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Seismic Upgrade of the Canadian Parliament Building: Part 6-Peace Tower Strengthening

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ABSTRACT

At 90 m tall, the Peace Tower is a dominant feature of Centre Block, Canada's Parliament building. Completed in 1925, its primary structural elements are its four corner piers and the walls/spandrel beams that connect them intermittently over its height. The piers and walls are constructed of unreinforced concrete with an exterior wythe of sandstone masonry. Due to its height and historic method of construction, the Peace Tower is seismically vulnerable. This paper provides an overview of the Peace Tower's current seismic performance level, key structural deficiencies, and the conceptual details for its seismic strengthening.

Keywords: seismic upgrade, seismic isolation, heritage tower.

INTRODUCTION

The Peace Tower is the dominant feature of Canada's heritage designated Parliament building and a widely recognized symbol of Canada. Figure 1 shows the Peace Tower and adjoining Centre Block. The Peace Tower is 90 m tall and 12 m wide. The Peace Tower was constructed following the completion of the main Centre Block building in the 1920s, after fire destroyed the original Centre Block in 1916. The main ceremonial entrance to Centre Block is through the Peace Tower's porte-cochere. The Peace Tower has special cultural significance as it houses the Memorial Chamber to Canadians who have given their lives in service to the country (see Figure 2). In addition, it houses a 53-bell carillon and a publicly accessible observation deck, located just below its clock faces. It is one of the most visited tourist sites in Canada. Centre Block and the Peace Tower are currently undergoing a major rehabilitation. Part of the rehabilitation includes a seismic upgrade. The following sections provide a brief overview of the existing structure, historic alterations, key seismic deficiencies, and conceptual details for its seismic strengthening.

Figure 1. South facade of Centre Block, Canadian Parliament, Ottawa.

Figure 2. Memorial Chamber, Peace Tower.

EXISTING STRUCTURE AND HISTORIC ALTERATIONS

The Peace Tower's primary structural elements are its corner piers and the spandrels that connect them intermittently over its height. Figure 3 shows an elevation of the Peace Tower with its primary structural elements identified. A mixture of structural systems was used in its construction. The piers of the Peace Tower were constructed with unreinforced concrete and an exterior wythe of sandstone masonry. The spandrels vary in composition but are typically composed of unreinforced concrete with stone wythes, reinforced concrete, structural steel beams embedded in concrete, or a combination of these materials. The spire/roof is a cast-in-place reinforced concrete shell structure. The Peace Tower resists seismic loads via frame action of its corner piers and spandrels.

In 1981 a new elevator was installed to allow uninterrupted travel from the memorial chamber level to the clock level observation deck. The elevator is quite unique, as its initial travel path is inclined, moving 3.7 m laterally in the southward direction over the first 30 m of height. Implementation of this elevator required removal of a spandrel beam on the north face of the tower ('Spandrel 2' in Figure 3).

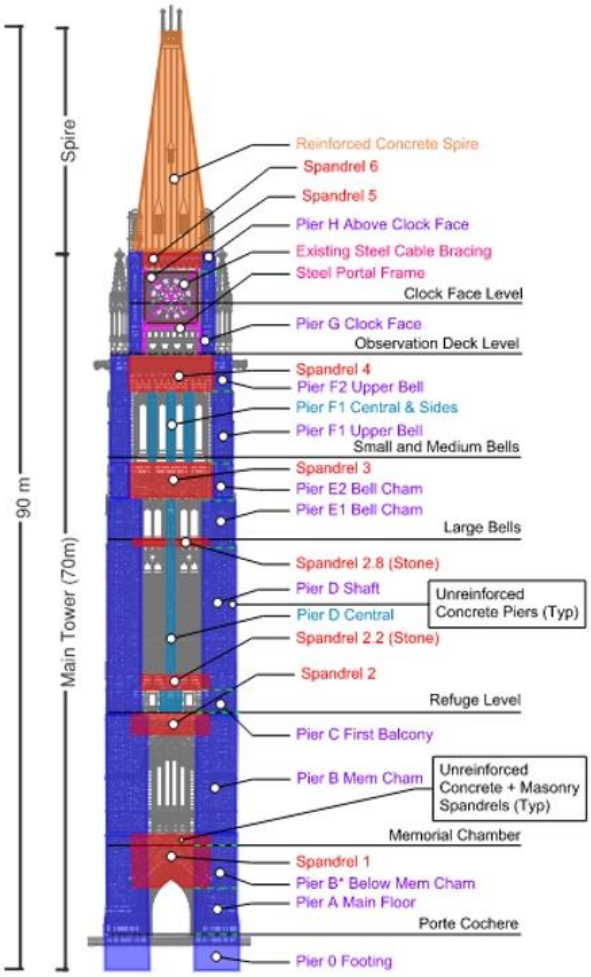

Figure 3. Primary structural elements of the Peace Tower.

CURRENT SEISMIC PERFORMANCE LEVEL

The Peace Tower's current seismic performance is limited by the capacity of its pier/spandrel moment frame to resist bending. The existing beams are pocketed into the piers, and their bending capacity and connection fixity to the piers are weak links in the lateral force resisting system. Additionally, the existing pier bending capacity is limited by both axial load eccentricity limits as well as the cracking stress limit for unreinforced concrete. The existing capacity of the Peace tower is significantly deficient compared to the 2020 NBCC seismic hazard.

PROPOSED SEISMIC UPGRADES

The main building seismic upgrade includes the implementation of seismic isolation system. The Peace Tower will also be seismically isolated and connected to the same isolation system through a suspended transfer slab at Level 1. The slab will also be used to transfer the weight of the Peace Tower on to its seismic isolation bearings. However, additional strengthening is also required for the Peace Tower to withstand 2020 NBCC seismic loads. This includes drilling and post tensioning the existing piers and spandrels to increase their bending capacity. For the piers, this requires core drilling 50 m deep holes (beginning at approximately the clock level) and grouting in post-tensioned rods. Similarly, the spandrels will be drilled horizontally and post-tensioned to increase their bending capacity and connection to the piers. Additionally, steel bracing will be added on all four elevations above the memorial chamber up to the underside of bell chambers, and again at the observation deck and clock face up to the underside of the spire.

At the north side of the Peace Tower, a three-story structure connects the Peace Tower to the main Centre Block building. The proposed upgrade also includes separating the Peace Tower from Centre Block by creating a movement joint such that the two structures act independently above the transfer slab.

PROJECT STATUS

The Centre Block rehabilitation is currently in the design development phase, with some early structural work already under construction, including the construction of the Peace Tower suspended transfer slab and supporting footings surrounding the piers.

SUMMARY

Due to its height and method of construction, the Peace Tower is seismically vulnerable. Design of its seismic upgrade is well underway. Seismic isolation, in combination with more conventional strengthening methods will be used to enhance the seismic resistance of the most iconic heritage building in Canada.

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