing significantly.

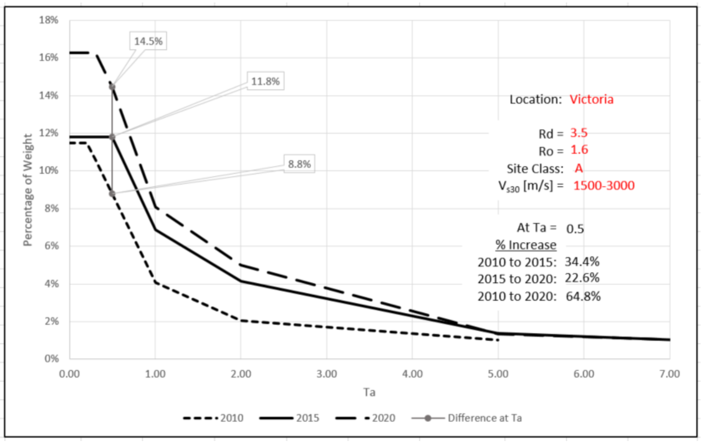

Figure 5 – Design Spectra (NBCC 2010, 2015, & 2020)

Figure 6 shows a seismic hazard curve for Victoria. We note that this hazard curve is not directly applicable to the subject building but is provided to illustrate the nonlinear relationship between "%code" and probability of exceedance (i.e., risk)

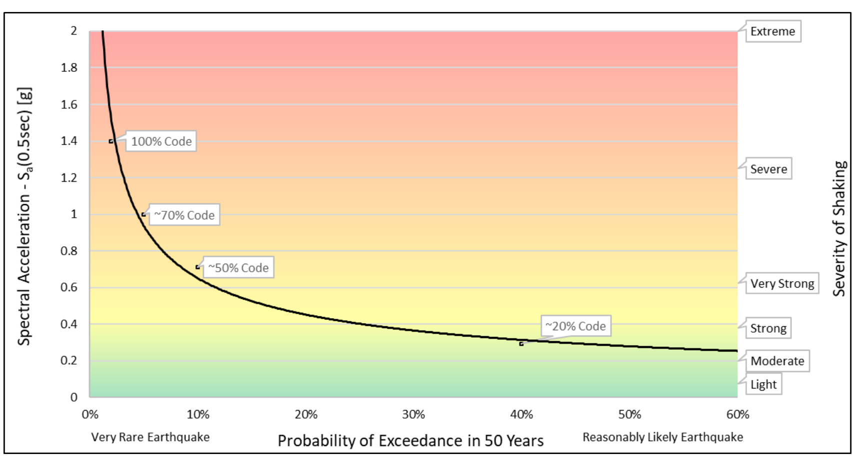

Figure 6 - Example Hazard Curve

1.7 BUILDING PERFORMANCE OBJECTIVES

Defining Performance Levels

When planning and designing seismic retrofits, all parties need to understand the desired building performance. The most commonly used building performance levels are noted below and shown in **Figure 7.**

- **Operational:** Backup utility services' main functions. Very little damage.
- **Immediate Occupancy**: The building remains safe to occupy though some minor repairs are needed.
- **Life Safety**: The structure remains stable and has significant reserve capacity. Significant repairs are likely required before the building can be re-occupied. Demolition may be more economical than repair.
- **Collapse Prevention**: The building barely remains standing. Occupants may be endangered. Demolition is virtually certain.

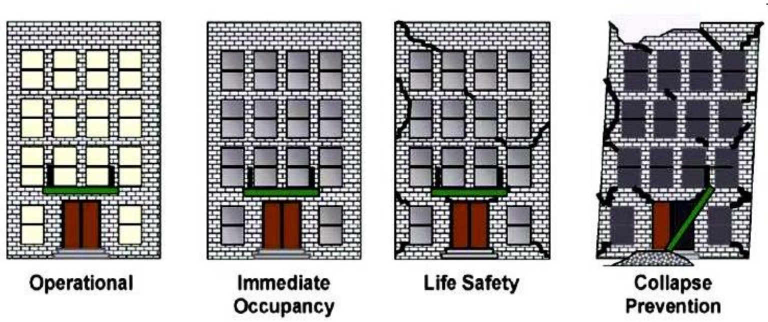

Figure 7 - Building Performance Levels Per ASCE 41

Typical building codes aim to achieve "Life Safety" performance for most buildings except hospitals, fire stations, or other high-importance buildings. This magnitude of damage occurs during a "very rare" earthquake, as portrayed by the point for "100% Code" in Figure 6. Performance under more frequent (less severe) earthquakes is typically not explicitly considered.

It is noted that seismic upgrades are not typically designed to achieve 100% code compliance. The primary reasons for accepting less than full code compliance are as follows:

1. Seismic design forces often increase as new scientific observations are made. Even relatively new buildings typically fall short of full code compliance.

2. In the case of a building owner with a portfolio of buildings, the most effective solution is typically to upgrade all inadequate facilities to a reasonable extent rather than render one building fully compliant.
3. The incremental cost of increasing design shaking intensity rises exponentially while the benefit decays exponentially as shown in **Figure 8.** This effect, in theory, should lead to a lower optimum level for design.

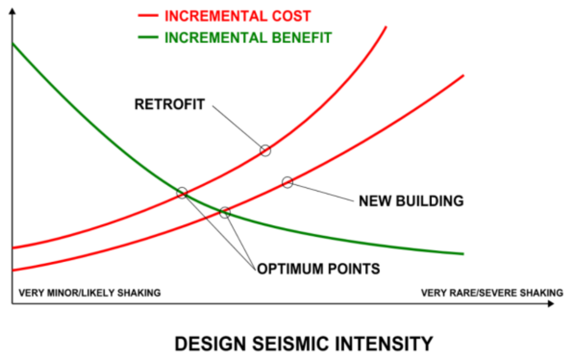

Figure 8 - Incremental Costs and Benefit of Seismic

4. Preservation of the historic fabric is a competing objective.

Example Performance Objectives Selected by Others

Designing seismic retrofits to somewhere between 33% and 75% of "full code" design requirements is common. The following are examples of building performance objectives:

- In BC, when a retrofit is required (for example, due to a planned renovation or change of use) by a building authority, the design typically achieves approximately 75% of the current code, with an implied performance level of "life safety," assuming it is a normal-importance building.
- The ongoing seismic risk mitigation program for BC public schools aims to achieve "Collapse Prevention" performance under shaking with a 2% probably of exceedance in 50 years.
- New Zealand legislation required deficient buildings to be retrofitted to meet at least 33% of their code.
- The American performance-based design standard ASCE 41 advocates for performance objectives as follows for retrofits of normal importance buildings:
    - "Life-safety" for shaking with a probability of exceedance of 20% in 50 years
    - "Collapse prevention" for shaking with a probability of exceedance of 5% in 50 years.

Performance Objective and Seismic Hazard Level Used in This Study

In this study, we have used a performance objective of "life safety" as described previously, to analyze the existing building. The upgraded design is for 100% of the soon to be adopted NBCC 2020.

2.0 ASSESSMENT OF THE EXISTING STRUCTURE AND PROPOSED UPGRADES FOR THE FUTURE DEVELOPMENT SCHEME

2.1 ANALYSIS METHODOLOGY

Structural analysis of the existing building was completed per ASCE 41-17 using the Linear Dynamic Procedure and Nonlinear Static Procedure. The existing structure and proposed development were modeled using ETABS 2018. Elements of both the primary lateral system and the gravity system were included. Diaphragms were modeled as semi-rigid. Seismic masses and element dead loads were computed from the self-weight of the materials, as well as appropriate design loads such as partitions, snow, and designated storage.

2.2 ASSESSMENT OF EXISTING SEISMIC CAPACITY

As shown in **Figure 9** below, an assessment of the existing structure was modeled using ETABS 2018 by RJC and analyzed for seismic capacity using the current code. It was found that the existing structure can resist approximately 40% of BCBC 2018 design demands, assuming site class A conditions, and that value is reduced to 30% when compared to the upcoming 2020 NBCC seismic design demand. Although this figure is significantly better than expected for a structure of this age, it is still sufficiently deficient. The building is much more deficient in the transverse (north-south) than the longitudinal direction. Substantial renovations would trigger comprehensive seismic upgrading of the existing structure.

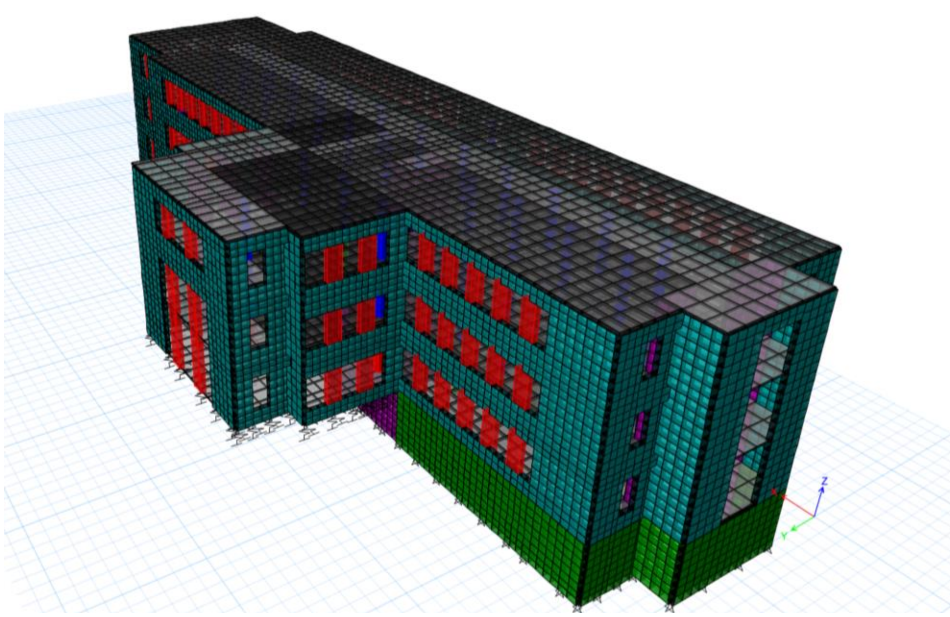

Figure 9 - 3D View of the Existing Building that was Seismically Analyzed using ETABS 2018

2.3 PROJECT OPTIONS CONSIDERED

A "traditional" seismic retrofit approach was considered. This option involves increasing the strength and stiffness of the structure primarily by adding new structural elements, as portrayed in **Figure 10.**

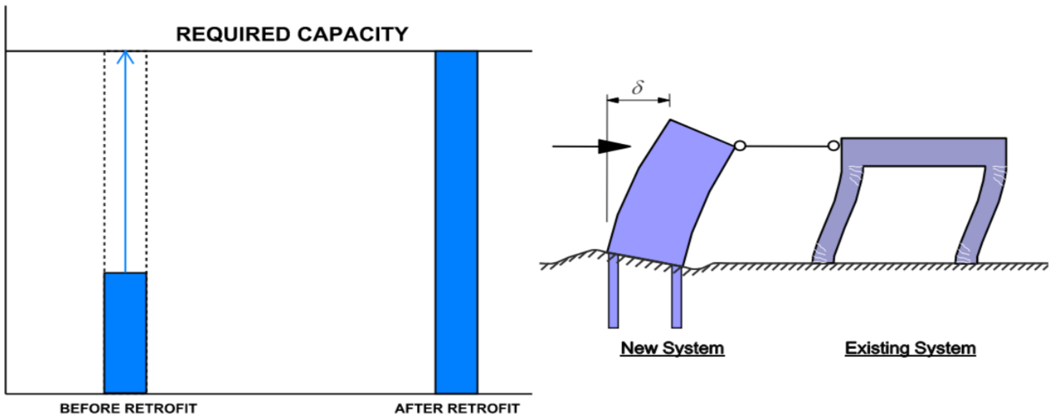

Figure 10 - Traditional Seismic Upgrade Strategy

A key consideration in the design was that the outside appearance of the building should not be impacted, and significant new structural members on the interior should be located away from prominent locations as much as possible. Concrete shear wall cores were incorporated into the model to provide the new seismic systems. Steel braces were also considered but were found not to offer sufficient stiffness.

As these concepts were developed, other ideas were considered to add density to the site and retain the existing building. Two options were analyzed by the team, as shown in **Figure 11.** We found that the project could increase density in Victoria's Downtown by increasing the height of the project. Both options were modeled using ETABS 2018 to asses how a structure would perform together with existing and new elements of a lateral seismic system based on adding additional floors. As noted above, elements of the primary lateral and gravity systems were included.

Figure 11 - 3D View of Alternate Options Considered

2.4 THE BAR OPTION

The BAR option would require extensive upgrades as the new construction would affect nearly all of the existing building components. The roof slab, all columns, foundations, and exterior walls would require upgrades. Seismic considerations have led to a distributed system of cast-in-place concrete shearwalls as the most plausible solution, as it would be most compatible with the existing structural components and exterior concrete walls. Concrete shearwalls provide adequate stiffness and are easier to connect to the existing structure than other solutions, such as a steel bracing system. Steel bracing systems also tend to be more flexible in stiffness and are, therefore, less desirable to preserve historical building elements during a seismic event. **Figure 12** shows a preliminary outline in blue of the approximate magnitude and distribution of seismic shearwall elements required for the BAR option. Additionally, new columns would be required over the entire footprint of the building to support the large new floor plates above and would trigger the removal of the majority of the existing interior floors. The construction sequence will likely result in an exterior bracing system while interior demolition is underway. Exterior bracing would be similar to that used during the renovation of the Custom House in Victoria, BC, as shown in **Figure 13.**

Figure 12 - Preliminary Shearwall Layout for the BAR Option

Figure 13 - Example Temporary Bracing Possibly Required During Construction Sequences for the BAR

2.5 THE TOWER OPTION

The TOWER option is a traditional high-rise form and was considered with a central circulation and seismic core supporting flat plate concrete floor slabs with small columns. Gravity upgrades would be less extensive than in the BAR option because upgrades would be focused on the central core area. A large portion of the existing structure could be salvaged, significantly reducing the bracing and the timeline required during construction.

Figure 14 and **Figure 15** show a preliminary outline of the approximate magnitude and distribution of seismic elements necessary for the lower and upper floors, respectively, for the TOWER option.

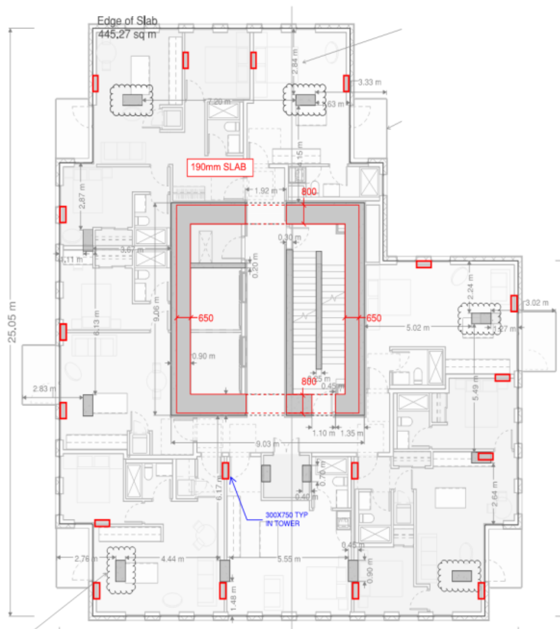

Figure 14 - Preliminary Shearwall Layout for the Upper Floors of the TOWER Option

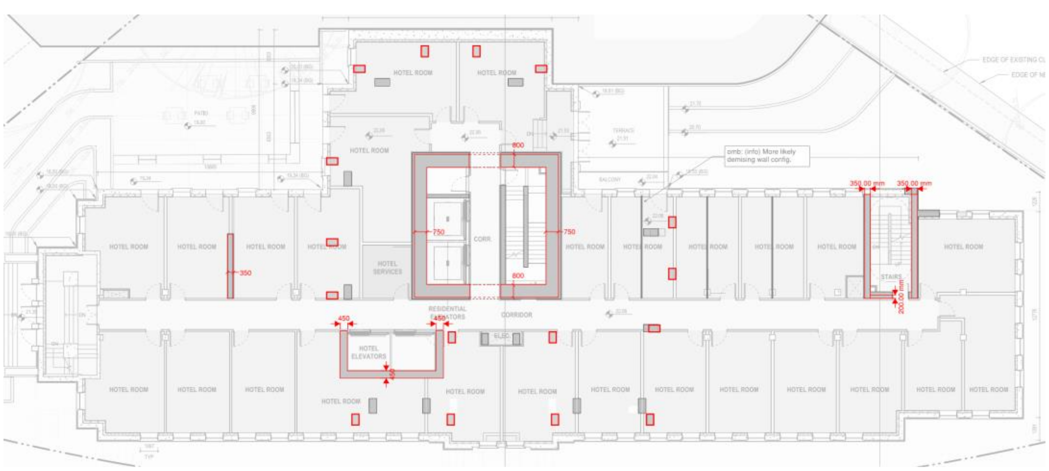

Figure 15 - Preliminary Shearwall Layout for the Lower Floors of the TOWER Option

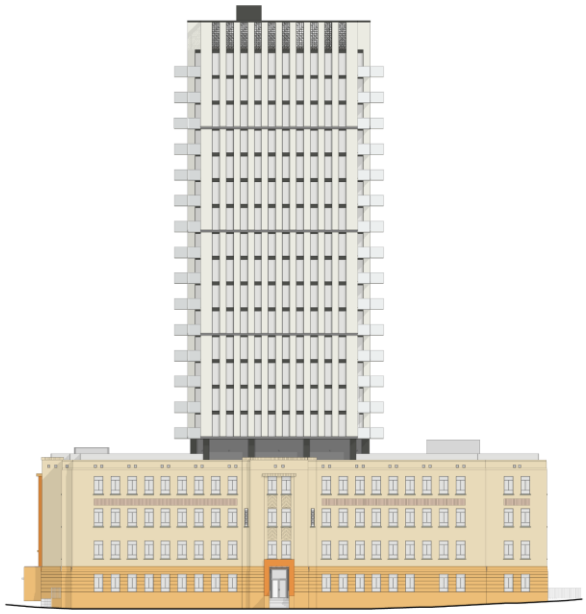

Figure 16 – Architectural Elevation of the Tower Option

2.6 THE PROPOSED BUILDING SCHEME AND SEISMIC BENEFIT

It was found that a 20-storey TOWER configuration or similar height provides the most density for Downtown Victoria and the most seismic benefit for retrofitting the existing building. Historical buildings generally benefit from stiffness in their lateral system to limit deflections and preserve their heritage. This system's proposed concrete shearwall core design will provide the most stiffness to the existing structure. Increased stiffness will significantly limit deflections of the heritage building during a seismic event and will help preserve the historical value of the building. The TOWER configuration offers the benefit of keeping and maintaining all exterior elements. It reduces the need for the addition of external seismic elements and bracing. The TOWER option also eliminates the need for seismic separation between new and existing structures. The completed building will be designed to act together and exceeds a life safety designation.

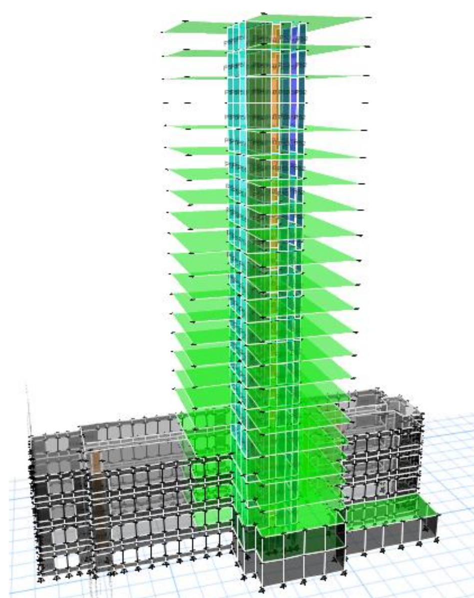

Figure 17 - 3D View of the Proposed TOWER Option that was Seismically Analyzed using ETABS 2018

2.7 RETENTION BENEFIT OF EXISTING COMPONENTS

The proposed TOWER scheme is intended to maintain all exterior facades and preserve most interior features and gravity systems. Our society benefits from limiting the disposal of materials in a landfill. The TOWER option provides the most retention of building components as a large part of the gravity system, and floor slabs will be preserved and retained.

Figure 18 - West View Architectural Rendering of the Proposed Project

2.8 EXISTING DIAPHRAGM CAPACITY

The existing building contains a concrete diaphragm that will be utilized for future gravity and seismic loads for 100% of the BCBC and upgraded if and where required. The existing slab diaphragms will continue to support the heritage façade laterally, thus assisting with construction time and eliminating a significant amount of external temporary steel bracing.

2.9 HERITAGE WALL RETENTION

By retaining the existing concrete diaphragms in place, we can maintain the look and feel of the heritage building during the construction phase and beyond. The existing external walls that form the current lateral system will remain unchanged and will not require additional stabilization components as the existing diaphragms tie existing walls together and provide building stability during construction. Repairing damage caused by temporary bracing will be minimal during construction as exterior bracing will not be required to attach to the existing façade. This approach provides benefits to the efficiency of construction as well as to the public in passing. RJC has utilized this approach on projects such as, the original Hudson Bay Building Redevelopment, the Time Colonist Building Alteration, and The Post Revitalization in Vancouver.

2.10 PARAPETS AND FALLING HAZARDS

Existing parapets and other exterior features are falling hazards during a seismic event. Existing parapets and all other feasible falling hazards on the historical building will be upgraded and restrained to 100% of BCBC prescribed requirements.

2.11 CURRENT DEVELOPMENT SCHEME

The proposed construction sequence is intended to stage the removal of a portion of the existing slab that is central to the existing structure. Removal will preserve the exterior façade and provide access to construct the central core, upgraded foundation, and columns that will support the tower. **Figure 19** shows in the red hatched area where the existing slab is proposed to be cut to allow for the addition of the 20-storey tower. The exterior wings will remain completely intact while the interior core of the existing building is integrated with the existing slabs. Amenity space on the roof of the existing building will be upgraded from the top and built up to retain the existing roof slab. There will be no seismic gaps required. Additional shear elements are incorporated into the existing building at the elevator, stairs, and demising walls. These elements will be constructed between existing slabs and located as indicated in **Figure 19.**

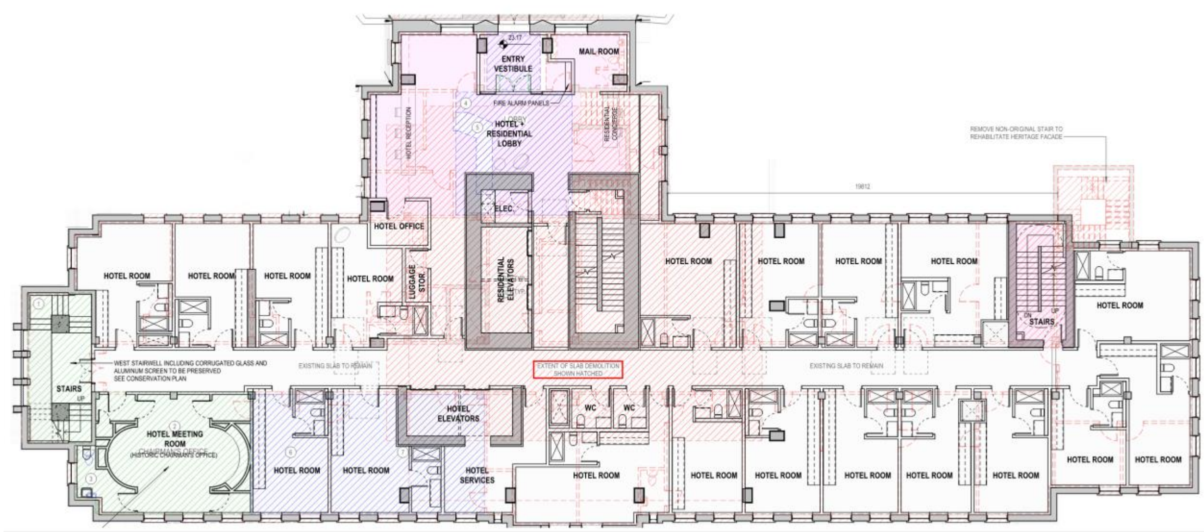

Figure 19 - Proposed Outline for Integration of New and Existing Slabs

3.0 SUMMARY

RJC has completed a seismic assessment of the existing building at 780 Blanshard street and determined the seismic capacity of the building is 40% of the current BCBC. The proposed redevelopment of a 20-storey tower will incorporate a retrofit of the existing structure to achieve life-safety performance to 100% of the next iteration of the BCBC (or NBCC 2020). The upgrade will include seismic and gravity enhancement to meet 100% of the code. The proposed project incorporates retaining a significant amount of the existing interior structure and all of the exterior heritage elements. The proposed structural rehabilitation concept for the redevelopment plan will extend the life of the existing BC Power Commission Building well beyond its initial life span.

4.0 CLOSURE

This schematic design report has been prepared for Reliance Properties to summarize the completed structural parameters and design for the proposed development of the site.

We trust this information meets your current requirements. Please do not hesitate to contact the undersigned if you have any questions, comments, or concerns.

Yours truly,

Read Jones Christoffersen Ltd.
EGBC PERMIT TO PRACTICE NO. 1002503

2023.03.02 17:26:59-08'00'
Clint Plett, P.Eng., CEng, MIStructE
Associate

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Encl.